STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

IN THE MATTER OF:
THE HEARING CALLED BY THE
OIL CONSERVATION COMMISSION
TO CONSIDER:

Case No. 10290

APPLICATION OF AVON ENERGY CORPORATION FOR AMENDMENT OF DIVISION ORDER NOS. R-3185, R-3185-A AND R-3528 TO EXPAND THE VERTICAL LIMITS AND TO ESTABLISH AN INJECTION PRESSURE LIMITATION FOR THE TURNER "B" LEASE WATERFLOOD PROJECT, EDDY COUNTY, NEW MEXICO.

REPORTER'S TRANSCRIPT OF PROCEEDINGS

DIVISION HEARING

BEFORE: DAVID R. CATANACH, Examiner

August 8, 1991
8:41 a.m.
Santa Fe, New Mexico

This matter came on for hearing before the Oil Conservation Division on August 8, 1991, at 8:41 a.m. at the conference room, State Land Office Building, 310 Old Santa Fe Trail, Santa Fe, New Mexico, before Susan G. Ptacek, Certified Court Reporter for the State of New Mexico.

FOR: OIL CONSERVATION DIVISION

BY: SUSAN G. PTACEK
Certified Court Reporter
CSR No. 124

I N D E X

August 8, 1991
Commissioner Hearing
Case No. 10290

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E X H I B I T S

A P P E A R A N C E S

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MR. CATANACH: At this time we will call Case 10290.

MR. STOVALL: Application of Avon Energy Corporation for amendment of Division Order Nos. R-3185, R-3185-A and R-3528 to expand the vertical limits and to establish an injection pressure limitation for the Turner "B" Lease Waterflood Project, Eddy County, New Mexico.

MR. CATANACH: Appearances in this case?

MR. RICHARDSON: Mr. Examiner, I'm Tom Kellahin of the Santa Fe law firm of Kellahin, Kellahin & Aubrey, appearing on behalf of the applicant; and I have one witness to be sworn.

MR. CATANACH: Any other appearances? Will the witness please stand and be sworn in?

MR. KELLAHIN: Mr. Examiner, our prehearing statements indicate that Mr. Roy Williamson would have been our engineering witness. He had a family problem he had to attend to, and he left last night. I would like to substitute Mr. Perry Hughes as my expert witness. Mr. Hughes is a petroleum engineer. He's been intimately involved with this project for Avon Energy Corporation, and with your permission I would like to substitute him at this time.

MR. CATANACH: Absolutely.

MR. RICHARDSON: In addition, let me hand you, Mr. Examiner, the copy of the application that we filed in

this case, because I think it might provide a quick reference to refresh your recollection of what Avon is seeking to accomplish. This is part of an old waterflood project that dealt with the Turner "B" lease. The Turner "B" lease has been divided into two areas that we're going to talk about. The original project area was approved in '67 by the Oil Conservation Division for flooding into the Grayburg and San Andres formations without a surface pressure limitation. It predates the underground injection control regulations.

There was -- and I can give you a copy of that now -- the original order that approved the flood is our 3185. Attached to that order is an amendment or a correction of the unorthodox well locations. Thereafter in '68 there was an expansion of this Turner "B" lease flood to what we've characterized as the expansion area. The expansion area deals with the flooding of the Premier member of the Grayburg, and it does so without a pressure limitation. That expansion order is set forth as 3528, and I've provided you with a copy of that order.

What Avon is seeking to accomplish, with the division's approval, are two basic things: One is to increase the vertical area exposed to water flooding, so that in the expansion area it is not solely limited to the Premier, but that it now also includes the entire Grayburg

and San Andres formations of the -- the Grayburg Jackson pool. In addition, we want approval to inject water into the injection wells at a surface pressure limitation of 450 pounds above the separate pressure. As additional items, we would like to have an administrative procedure by which we can ask for several things; one administrative approval for the drilling at standard and unorthodox locations of the additional injection wells, plus a procedure administratively to increase the injection pressure if that becomes necessary over and above the current request.

Mr. Hughes is intimately familiar with the Socorro project in Keel-West, which is just to the north of this project, in which the division has previously approved a prior application for Socorro in which they have a similar 450-pound over the step rate rakeover pressure, and would like to demonstrate to you the engineering reasons that support his ultimate conclusion about the appropriateness of applying a step rate increase pressure limitation of 450 pounds to this project.

With those preliminary statements then, I would like to go ahead and introduce Mr. Hughes and his testimony.

PERRY HUGHES,

the Witness herein, having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. KELLAHIN:

Q. Mr. Hughes, for the record, would you please state your name and occupation?

A. My name is Perry Hughes. My address is 707 Shell Avenue, Midland, Texas. I'm an engineering consultant, and I've worked with this project area for little over three years.

Q. On prior occasions have you testified before the division?

A. No, sir, I have not.

Q. Would you summarize for the examiner your education?

A. I'm a graduate of West Virginia University, petroleum engineering, 1965; 26 years of petroleum engineering experience.

Q. Summarize more specifically your engineering experience with regards to the Avon project, as well as your familiarity with the Socorro project in the Grayburg and San Andres waterfloods.

A. Socorro, and what has become part of their property operated by Avon, acquired these properties about three years ago from Hondo Oil and Gas, and I have worked very closely with the operations, the drilling and production and reservoir engineering of these properties

continuously in that time frame.

Q. As part of your engineering work have you specifically made a study of the pressures that you're going to require and need in order to make this waterflood project and the Turner "B" lease a successful project?

A. Yes, sir, I have. We -- when Socorro acquired the properties, and the Keel-West flood was instituted, it became very obvious that significantly high injection pressures would be required to move -- to put water into the formations and to move oil through the formations, because of the very type nature of the Grayburg and San Andres horizons.

We studied in detail the Keel-West area and subsequently the Turner "B" areas and have determined that they're very similar. They're the same -- under the same geologic conditions, and we've also studied -- I've also studied other floods in the area, dating from the middle '60s, and have determined that high injection pressures were required in those floods, and those floods were successful and there has been no evidence of any migration of injected fluids out of the objective horizons, being the Grayburg and San Andres intervals.

Q. As a petroleum engineer have you been able to develop what, in your opinion, is sufficient data and information upon which to formulate conclusions and

opinions concerning the appropriate level of injection pressures for these injection wells?

A. Yes, I have; and we have looked at -- we have conducted step-rates for Socorro, and that was part of our application and subsequent order in June of last year, which indicated high parting pressures. We have conducted similar studies and have determined that higher pressures are required. We have conducted step rates in the area of interest here on the Turner "B" and will present that evidence to you, and it is apparent to Avon and to me that the higher injection pressures will be required to recover significant quantities of the oil that remains in the reservoir.

Q. In addition, have you, Mr. Hughes, under your direction and supervision caused the Commission Form C-108 to be completed, prepared and filed with the division?

A. Yes, sir, I have.

MR. KELLAHIN: At this time, Mr. Examiner, we tender Mr. Hughes as an expert petroleum engineer.

MR. CATANACH: He is so qualified.

Q. (By Mr. Kellahin) Mr. Hughes, let me ask you to direct your attention to what we've marked as Avon Exhibit No. 1. On that locator map, if you will, to refresh the examiner's recollection, identify for us, first of at all, the Turner "B" waterflood project area.

A. That is in the lower right-hand portion shown as -- primarily in Section 29, 17, 31.

Q. And there is a white label that directs your attention to that area?

A. Yes, sir.

Q. When we look for the Socorro Keel-West waterflood, how do we find that?

A. Immediately to the north.

Q. How is that identified?

A. As "Socorro Petroleum Keel-West Phase 1 Waterflood."

Q. You have also shown two other areas that you outlined in a green outline. What's that purpose?

A. In the middle of the map is an area operated by Devon Engineering, which is one of the -- which an application was made in 1989 to provide for, and an order issued to provide for injection at 450 pounds above step-rate gradients, and in the lower left-hand corner is an Anadarko Ballard Unit, which Anadarko made application for and received order in 1988 to inject at 450 pounds above parting pressure.

Q. Let's turn now to Exhibit No. 2. Identify for me Exhibit No. 2.

A. Exhibit No. 2 is a lease map, which zeros in on the Socorro and Avon acreage, the Socorro acreage being in

the top half of the map, and the Avon acreage being down in Sections 20, 29 and 30. We also identify a line of cross section running north to south, which will show the relationship of the Grayburg and San Andres intervals across that section.

In the Avon acreage, which is identified as "Avon Energy Turner "B" Waterflood Expansion," we identify the 12 wells, which are injection wells which are a part of this application for expansion vertically and for the 450 pounds above parting pressure.

Q. How have you identified the -- is it 12 injection wells in the expansion area?

A. They are identified by -- the 12 wells are identified by the six-sided forms on the map.

Q. What is the current limitation on pressure for those six injection wells?

A. The current limitation for the injection wells is two-tenths of a psi per foot.

Q. On the expansion injection wells in the Premier member, is there any pressure limitation on those wells?

A. There is no pressure limitation under the 1968 order, no pressure limitation at all, only in the Premier member.

Q. Identify for us the area within the Turner "B" lease for which you seek approval to expand the waterflood

to include not only the Premier member, but the entire Grayburg/San Andres interval?

A. Is that interval -- that area including all of Section 29, the bottom quarter of Section 20, and the southeast quarter of Section 30, T 17 South, 31 East.

Q. Let's use this display, Mr. Hughes, to also identify for the examiner those injection wells that have been used as test wells upon which you have taken the new step-rate test information.

A. Step-rate tests have been run in three wells in -- each of those being in Section 29. Those are in -- are numbers 47, 50, and 61. 47 is located in the northwest of the northeast quarter. 50 is in the northwest of the northwest quarter, and 61 is the northwest of the southeast quarter of that section.

Q. Did you obtain the division district approval for the selection and use for those three wells as the test wells by which you took the step rate test information?

A. Yes, we did.

Q. When we look at the line of cross section going from the Keel-West waterflood down through -- in a north-south direction through the Turner "B" explanation area, there is a line of cross section. What is the purpose of making that cross section, Mr. Hughes?

A. What I wanted to portray by the cross section,

which we will show in Exhibit 4, is that the Grayburg and San Andres intervals are the same going from north to south. There is only a slight expansion or thickening of the Grayburg as we move from north to south.

Q. Let's use Exhibit No. 2 as a reference map, and have you turn now to the type log that's marked as Exhibit No. 3. Identify for us, using the type log, the interval that you're seeking to have approval to waterflood in this expansion area.

A. The type log is one of the -- is a log of one of the 22 new wells drilled by Avon in -- in this case it's number 97 in Section 20, indicating -- showing the entire Grayburg interval with local designations of productive horizons being the Loco Hills, Metex, Square Lake and Premier; and the San Andres interval productive horizons being the Vacuum, the Lovington and the Jackson.

Considerable San Andres interval extends below the bottom of this log, something on the order of a thousand feet, but it is not indicated to be productive in any area of the subject area.

Q. When we look at the top of the Grayburg, how do we find that on the type log?

A. It's designated and it occurs in this well at about a measured depth of 2760 feet.

Q. So the label that says "Grayburg" indicates the

top of the Grayburg?

A. That is correct.

Q. When we look at the expansion area and the wells -- producing wells in the expansion area, identify for us the general area in the Grayburg and San Andres in which those wells have been perforated.

A. Most of the wells, the productive and the proposed injection wells, have productive intervals in all of the indicated horizons in the Grayburg, being the Loco Hills, Metex, Square Lake and Premier; and in the San Andres, being the Vacuum, Lovington and Jackson. It appears that wherever porosity is developed, we have oil saturation in place.

Q. Let's turn to the cross section now, Mr. Hughes, Exhibit No. 4. Using this cross section, Mr. Hughes, please give us the factual information upon which you base your conclusion that the Turner "B" Expansion Area is geologically similar to the Keel-West waterflood area.

A. This cross section shows three wells; and if we refer to Exhibit 2 as to their location, left to right is north to south. We have each of -- on these logs is a -- is a porosity -- gamma ray porosity log. We show the top of the Grayburg and the top of the San Andres in each well, and we can see porosity development in -- the porosity development in the Grayburg and in the San Andres

intervals.

We go from -- and as I mentioned before, as we go from north to south we have an expansion of the Grayburg section, and that is due to coming off of the major geologic feature that runs east and west from -- from the Artesia area toward the Vacuum area in Lea County.

Q. Are both the Keel-West project and the Turner "B" Expansion project in the Grayburg-Jackson pool?

A. Yes, they are.

Q. When we look at the expansion area, do you have an opinion as to whether or not it is geologically suitable to flood not only the Premier member but the entire Grayburg-San Andres productive intervals?

A. It appears to me that the Grayburg and San Andres intervals will be extremely amenable to water flooding. We know that in the expansion area the Premier flood was successful. We know that in the areas, as set out in the 1967 order, which includes the Turner "B" in the southern part of Section 17 and northern part of Section 20, that that flood which was conducted into all members of the Grayburg and San Andres was successful.

Q. In your opinion, are there additional oil reserves to be recovered if the interval being flooded is expanded to include not only the Premier, but the other members of the Grayburg-San Andres?

A. Yes, sir. It's my opinion that significant quantities of oil will be recovered under waterflood operations.

Q. Let's turn now to the issue of the pressure limitation. Describe for us what your opinion is concerning the appropriate level to start water injection in the expanded area in terms of the pressure limitation at the surface. What's your ultimate conclusion?

A. Based on the work that I have done, it appears that pressures significantly higher than the two-tenths of a psi per foot gradient will be required. Studying old injection records from the Sinclair and Arco floods that were conducted in the '60s and '70s, we find out that significantly higher pressures were required.

There were no pressure limitations at the time those floods were conducted, instituted and conducted, and that we see that significantly higher pressures are required in the order of 1600- to 2,000-pound surface injection pressure.

Q. As a general rule of thumb, if we apply the .2 psi per foot of depth limitation and calculate that surface pressure, what would it generally be in the expansion area?

A. We're looking at a maximum allowable pressure in the range of 600 to 650 pounds, and our testing that we have been able to conduct on the wells in Section 29 --

those being 47, 50 and 61 -- have indicated that at the two-tenths of a psi per foot gradient, that little or no water could be injected at that pressure -- at those pressures.

Q. When you conduct the step rate test, what is the surface pressure range in a general range for the level of pressure using the step rate by itself?

A. Step-rates indicated a parting pressure of little over 1200 pounds. 1200 -- we have an exhibit that sets these out, but it's a little over 1200 pounds on average of the three.

Q. You have requested a surface pressure limitation of 450 pounds above the parting pressure shown on the step rate test.

A. That's correct. We're asking for 1650 pounds surface injection pressure maximum.

Q. That is an initial starting pressure then for a surface limitation for this waterflood project?

A. That's correct. It's possible that -- and I think you alluded to this in your introductory statements -- that we may need to come back at some point in time in the future. We would like to have the opportunity to handle that administratively if possible. There's question in my mind as to whether the 1650 pounds will be adequate over the life of the project.

Q. What is the basis for your conclusion that you need a starting pressure of 450 pounds above the parting pressure?

A. Based on my studies of old floods, the Premier flood that was conducted, the Grayburg-Jackson -- Grayburg-San Andres floods in Sections 17, 18, 19 and 20, as shown on Exhibit 2, and my studies of the Socorro -- the ongoing Socorro Phase 1 Keel-West flood, and the Sinclair Arco flood that was conducted the west half of the Socorro acreage to the north.

Q. Let's take a moment and talk about Socorro's Keel-West. That is a project that's previously approved at the pressure rates you're proposing for Turner "B". Has that approval of those pressures been a positive?

A. Yes. Socorro, upon obtaining the order in June of 1990, started injecting at the allowed pressure of 450 pounds above the step rate. The average step-rate in the Keel-West Field Phase 1 Waterflood was 1711 pounds; therefore the average allowed injection pressure in that area is 2150 plus psi. Response has been seen. Socorro perhaps has not pursued this flood as diligently as they might. They have not yet converted some of the old producing wells to injection, and have indeed instead focused their attention and their available monies down into the Socorro-Avon project down in the Turner "B" area.

Q. When we look at the Keel-West, at a current state of development under that order, have there been any operational problems for that operator?

A. What Socorro has seen is high injection pressures, which we anticipated. A decreasing volume -- injection volume on a per-well basis. We feel that this is probably caused by plugging of the formations in the near wellbore area by solids, which are injected into the -- with the injected fluids. The injected fluids in both cases are primarily produced water with some make-up fresh water. And it appears that plugging is occurring and Socorro is currently investigating how to -- what procedures are required to reduce the injection pressures or to better manage their flood through proper injection volumes.

Q. Are you aware of any problems in the Keel-West area that would cause you concerns about recommending to the examiner that he approve the Turner "B" expansion?

A. There have been no indications of problems, mechanical or the migration of fluids, in the Socorro area at all.

Q. Have you made an investigation, Mr. Hughes, to determine whether or not the fractures propagated by use of a surface pressure limitation of 450 pounds above the parting pressure would cause those fractures to be

propagated outside the limits of the pool?

A. We have done -- Socorro and Avon used frac height log predictions as to surface pressures that would be required to propagate a frac upward into or out of the Grayburg. We have run after-frac prism logs, in which the frac material was tagged with radioactive material, and have run many after-frac logs, which are designated as prism logs or gamma control logs. There has been no indication that the fracs have extended more than a few feet above the uppermost perforated interval, and in no case out of the Grayburg interval.

Q. Let's turn to that data now, Mr. Hughes. Let me turn your attention to what is marked as Exhibit No. 5. Identify and describe for us what you have summarized on the cover page for Exhibit 5.

A. Avon, as part of their 22-well infill development program, ran frac hite or frac migration logs on two wells; those being Turner "B" 85 and Turner "B" 84. Those are located in the northeastern part of Section 29. These logs are --

Q. Let me ask you this: Is the use of 85 and 84, in your opinion, typical of what you would see if other wells had been used in the expansion area?

A. The logs, the open hole logs, and the performance of these wells, 84 and 85, would appear to be

typical of all of the area under this expansion application.

Q. What does this show?

A. Frac hite, frac migration logs are calculations using open hole logs and in particular full- or long-wave sonic logs, and the calculation the rock mechanics which are required to fracture a particular interval in a wellbore. It's an electric log measurement, and then the calculation is done utilizing in this case Schlumberg J and Atlas computer programs; and they determine a frac gradient at any point in the wellbore, and in this case we examined the frac gradient at the point of the highest perforation in each well, and then calculated what that gradient would mean as a surface injection pressure.

In this case we find that in these two wells surface injection pressure of about 2175 psi would be required to frac above the uppermost perforation. In the case of 85, it's 20 feet, and in the case of 84 it's 75 feet. Both of these intervals are -- remain well within the Grayburg interval. The logs are attached which show the computer process interpretation as done by Schlumberg J and Atlas.

Q. A requested maximum injection pressure at the surface for this project area would be below the surface pressure calculated for 85 and 84?

A. More than 500 pounds below.

Q. All right. Let's turn now to Exhibit No. 6, Mr. Hughes. Identify that for us.

A. Exhibit No. 6 is a summary of frac treatments, which have been conducted on the Turner "B" lease. There are 29 treatments summarized, and what is of interest -- most interest on this summary is the column, the far column to the right, which is the initial shut-in pressure after frac.

The initial shut-in pressure and frac is an indication of the parting pressure of the formation, and the average of all of these treatments indicate a pressure in the range of 21 to 2200 psi, which is in good agreement with that calculated by the frac hite log as shown in Exhibit 5.

Q. What is the significance of the data on Exhibit No. 6 in your study?

A. The initial shut-in pressures, the ISIPs, as being an indication of parting pressure, show that the parting pressures are well in excess of the requested 1650 psi that is being requested in this application.

Q. Let's turn now to Exhibit No. 7. This is captioned "After Frac Logs." What does this show?

A. Avon tagged with radioactive materials, radioactive isotopes, the material in 28 wells. After-frac

logs have been run on 18 wells. These after-frac logs are run after -- at some point after the frac is being completed and during the early part of the radioactive half-life of the isotope introduced, and these logs show where the frac material went. The center of the log shows the wellbore, the perforation, and where the frac material went when it was introduced through the perforations.

Q. Let's take one of these as an example to illustrate for the examiner your conclusion, and simply pick one for us.

A. I think that one shown at the top log is on Turner "B" No. 86, one of the 22 infill wells that has been drilled. We see that that well was fracked in the Loco Hills interval the top of the Grayburg. We marked on here the top of the Grayburg and the top of San Andres, and even though the top perforations in the well, which is rather anomalous, normally the wells have not been productive immediately under the Grayburg; but we see that the frac material has not migrated above the top of the Grayburg in this well.

Q. Do you find that to be true in all the wells that you have examined that have been subject to the after-frac logging and the tagging of this radioactive material?

A. My analysis of after-frac logs has indicated

that in no cases of the 18 wells that have been logged thus far has there any indication that frac material has extended above or even to the top the Grayburg interval.

Q. How does this support your conclusion that the requested level of pressure limitation is one that can be safely approved?

A. There is no indication that injection at 1650 pounds would cause migration of fluids out of the application interval, the Grayburg-San Andres.

Q. Let's turn now to the step rate results. I think that's marked as Exhibit No. 8. There are three wells that are shown on Exhibit 8, and the information is tabulated for Well 47, 50 and 61?

A. These three wells, Turner "B" 47, 50 and 61, all located in Section 29, as described previously, were originally producing wells that were converted to injection in 1968 as a part of the Turner "B" Premier Flood expansion.

These wells have had injected volumes ranging from 1.8 to 2 million barrels of injected water per well. These wells were -- were chosen after consultation with the division and with the district office in Artesia. Perforations in these wells, in addition to the existing perforations in the Premier, were added in the Vacuum; the additional perforations in the Premier, the Square Lake,

the Metex and the Loco Hills. All of the new perforations were broken down with acid only. The new intervals, the new perforations, have not been fracked.

The wells were completed on a test basis, with the approval of the district and the division, for 30- to 45-day test. The wells were completed with a single string of tubing with the packer set above all of the perforations, and step-rate tests were conducted after approximately two weeks of injection into the wells.

The parting pressure indicated by the step-rates averaged 1208 psi, ranging from 1075 to 1300 psi, and the parting pressure plus the 450 psi requested would give an average of 1658 psi as the requested pressure.

Q. Do you have a basis upon which to conclude that these would be representative step-rate tests, if additional step-rate tests were taken in the expansion area?

A. It's my opinion that these step-rate tests will probably be low. The parting pressure will probably be low when -- because the part of the exposed interval is the Premier. This is what's injected into for 20-plus years, and was fracked initially and probably -- well, an injection has occurred for the 20 years in the Premier in flood life at pressures above the indicated parting pressures.

It's my opinion the parting pressure on the new zones, the new perforations, will probably be higher than what is indicated by these parting pressures; and hence, our request to be able to come back to the division in the future based on new tests to obtain higher permitted pressures.

Q. Do you think that these three wells are characteristic and represent typical examples of the step rate tests, if conducted on other wells in the expansion area, that have previously been completed and produced out of the Premier, would show similar results?

A. I think these are representative of what we see on all 12 of the wells.

Q. Let's talk for a moment about the fact that we've already produced out the Premier. If we inject -- explore the total interval, now, including the other zones in addition to the Premier at this higher injection pressure, do you have any concerns, as an engineer, that the increased pressure would propagate, if fractured; that the Premier would take that out of the pooling?

A. No, I have no concern that pressures as requested will cause any propagation of fractures in any horizon that will result in fractures out of the Grayburg-San Andres.

Q. Let's turn now, Mr. Hughes, to Exhibit No. 9.

What have you summarized on this display?

A. Exhibit No. 9 provides current information, ongoing injection in the Socorro Avon acreage. Number 1 indicates the Russell Turner, Turner "B" area, and we're speaking now of the Turner "B" area to the north or in Section 17 in the north half of 20, and the Russell Turner being in Sections 18 and 19. There are five wells which are currently being injected into, and the May averages for those wells are 535 barrels of water per day at an average injection pressure of 1744 psi.

Item number two indicates what is occurring in the Socorro Keel-West Phase 1 area; that for May 1991 for 13 injection wells indicate an average barrels per day per well of injection of 163, and an average injection pressure of 2,024 psi.

Q. How have you utilized this information to support your conclusion about the reasonableness of the pressure request?

A. Studying these wells and these waterflood areas, we have seen no evidence that the pressures and volumes that are indicated have caused any problems in terms of migration of injected fluids or reservoir fluids out of the injected intervals of the Grayburg and San Andres.

Q. Have you also studied, Mr. Hughes, whether or not there is incremental oil that can be recovered by

utilizing these injection wells for waterflood operation that cannot otherwise be recovered?

A. I have done some work in conjunction with Roy Williamson of William Petroleum Consultants, and those studies have indicated that -- as shown on Exhibit No. 10, that an incremental 2.3 million barrels of oil can be recovered under waterflood operations. These barrels would not be recovered if a waterflood -- a successful waterflood was not conducted.

Exhibit 10 is the profile of gross oil -- projected gross oil production in barrels per year. This was prepared by Roy Williamson of Williamson Petroleum Consultants.

Q. What assumption is made in this calculation concerning the surface pressure limitation?

A. It is assumed that a surface pressure limitation of 1650 psi, surface injection pressure, will allow the -- the proper flooding of the interval; that 1650 psi will be sufficient to conduct the flood. It's assumed that -- it's believed that the two-tenths of a psi for a further 650 pounds approximately would not allow for the injection of water; and therefore, these reserves would be unrecovered.

I will note that the total, as shown, the years, is 2.657 million barrels. That was -- that was calculated based on 22 completed patterns. The application area is 19

completed, and, hence, the number of 2.295 million barrels are applicable to this application.

Q. You have indicated that your project cannot be successful if you're required to maintain the .2 gradient. What is the impact on the project if you're only allowed to inject at the parting pressure?

A. We have monitored closely the injection into the three wells that we ran the step rates on, Nos. 47, 50 and 61. Exhibits 11, 12 and 13 are plots of the daily injection pressure and volume for each of these wells.

What we can see is that in the case of the first well, No. 47, that a surface injection pressure of 1400 pounds is occurring at this point, and this is after a total injection of only 13,000 barrels of water. In the case of Well No. 50, 16,000 barrels have been injected and our surface injection pressure is a thousand pounds; and in the case of 61, 19,000 barrels of water have been injected, and surface injection pressure is about 750.

The conclusion to be drawn from this is with very little cumulative water injected, the surface pressures are already approaching and, in fact, have exceeded the indicated parting pressures as found by the step rates.

Q. Avon has undertaken in this area an infill drilling program for the project?

A. That's correct. Avon has drilled 22 infill development wells, has conducted remedial workover operations on several of the old producers in the Turner "B" expansion area, and has cleaned out all of the old injectors in the expansion area; in fact, the 12 wells that are the subject of this application. Those wells and particularly the old injection wells were found to have a lot of solid material build-up in the wellbore, indicating the formation -- either the introduction of solid materials that would plug the formations, or the formation of solids due to the injection of unclean water.

Q. Your development on an infill leads you to what spacing pattern?

A. The infill development has resulted in 20-acre spacing.

Q. Have you plotted or tabulated the production from the project?

A. Exhibit 14 provides the production profile, average barrels of oil per day, per month, and indicates from the middle of 1990 until April of '91 a significant increase in oil production from less than a hundred barrels of oil per day to approximately 1900 barrels of oil per day. Since that time -- and this I would interpret to be the primary production in the vicinity of the new 22 wellbores. Since that time we've seen a decline in

production down to about 1100 barrels of oil per day. I would interpret this to be the depletion of the reservoir pressure, indicating that we have a tight formation and that we need to be injecting water for pressure maintenance and for water flooding operations.

Q. I direct your attention now to Exhibit No. 15, Mr. Hughes. This is the division form C-108, and this has been prepared and compiled under your direction and supervision?

A. That is correct.

Q. Let me ask you some summary questions about the C-108. Within the half mile area of review, have you tabulated all the wellbore information for not the only plugged and abandoned wells, but the producing wells that penetrate through the Grayburg-Jackson pool?

A. I have examined the records on 82 -- on each of the 82 wells within the subject area, within the cloud area. There is a map attached which indicates the area of study. 16 of the wells in the area have been plugged and abandoned, and a sketch indicating how the wells were plugged is attached. There is attached to this Exhibit 15 all of the requested data in the -- as required by the C-108.

Q. I don't propose to cover all that with you this morning. Let's hit the high points. Have you satisfied

yourself that you have a complete and accurate tabulation then of the wellbore data within the area of review?

A. Yes, I feel I do.

Q. Have you reviewed that information with OCD district office to identify problem wells for which remedial action will be required?

A. Yes. I reviewed it with district and division personnel and certain suggestions and requirements were made, and Avon has completed part of the work that's required in terms -- and this was primarily work to bring the top of cement further above the top of the uppermost perforation.

Q. Let's identify either the problem wells or the problem areas, and then have you describe what remedial action you have undertaken.

A. The problem wells, as identified in our discussions with the district and the division, were located in Section 29, and they are wells No. 68, 71, 55, and 60. Remedial cementing operations have been completed to the satisfaction of the district in 71. I believe that the work on 68 is in progress and nearing completion to the satisfaction of the district, and work will be conducted on 55 and 60 in the near future.

Q. Specifically what is required for each of those four wells to make them adequate for approval?

A. Perforations are at or near the existing top of the cement as determined by cement bond log or temperature survey, and then cement is pumped into the formations, squeezed into the angular space and is circulated up the hole to achieve the required 500-foot of coverage above the uppermost perforation. The cement is then drilled out and the wellbore returned to either production or prepared for injection.

Q. Those four wells represent the only problem wells within the identified area of review?

A. There is Well No. 56 in Section 30 that will require, when operations are conducted on it -- it's one of the wells that has not been worked on yet. As a part of cleaning out that well, the district has requested that a CBL be run on it -- the cement bond log -- and the top of cement determined. If additional remedial work or additional cement is required, then that will be done at that time.

Q. Any others?

A. I believe that completes the requirement, as I understand it, from the district and division.

Q. Summarize for us what you anticipate to be the source of the water used for the waterflood project?

A. All of the produced water will be cleaned and injected and makeup water, which will be fresh water

obtained from Ogallala source, approximately 10 miles to the northeast of the -- of the subject lease will be utilized. This is the same water, fresh water supply, that is being used by Socorro in the Keel-West area. Compatibility tests have been run with the produced waters and fresh water in varying ratios, both for the Keel-West produced water and the Turner "B" are produced water. No problems are indicated as to the compatibility of the mixing of those waters in either lease.

Q. Do you have a schematic showing the injection wells and their configuration for the project area?

A. I have attached the proposed perforations for six of the 12 wells in the expansion area. Avon is currently preparing proposed perforations for the other six.

The configuration, the mechanical configuration, of the completion will be initially tubing and packer set above all of the perforations. I would anticipate that because of the production -- the injection history into the Turner "B" Premier interval that some sort of a mechanical separation will be required to conduct a proper flood of the other productive horizons. This will be done mechanically, either utilizing multiple strings of tubing or -- and packers or utilizing a single string of tubing with multiple packers and flow injection regulators to

govern the volume of water to be put into each selected interval for injection.

Q. Have you made a search for sources of fresh water in the area?

A. Socorro has the rights -- owns the rights to 17,000 barrels a day of fresh water from the Ogallala in the area as mentioned to the northwest -- to the northeast; excuse me. As a part of the agreement between Avon and Socorro, Avon will be provided sufficient water to properly conduct the flood, using the fresh water as makeup and injecting the produced water.

Q. Do you have an approximate depth of the deepest producing fresh water in this vicinity?

A. Our studies, which were conducted for the Socorro application in May of 1990, indicated that there is no fresh water in the area of the Socorro-Avon acreage.

Q. Let's identify the offsetting operators to your project, and let's return to Exhibit No. 2, if we might. We provided notification of this hearing to Texaco, Inc. Show us where the Texaco properties are.

A. Texaco properties are located in Sections 28 and 21 to the east of Avon acreage.

Q. You provided notification to Marbob Energy Corporation. Where are their properties?

A. They're located in Section 30, in the west half

the of northwest quarter.

Q. The HEYCO acreage, where is this property?

A. HEYCO and Yates acreage is in Sections 31 and 32, south of the subject acreage.

Q. Notification was sent to Jack Plemons.

A. In the east half of the northwest quarter of Section 30.

Q. And then notification to Yates Petroleum.

A. In Section 32.

Q. And finally Socorro Petroleum.

A. In Sections 20, 19, 17, 18 and part of Section 30.

Q. Additional notification was sent to the Commissioner of Public Lands and the Bureau of Land Management concerning the surface. Would notification to those two agencies cover all the surface use for injection well locations?

A. Yes, sir.

Q. Did you receive any objection from any of those individuals or companies to your project?

A. I have seen no correspondence from any of the notified parties.

Q. In your opinion, Mr. Hughes, is approval of your application on behalf of Avon necessary in order to recover oil that would not otherwise be recovered?

A. Yes, it is.

Q. And can it be done without the violation of correlative rights of any of the offsetting operators or interest owners?

A. Yes, it can.

MR. KELLAHIN: That concludes my examination of Mr. Hughes. We move the introduction of his Exhibits 1 through 15.

MR. CATANACH: Exhibits 1 through 15 will be admitted as evidence.

(Avon Exhibits 1 through 15 were admitted in evidence.)

MR. KELLAHIN: If I may sometime later today, I will provide you with our certificate of mailing of notice to these people. We have the green cards back, and I simply neglected to bring the certificate this morning.

FURTHER EXAMINATION

BY MR. CATANACH:

Q. Mr. Hughes, I'm looking at Exhibit No. 2, and you show -- well, let me ask you this: What is your understanding of the extent of the Turner "B" project, which -- had all the formations been authorized to inject into?

A. It includes the north three-quarters of Section 20, and the south quarter -- the south -- south quarter of

Section 17 and the northwest of the southwest of 17. That is the Turner "B" lease that was part of the original order in 1967.

Q. So the north half of Section 20.

A. The north three-quarters of Section 20.

Q. North three-quarters of Section 20. The --

A. The south quarter of 17 running - the quarter running --

Q. The south half of the south half?

A. Yes, sir. And the northwest quarter of the southwest of 17.

Q. But you now show that to be included in the Russell Turner project; is that correct?

A. That is correct. It was a part of the original order in February of '67, along with Section 18, excepting the east half of the northeast, and Section 19, north half of 19. That was the original order that was set forward in February of '67.

And then the expansion of the order in October of '68 resulted in the Premier only flood, the south half of the south half of 20, all of 29, the southeast quarter of Section 30.

Q. So basically we've got one large waterflood, that Russell Turner and then you've got the expansion area?

A. That's correct.

Q. Are the -- will the Russell Turner and the expansion area be operated as one project or two separate projects?

A. Avon in their agreement with Socorro has the rights, and it's my understanding we will exercise the rights to drill to earn the rest of the area that we just described, the rest of the Russell Turner flood area. The mechanism within the agreement between the two entities is on a drill-to-earn basis. You drill an infill well and you basically earn the area around that that would complete that pattern. Avon has indicated that they intend to exercise their option to drill to earn and to earn the entire area of the Socorro acreage, which is in 17, 18, 19, 20 and 30.

So it will be operated as a single flood, but that will occur gradually over the next two or three years, according to the agreement between the parties.

Q. So you will acquire additional acreage as you drill new wells?

A. That's correct.

Q. That's going to play hell with the division trying to keep the two projects separate.

The 12 wells in the expansion area, have those wells already been approved for injection, all of those wells?

A. Those wells were originally approved for injection into the Premier only by the order of '68.

Q. But they were all permitted, all of them were permitted to inject?

A. Yes.

Q. Well No. 56 in Section 30, do you propose that be included in the expansion area at this time?

A. I would like to propose that -- that is in acreage that has not been earned by Avon but is a part of the 1968 Turner "B" expansion order.

MR. KELLAHIN: Let me make a comment. I'm perhaps not correct, but I think the plat is slightly confusing. My understanding of the prior order and injection well 56 is that the southeast quarter of 30 is already in an approved position, as far as the OCD is concerned. The map simply reflects the Socorro-Avon relationship and should not be misunderstood as the expansion area approved by the division. You've already approved the southeast quarter of 30, and the 56 well is already approved as to the Premier. So we think the outer boundaries of the expansion area are going to remain the same.

THE WITNESS: Right.

Q. (By Mr. Catanach) But it's not Avon's acreage?

A. Not yet.

Q. Mr. Hughes, I was involved in the pre-hearing

discussions with Avon and the district office, and it was my understanding that more than three step-rate tests were going to be required to substantiate the data you presented.

A. That is correct. It's my understanding that the discussions that you were involved in requested that six of the 12 wells have step rates. Two things have occurred since that time. There has been a lot of discussion with the district, and in fact the district had pretty strongly requested that only one well be injected into and a step rate, and Avon requested that at least three step rates be conducted. In addition, mechanical problems and approval of pipeline injection right of ways were not -- had not been received. It was indicated by the BLM that new archeological approvals would be required for the laying of the injection lines, which was required before injection could be conducted into any of the other nine wells. That has been approved -- approval has been obtained in the last 10 days on -- two additional approval has been obtained in the last 10 days for the pipeline rights of ways on two additional wells, No. 64 and 54. It's my understanding that Avon will conduct that work timely.

Q. Does Avon propose to conduct any more step-rate tests?

A. Avon feels that step-rate tests that have been

conducted are representative. If the division feels that additional step rates are required, Avon would certainly conduct those.

Q. Now, did you say you were going to use downhole regulators to control the rates or the flows into the separate strata?

A. That is one of the considerations. It appears that some separation will be required. The way that the three test wells are completed now is with a single string of tubing, packer set above all perforations. It's our feeling that the injected fluid during the step rate -- most, if not all it, went into the Premier, which had previously been injected into and previously been fracked and the completion -- Avon is currently working on the mechanical arrangement for the completions, but it will either be done with multiple strings of tubing and packers to isolate various intervals or with downhole flow regulators.

I'm not aware that that decision has been made yet. It will probably be -- that decision will be predicated on injectivity profiles which -- to my understanding, that Avon will be conducting in the near term. This was another reason for having the test period available on -- the 30- to 45-day test period available.

Q. Is Avon targeting a specific flow rate for each

of these wells or --

A. Flow rate or injection rate?

Q. Injection rate, sorry.

A. I have indicated in the C-108 a maximum injection rate or volume per well of 500 barrels per day, an average of 400 barrels per day; and this has been determined utilizing some projected withdrawals such that pattern withdrawals and injection can be matched, and therefore the flood properly managed. It may be that these numbers will turn out to be either too high or too low; and if so -- if Avon would need additional volume, they would come to the division to request it.

Q. What is the formation directly overlying the Grayburg in this area?

A. The Queen.

Q. The Queen.

A. The Queen series.

Q. What's the lithology of the Queen in this area?

A. The lithology of the entire section is dolomites and hydrates. I think the Queen itself -- and I'm not very familiar with it, but I think that it's probably a sand; but it's quite some distance up the wellbore the main Queen horizon, which is not productive in this area.

Q. You seem to be familiar with the Keel-West area somewhat. They've been injecting at that high pressure for

approximately a year?

A. Yes, sir.

Q. Have they done any infill drilling during that time?

A. There has been no infill drilling done to date. It's my understanding that Socorro has an infill drilling program proposed, and, in fact, have submitted applications to drill on -- I think about six wells; operations have not initiated yet.

Q. But they've seen no water of the zone in any of the area?

A. There has been no indication of any mechanical problem, any water out of zone.

Q. Mr. Hughes, did you actually run a frac hite log on one of these wells in the expansion area?

A. Two.

Q. Into the wells?

A. Turner "B" No. 84 and Turner "B" No. 85.

Q. Was the frac hite log actually submitted to the division or not, a copy of the frac hite log?

A. It is submitted here. I'm not aware it's been submitted previously.

Q. It is here?

A. A copy of the frac hite log is attached to --

MR. KELLAHIN: I think it's 7.

A. Exhibit 5 has attached the Schlumberg J frac hite log for No. 85. And the Atlas Wireline Service frac migration log for No. 84.

Q. (By Mr. Catanach) Now, as I understand it, you're asking 1650 pounds for all of the 12 wells?

A. That is correct.

Q. And you also requested an administrative procedure so that can be raised?

A. That is correct.

Q. Based on what?

A. Based on step rates, based on other operating information that becomes available as testing or injection is conducted. We may see that as injection is initiated that sufficient volumes of water are not being -- are not able to inject sufficient volumes.

Q. The reserve calculations that have been submitted as evidence, is that over the entire productive interval, including all of the Grayburg and San Andres formations?

A. Yes, sir.

Q. Mr. Hughes, were there any wells that were targeted by the district -- any P&A'd wells that had to be reentered or replugged?

A. There was a question on a well in Section 31, the Stogner or Stagner No. 2. It was initially indicated

that that well was within the study area. Subsequent information indicates that the well was misspotted on the map, using the information at the district, and that the well was outside -- is outside the half-mile area.

Q. You indicated that there is scarce fresh water in this area, or what have you determined to be that?

A. The results of the study that was conducted for Socorro for their application and subsequent order indicated no fresh water in any of the sections within the Socorro-Avon acreage, or any fresh water indicated in any of the surrounding sections. I think that the closest fresh water, as I remember the study, was in -- was about five miles -- four or five miles to the east, and I'm not sure what section. It seems to me like that was in Section 24. We can get and provide to you the results of that study. I do not have it with me.

Q. Mr. Hughes, how do you determine after the -- after you've started doing this, injecting the 450 pounds above frac pressure, how do you determine that you're not going to lose any water -- or you're not losing any water to any other formations, or that it's working that you want it to?

A. Well, I suppose the most obvious indication that it's working will be the response that's expected. I think that if we had wells that -- that we had a question about,

maybe we weren't seeing the response, we would run injectivity profiles or temperature surveys, which would indicate if we have water being injected into and going out of zone. Proper management of the waterflood will require certainly that we run injectivity profiles, and from those we can see where water is going. If we have a question, I'm certain that we want to know the answer; because if the water is not staying where we want it to, the flood is not going to work.

MR. CATANACH: I believe that's all I have at this time. You may be excused.

Mr. Kellahin, I would like to get a rough order from you.

MR. KELLAHIN: Smooth rough or rough, rough?

MR. CATANACH: Smooth rough. Is there anything further in this case?

MR. KELLAHIN: No, sir.

MR. CATANACH: There being nothing further, Case 10290 will be taken under advisement.

(Whereupon, the hearing was concluded at the approximate hour of 10:07 a.m.)

* * *

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

REPORTER'S CERTIFICATE

I, Susan G. Ptacek, a Certified Court Reporter and Notary Public, do HEREBY CERTIFY that I stenographically reported the proceedings before the Oil Conservation Division, and that the foregoing is a true, complete and accurate transcript of the proceedings of said hearing as appears from my stenographic notes so taken and transcribed under my personal supervision.

I FURTHER CERTIFY that I am not related to nor employed by any of the parties hereto, and have no interest in the outcome thereof.

DATED at Santa Fe, New Mexico, this 18th day of October, 1991.

Susan G. Ptacek

SUSAN G. PTACEK
Certified Court Reporter
Notary Public

My Commission Expires:
December 10, 1993

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 10290 heard by me on August 8 1991.

David R. Catanach, Examiner
Oil Conservation Division