SOAH DOCKET NO. 582-07-2673
TCEQ DOCKET NO. 2007-0204-WDW

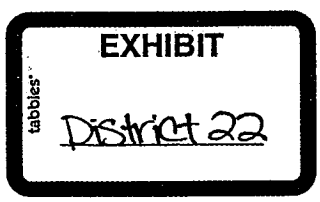
APPLICATIONS OF TEXCOM GULF DISPOSAL, L.L.C. FOR TEXAS COMMISSION ON ENVIRONMENTAL QUALITY COMMISSION UNDERGROUND INJECTION CONTROL PERMIT NOS. WDW410, WDW411, WDW412, AND WDW413	§ § § § § § §	BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS

SOAH DOCKET NO. 582-07-2674
TCEQ DOCKET NO. 2007-0362-IHW

APPLICATION OF TEXCOM GULF DISPOSAL, L.L.C. FOR TEXAS COMMISSION ON ENVIRONMENTAL QUALITY COMMISSION INDUSTRIAL SOLID WASTE PERMIT NO. 87758	§ § § § §	BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS

DIRECT EXAMINATION OF PHILIP R. GRANT, P.G.
BY LONE STAR GROUNDWATER CONSERVATION DISTRICT

SUBMITTED ON FEBRUARY 26, 2010



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District Exhibit 23	PRESS2 Program Results
District Exhibit 24	Model of Parameters ordered by TCEQ Commissioners December 12, 2008 Interim Order
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District Exhibit 26	Email Correspondence with EPA

I. INTRODUCTION AND BACKGROUND

Q. MR. GRANT, WOULD YOU PLEASE IDENTIFY YOURSELF, YOUR OCCUPATION, AND YOUR PLACE OF BUSINESS?

A. My name is Philip Robert Grant. I am a licensed professional geoscientist in the state of Texas, and I am licensed as a geologist in the states of Kentucky and Washington. I am a Senior Geologist for Terra Dynamics, Incorporated, located here in Austin.

Q. IS TERRA DYNAMICS STILL LOCATED ON SPICEWOOD SPRINGS ROAD?

A. No. In January 2009 Terra Dynamics, Inc. changed locations. Our address is now 4616 West Howard Lane, Suite 9-980, here in Austin. The ZIP Code is 78728.

Q. CAN YOU PLEASE REMIND THE JUDGES OF THE TYPES OF SERVICES THAT YOU AND TERRA DYNAMICS TRADITIONALLY PROVIDE TO YOUR CLIENTS?

A. Terra Dynamics, Incorporated, is an employee-owned engineering consulting company. Most all of our senior staff members, including myself, have been at TDI since its creation in 1992—giving us many years of combined experience in providing technical assistance to various clients regarding all aspects of Class I injection well siting, permitting, construction and remediation processes, as well as engineering and geologic services for oil and gas exploration and development.

Q. IN YOUR PREVIOUS DIRECT EXAMINATION SUBMITTED ON NOVEMBER 13, 2007—WHAT WAS ADMITTED INTO THE RECORD AS DISTRICT EXHIBIT 8—YOU DESCRIBED THE DEPTH OF YOUR EXPERIENCE IN MATTERS INVOLVING CLASS I UNDERGROUND INJECTION CONTROL, PARTICULARLY WITH PROJECTS LOCATED IN TEXAS. CAN YOU DESCRIBE HOW MANY, IF ANY AT ALL, ADDITIONAL CLASS I UNDERGROUND INJECTION CONTROL WELLS YOU HAVE BEEN ENGAGED TO ASSIST WITH PERMITTING SINCE YOUR TESTIMONY IN 2007?

A. Approximately 8 – 10.

II. TCEQ COMMISSIONERS' INTERIM ORDER OF DECEMBER 12, 2008

Q. MR. GRANT, HAVE YOU REVIEWED THE DECEMBER 12, 2008 INTERIM ORDER OF THE TCEQ COMMISSIONERS REMANDING THIS CONTESTED CASE BACK TO THE STATE OFFICE OF ADMINISTRATIVE HEARINGS?

A. I am familiar with it, yes.

Q. YOU ARE AWARE, THEN, THAT THE ORDER REQUIRED TEXCOM TO CONDUCT AN ANALYSIS OF LOWER COCKFIELD PRESSURING USING A PERMEABILITY OF 80.9 Md AND AN ASSUMPTION THAT THE EW-4400-S FAULT IS LATERALLY SEALING?

A. Yes.

Q. IN WHAT WAS ADMITTED IN THIS CASE AS DISTRICT EXHIBIT 13, YOU MODELED ANTICIPATED PRESSURING OF THE LOWER COCKFIELD USING THE SAME ASSUMPTIONS THAT THE COMMISSIONERS ULTIMATELY ORDERED TEXCOM TO USE. CAN YOU REMIND THE JUDGES WHAT THAT MODEL TELLS US?

A. District Exhibit 13 is a printout of the reservoir pressure modeling of WDW315 that I conducted using the PRESS2 modeling software that is used by the TCEQ technical review staff and very commonly used in the underground injection control industry for assessments of this type. In this model, I used all of the input parameters that TexCom used in its original 2005 pressure modeling, with the exception of two inputs. I used what I believed was the most reasonable and appropriate formation permeability assumption given our understanding of the Lower Cockfield at WDW315 at the time—81 mD instead of the 500 mD average permeability TexCom claimed was likely to exist there. In addition to permeability, I recognized the probable sealing nature of the EW-4400-S fault and modeled it as a pressure barrier.

Under these assumptions, the model output shows a cone of influencing pressures extending out to a minimum distance of 14,300 feet—or 2.7 milies—to the north from WDW315.

Q. DOES DISTRICT EXHIBIT 13 SHOW HOW FAR THE CONE OF INFLUENCE EXTENDS FROM WDW315 IN DIRECTIONS OTHER THAN NORTH?

A. That information can easily be plotted using the PRESS2 model by adding additional observation well locations. In District Exhibit 13, I did not list specific locations other than those to the north of WDW315. However, I have run the exact same model again using data points in directions from WDW315 other than just those to the north of the well to illustrate how the pressure increase is expected to extend in other directions.

Q. I AM HANDING YOU WHAT HAS BEEN MARKED AS DISTRICT EXHIBIT 23. CAN YOU IDENTIFY THIS DOCUMENT?

A. This is a printout of the reservoir pressure modeling of WDW315 that I obtained using the PRESS2 modeling software with the same inputs that I used in District Exhibit 13.

Q. IS PRESS2 AN ACCEPTED PROGRAM WITHIN THE UNDERGROUND INJECTION CONTROL INDUSTRY FOR DEVELOPING FORMATION PRESSURE MODELS OF THE TYPE REFLECTED IN DISTRICT EXHIBIT 23?

A. Yes it is.

Q. IS PRESS2 KNOWN WITHIN THE UNDERGROUND INJECTION CONTROL INDUSTRY FOR PRODUCING RELIABLE OUTPUTS OF THE TYPE REFLECTED IN DISTRICT EXHIBIT 23?

A. It is, yes.

Q. CAN YOU DESCRIBE YOUR LEVEL OF EXPERIENCE IN USING PRESS2 FOR DEVELOPING PRESSURE MODELS OF THE TYPE OF REFLECTED IN DISTRICT EXHIBIT 23?

A. I use the PRESS2 model to calculate pressure increases around an injection well for most of the TCEQ Class I injection well permit applications that I prepare. This model was developed by TCEQ UIC technical staff to evaluate submitted Class I injection well applications.

Q. IS DISTRICT EXHIBIT 23 A FAIR AND ACCURATE DEPICTION OF THE PRESSURE MODELING YOU CONDUCTED ON THE INJECTION RESERVOIR THAT IS THE SUBJECT OF THE TEXCOM UIC APPLICATION, BASED ON THE PARAMETERS THAT YOU HAVE PREVIOUSLY DESCRIBED?

A: It is, yes.

Q: WOULD IT ASSIST YOU IN YOUR TESTIMONY, OR HELP THE ADMINISTRATIVE LAW JUDGES UNDERSTAND YOUR TESTIMONY, IF YOU HAD THIS EXHIBIT AVAILABLE FOR YOUR USE?

A. I believe it would, yes.

THE DISTRICT OFFERS DISTRICT EXHIBIT 23 FOR ADMISSION INTO THE RECORD.

Q. IS DISTRICT EXHIBIT 23 THE MODEL YOU TESTIFIED TO EARLIER THAT REFLECTS THE SAME MODEL SHOWN IN DISTRICT EXHIBIT 13 WITH DATA POINTS OTHER THAN THOSE JUST NORTH OF WDW315?

A. It is, yes.

Q. CAN YOU SUMMARIZE WHAT THE DISTRICT EXHIBIT 23 INDICATES REGARDING PRESSURING FROM WDW315 IN DIRECTIONS OTHER THAN JUST TO THE NORTH OF THE WELL?

A. Yes, I can. Directly to the east of the TexCom well, the cone of influence (a pressure increase of 421 psi) extends out a distance of 3.2 miles, or 17,130 feet. To the southeast,

along the fault, the cone of influence extends out a distance of 3.4 miles, or 18,140 feet.

Q. DO YOU HAVE AN OPINION ABOUT WHAT THE CONE OF INFLUENCE IS USING THE MODELING PARAMETERS REQUIRED BY THE COMMISSIONERS' DECEMBER 12, 2008 INTERIM ORDER?

A. Yes. My opinion is that the cone of influence extends a minimum distance of 14,300 feet (2.7 miles) to the north of the WDW315 well, 17,130 feet (3.2 miles) to the east and west of WDW315, and 18,140 feet (3.4 miles) to the southeast and southwest along the EW-4400-S fault.

Q WHY DOES THE MODELED CONE OF INFLUENCING PRESSURES EXTEND FURTHER FROM WDW315 IN SOME DIRECTIONS THAN IT DOES IN OTHERS?

A. The presence of the non-transmissive fault located 4,400 feet south of the TexCom well serves as a pressure boundary which distorts the shape of the cone of influence by expanding it laterally along the fault to compensate for the lack of pressure "relief" any farther south than the fault. In contrast, the cone of influence extends the minimal 2.7 miles to the north due to the lack of a pressure boundary in that direction.

Q. HAVE YOU REVIEWED THE CONE OF INFLUENCE DESCRIBED BY TEXCOM IN TEXCOM EXHIBIT NOS. 84 AND 85?

A. Yes I have.

Q. WHAT WAS THE EXTENT OF THE CONE OF INFLUENCE THAT TEXCOM DESCRIBED IN THOSE EXHIBITS?

A. Purportedly using the modeling parameters required by the Commissioner's December 12, 2008 Interim Order, TexCom described a cone of influence that extended only to 12,000 feet (2.3 miles) to the north of WDW315, and 15,500 feet (2.94 miles) to the east and west of WDW315 along the EW-4400-S fault.

1 **Q. I AM HANDING YOU WHAT HAS BEEN MARKED AS DISTRICT EXHIBIT**
2 **24. CAN YOU IDENTIFY THIS DOCUMENT?**

3 A. Yes this is a map, or planar view, that I developed to illustrate the pressure increases that
4 are demonstrated in District Exhibit 23, as juxtaposed against the cone of influence
5 TexCom presents in its exhibit numbers 84 and 85.

6 **Q. IS DISTRICT EXHIBIT 24 A FAIR AND ACCURATE DEPICTION OF THE**
7 **PRESSURE INCREASES THAT ARE DEMONSTRATED IN DISTRICT**
8 **EXHIBIT 23 AS JUXTAPOSED AGAINST THE CONE OF INFLUENCE**
9 **TEXCOM PRESENTS IN ITS EXHIBIT NUMBERS 84 AND 85?**

10 A. Yes, it is.

11 **Q. WOULD IT ASSIST YOU IN YOUR TESTIMONY, OR HELP THE**
12 **ADMINISTRATIVE LAW JUDGES UNDERSTAND YOUR TESTIMONY, IF**
13 **YOU HAD THIS EXHIBIT AVAILABLE FOR YOUR USE?**

14 A. I believe it would.

15 **Q. DO YOU ADOPT THE INFORMATION CONVEYED IN DISTRICT EXHIBIT 24**
16 **AS YOUR SWORN TESTIMONY?**

17 A. Yes.

18 **THE DISTRICT OFFERS DISTRICT EXHIBIT 24 FOR ADMISSION INTO THE**
19 **RECORD.**

20 **Q. TITLE 30, SECTION 331.42(a)(1) OF THE TEXAS ADMINISTRATIVE CODE**
21 **DEFINES THE "AREA OF REVIEW" FOR THE TYPE OF CLASS I**
22 **INJECTION WELLS THAT TEXCOM IS ATTEMPTING TO PERMIT AS "AN**
23 **AREA DETERMINED BY A RADIUS OF 2 1/2 MILES FROM THE PROPOSED**
24 **OR EXISTING WELLBORE, OR THE AREA WITHIN THE CONE OF**
25 **INFLUENCE, WHICHEVER IS GREATER."**

WHAT IS YOUR OPINION REGARDING WHETHER, IN ACCORDANCE WITH TITLE 30, SECTION 331.42(a)(1) OF THE TEXAS ADMINISTRATIVE CODE, TEXCOM HAS ACCURATELY DESCRIBED THE AREA OF REVIEW WHEN USING THE MODELING PARAMETERS REQUIRED BY THE COMMISSIONERS' DECEMBER 12, 2008 INTERIM ORDER?

A. Based on my review of the cone of influence described by TexCom in TexCom Exhibit Nos. 84 and 85, the pressure modeling that I performed for the injection reservoir using the parameters required by the Commissioners' December 12, 2008 Interim Order, and my experience with TCEQ's Underground Injection Control permit rules and my other professional experiences, my opinion is that TexCom still has not accurately described the area of review required of it by the Commissioners' December 12, 2008 Interim Order.

III. 2009 PRESSURE FALL-OFF TEST REPORT

Q. I WOULD LIKE TO ASK YOU A FEW QUESTIONS ABOUT THE 2009 FALL-OFF AND RELATED TESTING CONDUCTED BY TEXCOM ON WDW315, GIVEN YOUR REVIEW OF KEY COMPONENTS OF THE SAME. TO BE CLEAR, DID YOU REVIEW THE APPLICATION TO TCEQ BY TEXCOM FOR A CLASS V AUTHORIZATION—WHAT I WILL REFER TO FOR PURPOSES OF BREVITY AS TEXCOM'S "CLASS V INJECTION REQUEST"?

A. Yes. TexCom submitted its Class V Injection Request to TCEQ in May 2009. Subsequently, the TCEQ staff issued a notice of deficiency to TexCom, to which the applicant provided responses on June 12, 2009. In preparation for my testimony, I reviewed all of these materials.

Q. WHAT IS DISTINGUISHABLE BETWEEN A CLASS I APPLICATION AND A CLASS V INJECTION REQUEST?

A. The U.S. Environmental Protection Agency, pursuant to the Safe Drinking Water Act, classifies injection activity by the materials that are, or that will be, injected. It has developed five classes of injection activity—Classes I – V—and is in the process of

developing a sixth class. The Class I designation indicates that the well is to be used for injection of either hazardous waste, non-hazardous waste, municipal waste, or certain types of radioactive waste. The Class V designation is a type of "catch-all" classification. It encompasses otherwise unclassified injection activity such as groundwater remediation injection, aquifer storage and recovery, and geothermal heat exchange, as a few examples. The injection of non-waste materials like clean brines into an otherwise unpermitted well, as is WDW315, for purposes of conducting a fall-off test is another example of injection activity that is appropriate to authorize pursuant to a Class V injection authorization. While EPA has delegated the primary regulatory authority for underground injection to the State of Texas, the UIC program administered by the TCEQ nevertheless employs the same classification approach developed by EPA.

Q. IN THE TESTIMONY YOU PROVIDED IN THE DECEMBER 2007 HEARING ON THE MERITS IN THIS CASE, YOU PROPOSED TERMS OF A SPECIAL CONDITION THAT WOULD REQUIRE TEXCOM TO CONDUCT A FALL-OFF TEST OF WDW315. THE JUDGES INCORPORATED YOUR PROPOSAL INTO WHAT BECAME THEIR PROPOSED CONCLUSION OF LAW NO. 51. DO YOU RECALL YOUR PROPOSED SPECIAL CONDITION TERMS, AND THE JUDGES' PROPOSED CONCLUSION OF LAW NO. 51?

A. I do recall my testimony suggesting that if the TexCom permits were going to be issued, then among other things it should be required to investigate the transmissive nature of the east-west fault that is found approximately 4,400 feet to the south of WDW315—what I referred to as the EW-4400-S fault. And I recall the special permitting condition proposed by the Judges that would have required, again among other things, that TexCom conduct a pressure fall-off test with a radius of investigation of at least 5,400 feet from the wellbore of WDW315. The stated purposes of this proposed special condition appeared to be in accordance with my testimony suggesting that, before commercial injection operations are allowed to commence, a fall-off test should be conducted to determine whether the EW-4400-S fault is in fact laterally transmissive.

Q. GREG CASEY THROUGH HIS TESTIMONY IS ASKING THE JUDGES TO

BELIEVE THAT ITS SEPTEMBER 2009 PRESSURE FALL-OFF TEST OF WDW315 COMPLETELY ACCOMPLISHED WHAT THE JUDGES' CONCLUSION OF LAW NO. 51 WOULD HAVE REQUIRED TEXCOM TO ACCOMPLISH, AND THAT THE PROPOSED SPECIAL CONDITION IS NO LONGER NECESSARY. ARE YOU FAMILIAR WITH THAT TESTIMONY?

A. I have read it, yes.

Q. DO YOU AGREE THAT THE SEPTEMBER 2009 PRESSURE FALL-OFF TEST CONDUCTED BY TEXCOM WAS SUFFICIENT TO DETERMINE WHETHER FAULT EW-4400-S IS LATERALLY TRANSMISSIVE?

A. I do not agree. The September 2009 pressure fall-off test conducted by TexCom was most certainly not sufficient to investigate the transmissive nature of fault EW-4400-S. In this regard, the September 2009 pressure fall-off test was not the same type of test that the Judges specifically recommended that TexCom be required to undertake in their April 25, 2008 proposal for decision in this case.

Q. GREG CASEY ULTIMATELY SEEMS TO ATTRIBUTE THIS SHORTCOMING TO A "LOWER-THAN-EXPECTED PERMEABILITY" OF THE TESTED INJECTION INTERVAL—THE LOWER COCKFIELD FORMATION. HOW DOES PERMEABILITY AFFECT THE RADIUS OF INVESTIGATION OF A FALL-OFF TEST?

A. It is not unusual, or particularly difficult, to design a pressure fall-off test that will reach a predetermined radius of investigation. In these instances, it is necessary to run the test for a sufficient length of time to ensure that the desired radius is actually reached. The formation's permeability impacts how long the test will have to run for the pressure transients to reach a given radius of investigation. Thus, in designing a pressure fall-off test to reach a certain target radius, it is important to have at least a general comprehension of the formation permeability you are likely to encounter during the test.

Q. DO YOU AGREE WITH TEXCOM THAT ITS FAILURE TO INVESTIGATE

THE EW-4400-S FAULT IS BEST ATTRIBUTED TO A "LOWER-THAN-EXPECTED PERMEABILITY" OF THE LOWER COCKFIELD FORMATION?

A. I do not. As an initial matter, I would be remiss if I did not point out that it was TexCom that originally used unjustifiably high permeability assumptions for its proposed injection interval during the first phase of this contested case. If you remember, they claimed to have had literature support for a 1,400 mD permeability assumption that made the 500 mD assumption that went into their pressuring calculations supposedly an "ultra-conservative" prediction. Yet we knew from actual, admittedly reliable, pressure fall-off testing conducted in 1999 on WDW315 that at least 2/3 of the Lower Cockfield had an average permeability of 80.9 mD. No reasonably objective observer should have anticipated permeability in that portion of the Lower Cockfield that grossly deviated from the known 80.9 mD permeability. So, my first basis for disagreement here is that the permeability that TexCom purports to have recorded during its 2009 fall-off testing is not lower than any reasonable person should have expected. That is not to say that I agree that its analysis reflects an accurate permeability value for the area of the Lower Cockfield that it tested during its fall-off test. I have serious reservations about the validity of the average permeability calculations it has made in its fall-off testing report—TexCom Exhibit No. 91.

But I have another basis for disagreement with TexCom's insinuation that it never reached the EW-4400-S fault because of a surprisingly low average permeability of the Lower Cockfield. As I explained earlier, when designing a pressure fall-off test that is intended to reach a specific radius of investigation—like, 5,400 feet, as an example—you must have a basic level of understanding of the formation characteristics so that you can calculate the amount of time that injection will be required. Here is where I have difficulty accepting TexCom's purported surprise at not reaching a 5,400-feet radius of investigation. It ran the injection component of its fall-off test for a total of 35.1 hours. By comparison, if the Lower Cockfield had an average permeability of 81 mD, it would take TexCom 517 hours of injection to reach a radius of investigation of 5,400 feet. At 500 mD, it would have required 84 hours of injection to reach a 5,400-foot radius. Looking at it another way, if TexCom had actually intended to reach a radius of

investigation of 5,400 feet by injecting for only 35.1 hours, it would have had to be expecting an average permeability of 1,195 mD in the Lower Cockfield. There is just no rational explanation, in my opinion, for designing a test of this importance using such an unfounded premise.

Q. SO IN YOUR PROFESSIONAL OPINION DO YOU BELIEVE THAT TEXCOM'S FAILURE TO REACH A 5,400 FOOT RADIUS OF INVESTIGATION WITH ITS SEPTEMBER 2009 FALL-OFF TEST SHOULD HAVE BEEN A SURPRISE?

A. No. If TexCom was truly intent on resolving this issue, it had the perfect opportunity to do just that during its September 2009 test. But it let the opportunity come and go. Its failure to investigate the transmissive nature of the EW-4400-S fault was, in my opinion, either by design or the result of gross miscalculations. Either way, the result is not at all consistent with what the Judges required in their proposed Conclusion of Law No. 51. This is particularly frustrating because throughout TexCom Exhibit No. 84 we still see TexCom attempt to argue about the transmissive nature of the EW-4400-S fault.

Q. ARE THERE ANY OTHER ISSUES RELATING TO TEXCOM'S ADMINISTRATION OF ITS SEPTEMBER 2009 FALL-OFF TEST THAT YOU FOUND TO BE NOTEWORTHY?

A. I did. In TCEQ's July 23, 2009 letter to TexCom approving its Class V Injection Request—TexCom's Exhibit No. 90—TCEQ specified a series of parameters within which TexCom was authorized to operate in conducting its September 2009 fall-off test. Item No. 14 of the letter, found at page 3 of the exhibit, specifies that TexCom was to use an injection fluid during the test that had a specific gravity of between 0.9 and 1.05. On page 23 of TexCom's Exhibit No. 91—what I will refer to as the 2009 Fall-off Test Report—it appears that TexCom ignored that requirement and used an injection fluid for its test that had a specific gravity of 1.18 instead.

Q. WHAT IS THE SPECIFIC GRAVITY OF A FLUID?

A. Specific gravity of a fluid is the ratio of the density of that liquid to the density of a given reference fluid, typically fresh water, which has a density of 1.0.

Q. DO YOU CONSIDER TEXCOM'S DEPARTURE FROM THE CLASS V AUTHORIZATION TO BE SIGNIFICANT?

A. The difference between the permitted maximum specific gravity of 1.05 and the injected brine specific gravity of 1.18 exceeds the permitted authorization by 12 percent. This is a significant margin in that the maximum specific gravity listed in an injection well permit is typically calculated to provide a safety margin to prevent fracturing of the injection interval. This can sometimes happen through the injection of a heavier than contemplated injectate that exceeds the formation's fracture gradient, even though the operator might not be exceeding its permitted maximum allowable surface injection pressure. In addition, the July 23, 2009 Class V authorization is nothing short of a permit—with specific terms and conditions that, in my experience, the permit holder is obligated to respect and adhere to. What concerns me about this issue is that it indicates that TexCom, at a minimum, failed to consider the specified Class V permit terms when designing and performing its fall-off test.

Q. YOU MENTIONED EARLIER THAT YOU HAVE "SERIOUS RESERVATIONS" ABOUT THE VALIDITY OF TEXCOM'S PERMEABILITY CALCULATIONS BASED ON ITS FALL-OFF TEST. I WOULD LIKE TO ASK YOU A FEW QUESTIONS ABOUT THAT. BUT BEFORE I DO, COULD YOU REMIND THE JUDGES HOW A PRESSURE FALL-OFF TEST IS USED TO DETERMINE THE AVERAGE PERMEABILITY OF THE TESTED FORMATION?

A. A pressure injection/fall-off test generates a pressure "wave"—or transient—in the formation away from the wellbore. This pressure transient generates a pressure response back at the well that is recorded by a measuring gauge that is placed into the wellbore. The data gathered during the fall-off test is used to calculate the permeability of the formation out beyond the near-wellbore region, to the limits of the test's radius of

investigation. The permeability value that is determined from the fall-off test data is expressed as an average permeability of the entire injection interval receiving fluid during the test.

Q. SO DETERMINING THE PERMEABILITY OF AN INVESTIGATED FORMATION IS NOT A SUBJECTIVE ASSESSMENT?

A. No. The permeability of the receiving reservoir is calculated analytically through well-documented and accepted methodologies. For purposes of making an assessment of permeability in this context, the *average* permeability of a formation like the Lower Cockfield is changed only as a result of including or excluding segments of the formation that are more or less permeable in the injection interval. When analyzing the results of a pressure fall-off test, we come to understand what the average permeability of a tested interval is by employing a relatively simple formula that incorporates several variables. The process is very much an objective one, but the result of the final calculation is still only as valid as the variables that were used to solve it.

Q. HAVE YOU REVIEWED TEXCOM EXHIBIT NO. 91?

A. I have, yes, as well as the digital data that are referenced in TexCom Exhibit No. 84.

Q. CAN YOU PLEASE EXPLAIN GENERALLY WHAT TEXCOM EXHIBIT NO. 91—ITS "2009 FALL-OFF TEST REPORT"—CONTAINS?

A. It contains a summary of the steps taken during the well workover, the mechanical integrity test conducted on WDW315, and the pressure fall-off test conducted on the well.

Q. GREG CASEY TESTIFIES IN TEXCOM EXHIBIT NO. 84 THAT THE SEPTEMBER 2009 FALL-OFF TEST INDICATES THAT THE LOWER COCKFIELD HAS A PERMEABILITY OF 190.6 mD. DO YOU AGREE THAT THE SEPTEMBER 2009 FALL-OFF TEST INDICATES THAT THE LOWER COCKFIELD HAS A PERMEABILITY OF 190.6 mD?

A. I do not agree with that conclusion.

Q. WHAT DOES THE SEPTEMBER 2009 FALL-OFF TEST INDICATE IS THE AVERAGE PERMEABILITY OF THE LOWER COCKFIELD FORMATION?

A. The results of the fall-off test show that the Lower Cockfield has a permeability of less than 50 mD.

Q. CAN YOU PLEASE EXPLAIN THE BASIS FOR YOUR CONCLUSION?

A. Earlier I explained that the average permeability of a tested interval is determined by employing a relatively simple formula that incorporates several variables. These include flow rate history, receiving interval thickness, total compressibility of the formation fluid and rock, and formation porosity. Another variable that is needed to assess formation permeability is the formation fluid viscosity, as it exists at the relatively high native formation temperature—commonly referred to as the "bottomhole temperature. Viscosity is one of the key input variables that is required to calculate formation permeability. In attempting to calculate the average permeability of the tested injection interval, TexCom employed the viscosity of the wrong fluid at the wrong temperature. This error completely corrupted its permeability calculation. As a result, its conclusion regarding the average permeability of the injection interval is wrong.

Q. WHAT IS FLUID VISCOSITY?

A. Fluid viscosity is a fluid's resistance to flow at a certain temperature.

Q. HOW DOES TEMPERATURE AFFECT FLUID VISCOSITY?

A. As the temperature of a fluid increases, its resistance to flow decreases.

Q. YOU SAID THAT TEXCOM USED THE VISCOSITY OF THE WRONG FLUID IN ITS PERMEABILITY CALCULATION. CAN YOU EXPLAIN WHAT YOU MEAN BY THAT IN MORE DETAIL?

A. A pressure injection/fall-off test requires actually injecting fluid into the formation through the subject well's perforated interval. The radius of investigation is the distance that the pressure transients created by the test have moved out into the formation. The feedback generated by the pressure transients have different substantive meanings depending on the viscosity of the fluid through which they are understood to be traveling. It is important to understand that the radius of investigation is not limited by how far into the formation the injected fluids are pushed during the test. It is defined by the pressure transients generated by the test. To illustrate, while TexCom injected brine into the Lower Cockfield during its September 2009 test for approximately 35 hours, the plume of this injectate migrated only a few feet from the wellbore. By contrast, the radius of investigation at the conclusion of the test extended out to over 1,000 feet from the WDW315 wellbore.

So when permeability is ascertained through a fall-off test of this nature, it is assessed out to the radius of investigation—that is, at distances out into the formation well beyond the near-wellbore region. As I mentioned, permeability of this investigated area is derived in part from understanding the viscosity of the fluid in the formation that is being influenced by the fall-off test. In formations that have been receiving injected waste for many years, and thus contain large waste plumes that extend to or beyond the radius of investigation of a particular fall-off test, the viscosity of the historic waste plume should be used to when assessing the formation permeability. However, for wells like WDW315 where little or no injection has occurred, the viscosity of the native formation fluid should be used to calculate formation permeability because that is the fluid that will primarily influence the fall-off test transients. Pressure fall-off testing guidelines published by EPA Region 6, along with most accepted treatises on pressure fall-off testing analysis for wells of this nature, employ this approach.

TexCom did not use this approach. Instead, it inappropriately used the viscosity of its injectate—the brines that it injected during its test and that traveled no more than a few feet from the wellbore—in its permeability calculation. In addition to this critical error, it did not correct its viscosity value for bottomhole temperature. Instead, it appears to have used the surface temperature of its oilfield brine injectate. These are fundamental errors

that entirely compromise the integrity of its resulting permeability calculation.

Q. WHAT VISCOSITY VALUE DID TEXCOM USE IN ITS PERMEABILITY CALCULATIONS?

A. TexCom appears to have employed a surface temperature value of its brine injectate, and a resulting viscosity value of 1.26 centipoise—or cP.

Q. AND TEXCOM DETERMINED THE VISCOSITY OF THIS BRINE AT WHAT TEMPERATURE?

A. It appears to have measured the viscosity at 97.6 degrees Fahrenheit.

Q WHY DO YOU BELIEVE THAT 1.26 cP WAS THE INCORRECT VISCOSITY VALUE?

A. As part of the 1999 pressure fall-off test on WDW315, one of the contractors involved with the testing—ACE Technology—gathered a sample of the native fluids from the Lower Cockfield. I looked at TexCom's own application records to see that the analysis performed on this sampling of native formation fluids indicated a total dissolved solids content of 105,000 milligrams per liter. From this value I was able to calculate an equivalent fluid viscosity of 0.43 cP at 185 degrees Fahrenheit—the bottomhole temperature of the Lower Cockfield formation. If TexCom was intent on correctly calculating the average permeability of its proposed injection interval, then it should have used the viscosity of the native formation fluid at 185 degrees Fahrenheit.

Q. I AM HANDING YOU WHAT HAS BEEN MARKED AS DISTRICT EXHIBIT 25. CAN YOU IDENTIFY THIS DOCUMENT?

A. Yes, this is the Third Revision of the EPA Region 6 UIC Pressure Falloff Testing Guideline, dated August 8, 2002.

Q. IS THIS A TRUE AND CORRECT COPY OF THE SAME SET OF GUIDELINES YOU MENTIONED EARLIER IN YOUR TESTIMONY THAT DESCRIBE THE

1 **CORRECT METHOD FOR CALCULATING AVERAGE FORMATION**
2 **PERMEABILITY?**

3 A. It is, yes.

4 **Q. DOES DISTRICT EXHIBIT 25 CONTAIN THE PERMEABILITY**
5 **CALCULATION GUIDELINES THAT YOU REFERENCED EARLIER IN**
6 **YOUR TESTIMONY?**

7 A. It does.

8 **THE DISTRICT OFFERS DISTRICT EXHIBIT 25 FOR ADMISSION INTO THE**
9 **RECORD.**

10 **Q. YOU MENTIONED EARLIER THAT EPA HAS RAISED THIS SAME ISSUE**
11 **WITH RESPECT TO TEXCOM'S INVALID PERMEABILITY**
12 **CALCULATIONS. CAN YOU EXPLAIN WHAT YOU ARE REFERRING TO?**

13 A. EPA apparently has conducted its own review of TexCom's 2009 Fall-off Test Report. It
14 appears to have drawn similar conclusions to the ones I have drawn regarding TexCom's
15 grossly flawed permeability assessment.

16 **Q. HOW ARE YOU AWARE OF THIS?**

17 A. As part of my preparation for this testimony, I reviewed a January 13, 2010 and a
18 February 2, 2010 email communication from EPA Region 6 staff to TCEQ staff and staff
19 attorneys articulating concerns about TexCom's conclusions in its 2009 Fall-off Test
20 Report, and explaining the scope and conclusions of EPA Region 6's own review and
21 analysis of information in the same report. In the EPA's communications and
22 accompanying materials, it notes that it calculated a permeability that "was significantly
23 lower" than the results calculated by TexCom's consultants. In fact, the EPA technical
24 staff calculated an average permeability of the Lower Cockfield of 42 mD. Before I even
25 became aware of EPA's concerns and analysis, I calculated a substantially similar
26 permeability of 49 mD based on the information contained in the TexCom application

1 and the 2009 Fall-off Test Report.

2 **Q. I AM HANDING YOU WHAT HAS BEEN MARKED AS DISTRICT EXHIBIT**
3 **26. WILL YOU PLEASE IDENTIFY THIS DOCUMENT?**

4 A. This is the email correspondence and accompanying materials from EPA Region 6 staff
5 to TCEQ staff and staff attorneys that I referenced earlier in my testimony.

6 **Q. IS THIS A TRUE AND CORRECT COPY OF THE EMAIL**
7 **CORRESPONDENCE THAT YOU REVIEWED?**

8 A. It is.

9 **THE DISTRICT OFFERS DISTRICT EXHIBIT 26 FOR ADMISSION INTO THE**
10 **RECORD.**

11 **Q. MR. GRANT, DO YOU HAVE AN OPINION REGARDING THE VALIDITY OF**
12 **TEXCOM'S ASSESSMENT OF THE AVERAGE PERMEABILITY OF THE**
13 **LOWER COCKFIELD FORMATION, AS INDICATED IN ITS 2009 FALL-OFF**
14 **TEST REPORT?**

15 A. I do have an opinion.

16 **Q. WHAT IS YOUR OPINION?**

17 A. Based on my professional experience in conducting and analyzing the results of fall-off
18 tests for Class I underground injection wells, my understanding of the applicable industry
19 standards for fall-off test analysis, my review, comprehension and appreciation of the
20 regulatory standards promulgated by EPA Region 6, my review of the TexCom UIC
21 application, its 2009 Fall-off Test Report and supplemental digital information, and my
22 review of the EPA Region 6 reservoir engineers' analysis of the same, my opinion is that
23 TexCom's purported 190.6 mD average permeability calculation for the Lower Cockfield
24 is not a valid calculation.

Q. THROUGH ITS PREFILED TESTIMONY, TEXCOM ASSERTS THAT THE PERMEABILITY OF THE LOWER COCKFIELD WAS INFLUENCED BY THE ADDITION OF PERFORATIONS IN THE WDW315 CASING BETWEEN 6,046 FEET AND 6,390 FEET BELOW SURFACE. CAN THE PERMEABILITY OF A FORMATION BE ALTERED BY PERFORATING WELL CASING?

A. The addition of these perforations affects the overall average receiving interval permeability because TexCom has added 45 feet of additional sands that themselves have varying permeabilities. The net result can be a different average, but the permeabilities of the distinct sands themselves are not actually affected by this change. The actual result of TexCom's additional perforations changed the average permeability of its designated injection interval from 80.9 mD to under 50 mD.

Q. GIVEN WHAT WE KNOW FROM TEXCOM'S OWN RECORDS ABOUT THE CHARACTERISTICS OF THE PROPOSED INJECTION INTERVAL, ARE THERE ANY FAVORABLE SANDS LEFT IN THE LOWER COCKFIELD THAT TEXCOM COULD ACCESS BY ADDING EVEN MORE PERFORATIONS TO THE WDW315 CASING?

A. No.

Q. TEXCOM EXCUSES WHAT IT REFERS TO AS A "LOWER-THAN-EXPECTED" AVERAGE PERMEABILITY OF THE LOWER COCKFIELD ON THE PRESENCE OF A "SKIN FACTOR" AT WDW315. CAN YOU DESCRIBE TO THE JUDGES WHAT A "SKIN FACTOR" IS?

A. A "skin factor", or more appropriately called the skin effect, is near-wellbore flow impediment or improvement created when flow restrictions occur because of damage sustained by the formation during drilling, completion, or operations. This damage, when it is even present, typically extends out to just a few feet beyond the wellbore itself.

Q. WHY IS UNDERSTANDING THE PRESENCE OF WELLBORE SKIN IMPORTANT IN THE CONTEXT OF ANALYZING THE RESULTS OF A

PRESSURE FALL-OFF TEST?

A. Skin effect is indicative of the distance beyond which a true measure of formation permeability is valid. Understanding the existence and extent of wellbore skin is necessary so that its effect does not unduly influence the fall-off test analysis. It is important to realize that when the permeability of a formation is assessed through a pressure fall-off test, that determination is typically being made on a part of the formation that is well beyond any area that is affected by skin damage. A competent permeability determination will accordingly incorporate any skin effect that may exist around the wellbore so that it does not skew the final results.

IV. CONCLUSIONS

Q. THERE APPEARS TO BE AT LEAST TWO ISSUES RAISED BY TEXCOM'S DECISION TO ADD PERFORATIONS IN WDW315 AND TO SUBSEQUENTLY CONDUCT A PRESSURE FALL-OFF TEST IN THE FACE OF THE COMMISSIONERS' DECEMBER 12, 2008 INTERIM ORDER: (1) WHETHER TEXCOM IS YET ABLE TO DEMONSTRATE COMPLIANCE WITH TCEQ RULES GIVEN THE COMMISSIONERS' SPECIFIC INSTRUCTIONS, AND (2) WHETHER TEXCOM'S ANALYSIS OF ITS OWN FALL-OFF TEST REPORT IS CREDIBLE.

DO YOU BELIEVE THAT TEXCOM HAS YET DEMONSTRATED COMPLIANCE WITH TCEQ RULES GIVEN THE COMMISSIONERS' SPECIFIC INSTRUCTIONS IN THEIR DECEMBER 12, 2008 INTERIM ORDER?

A. I do not. Unfortunately for the people of Montgomery County, TexCom failed, again, in demonstrating that it has conducted the required area of review well records search of the appropriate size area based on the cone of influence that is calculated using the Commissioners' express input parameters.

Q. DO YOU BELIEVE TEXCOM CONDUCED A CREDIBLE ANALYSIS OF ITS 2009 FALL-OFF TEST RESULTS?

1 A. For the reasons I stated earlier, I do not. TexCom made two critical mistakes in its
2 calculation of formation permeability. Its errors have resulted in a fundamentally flawed
3 analysis of its 2009 fall-off test results. In contrast to TexCom's promise of a
4 permeability of at least 500 mD, its 2009 Fall-off Test Report shows instead an average
5 permeability of under 50 mD.

6 **Q. THESE ARE ALL OF THE QUESTIONS I HAVE FOR YOU AT THIS TIME**
7 **MR. GRANT. DOES THIS CONCLUDE YOUR TESTIMONY?**

8 A. It does. However, in the event that additional information or evidence is brought to my
9 attention in this case, I would like to reserve the ability to supplement my testimony as
10 appropriate and necessary.

11 **THANK YOU, MR. GRANT. THE DISTRICT HAS NO FURTHER QUESTIONS OF**
12 **THIS WITNESS AT THIS TIME.**