BEFORE THE

Oil Conservation Commission

SANTA FE, NEW MEXICO

April 18,1956

IN THE MATTER OF:

CASE NO. 1052

TRANSCRIPT OF PROCEEDINGS

ADA DEARNLEY AND ASSOCIATES

COURT REPORTERS

605 SIMMS BUILDING

TELEPHONE 3-6691

ALBUQUERQUE, NEW MEXICO

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
April 18, 1956

IN THE MATTER OF:

CASE NO. 1052: Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico. Operators are requested to furnish all available production data, reservoir data, and any other pertinent information in order to determine if the present existing system of allocation in the Denton (Devonian) Oil Pool might result in waste and to enable the Commission to establish the proper producing rate.

BEFORE:

Honorable John F. Simms, Jr.,
Mr. E. S. (Johnny) Walker,
Mr. A. L. Porter.

TRANSCRIPT OF HEARING

MR. PORTER: We will move on to Case No. 1052.

MR. GURLEY: Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico.

I would like to read a letter into the record of this case dated April 5th, 1956, addressed to Mr. R. E. Howard, Atlantic Refining Company, P.O. Box 871, Midland, Texas.

"Dear Mr. Howard: Reference is made to your letter of March 22, 1956, in which you request continuance of Case 1052 from April 18th to a date in June, 1956. It is noted that your request is made on behalf of the operators in the Denton Pool, subsequent to a meeting of the operators held in Midland, Texas, on March 20, 1956. You

letter further indicates that a study of the pool is being made at this time which would make available considerable information which would be of value in the case.

"In consideration of the foregoing, I will recommend to the Commission that the case be continued to a definite date in June. In the meantime I am sending a memorandum to all operators in the pool directing them to take gas-oil ratio tests on all wells in the pool between the dates of April 10th and May 10th, 1956, and report them in the usual manner to the Commission not later than May 25th, 1956. These tests will serve as the regular annual tests which were previously scheduled for August and September, 1956.

"We shall expect your full cooperation in the matter to insure that disposition of the case will be made in June.

"Very truly yours, A. L. Porter, Jr., Acting Secretary-Director."

MR. PORTER: Are there any statements from any interested parties at this time concerning Case 1052?

For the record, the memorandum which was referred to in the letter just read was sent to all of the operators in the Denton Pool, requesting, or directing, that gas-oil ratio tests be taken between the dates of April 10th and May 10th, and reported not later than May 25th, which should give us time to get that information in and for the Pool Committee to continue and complete its study.

We would like to insist, however, that all parties who are interested in this case, in presenting testimony, be ready by June 14th, to which date the case will be continued, June 14th being the regular hearing date for that month.

MR. GURLEY: The reports on that, Mr. Commissioner, are to be made not later than May 25th, is that not correct?

MR. PORTER: Gas-oil ratio tests are to be filed not later than May 25th.

-- - - --

STATE OF NEW MEXICO)
: ss
COUNTY OF BERNALILLO)

I, THURMAN J. MOODY, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the Oil Conservation Commission for the State of New Mexico was reported by me in stenotype and reduced to typewritten transcript by me and/or under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal, this, the 25th day of April, 1956, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Thurman J. Moody
Notary Public.

My Commission Expires:
April 3, 1960.

BEFORE THE

Oil Conservation Commission

SANTA FE, NEW MEXICO

June 14, 1956

IN THE MATTER OF:

CASE NO. 1052

TRANSCRIPT OF PROCEEDINGS

DEARNLEY-MEIER AND ASSOCIATES
COURT REPORTERS
605 SIMMS BUILDING
TELEPHONE 3-6691
ALBUQUERQUE, NEW MEXICO

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Before the
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
June 14, 1956

IN THE MATTER OF:

Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico. Operators are requested to furnish all available production data, reservoir data, and any other pertinent information in order to determine if the present existing system of allocation in the Denton (Devonian) oil pool might result in waste and to enable the Commission to establish the proper producing rate.

Case 1052

BEFORE:

Honorable John F. Simms
Mr. E. S. (Johnny) Walker
Mr. A. L. Porter

TRANSCRIPT OF HEARING

MR. PORTER: The next case on the docket is Case No. 1052. Mr. Gurley, will you read it briefly?

MR. GURLEY: "Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico. Operators are requested to furnish all available production data, reservoir data, and any other pertinent information in order to determine if the present existing system of allocation in the Denton (Devonian) oil pool might result in waste and to enable the Commission to establish the proper producing rate."

If it please the Commission, at this time, on behalf of

the Commission's staff, I would like to have Mr. Dan Nutter make a statement into the record.

MR. NUTTER: I would like to make a brief statement regarding the Denton Pool and the reasons for which the Commission called this hearing.

This pool was discovered by McAlester Fuel Company Denton #1, located SW/4 SE/4 Section 15, Township 11, Range 37, September 26, 1949.

Since that time some 121 wells have been drilled to the Devonian in the immediate area, of which 109 are presently producing from the pool.

Your attention is called to the production chart on the wall here. You will note that the pool's monthly oil production, as indicated by the black line on the chart, started climbing upward in early '51 as the pool was developed. The pool had pretty well reached its peak rate of production by early '55, and since that date has rocked along at a rather uniform rate, discounting differences in the number of days per month pipeline prorationing and back allowable.

Water production in the Denton Pool, as indicated by the red line, which incidentally is on a different scale than the Oil production, did not experience any significant increase until early 1954. It has increased rather sharply since that date, however, and the pool produced 135,000 barrels of water in March, 1956, while it was producing approximately 700,000 barrels of oil.

Speaking of water production, it is interesting to note at this point that 61 out of a total of 109 wells, or 56% of the wells, reported water on the GOR tests concluded last month.

28 wells, or 25.7% of the total, reported water amounting to 10% or more of the oil production. These wells making water are not confined to the edges of the pool or the lower parts of the structure. Rather they are to be found on the flanks, on both ends and at the top of the producing formation.

That in essence is the reason for the call of this hearing. The Commission and the staff took a broad overall view of the producing history of this pool and decided that there is a possibility that an undesirable situation exists whereby one of the best pools in the state will be damaged by a rate of production which is too high to sustain proper bottom hole pressures and avoid undue water encroachment, fingering and/or coning. We know that many of the wells have watered out, been plugged back and reperforated and restored to top allowable. I frankly feel that this has been a source of waste -- that every time a well is plugged back some of the oil is left behind.

We also realize that the Denton Devonian reservoir is a complex system, and that only a thorough study can give the answer. That is the reason for the call of the hearing.

MR. SELINGER: On behalf of Skelly Oil Company, we wish to concur in the statement that Mr. Nutter just made.

MR. PORTER: Thank you.

MR. HINKLE: If the Commission please, Clarence Hinkle of Hervey, Dow and Hinkle, Roswell, appearing on behalf of Atlantic Refining Company. I would like to make a brief statement before offering any testimony.

The notice published in connection with this case requests the operators in the Denton Devonian Field to furnish all the

reservoir data, production data, and pertinent data to the Commission in order to determine if the present condition might result in waste, and to help the Commission establish a proper producing rate.

At the outset, I would like to point out that most of the exhibits that the Atlantic proposes to present have been prepared by an engineering committee representing the operators in the Denton Devonian Field, and consequently represent factual data and information compiled through the joint efforts of most of the operators in the Field. In addition, Atlantic will present its own interpretation.

With regard to the statement of Mr. Nutter, which he has just made, I think the evidence will show, that we propose to introduce, that the water encroachment in this field is not unusual, it is more or less normal for a field of this characteristic.

I would like to call Mr. Tomlinson as a witness.

W. P. TOMLINSON,

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. HINKLE:

Q State your name, please.

A W. P. Tomlinson.

Q By whom are you employed?

A By the Atlantic Refining Company.

Q In what capacity?

A As petroleum engineer.

Q And as a reservoir engineer?

A Yes, sir.

Q How long have you been employed in that capacity?

A Seven years.

Q Have you previously testified before the Conservation Commission?

A Yes.

MR. HINKLE: Are the qualifications of the witness accepted?

MR. PORTER: Yes, sir, they are.

Q Mr. Tomlinson, have you made a study of the Denton Pool, particularly the Devonian formation?

A Yes, sir, we have. Actually, the first study of the Denton Pool began in 1951. It was a study that was projected to furnish data for the construction of a gasoline plant--

Q Let me interrupt you there, was the study made by you individually, or was it by an engineering committee for the operators in the field?

A It was made by an engineering committee on behalf of the operators.

Q What was the purpose of appointing the engineering committee, the primary purpose?

A The primary purpose was to ascertain the supply of gas available and to predict future rate of production.

Q In connection with the erection of a gasoline plant?

A Of the plant, yes.

Q What was the work of the committee, or what kind of work did that committee perform at that time?

A That committee studied both the Devonian and Wolfcamp reservoirs. At that time data was not as available as it is today,

and it did not have the scope of this work. However, it did forecast rates and available supply of gas, was actually the scope of the work.

Q Did they establish any percentages of participation for the purpose of erection of the gasoline plant?

A That was an additional duty assigned to the engineering committee, and they did calculate equities for each operator in the field, so that they might go ahead with the plant.

Q Did that committee make a recommendation to the operators committee, and was the plant established on the basis of their recommendation?

A Yes, sir.

Q Subsequent to that time, and the erection of the gasoline plant, has any additional engineering committee been appointed by the operators in the field?

A Yes, sir. I would like to enlarge a little bit. That engineering committee that was established in 1951 continued to function until March of 1955 at various times. Then, to answer your question, we established another engineering committee for the purpose of determining the optimum methods of operation of both the Devonian and Denton Wolfcamp reservoirs on January 10, 1956.

Q Were all of the operators represented in connection with the appointment of this committee?

A All were invited; certain operators who have very small interests in the reservoir do not feel that they can participate.

Q Who was made chairman of that committee?

A Atlantic has acted as chairman of the committee.

Q By reason of the fact that it was one of the largest operators in the field?

A Yes, sir.

Q I believe you stated that most of the operators have been represented in connection with this committee?

A Yes, sir, all operators who operate wells have been represented at one time or another.

Q Have most of them taken an active part in connection with this committee?

A Yes, sir.

Q They have joined in the work of filing the data of the committee?

A Yes, sir.

Q Did you serve on both committees that you have referred to?

A Yes, sir.

Q I assume that several of the members of the present committee also served on the previous committee?

A Yes, sir, they have.

Q What was the scope or work of the last committee, which you state was formed on January 10, 1956?

A It was actually, the primary purpose was to determine the optimum method of operation of the two reservoirs. Now in March of this year, we received notice from the Commission that they planned a hearing to review the operating conditions in the field to the Devonian reservoir.

Q The committee had already performed some work prior to your receiving notice of this hearing?

A Yes, sir, we had started work on both the Devonian and

Wolfcamp. However, at the time that we received notice of the hearing, we suspended work on the Wolfcamp and concentrated our efforts, all our efforts on the Devonian. At the time, or rather shortly thereafter, we received the notice of the hearing, the committee was responsible for coordinating the bottom hole pressure survey in the field which was conducted during the first part of April. We went ahead and assembled basic data which we thought might be pertinent to our study, and also the data that we thought might be useful to the Commission in providing background information. After we had collected the data, we arranged it in exhibits and some analyses have been performed by Atlantic subsequent to that time.

Q Did you make an analysis of the past performance of the Devonian reservoir?

A Yes, sir.

Q Did you also make a prediction of the performance of the reservoir projecting --

A (Interrupting) Yes, sir.

Q For how long a period?

A We projected that for two years.

Q Did you also make an analysis of the individual well performance to determine factors affecting water encroachment?

A Yes, sir.

(Atlantic Exhibits Nos. 1 to 25 inclusive marked for identification.)

MR. HINKLE: If the Commission please, we have put on the walls here 25 exhibits, and they have all been marked from 1 to 25. The witness will refer to them in the order in which they are

numbered, and after he has gone through the whole thing, I would like to defer offering them in evidence and offer them all at once at the conclusion of the testimony. I think it would save time.

MR. PORTER: I think that would be satisfactory, Mr. Hinkle.

Q Now, Mr. Tomlinson, you stated that a lot of maps and data were prepared by this committee. Are those the maps which are or have been referred to here as Exhibits 1 to 25?

A Yes, sir.

Q Have all of the members of the engineering committee of the Devonian Field had an opportunity to go over these maps, and have they approved them?

A Yes, sir. They have all reviewed them.

Q Have these exhibits been presented to the operators' committee of the Devonian Field?

A Yes, sir.

Q Have they taken any action either pro or con?

A They were viewed and since it was an original directive of the operators' committee for the engineering committee to prepare such exhibits and data, we presented them and they accepted them without objection.

Q I would like to make a correction there. I believe that the first 24 of the exhibits are the work of the committee and 25 is your own, is that not right?

A Yes, sir, there is one additional exhibit which we will point out when we get to it.

Q Which is No. 25. Mr. Tomlinson, I wish you would refer to Exhibit No. 1 and state to the Commission what it is and what it shows. It might be advisable for you to go to each exhibit and

point out, in connection with your testimony, anything that you would like to.

A Exhibit No. 1 is a structure map contoured on top of the Devonian formation. You will note that the Denton Devonian structure is a domal feature, elongated in the north-south directions. The productive limits include an area approximately five miles long, two miles wide at the broadest point, and it has an areal extent of approximately 4900 acres. The reservoir is found at a depth of approximately 12,500 feet. The maximum closure is found on the southern end of it where the flanks dip at an angle of approximately 35 degrees. The structurally high area in the north has lesser relief and dips at an angle of approximately ten degrees.

One well in the Denton Field has penetrated all of the Devonian reservoir and the siluro-Devonian interval lying immediately below it. It encountered rock from 1300 feet of section. Several other wells have penetrated approximately 1000 to 1200 feet into the interval and were bottomed in a zone which may be presumed to be the Fusselman. A gross thickness of 1100 feet is arbitrarily assigned to the Devonian in this locality.

Drill stem testing early in the life of the reservoir established the water-oil contact at 8915 feet subsea. I think that has generally been accepted since that time as being the original contact. In this area some of the water-oil contact lies below what may be considered to be the base of the Devonian; in other words, there is a siluro-Devonian knob that may stick up in the bottom of it. This reservoir did not have a gas cap and it was considerably under-saturated originally.

Q Mr. Tomlinson, what are the physical characteristics of the reservoir rock of the Devonian Formation?

A The matrix rock of the Devonian is a dense crystaline dolomite having numerous fractures and vugs. Good correlation of pay intervals cannot be noted by examination of logs and core data and consequently data presented here pertains to the gross section of the reservoir.

Analyses have been made of 2706 feet of Denton Devonian core taken from 9 wells. The average porosity of the gross section was calculated to be 2.86%. An attempt to determine the average permeability from the core analysis was not pursued extensively; however, from pressure build-up data, it has been estimated that the average permeability is in the order of 5 to 10 millidarsis. Capillary pressure data for one group of core samples indicate the average water saturation to be approximately 40%. It is thought the water saturation in the fractures and vugs will be near zero, while the less porous and permeable rock, which will contribute a considerable portion of the oil ultimately produced, has a high water saturation.

Q Now, referring again to Exhibit 1, which is the structural map, does that reflect any faulting?

A No, sir, as this map is contoured here, you cannot find any faulting on it. That is the conventional method of contouring, I believe.

Q Refer to Exhibit 2 and tell the Commission what it is and what it shows.

A Exhibit 2 is a cross-section index. We have prepared several cross-sections in this field, two major north-south cross-

sections lying in the end, and three running from west to east. Cross-section A to A-prime is this short one here. It is in the lower end of the Field where higher relief is noted. Cross-section B to B-prime is this one right here, going through a little wider section of the reservoir, and is noted as less relief shows on that one. Cross-section C to C-prime is this one; it goes through the wide portion of the north part of the field and shows considerably less relief. These lines are connecting points between the top of the Devonian. D to D-prime is this cross-section on the bottom; it shows it dips off a little bit on the very north edge of the field and has a high point here and then has a tendency to have a saddle. That is a cross-section that continues on to E to E-prime right here, and you can see that it rises up from that point coming up to the highest portion of the field, and dips off fairly steeply on the south.

Those cross-sections are useful in that they do picture the shape of the reservoir. They are drawn to equal scales both horizontally and vertically. The scales are one inch equals 200 feet. We have put some completion data on these maps; they consist principally of initial potentials and some use intervals are noted on there among the various other information. The logs are either radioactive logs or electrical logs.

Q Is there any further statement you wish to make in regard to Exhibits 3 through 7, cross-sections?

A I would say those exhibits do not show any faulting. We have looked for faulting on these and have not been able to detect it any place where we can prove there is faulting.

Q What are the characteristics of the fluid found in the

Denton Devonian Formation?

A We have had access to four fluid analyses obtained from the Devonian Reservoir. We have selected one fluid analysis as being representative of all of them. They are all very similar. This particular fluid analysis was obtained from the McAlester Fuel Company's J. M. Denton A No. 1 well in 1949. That was shortly after the field was discovered. The average gravity of the oil is 44.7 degrees API. The average gravity of the gas is 1.031 specific gravity. The salinity of the water is 31,000 parts per million chlorides. The reservoir, as I have stated before, was initially undersaturated. The saturation pressure for this fluid analysis is 2,665 psig. The solution gas-oil ratio was 1116 standard cubic feet per barrel at 2,665 psig. At 300 psig the solution gas-oil ratio was 255 standard cubic feet per barrel. The formation volume factor is 1.688 at the low point pressure of 2,665 psig. It has a formation volume factor of 1.278 at 300 psig. The viscosity of the oil is 0.35 centipoise at 4800 psig and 169 degrees Fahrenheit. It has a viscosity of 0.32 centipoise at 2665 psig and 169 degrees Fahrenheit. It has a viscosity of 0.44 at 1100 psig and 169 degrees Fahrenheit. Viscosity is 0.56 centipoise at 300 psig and 169 degrees Fahrenheit. The compressibility of the saturated oil at 169 degrees Fahrenheit from 5,000 psig to 4200 psig equals 12.75 times 10 to the minus 6 volumes per volume per psi; from 4200 psig to 3400 psig the compressibility is 15.13 times 10 to the minus 6 volumes per volume per psi. From 3400 psig to 2655 psig, is 19.46 times 10 to the minus 6 volumes per volume per psi.

Q Mr. Tomlinson, do you have any information concerning the

reservoir temperatures and pressures?

A The original reservoir pressure was measured in the McAlester discovery well shortly after its discovery at 5,009 psig at 8200 feet subsea datum. The original reservoir temperature was 169 degrees Fahrenheit at 7901 feet subsea. Now in connection with the reservoir pressures, we have included a bottom-hole pressure map --

Q (Interrupting) What exhibit is that?

A That is Exhibit 8. On Exhibit 8 is an Isobaric Map for the April, 1956 bottom-hole pressure survey. The contour intervals on here are 100 psig. The field datum is at 8200 feet subsea. Those wells as other surveys in the past were shut in --

Q (Interrupting) Let me interrupt you there. When was this survey made represented by the isobaric map?

A It was made in April, 1956.

Q Was the whole survey made at substantially the same time?

A At substantially the same time.

Q Under the same conditions?

A Yes, sir.

Q And all the wells were tested alike?

A Well, it was the intention of all the operators to test the wells alike, and the minimum shut-in time of 40 hours was established; some may be slightly over that. These lines on here are connecting points of equal pressure in the reservoir. For example, we have one well down here that had pressure of 4400 pounds. We feel that the pressure around there is 4400 pounds, others near it were in the range of 4300, 4200, 4100 and so on. Pressures on this side are actually ranging from around 3700 pounds

up to 4400 pounds.

Q Explain to the Commission what the red area reflects.

A Well, the red area delineates a strip through the field approximately one location wide in which we do not feel that we had enough pressure information. This is not through any fault of the operators, it is simply because we are on forty-acre spacing here. We noted a very sharp gradient between these two parts of the field. This gradient ranges in the order of 12, 1400 pounds in most places. I have already stated that the west side of this reservoir has the range of pressure from 3700 to approximately 4400 pounds. The pressures on this side range from approximately 2200 pounds up to around 27, 2800 pounds, except in a small portion here, which is a little higher. We believe that that is indication of an effective barrier to movement of fluid in the reservoir. We have drawn this red line through here because we do not know exactly where this barrier is. It may be very near this side or it may be further over here. We would point out that it can be in there. I would like to remind you that we did not see on any of the other maps or cross-sections, but we do feel that this is self-evident, that we have a very effective barrier across there. It is further evident that this fluid is not migrating from the high-pressure side to the east side where it has a low pressure and the fact that right along near this barrier we see several of the lowest pressures on the east side. Now if we had the situation of fluid migration, of replenishment of fluid into the east side from the west, we would have this being the highest pressure area in the east side and this grading off, but such is not the case. It appears from this that it's very

effectively sealed off.

MR. NUTTER: Could you tell me, Mr. Tomlinson, what the boundaries of the red interval are, do they follow pressure lines?

A No, sir, they don't. They are drawn through that gradient area between wells that are nearest to the gradient. In other words, those are the nearest pressures we have. We know the barrier is somewhere between there. We did not try to pin it down. There is a reason for this ignoring the pressure lines; actually, we don't know exactly where those pressure lines fall among these wells. There is one well in the east side which is anomalous to the interpretation we placed on here, that is the Magnolia Hope No. 10. That well has a pressure of 3,438 psig field datum. On past surveys it has shown pressures of the same order considerably above the other pressures. As these pressures over here begin to drop, this well remains high, so that it always appeared as an anomaly. We ignored that in contouring this map, but because we felt that it actually did not represent a true picture of the pressure conditions in the east side. We will talk a little more about that well later and show how it is anomalous in other ways.

Q Refer to Exhibits 9, 10, and 11 and show what they show.

A Exhibit No. 9 is a plot of oil, water and gas-oil ratios, number of wells, cumulative oil production and bottom hole pressures versus time. Now the red line here is the monthly oil production. The blue line is the monthly water production. I believe that is plotted to the same scale here as the oil production. The gas-oil ratio is the black line in the middle and shows that the ratio has been essentially constant between 800 and 1000 cubic feet per

barrel over the last three years. The number of wells is this line here, it shows it has pretty well reached a peak. It is the number of wells on production rather than the number that have been drilled in the reservoir. At the present time there are approximately 109 wells. Now this shows a fairly gradual decline in bottom hole pressure of the reservoir as a whole. We feel that this map, this graph may be a little bit misleading. We would like to explain to you Exhibit 10, which is the same information plotted for the west sector of the reservoir. The west sector of the reservoir shows that it has monthly oil production at the present time in the neighborhood of 325,000 barrels. Monthly water production in the neighborhood of 90,000 barrels. The gas-oil ratio for the west side has remained constant throughout 1952, '53, and '54 and '55. The bottom hole pressure, you can see, is a little flatter here, it shows a leveling tendency in here. We believe that is indicative of quite a bit of water drive in the west sector. The east sector's data is found on Exhibit 11. It is the same plot as we have explained on the other two. You can see here that water production is comparatively low and we believe most of that is coming out of one well in the east sector. The gas-oil ratio ranges between eight to nine hundred cubic feet per barrel. The current oil production on a monthly basis is around 375 barrels. This sector was developed a little later than the west sector, but it was essentially developed by the middle of 1955.

Q Mr. Tomlinson, do those performance charts show any abnormal condition for a water drive field?

A I do not believe they do. It is my opinion they don't.

Q I believe you mentioned that most of the water on the east sector was coming from one well?

A That is the Magnolia Hope No. 10. I understand that it has a water percentage of 87%.

Q Is that normal or abnormal condition?

A Well, that is abnormal for the east sector. Certainly it is out, and surrounded by wells that produce little or no water.

Q Is that the same well you pointed out previously as being an anomaly?

A Yes, sir, that is the one that has a high bottom hole pressure and has had over a period of several years.

Q Now, if you refer to Exhibits 12, 13, and 14 and state to the Commission what they show.

A These exhibits show some of the information that has been plotted on the other three preceding exhibits. We feel that the total field exhibit, which is this long one here, does not necessarily represent the true picture of operations, since we have explained that this field is actually behaving as if it consisted of two reservoirs; so I believe I will pass that up and just concentrate on these other two. Now, this is the west sector of the reservoir and is plotted on the same scale as this. If it looks a little strung out and if you plot on the cumulative basis, they fall close together.

Q Let me interrupt you, they plotted against time?

A Plotted versus cumulative oil production. We have plotted bottom hole pressure, gas-oil ratio, and water percentage in this case. The others showed water production in barrels. This is actually percentage here. The monthly oil production is shown as

the red line; it has been constant for some time. The gas-oil ratio has been constant over a large part of the producing life, and you will note that the water production has been with us for some time in small amounts and has shown a gradual increase. The bottom hole pressure curve shows a very little flow to it. We believe that indicates that a lot of water is replacing produced oil in the west sector. The average weighted bottom hole pressure for the west sector in April was 3,855 psig. That is a decline of about 1150 pounds from its original. That still has approximately 1200 pounds to go before it reaches that first place. The east sector has the same information plotted for it on Exhibit 14. You will note that this oil production is essentially leveled off here and no more development going on in the east sector. Gas-oil ratios have leveled off as pointed out on the other exhibit, and water production is on the order of five to six percent, I believe, on this one. On the west sector the water production is around 20% at the present time.

Q What is the average bottom hole pressure for the east sector?

A The east sector is 2,638 psig. That is approximately 30 pounds below the bubble point pressure, 2,655 psig.

Q Is the gas-oil ratio in either the east or west sector increasing or decreasing?

A They are remaining constant.

Q Pretty well stabilized?

A Yes.

Q Now, Mr. Tomlinson, refer to Exhibits 15, 16 and 17 and explain to the Commission what these are and what they show.

A I believe you have those. Exhibit 15 is a tabulation of the same information that we have presented on our graphs for the total field. It contains some additional information and that additional information, I believe, is the cumulative water production and cumulative gas production.

Q These show essentially the oil and gas, water production rates for the entire field and then for the east and west sectors, is that right?

A Well, the next two exhibits show the oil, gas, water production rates for the east and west sectors.

Q That is 16 and 17?

A Yes, sir. I don't think that these tell anything that we haven't pointed out already.

Q Now refer to Exhibit 18 and explain to the Commission what that shows.

A Exhibit 18 is a summary of productive index tests in the Denton Devonian Reservoir. There have been tests of 42 wells that have indicated productivity indices ranging between 0.0483 and 56.0 barrels of oil per day per psi drop in bottom hole pressure. The average of the latest productivity index test for the wells shown here is 3.426 barrels of oil per day per psi drop. I believe that is about all that shows. It does show a considerable range.

Q Do you have any other statistical data on the field, other than shown by the exhibits you have already referred to?

A I have some statistical data that pertains to the current status of the reservoir. The oil production for April, 1956, was 22,557 barrels per calendar day. Now, I believe that that possibly

may be shown on some of the closure that the Commission engineers have as being for March. I believe that is an error and should be shown as April. The cumulative oil production at May the 1st, 1956 is 28,644,415 barrels. The cumulative gas production, 24,888,015 MCF. The average weighted gas-oil ratio during April, 1956 was 880 cubic feet per barrel. The water production for April, 1956 was 14.4 per cent of total liquids. Our latest information based on the gas-oil ratio testing that was performed during May is that 88 wells are flowing, 19 are on artificial lift and 2 are shut in. The June, 1956 proration schedule shows that 88 are top allowable and 19 are limited capacity. Two of the wells that are shut in, I believe, don't have an allowable. The majority of the wells in the field were completed by cementing casing at total depth and perforating for production. Those that were not completed in that manner were completed in open hole either by setting casing at the top of the pay or in some cases near the middle of the Devonian section. Most wells were,acidized upon completion. Major workover operations have been performed on 19 wells, principally for the purpose of eliminating or reducing water production.

Q Now refer to Exhibit No. 19, I guess that is there. Explain what Exhibit 19 shows.

A Exhibit 19 is an indexed cross-section diagram. You can see that we have constructed several cross-section diagrams. Now those cross-section diagrams were drawn to scale but they are not to the same scale horizontally and vertically, since we are not attempting to depict the general outline of the top of the Devonian. I believe I can best explain those by using Exhibit 20 which is cross-section A to A-prime. That is a cross-section running

from south to north. Cross-section B to B-prime which will be next will be one, two locations east of it running from, also from south to north. Now, exhibit A to A-prime is constructed in the manner of all of these cross-section diagrams. We have shown producing intervals on subsea basis and we have shown them in relation to their original water-oil content. The top of the Devonian is connected by the black lines and the top of the Devonian we have indicated the water production that was obtained by testing during May on the GOR survey. Now, this well on the south has been worked over twice, originally in that well was producing here, and I believe it has been plugged. I think they had water obstruction trouble, was plugged back and was eventually plugged back to the Wolfcamp. This well here, which is also very near the south edge of the reservoir, south end of the reservoir, was first plugged back here and then to here. Currently, it produces 28% water. The bottom of its producing interval is some, it's approximately six to eight hundred feet above the water-oil contact. The next well north of it is the Ohio Denton No. 5 and that is its producing interval and you will note that it is considerably below this other well, yet it produces less water, 17%. Now, this well here, the Ohio Denton No. 4 actually does not make any water. There appears to be some movement of water in this particular place in that map.

The next well north of that is only a hundred feet or so above the water-oil contact. It is producing very close. It doesn't make any water. The next one is still lower, doesn't make any water. This one is zero; you can see how close it is. The next one here is open hole and that is total depth of it; it doesn't

make water, either. This one right here makes 6% water, and it is producing very near the water-oil contact. On this map it is shown to have a plugged back depth. However, that plug was left in the bottom of the pipe with the pipe cemented in the hole. There never has been a major workover on the well. This well has had a record of water production of from around zero up to five, possibly seven or eight percent for several years. It is not increasing.

MR. NUTTER: Which well is that that you are referring to now?

A That is Atlantic State P No. 2. Water will fluctuate in the well, but generally it remains around 6%. The Skelly State F No. 1 is perforated very near the water-oil contact, in fact it looks right here as if it is perforated down to water-oil contact. It makes 1% water. This well is somewhat higher. It makes zero percent. We don't have any figures on this one. This one makes 5%. This one, 1%, 0.3%, and zero. All of those wells, as you can see, are considerably below this one right here.

MR. PORTER: Mr. Hinkle, before he starts on another exhibit, I believe our reporter has had a pretty long day. I think this would be a good stopping point.

The hearing will recess until 9:00 in the morning.

(Recess).

MORNING SESSION

June 15, 1956

MR. PORTER: The meeting will come to order. We will proceed with Case 1052. Mr. Hinkle.

DIRECT EXAMINATION (Continued)

By MR. HINKLE:

Q Mr. Tomlinson, when we recessed yesterday, I believe you were explaining to the Commission Exhibit No. 20. Had you finished your explanation of that exhibit?

A I would like to summarize what I believe this exhibit shows and what the others show, and that is that the water encroaching in the field is coming from the edge, and in this case this is from the south end of the field. I point out that this losing interval was plugged back to that point. Numerous others here, here, in here near the line showing the original water-oil contact, and also to point out one additional feature, that there may be wells shown making small percentages of water. Those wells are not considered significant in our analysis because the matrix rock in the Denton Reservoir is relatively tight. It has permeabilities ranging from, oh, from zero up to several hundred millidarsis. A number of these wells have a lot of that low permeability pay in there and it is characteristic of low permeability pay to have a high water saturation in the pores of that pay, and there is a tendency when wells are produced, this water will work out along with the oil and contribute a small constant water percentage. That water percentage should not be regarded as water from the aquifer. Only when, in this field we feel that only when water percentage rises up to

values of 10% or higher that it is significant.

Q Turn to Exhibit No. 21 and explain to the Commission what that says.

A This is an exhibit B to B-prime cross-section diagram, went along the east side or near the east side of the structure, running north and it goes more through the middle of the structure as it gets to the north. You'll see several of these wells here making some water, because they are fairly close --

Q (Interrupting) You are now referring to Exhibit 21?

A Exhibit 21, that is correct. You will see that several wells do make water here. Here is one on the south end, McAlester McClure No. 1-C, that makes 24% water; this is the bottom of the producing interval in that well. That is fairly close to the water-oil contact, but it is also on the edge. Here is one that is completed a little bit lower, originally it was a little bit lower and has been plugged back; that well is producing from this interval here and does not make any water at the present time. This well has been plugged back.

MR. WALKER: It is going to make the record a lot better if you would identify the well.

A That's a good point. Ohio Denton 7 has been plugged back to a higher level and shows 19% water. The Phillips Denton No. 2 is completed fairly low and produces 21% water. The Phillips Denton No. 9, according to our information, is actually perforated a little below the water-oil contact; that well makes 8% water. The next one north is Gulf State G No. 4, making 0% and I believe from that point on there are no wells making large percentages of water until we get to the Magnolia Pope No. 10. Magnolia Pope No.

10 was drilled to approximately 50 or 60 feet of the water-oil contact and was perforated down near the bottom, as you can see, that well makes 87% water. As we pointed out previously, the bottom hole pressure for that well has always remained higher than the nearby wells, especially during recent years when the pressure on the east side of the field began to drop. The only way we can explain this water production here --

Q (Interrupting) What well is that that you are referring to?

A That is the Magnolia Pope No. 10. -- is that apparently a crack or a fracture extends down the water from this well. We believe that it is anomalous in that the bottom hole pressure does not conform to that of wells nearby and probably it is not very well connected to nearby wells. In other words, the offset wells of Magnolia Pope No. 21 and the other well on the cross-section next to it, Magnolia Pope No. 17, do not have low bottom hole pressures. We feel that if that bottom hole pressure, or let's say the water drive that the Magnolia Pope No. 10 apparently has, if it were connected to the rest of the reservoir, you would see evidence on nearby wells of some higher pressures. Those other wells are completed at approximately the same total depth, yet they make very little water.

Q What is the difference in the amount of water which they make?

A The Magnolia Pope No. 21, which is the south offset, makes 4% water. The Magnolia Pope No. 17, north offset, makes 2% water.

Q As compared with what?

A 87% for the Magnolia Pope No. 10.

Q Those are just 40-acre offsets--

A Yes, sir, approximately, I believe, 1320 feet apart.

Q -- to the Magnolia No. 10?

A Yes, sir. Now this cross-section, as I pointed out, runs near the east side of the reservoir here. We believe that accounts for several of these wells making water. In other words, when we talk about our west, east cross-sections, we believe that we will see there several of the edge wells showing more water; if they show any at all, they will show more than they show up in the center.

Q Referring again to Exhibit No. 21, considering the characteristics of the field and the productive history, does this graph or chart show any abnormal condition as far as the water production is concerned?

A In my opinion, it does not.

Q Mr. Tomlinson, with respect to your last answer, you said that Exhibit No. 21 doesn't show an abnormal condition as far as the water is concerned; do you wish to qualify that with respect to the Magnolia No. 10 you have testified to?

A Yes, sir. I would qualify that as to the Magnolia No. 10. However, I believe I stated that I did not believe that well was significant in our analysis.

Q That is an anomaly anyway?

A Yes, sir.

Q Now refer to Exhibit No. 22 and explain to the Commission what that shows.

A The Exhibit No. 22 shows three cross-sections, C to C-prime, D to D-prime, and E to E-prime. They run from west to east through

this portion, through here and through here. There have been some supplementary cross-sections prepared which we will talk about a little later. The Ohio Denton No. 9, I believe, is currently off production. I do not know the status of that well.

Q The wells you are now referring to are in connection with Exhibit No. 22?

A Yes, sir. The Ohio Denton No. 4.

Q You are also referring to C - C-prime?

A Yes, sir. On cross-section diagram C to C-prime, Ohio Denton No. 4 shows 0% and this shows 5%. You will notice those are completed fairly high. The Ohio Denton No. 7 is, I believe, on the east side of the reservoir. That well is producing from this interval here and has 19% water.

MR. PORTER: What interval, Mr. Tomlinson?

A That interval appears to be from about 8400 to 8450 subsea depth. That is some 550 feet above the water-oil contact originally. However, it is on the edge, as we pointed out. On cross-section D to D-prime, running from west to east, the Gulf Simpson No. 3-D is producing from approximately 150 feet above the original water-oil contact. However, it tested 97% water. It is on the edge. These other wells across here, starting with Gulf Simpson No. D, Shell State No. 1-A and Atlantic State No. T-3, and the Gulf State G No. 1-D show less than 10%. Three of them show 0% and one 7%. Next to it is the Gulf State No. G No. 3-D which also shows 3%. Now on the east side of the reservoir, we have the Atlantic Dickinson A-1 No. 2 which is completed within approximately 100 to 150 feet above the original water-oil contact. It shows 10% water. The Atlantic Federal Johns No. 2 on Section E to E-prime and on the

extreme west side of the reservoir shows 65% water. The Atlantic Federal Johns No. 1 having a producing interval lower than that of the Federal Johns No. 2 tested 0% water. The Atlantic Dickinson D No. 1 which is bottomed fairly near the top of the Devonian and approximately 350 feet above the water-oil contact shows 0%. Other wells on here, you can see, show lower producing intervals than the Atlantic Federal Johns No. 1 and show, also show low percentages of water. Now the conclusion drawn from this cross-section is that these wells that produce low percentages of water yet are completed lower than other wells producing higher percentages of water indicate that water is encroaching from the edge of the reservoir rather than from the bottom. In time it may be that this bottom water may move up slightly, but principal water encroachment seems to be from the edge.

Q Refer now to Exhibit No. 23 and explain to the Commission what it shows.

A Exhibit No. 23 shows cross-section diagrams F to F-prime and G to G-prime. These may be supplementary in that they, we thought that perhaps we need a little bit more control between some of the principal cross-sections, so we went back and showed some additional data. F to F-prime starts with the Phillips Fort No. 1 and extends eastward through the Sinclair Mann No. 2.

Q Is that shown on the index plat, Exhibit No. 19?

A Yes, it is shown on Exhibit 19; G to G-prime is located immediately north and starts with the Magnolia Maxwell No. 3 and extends eastward through the Stanolind Fort No. 2, the Phillips Fort No. 1 I think shows.

Q Is that on --

A (Interrupting) That is on cross-section F to F-prime and Exhibit No. 23. The Phillips Fort No. 1 shows that it is an edge well producing 88% water. Immediately east of it is one Phillips Founso No. 1 which is completed at approximately the same total depth showing 0%. Other wells on the cross-section are completed at varying depths and show either no water or a very low percentage. The cross-section G to G-prime on the same exhibit shows that Magnolia Maxwell No. 3 is on the edge producing 64% water. Immediately east of it is the Magnolia Pope No. 16 showing 32% water. There is not much difference in the producing depth of these wells. Other wells across the cross-section show no water, with the exception of the Shell Buckleigh A No. 5 which shows 21%, and the extreme east well shows the Stanolind Fort No. 2 producing 55%. Now it appears here that there is some water moving in from the east side of the reservoir. In this case, it might be termed northeast side. I think our conclusions regarding these two are the same as we expressed on the other exhibit.

Q Refer now to Exhibit No. 24 and explain to the Commission what it shows.

A Exhibit No. 24 shows cross-sections H to H-prime and I to I-prime. H to H-prime is near the south end of the field. I to I-prime is shown on the cross-section index, Exhibit 19, as lying between D to D-prime and G to G-prime, a little further north. The Ohio Denton No. 13 has not been tested during a recent survey.

Q Is that on H to H-prime?

A That is on H to H-prime on Exhibit No. 24. It shows it has not been tested on a recent survey. That well is, I believe, shut-in pending installation of artificial lift equipment. Now,

this particular well lies on the edge and it has made water and I believe probably still will make water. It made it in this producing interval here, which was originally, the bottom of it was approximately 600 feet above the original water-oil contact. The plug back or the new set of perforations is around 900 feet above the water-oil contact. Now, we think this will be a good example of how water is moving in in that region from the side of the reservoir, rather than coming in from the bottom, since that point is very high above the original water-oil contact. The Ohio Denton No. 15 shows 17% water; the McAlester Denton A No. 1 shows 0%; and the Ohio Denton No. 6 shows 0%. This well here was originally completed near the water-oil contact and water showed up in it and they went ahead and plugged back, perforated considerably higher in the Devonian section. My understanding is that it still does not make any water.

MR. PORTER: What well is that?

A That is the Ohio Denton No. 6. The Atlantic Dickinson B No. 3 shows 29% water, is completed very near the original water-oil contact, and my recollection is that well has produced water for several years. It is still on production and is a commercial well. The next cross-section is I to I-prime on Exhibit No. 24; it shows Shell Pacific Royalty No. 1, makes 3% water. The Phillips Denton No. 13 is shown on here as producing from fairly near the water-oil contact, I believe these perforations show right at the water-oil contact; that was 13%. This one is 0%, Phillips Denton No. 6; Phillips Denton No. 3-A shows 0%. This well was completed originally very near, rather, most of the perforations were below what we think is the water-oil contact in the field.

It is possible that there is some isolation of this section right there that would prevent the water from coming into it initially. It has been perforated in the very top of the section and shows 0%. The Phillips Denton No. 9 on the east end of this cross-section shows 8% water. I think our conclusions on this would be the same as on the other exhibits.

Q Now, Mr. Tomlinson, in regard to these cross-section plats, Exhibits 20, 21, 22, 23, 24, by way of summary, do those show any abnormal condition or bad condition as far as water encroachment is concerned?

A In my opinion they show normal encroachment in the reservoir.

Q Is that normal encroachment from the flanks or otherwise?

A It shows from the flanks in this instance. It appears to be a water drive reservoir with water encroaching from the flanks.

Q Now, I believe that you have testified that all of these exhibits from 1 to 24 inclusive are the result of the engineer committee of the Denton Pool, is that right?

A Yes, sir.

Q Did you participate in the preparation with other engineers of operators of the Denton Pool, in the preparation of these exhibits?

A Yes, sir, I did.

Q Now refer to Exhibit No. 25 and tell the Commission what it shows.

A Well, first, this is a structure map; as you can see, it is similar to our Exhibit No. 1. It is contoured on top of the Devonian. We have plotted on this exhibit the area which we think

the barrier lies for migration between the two sectors.

Q Is that the area shown in red?

A That is the area shown in red or I believe more accurately, pink. It shows wells that produce in excess of 10% water, those wells are designated by the pie-shaped symbol, the more red that it has on it indicates the higher percentage of water, so that if only one-fourth of a circle is colored in, it would mean 25% and if half, 50%, and so on. There have been purple circles drawn outside of wells that are on artificial lift. We see three wells on here that are on artificial lift that do not make water. There are several wells making excess of 10% water that do not have artificial lift. Now this summarizes the data shown on the other exhibits, and we believe --

Q (Interrupting) That is Exhibits 20 to 24 you are speaking of?

A Yes, sir, cross-section diagrams and it shows that water is coming in on the west flank of this reservoir; it shows that water is encroaching from the south and to a lesser extent along the southeast flank of the reservoir. It shows some encroachment from the northeast in this area and it also shows the Magnolia Pope No. 10 out in the middle of it, as we have explained, making a lot of water. We have pointed out that Magnolia Pope No. 10 is an anomaly.

Q Exhibit No. 25 was prepared by you?

A It was prepared by me.

Q Does that represent your interpretation of the information as reflected by the other exhibits which have been referred to here?

A Yes, sir.

MR. HINKLE: I would like to offer in evidence Exhibits 1 to 25 inclusive.

MR. PORTER: Any objection to the admittance of these exhibits? They will be admitted.

Q Mr. Tomlinson, Mr. Nutter yesterday made a statement to the Commission with regard to the water encroachment in the Denton Field and also exhibited to the Commission a plat which has been placed on the wall but which I understand has not been offered in evidence. I would like for you to make a comparison of that plat with Exhibit No. 9, which is the performance chart which you have already testified to, and tell the Commission in what way, if any, these plats differ.

A I believe the principal difference in the two plats is the difference in scales on which the water production is shown. I believe that Mr. Nutter pointed out that the water production was shown in thousand barrels per month and was plotted on a different scale. Now that scale is approximately one-fifth of the scale that was used for oil. In other words, the top of the scale reads 160,000 barrels, whereas the oil production scale has a top figure of 800,000 barrels per month. Now if that scale had been plotted the same as the oil production, as we did on this Exhibit No. 9 which shows the performance of the Denton Reservoir versus time, it would show that the water production in the field is not as rapidly, does not increase as rapidly as you would think when you look at the other exhibit where the water production is plotted on five times larger scale.

Q In other words, the way the plat has been drafted magnifies

the water production, does it not?

A Yes, sir.

Q Now, Mr. Tomlinson, have you made any other studies or calculations not shown on the exhibits which have been referred to?

A Yes, sir, we have.

Q What are they?

A We have made material balance calculations for the west and east sectors of the reservoir.

Q What do you mean by material balance calculations?

A Those are calculations that are made on the principle that material and energy is not destroyed, it is converted. It is a physical principle that is well accepted over a considerable period of time and has been adopted by the petroleum industry.

Q For what purpose, at arriving at what calculations and so forth?

A Well, in this instance, we were attempting to, or rather we did analyze the water encroachment into the west and east sectors of the reservoirs and we made a prediction of the future performance in the east sector for a period of two years.

Q Can you tell the Commission what that shows, what your study shows?

A The east sector has a very active water drive. It is not complete. It has allowed the pressure to decline, but not nearly so much as it would have had there been no water drive at all, I think we would have found that the pressure would drop much faster in the east sector. The analysis that we made showed that during the next two years the pressure on the east sector can be expected to drop 200 pounds or at the rate of 100 pounds per year.

Now that pressure decline is a lot less than was noted before the low point was reached. In other words, we were calculating performance slightly below the low point. Prior to that time, we found that the pressure was dropping on the order of 600 pounds per year.

Q Did your material balance study give you a check on the barrier shown on the isobaric map which has been introduced as Exhibit No. 8?

A Yes, it did. We found that by assuming no migration into the east sector from the west sector, we were able to check our volumetric oil in place, calculated within three percent. We believe that is a fairly close check. We, of course, in this we first have to go through and calculate oil in place before the remainder of the analysis, and we found that the two figures gave a very close check.

Q You pointed out in connection with Exhibits 13 and 14, I believe, that the pressures were tending to level off. Did your material balance study tend to corroborate this information?

A Yes, it did. Now on the west sector, or rather I would like to continue on the east sector, we find that the pressures are tending to level out and that an increasing amount of water is coming into the reservoir as pressure is lowered in that sector, so that more and more drive is derived from the water. As I pointed out previously, our prediction calculations show that we will level out the pressure a good deal more in the future.

Q What in your opinion has been responsible for the pressure drop?

A Well, the pressure drop in the past has been controlled by two factors; that is, the expansibility of the oil, water and

rock within the reservoir and by the encroachment of water into the sector. We feel that these expansion qualities in the reservoir are not so great as the expansibility of the free gas that will be liberated when you operate below the saturation pressure. Consequently, the free gas will provide a great deal more drive. That is responsible for the leveling off as well as the other factor that we mentioned, the increasing water encroachment that occurs with lowered pressure.

Q Now in your opinion will the predicted pressure drop cause any avoidable waste?

A In my opinion, it will not. The operation of the reservoir at a point slightly below bubble point pressure should enhance the recovery of oil from that portion of the reservoir. This is because for moderate pressure drops there is some free gas liberated within the matrix of the rock that will drive some oil out. In other words, it will occupy some space that would be occupied by oil that would be left behind when the water sweeps through it. So actually, for moderate decreases in pressure drop, you can be expected to recover more oil than you would if you remained above reservoir pressure.

Q In connection with your material balance study, did that apply to both the east and west sectors of the field?

A Yes, sir, it did. We made two separate studies for the field; actually, we analyzed the east sector as it appears to be, that is, as a separate reservoir, and then we did the same for the west sector. Essentially all of the oil and water and gas being produced from the west sector is being replaced by encroaching water. It appears that that reservoir will never reach bubble

point pressure, and of course it follows that in that respect the recoveries will be somewhat retarded over what they would be if it were operating a little below the bubble point pressure.

Q From your overall study and calculations and analysis in connection with the Denton Devonian Field, is any waste being committed by the present rate of production?

A In my opinion, no waste is occurring. I believe that the field is being operated very well at the present time and that any features that we see in the production are normal.

Q In your opinion is the field being produced above or below the maximum efficient rate at the present time?

A The field is being produced below the maximum efficient rate.

Q In other words, in your opinion you could produce at a higher rate and still not commit waste or injure the field in any way, in your opinion?

A Yes, the field could be produced more at a higher rate.

Q What if any are your recommendations to the Commission with regard to this matter?

A My recommendations are that no change be made in the allowables of the field and that bottom hole pressures continue to be run at six-months intervals so that adequate evaluation can be continued.

Q This applies to all the wells in the field?

A Yes, sir.

MR. HINKLE: I believe that is all at this time.

MR. PORTER: Cross examination now. Anyone have a question of Mr. Tomlinson? Mr. Nutter, did you have a question?

MR. NUTTER: Yes, sir, I do have a couple of questions I

might ask him.

CROSS EXAMINATION

By MR. NUTTER:

Q First of all, Mr. Tomlinson, on cross section A-prime to A, what is the water percentage shown on the Magnolia Pope 12, sir?

A We show 3%.

Q Now turning to the exhibit which shows cross section G to G-prime --

A (Interrupting) I believe I see what you are referring to there. This cross-section shows 0% for that well. I wonder if you know just which figure is correct? We appear to have made an error in one of our figures there.

MR. MONTGOMERY: According to my information, the well doesn't produce any water at all.

(Discussion off the record).

A The information that we put on these was obtained by one of our clerks in your Hobbs office and I believe I have that information here. I'll be glad to go over any of them that you like.

Q I believe I can find some information on that. That well did not show any water being produced on the gas-oil ratio test April 15th, so the 0% is correct. Since we have so many exhibits and there is so much to go through and study, I wonder if it is correct procedure, actually, but before I could really go into any questions or cross examination, I would like to have a chance to study these.

A We'd be glad to do that. The question, of course, how

long would it take to get your questions? I don't know what the limits are on the hearing.

MR. PORTER: Mr. Hinkle.

MR. HINKLE: That would mean, as I take it, that we would have to continue the case and come back at a later date and give you an opportunity to study it. We would rather go ahead and finish it today if possible to do so.

MR. NUTTER: Mr. Hinkle, there is an awful lot of information here. I don't know as anyone could digest all of this material in a matter of just a few hours and be in a position where they could really dig into it and ask just what it all means.

MR. GURLEY: If the Commission please, in view of the fact that the staff of the Commission has not in its opinion had an opportunity to amply study the exhibits, in view of the fact it is one of the most important questions that has appeared before us for some time, I would like as Commission's attorney to continue the case for one month and ask that it be heard at the next regular hearing.

MR. COUCH: Terrell Couch with Ohio Oil Company. If it please the Commission, in connection with the motion of Mr. Gurley for continuance of the case, I think we all recognize that both the Commission's staff as well as the operators have been conducting investigations and attempting to assimilate information on this subject. If the case is to be continued, I think that the operators are entitled to the same privilege of going over such information and evidence or testimony as the Commission staff may have available at this time, so that if the case is to be continued, I would like to suggest and request that such evidence and testimony

as the Commission staff has available be presented before this hearing is concluded today, in order that we might also be able to look over that information and be prepared to proceed at a later date. I prefer to see the hearing conclude today, but if it is going to be continued, I would like to see the other evidence in the record.

MR. HINKLE: I concur in that request. I think if we are going to continue it and the Commission has evidence, it ought to be introduced before we do continue it. That would be fair to both sides.

MR. GURLEY: If the Commission please, we feel after consulting with the engineering staff there that we have no testimony or evidence to present at this time and would like to reiterate the importance of being able to study what we have before us, which industry itself has made. We have placed before the Commission in Mr. Nutter's statement that which we wish to be entered into the record and that is all that we have to offer at this time.

MR. NUTTER: I stated yesterday, Mr. Hinkle, that we felt after a broad overall view of the thing, that is, without actually making a study of it, but just taking a wide-range view of it, we came to the conclusion that there might be a problem existing. I think I stated that yesterday. I think I stated that it was a very complex situation and that the operators themselves were the ones that should delve into the problem and come up with an answer. After a cursory examination of the exhibits, I found the one percentage of water and there was an error there. I don't say I would like to check the exhibits for the accuracy, but I

would like to look them over.

MR. HINKLE: We have no objection to your checking them. If it is continued, we think it ought to be limited to cross examination with respect to these exhibits. If you have any evidence, it ought to be presented now.

MR. NUTTER: There won't be any testimony.

MR. HINKLE: Then also if there are any operators who wish to produce any testimony at the present time, that they should be given an opportunity to do so before the continuance.

MR. GURLEY: We would go along with that.

MR. NUTTER: I think we have enough evidence here. I don't think any more evidence is necessary. I feel they have been sincere and done a good job in analyzing the job. I don't think any testimony on my part could add anything one way or the other.

MR. MALONE: May it please the Commission, Ross Malone for Gulf. We would like to express this view: We are a little bit concerned about the aspect that this thing has suddenly taken of the Commission staff against the industry. That isn't the way we started out, I don't think that is the way anybody wants to end up. The Commission very properly said to the operators that "we think, from the overall look, there is a problem here. We want you to go to work and come up with the information and with recommendations based on the information." So the industry turned to and did a pretty darn thorough job of it. They have had an engineering committee working on this thing a very substantial amount of time, for the past several months. We have brought to the Commission, in accordance with its request, the information we acquired and the recommendations based on it. We certainly

expect that the Commission's staff is going to have as much time as it may need to go over, to examine it and to reach their own conclusions, but it doesn't seem to me that that is particularly related with the cross examination of this particular witness.

Now to postpone the conclusion of this hearing, on the theory that maybe after these exhibits have been gone over there might be a few questions that would occur to somebody that don't occur now, doesn't seem to us to be within the spirit in which the hearing was started or within the scope of what either the staff or industry intended. I am sure, as Mr. Nutter said, he feels that industry has brought forth all the information industry could get together. The conclusions that we are presenting and that we expect to present are conclusions based on this study, and we are telling the Commission why we have reached those conclusions. It seems to me very little could be served by postponing the examination of the witness in the sense that sometimes occurs in a rate hearing or something like that. This just isn't that kind of a proposition. We would like to express a feeling that the purpose of the hearing can be accomplished by continuing through to a conclusion today and the staff and everybody else having a chance to examine the testimony later. If they want to move for a reopening, they would have the opportunity to do that; unless there is something here other than 0% and 3% and to indicate this should be postponed thirty days and asking everybody to come back for further session.

MR. GURLEY: In all due respect to Mr. Malone, the Commission is not placing itself in a position where, the Commission staff is not placing itself in a position where the staff is trying to

go against the industry, that isn't the idea at all. The call of the hearing is for bringing forth all the information available. 25 exhibits, a days testimony on those exhibits have proved that it is a tremendous problem and all the staff is interested in being able to examine them so they can delve into the problem more deeply and thoroughly. Mr. Nutter's suggestion there was not so that we could bring up evidence against what you gentlemen have introduced here, but so that we could study and cross examine, because after all, it is the Commission's staff that recommends to the Commission as to the engineering factors, and so forth, of the problem. We are interested in an opportunity to look carefully into it. We do not have this information at our disposal, as is obvious from what we introduced, in the statement yesterday. In all fairness to the importance of the problem, we feel that we should be able to take ample time to study it because the decision will be of greatest importance to the industry as well as to the State.

MR. LEONARD: B. M. Leonard, Magnolia Petroleum Company. Magnolia cannot say waste is occurring at the present time. However, we believe the reservoir performance should be watched closely and strongly urge the Commission to call another meeting some time in November, 1956, after the October pressure survey is taken.

MR. WALKER: Are you advocating that we do continue this?

MR. LEONARD: Go ahead and make up your minds, but I think we ought to review it again, reopen it and call another hearing of this type again, because I think the reservoir performance warrants it.

MR. WALKER: Any other comments?

MR. HOWARD: Paxton Howard with Shell Oil Company. I want to state that our conclusions on this thing, I could offer testimony to the same effect that has been expressed;with regard to the result, we do not feel that waste is occurring in the field. We agree with the recommendation that these tests be continued to be made so that the reservoir may be watched, because we all have a big stake in the reservoir. We do not think at this time there is any evidence brought out at all which would indicate that waste is occurring. Since New Mexico has a formula method of operation on a depth factor and this field is operated on the regular factor in New Mexico, in the absence of showing of waste, we feel that it should be continued on its present operation basis but subject to this review and continuation of tests. My recommendation would be that on the basis of the testimony here today and there is no testimony as to waste, that the present allowable be continued, subject to these reviews which we are all interested in having.

MR. PORTER: Any other comments?

MR. HURD: J. H. Hurd, representing Midland.

We are independent operators. We have working interest in the north part of the field operated by Magnolia, Shell, Phillips and Sinclair, and it is our desire that the allowable be reduced.

MR. PORTER: Any other comments as far as Mr. Gurley's motion is concerned?

MR. MONTGOMERY: I have some questions of the witness.

MR. WALKER: We haven't dismissed him yet, pending the decision on Mr. Gurley's motion.

The Commission has decided to reserve their decision on

Mr. Gurley's motion for the time being and allow anyone at this meeting to continue to examine the witness, and before the witness is dismissed, why, we will have a short recess and then give you our ruling on the motion, if that is agreeable. I am going to try to work this out so that it will be agreeable to everyone concerned. Does anyone have any further questions to ask the witness? Mr. Montgomery.

By MR. MONTGOMERY:

Q Mr. Tomlinson, you made a very thorough study here and I want to compliment you on your work and the engineering committee's work.

What I want to know, was it the 100% opinion of everyone working on the committee that the reservoir was producing at a maximum efficiency?

A At a 100%, that is Atlantic's conclusion there.

Q That is Atlantic's --

A (Interrupting) State that question again.

Q Did all the members of the engineering committee, did they concur with the recommendation you are making here today and all your findings?

A Well, I think you have heard from some of them. For example, Mr. Hurd did not. Those are actually Atlantic's conclusions. We did not try to reach our conclusions in the committee session at all. By that, the original scope of the committee work was to prepare data and analyses for such analyses as we deemed proper for presentation to the operators so they might be aided in making their recommendations to the Commission. In other words, we did not recommend to the operators that the field be

continued at its present rate or anything like that. It was not actually in the scope of the original charge to the engineering committee.

Q Did this engineering committee, were there some engineers that were on the committee that did not particularly agree with some of the conclusions that were arrived at, such as the barriers or maybe the water drives or some of the other factors that you used in your analysis here?

A Well, as I have stated, all the exhibits were reviewed after we all prepared them. They were all reviewed, talked over, and actually at that time Atlantic had not gone into all of its analyses and conclusions brought out by all of these. We did say to several members, I believe, of the engineering committee that we felt the reservoir was performing properly. Now I believe that possibly there may be actually two operators, I am not sure, because we haven't heard from everyone here, but I believe there are possibly, Skelly and Mr. Hurd certainly dissented in that.

Q In other words, there are some men who have excellent training and background who do not agree with the conclusions that possibly you have reached in this matter?

A I would say that as far as Mr. Hurd is concerned, he was not present at all our meetings. I can't say about his background in relation to the Denton Field. Skelly had an engineer present on several work sessions and I have learned that they do not believe that the present rate is proper. However, they have not stated to me their engineering reasons why. In other words, I do not know why except I just know that is a fact and I heard it

from them on occasion, too.

Q I just want to ask these few questions because I don't want all the operators producing all my oil out of this field with the danger of ruining it. I know that I have made some rather rapid studies and other members in our office, and we arrived at certain very minor conclusions, or slight differences based on interpretation, which doesn't really affect the overall problem. I notice that you have one water-oil contact minus 8415.

A Yes.

Q Do you feel that this is one common reservoir?

A Actually, in terms of geologic time, probably it was connected; in other words, when this reservoir was formed there, that it had sufficient time to equalize throughout the reservoir and the water was fairly level in it. Now, most of the water tests, if not all of them, were taken in the south portion of the field or what probably we would be terming the west sector. It is not certain, or rather, we do not have as good a control over where the water is on the east sector. However, the operators have generally relied on the water-oil contact in the neighborhood of minus 8915 feet.

Q In other words, you don't have all the information that you would like to have?

A That is correct.

Q You are still lacking some information on this analysis that you have made as of today?

A I don't believe we will ever have any information as to the original water-oil contact, other than what we have already, because drilling is about completed in the field.

Q The point I am making is that you never have enough information, that you are always working with a bunch of unknowns and some educated assumptions?

A I would say in this particular instance the assumptions and unknowns are about as minor as any case I have ever encountered.

Q Then you start talking about the west sector and the east sector, do you think that during the producing life of this reservoir, its economic life actually, it is performing as two separate reservoirs?

A I do.

Q Possibly they do not both have the same efficient rate of production?

A I think that is true, that they will not have the same maximum efficient rate of production.

Q What is the maximum efficient rate of production?

A In which sector?

Q In the east sector.

A I would say that the maximum efficient rate of production is very near what it is at the present time. That would be the conclusion that we have drawn. We have stated that we prefer that the reservoir be operated at a moderate decline in pressure below the bubble point. I believe we will reach it under present conditions.

Q Why do you say that you believe it is producing at about the maximum efficiency rate? I believe you testified to the fact that only 65% of the void space was being filled up with the water. Does that sound like a maximum efficiency rate?

A I don't recall saying 65%.

Q Maybe I heard that over the coffee tables.

A Here is the reason why the reservoir has shown an increasing water encroachment. As the pressure dropped, water came in more and more. Of course, originally the water encroachment was very little, until we got a substantial pressure decline in the reservoir. As it declines further, we expect that it will show up larger than has been planned. In addition, our belief is that if free gas can be liberated in a reservoir that has matrix porosity, the matrix actually contains oil which is part of the movable oil in the reservoir, that that gas that is liberated will occupy space that would be occupied by oil when the water is swept through there. So actually, the recovery factor is increased by the occupation of some gas. Now, that concept is, I believe, recent, within the past two or three years. I believe that it's generally coming to be accepted, I think.

Q You testified that the east sector was not below the bubble point?

A It is approximately 30 pounds below.

Q It is below the bubble point, there is more gas, so you expect the wells to produce more gas?

A Actually, the exact point in which gas production will increase is not known as to this reservoir. However, generally speaking, you must have a gas saturation of around 10% or sometimes even higher to note an increase. In other words, as soon as you go through your bubble point pressure, there is not an increase in pressures. Normally it will be some period of time that you get low bubble point; it depends on the reservoir for some of the pressure difference between bubble point and whatever it is, to

get the gas production increase.

Q But the gas production is not increased in this pool as yet?

A No.

Q At least according to your exhibits?

A According to what we found out, it has not.

Q You testified that this barrier that exists through the area, what type of barrier is that separating these two reservoirs?

A As I stated, we attempted to find it on our structure map work and on examinations of cross-sections and logs, and I believe we consulted with some geologists, I believe we had at least one geologist to attend one of our work sessions of the engineering committee, and in addition I consulted with my own company geologist. They were unable to help us in finding that barrier where it should be. We have made some conjectures. I guess that is about all anyone can do under the circumstances. It is probably due to some kind of a fault that we can't detect.

Q Although you did not put faults on your map?

A We did not. Well, as pointed out, we didn't because we just couldn't show them with the information we had.

Q I just want to point out to the Commissioners there that there are a lot of facts that we can't quite put our finger on.

A That is one of them. I think that actually the fault could lie anywhere within that red area on our bottom hole pressure map up there. Now, if there is a fault present, certainly it is not displaced to the extent of, does not have enough displacement equal to the thickness of the pay, or otherwise we would notice it. Possibly what may have been, there has been some shrinkage there

and some deposition by water in times past that deposited an impermeable layer. That is only conjecture, we do not know.

Q Even though your line meanders throughout the field and crosses numerous wells, you are not able to find it in any one of the wells?

A We were not.

Q Now we have got it down to two reservoirs, the west sector and the east sector. Why is there such a very great difference in the interval of perforations, which in some cases were five or six hundred feet?

A Between operators?

Q Between operators and sometimes the same operator.

A I can't tell you that. I think --

MR. FOSTER: (Interrupting) What is that last question?

Q Why is there such a great variance in the zones that were perforated in the different parts of the two pools? One well may have 700 foot of perforations, another well may have 50 feet, or one well may be 70 feet higher to the perforations on the offset well.

A I assume you are referring to the fact that wells that have nearly the same structural position, of course, wells that are low on structure don't have a whole lot of choice in that matter. Actually, earlier in the life of the reservoir, there may have been operators in there that didn't know much about it and thought perhaps they might better go down near the water-oil contact to perforate. You'll notice on some of the recent completions there has been quite a bit of difference in, say, I don't see one here, but some are perforated very low, and instead of perforating

higher, they went clear back to the top in some of the instances. So perhaps a lot more is known about the reservoir now than was known originally.

Q Did they perforate because that happened to be the only porosity or only production they might have in that well?

A I don't believe they did because porosity is noted up and down the section, generally.

Q It is throughout, it is not erratic to this extent of several hundred feet?

A No, not to that extent.

Q Referring to Exhibit No. 9, if you have a copy, I would like for the Commissioners to be able to look at this. Do you have an extra copy?

A Yes.

Q I would like for you to point out for the Commissioners there the pressure line,that is, do you notice that it declines and also look at the line which indicates oil production, which is "A", and during the month of October when we had the pipeline proration, of course, the oil production fell off very drastically; and shortly after that, there was a pressure survey, there was essentially no decline. Following that period, there was a back allowable and the peak on the oil production goes up considerably, and then we take another pressure survey and it has dropped off considerably more than from the normal decline, possibly.

A I think there are two factors influencing that. As we stated, that the water drive is not complete now but it is substantial, and of course, if you vary the producing rate in the reservoir, you can vary the bottom hole pressure. Now, the

principal factor on those last two points on that graph is that the survey taken in October of 1955 did not include a lot of wells, it isn't a complete survey. I think that there are several leases in the field that did not even have a bomb on the lease at all. We actually feel that that point is not representative; however, we did include the point for reasons of getting all points on there. We feel that that particular point, that's a little higher, tends to push the curve up in October of 1955, is not derived from a representative survey. I can show you the leases involved. It is this lease here, I believe, 320 acres, this one, and this lease right in here.

MR. HINKLE: What exhibit are you referring to?

A That is on Exhibit 25 I am pointing it out.

MR. HINKLE: What sections?

A Actually the south half of Section 26, east half of Section 35, and the majority of the north half of Section 2.

Q Also I want to point out to the Commission, notice that the water that is indicated by "B" how it also jumps up rather rapidly whenever the back allowable and the greater withdrawals were made from the pool. Then going to Exhibit 10, which is just on the west sector, I believe you stated that part of your reasoning for stating that this was not possibly indicative, as it would be otherwise, is that you didn't have a full water drive situation. Is that one of the reasons that you gave for that?

A Run that by again.

Q I will ask you the original question again. What was the reason for the pressures leveling off during the curtailment and then dropping during the greater production when we were allowing

the back allowable?

A You mean in the field?

Q In the field.

A My reasons there, actually, here, this part represents the total field bottom hole pressure curves, of course that represents the performance of the entire field. It reflects a reservoir with a fairly complete water drive and one in which virtually all the withdrawal fluid is being replaced by water. In other words, there are two degrees there. However, when you obtain these average pressures here, you will find that the east sector influences that.

Q The east sector influences it in what manner?

A Well, in that when we constructed a bottom hole pressure map, Exhibit 8, I believe is the number of it, we used the entire field in obtaining the weighted pressure, even though we realized that a number of wells were left out and probably it was not as representative as we would like to have it. Now, actually the production rate that you show or that we have shown there represents that of the entire field, the east half as well as the west sector. Now in a situation like that, if you are analyzing the entire field together, you can find that the pressure can be influenced; I think a more accurate way of reviewing that would be to look at the two sectors separately, rather than the total field, since you have a conglomeration of factors there.

Q Let's look at the performance versus time on the west sector. It reflects the same problem, does it not?

A Yes.

Q The water, during the back allowable when the production

was high, the water increases rapidly during curtailment, it was relatively stable, then, too, the pressure dropped off more rapidly?

A Well, there were some of the leases that were not tested that were also in the west sector. We originally had thought along that line, that we thought this was a significant point. After we realized the incompleteness of the pressure survey, we thought that it should be disregarded. Now, as to the water, there have been several recent workovers in the field, and while I do not have the dates of those workovers in memory, I do know that they have occurred within the past year, and possibly the first part of this year. I think that will account for a reduction of the rate of water increase in the field.

Q But actually the wells that were not surveyed are some of the more lower pressure wells in the field and if we did have those wells in the graph, the thing would probably be even more accentuated, would that not be true? The Magnolia lease, the south half of Section 26 and in the east half of 35.

A And this lease here. You see, you have one, two, three, four, five wells on the west sector that were not tested and have high pressures. I think if you turn to the exhibit showing the performance versus time for the east sector, you will find that that is even more accentuated because of this bottom hole pressure factor that we have mentioned.

Q You think it is adequately explained and it's not due to greater withdrawals?

A I think that greater withdrawals in the east sector and actually in the west sector, since we see virtually all the fluid being withdrawn from the west sector is being replaced. However,

there is still a small effect that can be gained from changing the rate in the west sector. A greater effect can be obtained in the east sector. I think that would be an influence on the curve. I believe that actually there are two factors affecting the incompleteness of the survey, and as you have pointed out, there has been a change, but even taking these changes into account, we still believe that the east sector is performing satisfactorily.

Q Have you plotted barrel per pound drop by survey periods, by any chance?

A No, we have not done that. That was one of the things that we were thinking about in regard to the east and west, or rather, yes, both sectors, in determining performance of the reservoir. However, since we were approaching the bubble point and we should see a marked change there, that actually such points would be relatively misleading, since it is expected that the pressure will level off.

Q I just want to tell the Commission that I have looked at some figures very hurriedly, and during the period when the oil production was curtailed, the barrels per pound drop produced was somewhat over one hundred thousand barrels, and during the period they were back making up the back allowable, the barrel per pound drop is only 13,000. I am talking about 100,000 and 13,000, which is quite a bit of difference. I think a study of this matter might be very enlightening. I am sorry I have not gone into it more fully myself. Of

A Of course, you know that when you say barrels of oil per pound drop for a point high on the curve, you will show actually a very large amount of barrels produced per pound drop and then

if you take the point immediately after, which we think is on the correct reservoir pressure trend and is normal, you will show an accentuated, rather, a very low barrels of oil per pound drop. I think that is just a trick of the curve if you derive it in that manner; since one point is high already and that would tend to make the next point, I mean the barrels per oil of pound drop for the next calculation, be very low and actually that is probably not the case.

Q I wanted to ask one question again that I have already asked you. You say in the east sector that there is not 100% water taking over the areas?

A No, there is not.

Q What is taking over that space, just oil or vacuum?

A Actually, in the past water has encroached in the reservoir and replaced some of the oil that has been produced. Now the remaining oil and connate water that is in the reservoir has expanded, it has an expansibility. In other words, when you lower the pressure a given amount, oh, say a barrel of oil in the reservoir, it is going to expand some and take up some more space, and that has turned part of the driving mechanism in the reservoir. Actually, expansibility of crude oil is relatively low compared to that of the gas in the reservoir. Gas has a greater expansibility when the pressure is reduced, so the replacement of that void space not occupied by water is occupied by expanding oil and connate water in the reservoir, and also to some extent by rock.

Q If you were trying to be very theoretical about the situation and wanted to produce at the best point, would it be better to have water replacing 100% or 1%? Which would be the

better reservoir?

A Well, to answer that question we would like for the water to replace the oil; however, we want to have it replace it under particular conditions. Now I might like to amend that statement just a little bit. Actually, we have stated that this part of the oil in the matrix should be replaced by gas. Then when that gas has expanded into the pore space that would otherwise be occupied by oil, we believe then water should come in and replace the remaining amount. That is under primary operation. That would be a desirable feature.

Q The better reservoir would be the one where water replaced 100% and not 1%, is that true?

A I think if you carried it to that extreme, it would, yes.

Q What extremes are we talking about in this particular situation, the east sector?

A Well, I imagine that it would be desirable to have the water to replace some 85%, would be probably around optimum. That point is not definitely tied down at this time at what percentage we should have, but we ought to have a fair percentage of gas present in the reservoir when water comes in.

Q You think we should have 85% in a reservoir of this type, in this reservoir, the east sector?

A I would say that that would be in the range, possibly maybe as low as 75%.

Q From 75 to 85%?

A I would think in that range.

Q What percent is coming in at this time?

A Actually, we calculate it approximately 65% over the last

six months' interval.

Q In other words, the field on the east sector is producing at a too rapid rate, is that correct?

A No. Now, the east sector, as I have stated before, will have increased water encroachment as the reservoir pressure is lower, the aquifer pressure, of course, is somewhat higher than the reservoir pressure. As you lower the reservoir pressure, more water comes in. That is actually a function of differential pressure between the reservoir and the aquifer. Now we said 65% is coming in now and we feel that that 65% possibly may be low, because we used a pressure point that you pointed out on the exhibit as being high, unlike last fall. We feel that some error was introduced by use of that. Had we used some other point, it might have been that we would have seen even more water coming in.

Q But even though your figures show 65%, you feel that the well should produce somewhere around 85%?

A 75 to 85. Now, in our prediction calculation, we found that the differential, increase in differential between the aquifer and the reservoir would increase water encroachment to around 75%. We feel that additional pressure surveys will serve to enlighten us on those points and we made our prediction actually for a two-year period, but we feel that even within the two years, of course, almost constantly we are going to be analyzing the reservoir to ascertain what is happening there.

Q In other words, you don't have all the information you want yet, you still need more?

A That is correct. We are asking for the survey so that we

can get it.

Q Going back to another situation, this is the last one. We have stated there are essentially just two reservoirs, and yet the perforations exist from some 700 foot intervals, some wells way high on the structure producing water, and yet wells considerably lower not producing water. We say this is all on the west sector, we say that is all one reservoir. If that is true and you also testified to the fact that probably the entire column was saturated with varying situations in the area, if the water is high on the structure or producing water, and wells low on the structure are not, we must be, apparently be bypassing an awful lot of oil.

A I do not believe that is true. Now, the cross-section F to F-prime on Exhibit 23 is an example of this. This well is producing 88% water now, actually that is in the comparable interval to this up here.

Q To what?

A That is on the Phillips Fort No. 1 that is producing 88% water, and it is the comparable interval in Phillips Founso No. 1, actually is not producing water. I can't say there that we have bypassed water or oil in the lower portion of the reservoir. In other words, this appears to be an average water encroachment; it may possibly be slanted at some 45 degrees, most likely it is somewhat uneven, but for practical purposes, it is uniform.

Q You say it is uniform?

A I would say for practical purposes the encroachment should be fairly uniform. To my knowledge, there have been no tests made in the wells in the field that showed water coming in an

upper set of perforations and no water coming in a lower set. All the workovers that I have been acquainted with, which have been quite a few, the water appeared in bottom sets of perforations first, sometimes almost simultaneously.

Q I believe I have just found a few exceptions to what you have said in there on it. I will point them out.

MR. PORTER: Let's point them out after 11:00 o'clock.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Montgomery, were you through with your questions?

MR. MONTGOMERY: I have just one other question and then I want to restate some things.

MR. PORTER: Go ahead.

Q I asked Mr. Tomlinson about wells that were higher structurally producing more water, or water, where wells lower were not producing any water or less quantities of water. I believe according to his exhibit, I found four or five instances where that did exist. Would you like for me to enumerate them?

A Yes, if you will, and point out which ones.

Q Actually, this is just percent; it doesn't mean that the water -- this is all water?

A Yes.

Q On the cross-section B - B-prime in the vicinity of the Magnolia Pope No. 21, that well which is structurally higher produces 4%, and then the well which is, then an anomaly, the Magnolia Pope 10, producing 87% water, and then a structurally lower well, Magnolia Pope No. 17, producing 2%. Of course, I realize there are anomalies, but these anomalies indicate far

more than 95% of the other information that a person has when you analyze it. That well has not been taken into any of the studies in this case here?

A Actually, now what is your question on that particular one?

Q Well, I believe you stated that there were no wells structurally higher that were producing more water than wells that were structurally lower?

A Well, I mean that to apply, this to apply in all except Magnolia Pope 10.

Q What about the Magnolia Pope 21, it is one of the highest wells in the field; it produces 4% whereas the wells around it produce 2%.

A Well, if you will recall, in our testimony we stated that actually water percentages in percentages less than 10% actually are not significant, since many wells have produced water in small quantities for several years. Actually, when you have water encroaching either from the bottom or from the sides, and especially from the sides, you will notice that the water percentages on those wells increased very rapidly. Those wells that are high on structure and very low percentages of water, I am talking about low, I mean in the general range of 10% or less, we believe that water is contributed by the matrix. In other words, reservoir rock has a peculiar characteristic when the permeability is low, and when you reduce pressure to some extent or flow oil by the water in the pore space, if the permeability is low that oil will pick up some water and carry it along with it, so that will account for various amounts of water. Actually, such wells tend to slug

water a little bit, since the water will come in and work its way in to the bottom of the well bore, and then come along a day maybe when the well is not flowing like it should, probably open up a little bit and it will slug out some water. That kind of water is connate water. There is a tendency generally to try to catch, if you are going to have to take a water shakeout on a well, to, since you can't take a shakeout of practically no water at all, you have to take such a large volume of fluid there would be a general tendency to catch some of the water when it is slugging. So actually the percentages may be a little lower because of that.

Q But also due to the characteristics inherent in the field, operation in the field, lands of ten times the low producers of water, the percentages are considerably off, are they not?

A They would be high. The field hands would probably report them as being actually higher than they actually are, to take a shakeout you have to have a volume of water, you have to catch a large sample. In other words, catch a small sample and under normal operations, you may not see any water in it at all. If you are trying to show water production there would be a tendency, I believe, to actually, through the method of obtaining the sample, actually have a little more water than actually normal production.

Q Well, oftentimes, possibly in the field there would be water in the tanks and the operators --

A (Interrupting) Yes.

Q (Continuing) -- on the lease will probably drain the water out of the bottom of the tanks?

A Yes.

Q Each one of the instances that I point out, if you think it is connate water, you might mention it. On E - E-prime, Sinclair Pope No. 1, 2% water, which is higher than Pope No. 9, producing 1% water. It is also perforated in the same stratigraphic interval?

A That is correct, and I also attribute it to the same factors.

Q Also the well, the Magnolia Pope No. 3, which offsets the well which produces 2%, shows 0% water. It is structurally a higher well, but it is perforated stratigraphically lower and closer to the water table?

A Yes.

Q On cross-section F - F-prime, the Magnolia Pope No. 21 shows 4% water where the structurally lower wells throughout the cross-section show 0%.

A That is correct, and in all of those cases, I believe that those percentages do not represent aquifer contribution.

Q Then on cross-section G - G-prime, the Magnolia Pope No. 17 and the Magnolia Pope No. 6, two highest structural wells producing 2% and offset by wells which produce no water?

A That is correct. Now, if you referred back to some of the New Mexico Oil and Gas Engineering Committee reports in years past, you will see that numerous wells have produced small amounts of water over considerable periods of time.

MR. MONTGOMERY: I am sure there are a lot of awful small points that I could bring out that really have no meaning and would not change the overall problem. The four things that I thought were more pertinent than anything else were that: one,

Q He will estimate the barrels as it flows out?

A That is a method of doing it. The disadvantage in that method, of course, is that you do not know precisely which wells are contributing water. Then again, over a period of several weeks or months, this water may accumulate and you may have been a little off on your water production, or as I say, one of the wells may kick out a little water that is accumulated in the bottom of the hole. So even in that instance, you don't obtain as accurate information as you like.

Q Water information as such is not as accurate as on our oil production or our gas measurements?

A That is true, now especially on low water producing wells. Now on wells that produce a considerable amount of water, it is much easier to obtain a sample that is representative as you get up in the higher range.

Q I want to ask you one other question. A well that happens to be on here for 4% today or 9.9 less than, then maybe 20 or 30 percent next month, that is another possibility there?

A It is a possibility, but not likely, since 20 or 30 percent would be in the range where you can obtain a more accurate shake-out.

Q On cross-section C - C-prime, the Ohio Denton No. 4 well shows 0 water. The Ohio Denton No. 3, which is structurally higher and apparently perforated in the same stratigraphic interval is producing 5% water.

A Yes. Well, I think that is one of the instances that I mentioned where it is connate water contributing to the water production.

the witness did testify to the fact that it would be best to produce the well, that the east sector is producing at about 85%, Phillips -- wait a minute -- will you state that for me? I will get it correct here, I have been missing it all the time.

A Well, actually we anticipate that for the next two years that the water encroachment will be on the order of 75 or 80 percent, that is, the water moving into the reservoir will replace 75 to 85 percent of the oil, water, gas production taken out.

Q But presently it is only 65%?

A That is right.

Q And 65% would be the optimum rate for producing that particular area we are talking about today?

A Well, I don't believe that we can, you say 65% would be the optimum rate to produce?

Q The east sector.

A Well, that --

Q (Interrupting) Produce it at a rate that would be 65 --

A That is occurring at the present time, we think it is right. However, it is not going to remain at that point. It will change.

Q As I understood that, you said that only 65% of the void space is being replaced by water at this time?

A That is correct.

Q But yet you are voiding 85% of the void space?

A No, I believe you misunderstood me.

Q I understand it, but I am not getting it in words.

A Actually, I believe you are, what you mean to say is that we would like for the gas saturation to be on the order of

15 to 25 percent when the water moves in and replaces the oil in the reservoir. Those are optimum conditions, actually, or I say they might be optimum conditions, but that is just a belief that we have right now. Actually water encroachment being 65%, it could have a condition where you could not reach that desired gas saturation, even with that rate of encroachment. In other words, the 65% is one percentage, the 15 to 25 percent gas saturation is another percentage. In other words, the critical point there is that you must have a pressure condition in the reservoir that will enable you to achieve those conditions. Now you can't say that since you are wanting 65, or rather you are wanting, say, 25% gas saturation in a reservoir, that you would expect that the rate of encroachment of water should be 75%. In other words, you may be starting off at a particular reservoir pressure where you have to have a different rate of encroachment to reach the desired conditions, that is what I am point out. The saturation conditions have to be achieved by a pressure, and it may take varying rates of encroachment to do it.

Q But you did testify that probably the eastern sector was producing at a too high rate, according to this 65% encroachment?

A No, I don't recall saying that.

Q I think it is in the record.

A I don't recall saying it was producing at too fast a rate.

Q You said at one time it was producing at the optimum or about at the present time, but later the record will speak for itself, but later said that 65% of the void space was being filled.

MR. WALKER: Let's let the record speak for itself.

MR. MONTGOMERY: All right, we have belabored that one. The second point, there are higher wells on the structure that are producing water, whereas the lower wells, whereas some lower wells were not producing water, therefore indicating there is a possibility that water is bypassing an amount of oil. When there was a drop in production, this is the third point, that the pressure tended to level off; then whever the back allowables were granted and there was a greater amount of production, the pressures tended to take a steeper dive in their drop. There was some explanation of that that some of the wells were not surveyed, but on the western sector there were only some three wells out of fifty that would be involved percentage-wise. It probably would not affect the curve appreciably.

The fourth point which I indicated was the barrels per pound drop that during the curtailment era they produced some 100,000 barrels of oil per pound drop, but during the high producing months when back allowable was being produced, the pressure, barrels per pound drop was some 13,000.

That is all I have.

MR. PORTER: Anyone else have a question?

MR. GURLEY: Before I start cross examining the witness, I would like to withdraw my motion to continue for one month.

MR. HINKLE: I wonder if it wouldn't be better, to keep the record straighter, if you would allow me to ask some questions on redirect that pertain to the questions on cross examination of Mr. Montgomery, before you proceed with your cross examination.

MR. PORTER: I think that is all right.

REDIRECT EXAMINATION

By MR. HINKLE:

Q Mr. Tomlinson, on the cross examination of Mr. Montgomery, he referred to the work of the engineering committee. I believe you have previously testified that Exhibits 1 to 24 are the work of the committee?

A Yes, sir.

Q Do these exhibits portray or reflect all of the factual data which was gathered by the engineering committee?

A They do.

Q Was there any disagreement among any members of the committee as to the factual data which these exhibits reflect?

A There was not.

Q How many operators in the field are there?

A I imagine there are around 15.

Q To refresh your memory, I believe it is 14, but it may be 15. I believe that you previously testified that practically all the operators were represented or had an opportunity to be represented on this committee?

A They did.

Q And that there had been no objections presented to the committee by any operator with respect to the factual data which these exhibits 1 through 24 reflect, is that right?

A Will you state that again?

Q There have been no objections by any of the operators to the factual data which these exhibits reflect?

A That is correct.

Q With respect to your other testimony and with respect to

Exhibit 25, those are interpretations of the Atlantic and your own, is that correct?

A That is right. We did not ask the other members to concur in those. In fact, they may not have had access to all our conclusions.

Q In the cross examination of Mr. Montgomery, reference was made to Exhibit No. 9. Would you like to comment further with respect to that?

A I would. I would like to point out some features of that. First of all, the Exhibit No. 9 shows water production in thousands of barrels per month. Now that is not water percentage. Now you will note that actually when the shut-in period occurred, I believe that was during September, that there was a small rise in water production that month. The next month, when we got back on production, there was still another rise, but in November there was a drop in water production. Then in December there was an increase in water production and in January there was a drop; in February there was an increase. Well, actually those are very small changes, and in addition, they are in barrels, so that when you increase oil production, even if you held your percentage constant, you would normally see a graph plotted like this that has an increased water production along with it, because the water, if it is constant in wells, will come out in greater quantities. A better way of looking at that would be to look at the exhibit, I don't have the number, but it portrays the west sector performance versus cumulative oil production.

MR. HINKLE: Exhibit 13, was it not?

A I believe it is Exhibit 13. It is the exhibit that shows

performance versus cumulative oil production. Actually, you will note that during December, we marked it on the graph December of 1955 and January of 1956, show when considerable allowable was being made up in the field, they actually show a lower percentage of water on this graph; we have actually plotted water percentage instead of barrels, so that actually there has been a decline during those months over a period there showing less water percentage, probably not less water production, as we have showed on Exhibit 9, but that was due to the fact that we increased the oil production during those months. Now, I would like to state in connection with one of Mr. Montgomery's points that we were able to change the bottom hole pressure slightly by changing the production rates. We believe that is due to two factors: One is that we had an incomplete survey and the other is, as we pointed out, these reservoirs, and especially the east reservoir is more sensitive to the rate of withdrawal than the west sector insofar as bottom hole pressure is concerned. We do not believe that is detrimental to our analysis, since we believe that we should reach a point several hundred pounds below the bubble point pressure before we level it out, so any changes in the slope of the line above that point means only that we possibly did achieve some changes in rate; and possibly some of the changes are noted, as we have noted, are due to incomplete survey, but it does not mean that the reservoir is being damaged, since it has not yet reached the optimum point as far as the reservoir pressure is concerned.

MR. HINKLE: That is all we have.

MR. PORTER: Mr. Mankin.

RECROSS EXAMINATION

By MR. MANKIN:

Q Mr. Tomlinson, referring again to Exhibit 13, which we were just talking about, which is the west sector performance versus cumulative oil production --

A Yes.

Q -- you mentioned the December and January water production, that is, percent of water, of total fluids going down slightly during that period where they were making up some back allowable. I am wondering, the very sharp increases that have been reflected at the 15,000,000 cumulative mark, and then the drop off of oil versus performance, what caused that? Is that due to these --

A (Interrupting) I would say that is possibly due to some workovers being obtained. Personally, I do not believe in increasing the rate of withdrawal will reduce the rate of water production. I think that it is due to other factors, but I was making the point that actually you should look at the water production on a percentage basis rather than on a number of barrels basis.

Q Doesn't this curve indicate that percentage of water of the total fluids?

A Yes, sir.

Q Getting back to this plug-back and remedial work, isn't this an indication that water was increasing rapidly and there was considerable plug-backs and therefore the oil column was increased considerably, and therefore you had a drop in the curve after this period of plug-backs?

A Well, in certain wells. You are talking about in particular wells that the oil column was decreased.

Q I am speaking of this graph in Exhibit 13.

A That doesn't reflect that the oil column in the field as a whole was decreased, as we have seen on these cross-section diagrams that we have shown, that the oil column in many places is still very near what it was originally, or probably is the same oil column we had originally.

Q In the west sector?

A In places on the west sector. Now, actually immediately before this time, this 15,000,000 cumulative mark on Exhibit 13, you'll see we had a constant rate of oil production there and actually there was no change in rate, yet the water percentage did increase. In other words, that indicates a factor that we attributed more to cumulative withdrawal of the oil from the reservoir than rate. In other words, the rate was not changed in that period, yet the percentage did go up.

Q What caused this to take a very drastic drop, then?

A Well, I would think that would be caused by some workovers.

Q But you don't feel it was a question of not having the oil column because you did have the fairly constant oil production during that period?

A Well, I don't know if I follow you there. Will you state that again?

Q Your oil production remained essentially the same during this period you had a decrease of your curve there, after the 15,000,000 mark?

A Yes.

Q I can't understand why it would drastically drop, unless for one thing you got rid of considerable water as a result of the

plug-back for one thing.

A I think that is probably the principal reason.

Q Secondly, I wonder if possibly there is no reflection that the oil column was decreased then, because you had a constant oil production?

A Well, decrease of oil column would appear, then you would have an increase.

Q It would follow that you would have an increase in water column, is that right?

A Well, if anything you would think that would make the water percentage go up. However, I assume that in the course of remedial work that a good many of the workovers were affected. Now as we've shown these things on our cross-section diagram, we have shown the percentages and production intervals.

Q I think that it would follow from looking at those that you would have an increased water percentage as the water comes in on the edges of the reservoir?

A It should be normal to have that.

Q I take it from your answer to the question, then, that you feel there is nothing unusual about that; that was primarily just decreasing the water production as a result of the workovers and plug-backs?

A I would think so.

Q On Exhibit 14, the east sector, the last bottom hole pressure, which is curve C, indicated about 37 pounds, the bottom hole pressure below the bubble point?

A Yes.

Q Is it not true as shown by some of the other exhibits that

there is a number of wells, particularly Magnolia wells, that are some over 200 pounds lower than the bubble point.

A That is correct.

Q Do you feel that there is any danger there?

A I feel that is within our predetermined range of desirable reservoir pressure for the east sector.

Q Although your average is considerably higher for the east sector, these scattered wells, particularly the Magnolia Pope lease, you don't feel there is too great a danger in dropping the pressures in the last six months or so?

A I do not, I feel that is entirely safe.

Q In regard to the exhibit, I don't know what the exhibit number is, it is the one that has the barrier in red.

A That is Exhibit 8.

Q Is that barrier something that was determined by the engineering committee?

A The barrier, I believe, was agreed on to exist. Now, the range at which we have shown that it may lie there, that range is approximately one location wide, that is simply a red color that we have placed on there after we started preparing the exhibits for presentation here, so the people could see it more readily.

Q Is it not true in a lot of Devonian Reservoirs that you do have some faulting conditions?

A That is correct.

Q But none has been found in this particular zone that is within the closure herein represented?

A All I can say there is,in connection with our committee work we could not find any.

Now I understand there are companies who have, they have, their geologists have prepared fault maps. However, we have questioned geologists of one or two companies in addition to our own in connection with this committee work, and this barrier could not be established by a fault. They were not able to help us on that matter.

MR. MANKIN: That is all.

MR. PORTER: Any other questions of the witness?

By MR. NUTTER:

Q In the case where you have indicated that water production of certain wells is probably connate water, I was wondering, would the connate water percentage change from time to time or is that pretty uniform as a rule?

A It should be fairly uniform, uniform to low percentage; actually, as explained a short time ago, there is a problem of testing wells at low percentages of water. In other words, the connate water could be coming into the well at fairly constant rate, but because it tends to accumulate in the bottom of the well bore, it may not come out at a constant rate, it may not be discharged at the surface at the constant rate, so that when you test the wells you can test them for months and months; one time it may test 1% and other times 7 or 8 percent. We have had that experience on our wells that I have noted it; on other wells in the field, they are not constant within low percentages. They do remain fairly low, however.

Q Another question: When you have water encroachment from the side of a reservoir, does it usually come in at an angle rather than perpendicular?

A I would say usually there is some angle associated with it. There is generally, the bottom will be a little bit ahead of the top. That is not necessarily true, though, if you have streaks of a little higher permeability at the top, it might be essentially straight up. We have not attempted to define the angle that the oil-water interface has in the Denton Pool. I would imagine that it varies some from place to place.

Q I think you mentioned at one time it was probably maybe in the range of maybe somewhere around 45% between the Fort and Fonso wells? That would appear to be a very likely figure in my way of thinking. Do you think that originally the water-oil contact in this reservoir was a flat plane?

A I didn't catch all your question. State that again.

Q Was the original water-oil contact in the Denton probably a flat plane at 8519 or 8915?

A I believe it was essentially flat. As I stated before, we had no control, or very little control on the east sector of the reservoir. Most of the water tests were taken on the west sector, and some time ago in connection with the engineering committee work for the Denton Gasoline Plant, we established water-oil contact at 8915, and at that time we had not noted any tilted condition, at least to the degree that it would be significant.

Q Is the water-oil contact still recognized to be approximately the same depth that it originally occurred?

A As far as I know, most places it is. From these cross-section diagrams we can't determine that this original water-oil contact has moved up. Actually, we did not make an analysis for

that point after we determined that most of the encroachment was coming in from the edges of the reservoir. It appears that way, and we have not tried to pin down the water-oil contact since it appeared that many wells are still producing very near the original water-oil contact.

Q I think in some of your cross-sections some of the wells were completed or perforated right down at the water-oil contact; I believe in one case there was one below it?

A There is, and the only way that can be explained is possibly a tight streak right at the bottom of the perforations, and that possibly may be boring at the well bore so the water does not enter there. That would be the most logical explanation to give you.

Q The water-oil contact below this anomaly well, the Magnolia Pope 10, whichever one it is, is probably the same level as the water-oil contact in the rest of the pool?

A We believe it is.

Q There is probably a geyser or something connecting the well with the aquifer down below?

A That would be one way of putting it. There appears there is a crack or fracture right at that particular well, and it is localized at that well leading down into the aquifer to the extent it has a very active water drive.

Q Did the water production increase very sharply when that well started making water, or was it a gradual increase?

A I can't answer that question. I do not know how it came about.

Q Another thing with respect to the production decline curves,

I think they are exhibits 9, 10, and 11, there was considerable discussion about the bottom hole pressure line. Do you know offhand whether the wells that had bottom hole pressures taken in them, I think there are only 50 of the total 80 that are normally taken, do you know whether there are any correlations attempted or made between the wells that were shut in as a result of Stanolind's pipeline prorationing and the wells that the bottom hole pressures were taken on? Is there any tie-in there at all?

A I don't know.

Q If the wells that you had pressure on were wells that had been shut down, not shut down but curtailed there for a month?

A I don't know if there was any connection. We didn't make a correlation.

Q You didn't attempt to?

A No.

Q That would probably, possibly, I should say, change the bottom hole pressure picture overall, if you knew whether the wells were producing? I don't think all the wells in the pool were curtailed during September, Gulf and Magnolia and some other pipelines are in there, Stanolind?

A Well, I do not have a map showing what pipelines are connected between the leases in there, so I couldn't answer that question.

MR. NUTTER: I believe that is all I have.

MR. GURLEY: I have a question.

MR. PORTER: Mr. Gurley.

By MR. GURLEY:

Q You have stated, as I remember, that 15, or there are 14

or 15 operators in the field, is that correct?

A I believe that is right. I can count them.

MR. PORTER: There are 10 operators in the Devonian, Mr. Gurley, I believe.

A There are some working interest partners that will not appear on the proration schedule.

Q You stated that they all had the opportunity to be represented on this committee, is that correct?

A They have all had the opportunity. Now, some of the active operators were all invited.

Q How many of the ones invited took advantage of the opportunity and became part of the committee?

A I didn't count them. I believe Mr. Hurd was represented, Magnolia Petroleum Company, Forrest Oil Corporation, Gulf Oil Corporation, Ohio Oil Company, Phillips Petroleum Company, Mr. Johnson, Judge Redfern, Shell Oil Company, Sinclair, Skelly, McAlester, and I believe Atlantic.

MR. PORTER: You didn't mention Stanolind.

A Stanolind was in this, too.

Q Now, of the committee members of the companies that were represented, how many actually participated in drawing these exhibits?

A In drawing the exhibits, well, of course, you realize that we can't have everybody doing the same thing in the study. If you are going to get anywhere, you have to divide the work up. Now I believe all companies in times past helped participate in the drawing of the structure map.

MR. HINKLE: That is Exhibit No. 1.

A That is Exhibit No. 1. That map has been used to determine equities in the Denton Gasoline Plant at previous meetings of the committee. A possible exception to that is Stanolind since they are not a member of the Denton Gasoline Plant. However, they had access to this map and have reviewed it. Now the cross-section diagrams, I believe, was prepared by Atlantic, that is Exhibit No. 2. The other operators have reviewed that, that is a relatively unimportant exhibit. The cross-sections which comprise Exhibits No. 3, 4, 5, 6, and 7 were prepared by Shell and by Atlantic. Now other operators have had the opportunity of looking at those.

Q Have they taken advantage of that opportunity?

A We have certainly furnished them with copies of our report and if they haven't it's their own fault.

Q You sent them copies of your exhibits and your report?

A Yes.

Q That is fine. My point is this in asking the question: Did all the participating or all the members on the committee actually participate in preparing the exhibits?

A Not all of them. We invited them in initially when we formed the committee. I believe Mr. Hurd and Mr. Redfern were represented at that time and again later when we reviewed the work that we had done.

Q Now on the review, did you review these exhibits and discuss them in an open meeting of your committee with all the members present and discussed all the exhibits to be presented here?

A Yes, we did not exclude anyone in that.

Q My point is not for the exclusion angle, but did everybody

see them and discuss them at the committee meeting?

A Yes, and certainly at the operators' meeting, too. Everyone was invited to that. They had an additional opportunity.

MR. GURLEY: That is all.

MR. MALONE: Ross Malone for Gulf.

By MR. MALONE:

Q I would like to return just a minute, to turn to Exhibit 9 and the pressure barrier that Mr. Mankin mentioned in his cross examinations. That was prepared on the basis of bottom hole pressure figures furnished in April, was it not?

A Yes.

Q Are you familiar with the fact that similar isobaric maps have been prepared on prior bottom hole pressure tests?

A Yes, sir, we did prepare prior maps.

Q How many such prior maps were prepared?

A I believe four additional.

Q That was over a period of how long a time?

A I believe the first map was prepared for April, 1954 survey. Probably in October of 1954 survey would be on there, the other was the first one and then they were continuous from that time up to the present.

Q At six months' intervals?

A Yes.

Q Did each of those studies demonstrate the existence of the pressure barrier just as this study has?

A Yes, sir, although not in such a degree as this one. Other maps since the pressures were nearer the same pressure, the reservoir was near the same pressure when they started production,

the barrier did not appear to be as effective on the earlier maps.

Q By that you mean that the differential between the two segments was not as great on the earlier maps as it was on this one?

A That is right.

Q But the differential did exist, did it not?

A That is correct.

Q It has increased, that is why such a study was made?

A That is correct.

Q So the gradient is greater now than it has ever been before?

A That is right.

Q And the existence of the pressure barrier was more distinctly demonstrated?

A Yes.

MR. NUTTER: Does the differential always follow the same lines?

A I believe it has. On some surveys there were some wells possibly that were not tested that were situated along the barrier. You understand this last survey is probably the most complete one we ever had. I believe that this has generally had this shape, of course, you realize if you miss a pressure on any of these wells it is going to change the shape of the barrier. Examination of the other pressure maps might show some slight variation, but I believe it would, had we had pressures, it would have shown that it would have taken the same course.

MR. WALKER: Any further questions of the witness? Anybody care to make any statements regarding this?

MR. HINKLE: We have another witness that we would like to

put on. He is an engineer from Dallas, he might not be able to be here if the case is continued or not concluded today.

MR. PORTER: We will recess the hearing until 1:30.

(Recess).

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. Mr. Hinkle.

MR. HINKLE: We have one additional witness we would like to have sworn.

MR. WALKER: As I remember, Mr. Tomlinson was still on the witness stand. If there are no further questions, the witness may be excused and you may call your next witness.

(Witness excused).

MR. HINKLE: Stand and be sworn.

T. W. STADE

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. HINKLE:

Q State your name, please.

A T. W. Stade.

Q By whom are you employed?

A Atlantic Refining Company.

Q In what capacity?

A I'm a senior reservoir engineer in charge of primary recovery.

Q At what office?

A In the Dallas office.

Q How long have you been with Atlantic?

A I have been with Atlantic nine years.

Q Are you a graduate petroleum engineer?

A Yes, sir. I graduated with the civil engineering degree and I have a master of science degree in petroleum engineering.

Q What school?

A University of Tulsa.

Q Are you familiar with the New Mexico area, and particularly the Denton Field?

A Yes, sir.

Q Have you followed the engineering studies that have been made of the Denton Field since the inception of the field?

A I have followed, closely followed the work of the reservoir, Denton Reservoir engineering committee for the past three years, and in particular I've followed the work that they have done since January of this year, and a man under my supervision has worked at various times directly with the committee to understand the work they are doing; and together, he, myself, have assisted Mr. Tomlinson in the analysis that our company has made of the factual data that the committee developed.

MR. HINKLE: Are the qualifications of the witness acceptable?

MR. PORTER: They are.

Q Mr. Stade, would you like to make a statement to the Commission regarding this case; before doing so, I would like to ask you whether or not you have been present during all the testimony in connection with this case and heard all the testimony?

A I have been present during all the testimony.

Q Would you like to make a statement to the Commission in

regard to some of the principles involved in connection with this case?

A Yes, sir. In general, I would like to comment on the testimony that was given this morning by discussing some of the principles of the material balance study that we have made and the concepts that we used to determine what the best rate of production for this pool was, or whether waste was occurring in this pool.

First of all, we want to operate the Denton Devonian Pool by a water drive mechanism. It's generally recognized that it is one of the most efficient methods of operating an oil pool or depleting an oil pool, and in this case it happens to be the most efficient primary method that we know of at this time. To do this naturally you have to flood out the reservoir with water in the process of displacing oil to the wells, and in answer to one of the questions that was brought up this morning, this naturally decreases the oil column in that part of the field where water enters the reservoir. What we want to do in this pool is to eventually have water flood out the maximum amount of reservoir volume and we want to do this so we can obtain the maximum amount of oil recovery in any part of the reservoir volume contacted by water. This means that we conduct this flood at the correct pressure level. Now the purpose of our material balance study was to find out what the correct pressure level was, or to put ourselves in a position to determine as we continue to operate this pool what the right pressure level will be and not let it get out of hand. In particular, I will talk about the east half of the Denton Devonian Pool which has been thoroughly discussed up to this

point, and I will repeat that our analysis considered the Denton Devonian Pool was in actuality two pools not connected, separated by a barrier. First of all, to obtain the maximum recovery from the water drive pool such as our analysis indicated, we have here, we desired to create some gas saturation in the pool. To do this requires that the reservoir pressure of the pool drop below the bubble point pressure, otherwise no gas would be created. The reason for this is that quite a bit of work has been done by the industry over the past two or three years indicating that for some moderate drop below the saturation pressure, increased recoveries will result due to the evolution of gas from the oil, and as stated previously, this gas will occupy space that otherwise would be occupied by residual oil. Now, discussing a few other principles here, in answer to some of the discussion that was brought up this morning, in any water driven pool, you have to have a pressure decline for the water to encroach into the pool, and this pressure decline is going to vary, among other things, with the rate of production of the pool. For instance, if the field rate were decreased the pressure would tend to go up and if the pool were completely shut-in would tend to approach the original pressure again. The fact that the pressure goes back up doesn't necessarily mean in any way that the pool is being operated more efficiently. As a matter of fact, the contrary is true. The recovery would actually be decreased at a higher pressure, not only due to the creation of the gas as I just mentioned, but other changes in property of the reservoir oil formation, volume factor in particular. For instance, in the eastern half of the Denton Devonian Pool originally there was very little water

influx with the first few barrels of oil that was produced. For practical purposes, it was zero influx. As the pressure declined, the water influx is gradually increased from zero to somewhere between 65 and 70 percent according to our previous testimony on our material balance results.

On the west side of the pool the same thing has occurred and we found by this analysis that we have a much more prolific source of water supply and it has encroached to a greater degree with pressure drop, to where it is now replacing a very high percentage of the withdrawals and maintaining the pressure, as is rather obvious from previous exhibits, at a rather constant level at current rates of production.

Following through on this performance and my previous statements, it actually indicates that the western half of this pool could be operated at a considerably greater allowable than is currently given it and not cause waste and in all probability would increase recovery from the western half of the pool due to the previously mentioned concept.

On the eastern half of the pool, as I stated, our material balance analysis indicated that the water influx which originally was essentially zero has now increased to a point where it is now replacing approximately 65 to 70 percent of the current withdrawals from that portion of the field. As the pressure continues to drop there will be a greater pressure differential available to force water into the pool, and the amount of replacement of voidage should increase. Our material balance indicated further that with production over the next two-year period, which was as far as we carried the analysis, that the pressure would

continue to drop but at a greatly reduced rate due to two reasons. One was the increase in influx that will occur with further pressure drop, that is, increase in water influx; and as the pressure drops below the bubble point pressure, which according to the p.v.t. data which was presented in testimony, the best data available, on the average that part of the field has fallen below the bubble point already slightly. These two facts will tend to create a much reduced rate of pressure decline. We carried this out for two years to determine whether the decline that would occur in that period of time would in any way cause waste, and our analysis indicated that the pressure drop that would occur would not cause waste.

Now one of the reasons we made our second recommendation this morning was -- this recommendation being that pressure data should be taken in all the wells at six months' intervals, as in general they have been in the past -- was that we want to continue making these material balance analyses on each pressure period and from that determine whether a satisfactory rate of production and operation of the pool is still taking place.

I believe that ends my testimony.

MR. HINKLE: That is all.

MR. PORTER: Does anyone have a question of the witness? Mr. Mankin.

CROSS EXAMINATION

By MR. MANKIN:

Q Mr. Stade, referring again to the mechanism which we have here of a water drive, which is coming in, is becoming more effective, particularly in the west sector, might I ask, the

water has been increasing, of course, as it should be with the pressure declining some, getting further below, approaching the bubble point on the west section, of course below the bubble point on the east section. There have been a number of completions and plug-backs in which, going up higher up in the hole, in an attempt to keep the wells flowing instead of pumping. Do you feel that sometime in the future, in order to get the best utilization of the energy that is being supplied there and the oil to be recovered, that you could go back in the wells again to a deeper portion of the reservoir and by pumping with the high fluid levels that we will very likely still obtain great amounts of oil that is now below the plug-backs?

A I think that an operator might be able to deepen some of his wells or go back to where he has plugged back from and obtain oil production from certain of those intervals. However, if he does not do that, it does not mean that the oil production is necessarily lost, because if they are connected with the remaining part of the pool that is not flooding out, bypassing, flooding out that area, it should push the oil ahead of it and displace up-structure to wells. Another operator may get it, but it is just a matter of what is the best operation for the particular operator is concerned.

Q Somebody might get the oil; I am speaking of a particular operator in a particular well.

A He might do it. It gets to be a sort of low chance proposition because of the great amounts of water that might be had with small quantities of oil. I think it could be done.

Q To further substantiate that, the water is very effective

on the west flank, I know some study has been given by the operators to taking the water produced from Denton and Devonian and possibly flood from the Wolfcamp. I think some thoughts have been given to that.

A My understanding of the function of the engineering committee that was formed here in January was that we would study both pools for the best method of operation, and with only a cursory look at the past performance, the Wolfcamp is a very much better prospect for some sort of secondary recovery or pressure maintenance type of operation. Whether water is the best or even possible there, I don't think we even got into it more than we should look at it.

Q I merely mentioned that as a possible source of water that is being produced, because many of the operators have been plugging back to get water. My particular thought is the water is being produced and there is a number of abandoned wells on the west flank that were dry. Has there been any thought to, instead of trying to get the water, of attempting to put it over there to further help the dry ones?

A None that I know of. I think it would be premature at this time to consider that, other than to recognize it as a source and then you would get into the question of whether it was the best source and the best water and other questions that would come a little later than a study that has been made at this time in the Wolfcamp. We haven't really determined, as far as I know, any conclusive results about the primary performance, which would have to be done first.

MR. MANKIN: That is all.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Stade, when you have a migration of oil up to the structure like you have on the west side out there coming from the aquifer clear of the pool, and that oil moves up into the structure of the Devonian, is that water-oil interspace more or less a straight line? Does that oil move in a flat plane? We established this morning it was moving in an angle, but now, is it a flat plane?

A I believe theoretically speaking and practically speaking from field observation, that it never moves in exactly a flat plane. There is quite a few factors affecting the movement of it, such as any degree of stratification or variation of the pay from top to bottom. Actually, you get into considerations of the mobility of the oil compared to the mobility of the water, and the pressure differential acting over different distances, depending on whether you are talking about the strata that is at the top or at the bottom of the pay, and even within one strata, and it creates a tilted condition if the water in the first place wasn't level and that it could actually not be exactly flat in the first place; but generally speaking, you try to analyze the data to determine whether it is flat or not, and this case, it turned out that for all practical purposes it looked like it was.

Q I know we don't have an ideal situation. The ideal situation is one of the big long glass test tubes in laboratories filled with sand, put the water in the bottom and it moves up in a flat plane. I wonder if water in a place like this might be moving up on the flat plane?

A I would say that one of the first thoughts about this type

of pool, Devonian pools similar to Denton, other types that are somewhat analogous like the Ellenberger Field of West Texas and New Mexico with the water lying,as far as they were able to determine, essentially under the entire pool, that the first thought would be that a bottom water movement, that is, it would move vertically upward in all parts of the pool as you deplete it. However, that depends on whether there is vertical permeability and whether there is vertical connection as opposed to connection and continuous permeability, say parallel to the bedding planes, and you are not able to determine that exactly in most cases until you have had some degree of production and are able to analyze the performance of the individual wells and observe where the water is coming in. It is well known that this pool is a low porosity fracture vugular, generally, in nature, and that there is variations in permeability throughout the reservoir as evidenced, for instance, by the rather wide difference in productivity indices and core data, I think indicates the same thing. So you don't have the ideal situation, if it were ideal I think that type of mechanism would occur here.

Q The speed with which that water-oil interface was moving would also affect the shape of it, too, wouldn't it? I mean if the thing came to rest and stopped moving, it would equalize and establish more or less a straight line, would it not?

A Theoretically, yes, sir. It might take some --

Q (Interrupting) In fact, the faster the interface is moving the more tendency there is for an indication in a straight line?

A Not necessarily so. The speed with which it moves basically depends on the comparison of the gross withdrawals to the gross

influx, and the speed with which it moves through various strata probably depends more on the variations in permeability than any other factor. Now I don't know if that answered your question or not.

Q Well, I guess so. In answer to Mr. Mankin's question, you remember talking about these wells which are plugged back and restored to top allowable production, in that event, later on, I think you stated that the oil that was left behind when that was plugged back, if the well weren't deepened again when put on pump, if it weren't deepened, that the oil left behind would migrate up the structure or up into the top of the Devonian, anyway, and be produced from the upper perforations?

A Not all the oil left behind is going to be pushed up to upper perforations. That oil may, might be produced if an operator deepened his well, and that being the oil that is flowable, not residual in the term, that is, being the oil that is bypassed by the water is unrecovered, that flowable oil may well be pushed up to the up-structure wells and would be if there is a continuous pay zone between that point and the up-structure wells.

Q What length of time would it take for that oil to migrate three feet and be producable if the well was plugged back, say, 300 feet?

A Well, generally speaking, the length of the -- instead of length, say the distance between the point of water encroachment whereby you can produce oil and the point of water encroachment where oil can no longer be produced or can no longer flow, is generally a rather sharp front, unless you have a very unusual system of a high viscosity oil; for instance, in some cases.

that period of flow behind the initial front of water might be longer and might be fairly, might take a fairly long time to be pushed any distance. However, by the time you ultimately deplete your well, you usually produce it up to a rather high water percent, and it's, for all practical purposes, had enough water flushed through the areas flooded out to get to that minimum residual point. It depends a little bit on your ability to handle water to determine the exact abandonment point. That has to be taken into consideration to study, you get to the physical capacity of your equipment and your ability to produce wells. The specific answer to your question, I don't think it would be a period of time that would be so long that you would lose that oil recovery.

MR. NUTTER: I believe that is all I have.

MR. PORTER: Anyone else have a question of the witness? The witness may be excused.

(Witness excused).

MR. PORTER: Anyone have a further statement?

MR. RAINEY: Joe Rainey. It is Skelly's recommendation that allowables be reduced for a period of six months, and during that time in order to gather additional pressure information we recommend that bottom hole pressure be taken ever 90 days.

We feel that since there appears to be a water drive on the low pressure east sector that a reduction in allowables could allow water encroachment to be in balance with withdrawals which would tend to maintain bottom hole pressure and increase recovery.

A reduction in allowables, we feel, will not harm the reservoir but could furnish additional information which could be

advantageous to the recoveries from the reservoir.

MR. MALONE: Ross Malone, Gulf. Gulf would like the following statement incorporated in the record of this case:

It is apparent that the operators in the Denton Devonian Pool are genuinely interested in producing this reservoir at an efficient rate, as evidenced by the fact that they have inaugurated a cooperative study group to analyze the reservoir before the Commission takes any action in this hearing.

Gulf, being the operator of 9 of the 110 Devonian wells, has studied this reservoir not only within the company, but also by assisting and reviewing the cooperative efforts of the Denton Engineering Committee. These studies indicate that, although the eastern and western segments of the reservoir appear to be producing independently, the energy in each is being supplemented by water encroachment. At the current producing rate, the western segment undoubtedly will be depleted at pressures well above the bubble point. To date, water encroachment in the eastern segment has not been as active as in the western segment and the pressure decline has been more pronounced.

The average pressure in the eastern segment is now near the bubble point. In a depletion drive reservoir, the pressure decline flattens below the bubble point. In a reservoir such as this where the fluid expansion is being supplemented by water encroachment, the pressure flattening becomes much more pronounced. Calculations indicate that at the current withdrawal rate, two years would be required to lower the average pressure in the eastern segment 300 psi. This should not be detrimental to the reservoir and, in fact, based on laboratory studies of cores, the

recovery efficiency may even be increased.

Further, data available to date would indicate no water coning has occurred because of this producing rate. There are cases of wells completed structurally high which have small oil cumulatives and yet produce appreciable water. Conversely, there are cases of low structural wells with large oil cumulatives which produce clean. Water production in this reservoir, in our opinion, is typical of fractured water drive reservoirs and is an individual well problem.

In view of the above, Gulf believes that the prudent course of action would be to continue the present producing rate and periodically review performance. Thus, no avoidable waste of reservoir energies would be allowed to occur should subsequent performance dictate another course of action. On this basis, Gulf, therefore, strongly recommends that the Commission maintain the present producing rate in the Denton Devonian Pool.

MR. ROGERS: W. J. Rogers, Sinclair Oil and Gas. Sinclair operates 18 wells all of which are in the east sector of the Denton Devonian Pool. We concur in the recommendation made by Atlantic.

MR. COUCH: Terrell Couch. It is my opinion that an order of this Commission reducing the rate of production in the Denton Devonian Pool would be valid only if the reduction of rate would prevent waste. This record, in my judgment, will not support a finding that reduction of the rate of production will prevent waste. In fact, it seems to me that the contrary is established by this record, that a reduction in the rate could possibly cause waste rather than prevent either eminent or occurring

waste. Under the existing facts as we understand them, the Ohio therefore recommends that the present rates be continued and that the pressures and the ratios and production performance of the reservoirs be kept before us all as we continue in the production of the present system.

MR. PORTER: Anyone else?

MR. HINKLE: Mr. Vernon Turner, who is assistant production superintendent of the McAlester Fuel Company, handed me a statement, inasmuch as he had to leave, which he would like to introduce in the record on behalf of the McAlester Fuel Company.

"Mr. Chairman and Members of the Commission:

We should like to concur generally with the engineering testimony presented by The Atlantic Refining Company in this case, and to recommend that no reduction in allowable be made for the Denton Devonian Reservoir at this time.

From information presently available to us we do not believe that any damage to ultimate recovery from this reservoir will result from the present allowable allocation to the pool.

We further feel that the future performance of this reservoir as it is followed by the Operator's Joint Reservoir Engineering Committee, which has been set up specifically to study this pool, will point out any possible harm which might result from excessive allowables in ample time to permit proper adjustments to be made."

In substance it simply agrees with the agreements and recommendations of the Atlantic and recommends that there be no decrease in the allowable.

Now with respect to the position of the Atlantic, you

already have in the record their conclusions and recommendations. I would like to bring to the attention of the Commission that the engineering committee which has been set up is going to be a continuing thing. It's going to be a group that is going to continue to study the reservoir. I think that I can assure you that the operators on that committee are just as interested or more interested than anybody else in seeing that this field is operated at the most efficient rate, so that the greatest ultimate recovery will be had. I think, too, that when that committee or the majority of them find that any condition is beginning to prevail where it is not being operated at the best rate, that they will be quick to come to the Commission and ask for a reduction in allowables. That has not been the case up to date. I think the great majority on the committee now feel that there should not be any reduction in allowables and that the field is being operated satisfactorily and without waste. I also want to point out again, as already has been pointed out by the representative of the Ohio, there is no evidence been introduced so far into the record here which in my opinion would justify any reduction in the present allowable or indicating that there is any waste of any nature being had.

MR. PORTER: J. Foster.

MR. FOSTER: J. Foster, representing Phillips. We concur in the recommendations made by the Atlantic.

MR. GURLEY: If it please the Commission, in view of the fact that as I said once before, this is a great problem in the industry at this time and concerns us all, the Commission staff feels that it would certainly do no harm, in fact, it might be of

great help to continue the case until after the October bottom hole pressures have been taken in the field and the report turned in thereon, and will give the industry as well as the Commission additional time to further study this situation.

I therefore would like to move at this time that the Commission continue the case until the December regular hearing, during which time both the Denton Engineering Committee and the Oil Conservation Commission staff will be able to give this question further study.

MR. HINKLE: If the Commission please, this is the first case of this kind which has ever been before the Commission. I don't think that a policy ought to be adopted by the Commission, on their own motion, having a hearing of this kind on the most efficient rate of production, and continuing the matter from time to time, maybe throughout the life of the field.

I think these things ought to be drawn to a conclusion. Of course, it is in the interest of having all the information available, and there has only been one test, that in April, which has been a full and complete test. It would probably be desirable to have another complete test and take a look at the situation, and we have no particular objection to continuing the case so that that may be had. That test would be taken in October, and your motion is that the case be continued until December. The work and the additional evidence showing the result of this test will have to be gotten up by this engineering committee. With so many operators involved, it will take a little time to do that, and then, too, you have a holiday coming in at Christmas, the hearing would be just before Christmas, which is a bad time, and

I would suggest that you change your motion to have the hearing continued until January, rather than December.

MR. GURLEY: We agree to that.

MR. PORTER: Mr. Mankin.

MR. MANKIN: I have a statement I want to make in regard to that. Do you want to rule on that first?

MR. WALKER: Any other comments regarding the motion, any discussion?

MR. PORTER: Your statement is in regard to this motion?

MR. MANKIN: They tie into it and the test that will be taken, it is very pertinent.

MR. WALKER: Does anyone have any objection to Mr. Mankin making his statement before we rule on the motion?

MR. MANKIN: On behalf of the engineering staff of the Commission, I want to make two or three points clear: First, that this is not the maximum efficient rate, that was a rather misnomer in itself. It should be the most efficient rate. I want to point out that it is the Commission staff's feeling that this should not set a precedent for MER hearings, which have been unsuccessful in the larger oil States, such as Texas. We do not anticipate that there will be any such hearings as this on other fields. It will be strictly when we feel there is a problem that should be brought to the attention of the industry. The other thing I have is that the regular bottom hole pressure survey is scheduled for October, to be taken by the operators, which will be reported by November 25 to the Commission. I think that should go on ahead, as evidenced by information submitted here today.

In addition, a directive went out to the operators prior

to the hearing that the gas-oil ratio survey should be taken in April, which would take the place of the August-September survey, the annual survey. It is my recommendation to the Commission that that not be done away with, but be slipped slightly and be taken during the same time that the bottom hole pressure is taken, or in the month of October, and to be reported by November 15, which would mean that it is as it should be, the bottom hole pressures and gas-oil ratios should be taken at the same time to get better material balance calculations and properly study the reservoir, rather than have two months as originally scheduled, August and September.

I recommend that the gas-oil ratio should be taken for the Denton Devonian Pool during the month of October, at which time I recommend that an additional directive go out to the industry in that respect, and that we then, of course, have a progress report during the month of January, not rehash this whole information, but it would be a waste of everyone's time, but strictly a progress report to see if there are any danger areas, see if anything that should be done at that time, and if not, to consummate the whole affair.

MR. PORTER: Any comments or objections to Mr. Mankin's recommendation?

The Commission will continue the case until the regular January hearing of 1957. In the meantime, we will direct that another gas-oil ratio survey be taken as Mr. Mankin has recommended during the month of October.

If nothing further to come before the Commission, the hearing is adjourned.

STATE OF NEW MEXICO)
: ss
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the Oil Conservation Commission for the State of New Mexico was reported by me in stenotype and reduced to typewritten transcript by me and/or under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal, this, the 27th day of June, 1956, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley

My commission expires:
June 19, 1959.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
January 16, 1957

IN THE MATTER OF:

Case No. 1052

DEARNLEY-MEIER AND ASSOCIATES
COURT REPORTERS
605 SIMMS BUILDING
TELEPHONE 3-6691
ALBUQUERQUE, NEW MEXICO

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
January 16, 1957

IN THE MATTER OF:

Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico. Operators are requested to furnish all available production data, reservoir data, and any other pertinent information in order to determine if the present existing system of allocation in the Denton (Devonian)Oil Pool might result in waste and to enable the Commission to establish the proper producing rate.

Case No. 1052

BEFORE :

Honorable Edwin L. Mechem
Mr. A. L. Porter
Mr. Murray Morgan

TRANSCRIPT OF HEARING

MR. PORTER: The meeting will come to order, please. We will take up the next case, Number 1052.

MR. GURLEY: Application of the Oil Conservation Commission upon its own motion for an order establishing the maximum efficient production rate for the Denton (Devonian) Oil Pool, Lea County, New Mexico.

MR. PORTER: Will the witnesses in this case that propose to testify -- Do you want to make your statement prior to swearing the witnesses?

MR. HINKLE: We have one witness, probably two. Do you

want to swear them?

MR. PORTER: Suppose we have them sworn at this time.

(Witnesses sworn.)

MR. HINKLE: If the Commission please, Clarence Hinkle of Hervey, Dow & Hinkle, Roswell, representing the Atlantic Refining Company. The docket in this case shows it is a continued case, the original hearing having been held before the Commission on June 19, 1954. Due to the fact that Edwin Mechem and our Land Commissioner were not members of the Commission at that time, I think it would be proper to make a short statement relative to the original hearing, and then you can get the continuity of this hearing.

At the opening of the June the 14th hearing, Mr. Dan Nutter, Engineer for the Commission stated it had been called to the attention of the Commission that there had been a rather sharp increase in the amount of water being produced from the Denton Devonian Field since 1954, and that the object of the hearing was to determine whether the present rate of production might be constituting waste. The Atlantic Refining Company put on the case in behalf of the most of the operators in the field at the original hearing, due to the fact it was one of the largest of the operators in the field, and chairman of the engineering Committee. Mr. W. P. Tomlinson of the Atlantic, a reservoir engineer, from Midland, was the principal witness at the original hearing on behalf of the Denton-Devonian Field Engineering Committee and on behalf of the Atlantic.

At the other hearing there were 25 exhibits introduced, numbers from 1 to 25, inclusive, all except one of which were pre-

pared as a result of the study of the Denton-Devonian Field up to the time of the hearing on June 14th. I have available, copies of the exhibits that were introduced at the original hearing in a folder, which I will present to the Commission, and which they may refer to during the course of the hearing, if they so desire. At the conclusion of the June the 14th hearing Atlantic recommended that the current rate of production, based on the current allowable from month to month be continued, as the evidence we believe showed conclusively that waste was not being committed by the present rate of production, and, in fact, that it would likely cause waste by cutting the rate of production.

The Commission determined to continue the hearing until this January with the understanding that a bottom hole pressure and gas-oil survey would be made as described by the Commission in October, 1956; and the Commission be advised of any changes that may have taken place since the June 14th hearing; also showing the results of the further study of the Denton Field Engineering Committee. Also at the conclusion of the original hearing, Mr. Warren Mankin of the Commission Engineer Staff pointed out that the hearing this January should not consist of a re-hash of the evidence introduced at the June hearing, but should be strictly a progress report to see if there are any danger areas, this is quoted from him, and if not to consummate the whole affair. That last is also quoted.

A new survey was made in October, 1956, of the bottom hole pressures and gas-oil ratios, as directed by the Commission, and there has been a continued study of the entire situation by the Denton Field Engineering Committee. As a result of the work of the

Engineering Committee, some 16 additional exhibits have been prepared, most of which have been arranged on the wall or board here, and have been marked from Exhibits A to P, inclusive. The reason for using the letters is not to confuse them with the original exhibits which were marked from 1 to 25 inclusive.

It is,the purpose of these exhibits, for the most part, to bring the exhibits introduced at the original hearing up to date. We want to shorten this hearing as much as possible, and Mr. Tomlinson, the witness, will cut his explanation of the exhibits to a minimum. However, we want to give the Commission a clear and concise picture of the facts as they now exist.

We believe that the evidence which will be introduced will conclusively show that waste is not being committed by continuing the present rate of production.

In the interest of saving time, I would like to question Mr. Tomlinson concerning the exhibits and then offer them all in evidence at the conclusion of his testimony rather than offering each one individually. I believe it will save time. Mr. Tomlinson. -- I might say this, we have prepared a folder which we will give to each member of the Commission and the Staff, which contains all the exhibits A to P, inclusive, which will be referred to by Mr. Tomlinson, and will be offered in evidence. Some of these exhibits are small, but they are a reproduction from the larger maps and are identical except they are on a smaller scale.

W. P. T O M L I N S O N ,

CALLED AS A WITNESS, HAVING BEEN FIRST DULY SWORN, TESTIFIED AS FOLLOWS:

DIRECT EXAMINATION

By MR. HINKLE:

Q State your name, please.

A W. P. Tomlinson.

Q By whom are you employed, Mr. Tomlinson?

A Atlantic Refining Company.

Q In what capacity?

A As a reservoir engineer.

Q Are you the same W. P. Tomlinson who testified at the original hearing on June 14th in this case?

A Yes, sir.

Q I believe at the original hearing you testified that the exhibits which were introduced at that time Exhibits 1 to 25, inclusive, were prepared as a result of a study made by the Denton Engineering Committee?

A Yes, sir.

Q And that you worked with that Committee and that they were prepared by the Committee and by you, personally?

A Yes.

Q Has the work of that Committee been continued?

A Yes, sir. The Committee has expressed approval of all these exhibits that we have prepared here for presentation.

Q You are referring to the Exhibits which have already been identified as Exhibits A to P, inclusive?

A Yes, sir.

Q All of those exhibits were prepared as a result of the work of the Engineering Committee?

A Yes, sir.

Q Did you work with the Committee and were they prepared at the direction of the Committee and by you, personally?

A Yes, sir.

Q All of the exhibits which will be referred to by you?

A Yes, sir, they were prepared by me, or under my supervision, or under the supervision of the Committee.

Q Are these exhibits based upon the work which has been continued by the Committee since the time of the hearing on June 14th?

A Yes, sir.

Q Are they also based upon the results of the survey which was made in October, 1956, at the direction of the Oil Conservation Commission?

A Yes, sir.

Q Now, Mr. Tomlinson, if you will refer first to Exhibit A and explain to the Commission what that is, and then without interruption, in the interest of saving time, if you will continue to take the Exhibits in the way that they are lettered and refer to them and explain briefly each exhibit.

A In the June, 1956 hearing, on this case we presented a map contoured on lines of equal pressure in the Denton-Devonian Field. It indicated an area of very high differential pressure down through the middle of the field as if there were a barrier at that point. It suggested that two reservoirs might be acting independently here. We have prepared this map this October -- This is Exhibit A -- to show that this differential still exists, and is, in fact, larger than it was before. For example, here we have between two off-

setting wells, one of them above 4100 pounds bottom hole pressure, and the other one to the east is below 2500 pounds. Those wells are Magnolia Maxwell Number 1, and the Magnolia Hope Number 8 -- I beg your pardon, I believe that is Well Number 4 instead of Number 8. The purpose of this map is to simply show such a differential still exists in the field. It does not represent the way that we think the pressure map should be presented to you, or should be used by the industry for studying the performance of the field.

Q Is that Exhibit A based upon the information which was obtained from the October, 1956 survey?

A Yes, sir.

Q That is the bottom hole pressure and gas-oil ratio pressure?

A Yes, sir, those pressures were taken in October at a datum of minus 8200 feet, and the contour interval on the map is 100 pounds.

Now, Exhibit B is a map based on the same information, that is contoured in the way that we believe will show an accurate picture of the pressures in these two reservoirs. We have placed in a barrier here, down through the middle of the field, it is based on one of the contours submitted, one of the contours on the April 1956 bottom hole pressure maps that was submitted at the June hearing. We still think that is a pretty good place to divide this field into two parts. The effect of this is to eliminate any rise in pressure along the west sector, the west side of the east sector of the field. As you can see on the other map here you have a pressure on the west side of the east sector that came up. It had

to be contoured that way if you assume that it was all one reservoir. Since we believe that it is not because of the high differential through there, it is more logical to separate the two fields and place the pressure contours on them independently. We have done this, and what it does for the east sector is to lower the pressure a little bit over there from what it would be if you interpreted it otherwise, as we had done before.

Q Do you think that that Exhibit B is a more realistic interpretation than that shown by Exhibit A?

A Yes, sir, I do. As I explained, on Exhibit A there is a differential along the west side of the east sector of the field that actually is an artificial rise in pressure. It is contoured in there because that is the way you have to contour if you use that concept. This way you have no such limitation placed on you, you canccontour it the way it looks like it should be. It will also effect the pressure on the west sector, since on Exhibit A and on our previous bottom hole pressure maps that we submitted in the June hearing there was a dropping off of pressure indicated along the east side of the west sector. Exhibit B doesn't show anything like that.

Q You might, Mr. Tomlinson, for the benefit of the Commission, identify the dividing line between the two sectors which you have testified to.

A Well, on Exhibit B that line is drawn generally in a north, northwest, south, southeast direction through the field. It splits it fairly nearly in half. It's a black line. It somewhat resembles

a fault on the structure map, except that it is a little more rounded.

Q Is it your interpretation that that reflects two separate reservoirs, or two separate sectors of the Devonian Field?

A Yes, sir, two reservoirs that are behaving independently.

Q Is that a different interpretation than that which you gave to the Commission at the original hearing?

A It isn't any different interpretation; however, we presented the pressures in a different way. The pressures have been interpreted differently, but at that hearing we did state that we thought we had two reservoirs here.

Q Has the information contained on Exhibit B been used for any purpose other than to show that two separate reservoirs do exist?

A We have used these pressures here, or these maps, to obtain volumetric weighted pressures for the east and west sectors of the reservoir. Those pressures during October were 3,972 pounds for the west sector and for the east sector was 2,405 pounds. Now, those pressures are referred to a datum of 8,200 feet sub-sea.

Q There is a pressure differential then between the two sectors?

A Yes, sir. Now, we have used these pressures here and some of our work that I will explain later on, in some of our calculations.

Exhibit C is a bottom hole pressure map showing the information that was obtained during the April, 1956 bottom hole pressure survey. We are presenting this map to show how that information might have looked had it been interpreted as we are doing now. We place

this map in here so that you will have one map for the April survey that you can compare with a similar map presented for the October survey. We used this map also in obtaining new volumetrically weighted average pressures for the east and west sector of the reservoir, and the effect on those pressures was, as I have mentioned before, it's a slight lowering of the pressure on the east side, and a small increase in pressure on the west side.

Q Mr. Tomlinson, have you made any calculations with respect to the production rates for the Denton-Devonian reservoir and any tabulations with respect to them?

A Yes, sir.

Q I hand you an instrument identified as Exhibit D. Please state to the Commission what it is, and what it shows.

A This is a tabulation of the production rates of oil and water and gas-oil ratios, bottom hole pressures in percent, water in total fluid, for the entire Denton Field. We have brought this up to date through October, to take into account the information that we felt was pertinent at that time.

Q Which was given in the original hearing here?

A Yes. This, as I stated before, applies to the whole field, but probably shouldn't be taken with much weight, because the statistics that mean more apply to the east and west sectors of the reservoir.

Q Have you made a separate tabulation as to the west and east sectors?

A Yes, sir, we have.

Q I hand you Atlantic's Exhibit E and ask you to state what it is.

A Exhibit E shows the same information noted for Exhibit D. We have brought that information --

Q (Interrupting) That is only, though, as to the west sector?

A Only as it applies to the west sector of the field. We have brought it up to date and made a few corrections in some of the production data that we found after it was retabulated, before the production information of the west sector was tabulated manually, and, at this time, we have access to IBM tabulations prepared by Shell Oil Company. We feel that they're more accurate. The bottom hole pressures noted on this Exhibit E have increased for the last four or five points, a small amount, because we obtained new volumetrically weighted average reservoir pressures for the west sector. What we did was to recontour our pressure maps, taking into account the fact we have two reservoirs there and because of that we came out with a slightly higher pressure for the west sector.

Q By increase, you mean they were increased over the original figures introduced at the original hearing?

A Yes, sir, there has been between the last four and five points shown on this tabulation, you'll find that there is a small increase.

Q I'll hand you Atlantic's Exhibit F and ask you to state what it is, and what it shows?

A Exhibit F contains the same information noted for Exhibits D and E. It was prepared in the same way and bottom hole pressures on that tabulation are a little lower for the reasons that we stated previously, and that is why we do not have the differential pressure

existing along the west side of the sector.

Q Now, Mr. Tomlinson, if you will refer to Atlantic's Exhibit G and explain to the Commission what it shows?

A Exhibit G is the Denton-Devonian Field performance versus time. On there we have oil production barrels per month, water production in barrels per month, actually they are thousand barrels multiplied, number of wells, average bottom hole pressures at minus 8200 feet, gas-oil ratios and cumulative oil production, all plotted, versus time. This graph shouldn't be given a great deal of weight in that we believe graphs, applying to the east and west sectors are more significant. We present it here simply to give a composite picture of the field.

Q What is the source of the information from which this graph is compiled?

A The majority of the information, production information, has come from the New Mexico Oil and Gas Engineering Committee tabulations, ultimately, or in the beginning; however, as I stated before, Shell has furnished us with an IBM tabulation and that is shown on Exhibits D, E, and F. You will find the same information for this one graph on Exhibit D.

Q Mr. Tomlinson, refer to Exhibit H and explain to the Commission what it shows?

A Exhibit H is a graph showing the west sector performance plotted versus time, and has the same information plotted as was on Exhibit G. The scales are the same and the source of the information is the same.

Q Is that a continuation of the information which was originally shown on Exhibit Number 10 at the original hearing?

A Yes, sir.

Q Refer to Exhibit I and explain to the Commission what that shows.

A Exhibit I is similar to the two previous exhibits, except that it applies to the east sector. The same comments that I made regarding the first, regarding the two previous exhibits also apply to this one.

Q Is that a continuation of the information of bringing it up to date as shown by original Exhibit Number 11 at the original hearing?

A Yes, sir.

Q Now refer to Exhibit J and explain what that shows.

A Exhibit J is a graph on which the performance of the Denton Field has been plotted, versus cumulative oil production. We feel that possibly this graph may be a little more accurate as to reflecting field performance, but still should not apply to the east and west sectors. We think that we have graphs that do reflect their performance more accurately. The source of the information on this graph is the same as were on the three preceding exhibits.

Q Now, would the reduction in the rate of production make any difference in the performance curve as shown on that exhibit?

A Yes, sir, I think it might make some difference. However, I don't believe that this is the best place to point out that difference. I think one of the other graphs will be better.

Q Refer to Exhibit K and see what that shows.

A Exhibit K corresponds to the west sector reservoir performance, that is plotted performance versus the cumulative oil production, , gas-oil percent ratios, monthly oil production. The source of this information is all the same as that for the other exhibits.

Q Would the reduction in the rate of production make any difference in the performance curve shown on this Exhibit K?

A Yes, sir, I believe it would.

Q In what way?

A Reduction in the well production in the west sector would raise the bottom hole pressures there. That would cause an unfavorable change in formation volume factor on the west side. In doing so would cause more stock tank barrels of oil to be left in the ground when the field is depleted.

Q Now, Mr. Tomlinson, refer to Exhibit L and explain to the Commission what that shows.

A Exhibit L is the performance for the east sector plotted versus cumulative oil production and has the same curve described for the previous Exhibit K. On this graph we see that the bottom hole pressure is still declining some, but has shown a tendency to level out. The gas-oil ratio performance is somewhat erratic, as has been shown in the past. At the present time it appears to be headed on a downward trend.

Q The information shown on the Exhibit L is the continuance of the information shown on the Exhibit 14 at the original hearing?

A Yes, sir, that comment also would apply to the two previous exhibits, in that they are a continuation of similar exhibits presented at the original hearing.

Q In other words, all these exhibits that you have referred to simply brings down to date the information that was shown on the original exhibits introduced at the original hearing?

A Yes, sir. I will point out one thing that we have rearranged some of the scales, but in no case have we changed a scale for the east and west sector of the reservoir. They're all the same as they were before. By re-arrangement we have made them a little bit easier to interpret, but the same scales have been used. There has been a change in the scale for Exhibit J, which applies to the field performance. The effect of that was to reduce a scale for cumulative oil production to make a shorter graph. We think it makes it easier to interpret, too.

Q Now, refer to Exhibit M and explain to the Commission what that shows.

A Exhibit M is a map of the Denton Field indicating movement of water into the east and west sectors of the reservoir. It is contoured on feet of water above the original water-oil contact and on contour intervals of 100 feet. In June we discussed how we thought it was coming into these sectors, and we are presenting this to show a more accurate picture of where we think the water is at this time. It is based on water information reported for our individual wells during the October GOR survey. These points here are high points along in that area of the reservoir. This

inside line here on the west sector is a zero feet contour line. That's a point in which it looks like there has been no water entering beyond that point. This line here on the east sector, the inside contour line is the zero line and that is a point which we have picked as the maximum advance of water. Now, you can see that we have colored part of this.

Q Before you go to that, how are the points for the contours determined?

A We use three methods of picking these points. First, to use an illustration, suppose a well had 100 feet of perforations. Let's say those perforations were down to the original water-oil contact. Now, if on the October GOR survey the well is reported as making 50 percent water, we assumed that the water-oil contact at that well was 50 feet up in the perforations. That method of picking a point may have limitations when applied in an individual well, in that you could have a dense streak in the bottom of the well and the water could be coming in a little higher, and there could be a dense streak in the top, and most of your production is coming out of the bottom of your perforations.

When it is applied to the large group of wells, those errors will tend to cancel each other out and you should get a reasonably accurate picture of water entry into the reservoir by using that point by that method.

There's another method that we used, and that was to observe work-overs in several of the wells around the edge of the field where they had been plugged down to let them make water production,

or where one or two wells had been completely watered out. Now, in those cases we assume that the water had moved in to the top of the perforations of the original set of perforations in the well.

The third method that we used for picking points on this map was to note the bottom of the producing intervals in various wells in the east and west sectors. Now, not all of these wells that are closed by these contour lines make water. Some of them are completed, say, for example, may be twohundred feet above the original water-oil contact. If that is true then say, for example, this particular well, I don't know the precise interval for that well, but let us say that --

Q (Interrupting) What well are you speaking of?

A Well, let us say, it happened to be the Atlantic Inson D, Number 3, shown on this exhibit M. If that well was not making water that would mean that the water had to be below those perforations. So that is another method that you can use to locate a place where the water isn't; instead of locating where it is, you can find out where it isn't, and say, we know that it can't be there, so those three methods were used. Now, they are subject to some errors when applied to individual wells, but when applied to the reservoir as a whole, it gives pretty good results, and I believe they are accepted by the industry, that method is accepted by the industry most of the time.

Q What does the part that is colored in blue represent?

A Now, when we contoured this map we found that there were portions of the reservoir that were completely flooded out by the water moving in the reservoir. We colored those in blue. Now, that's

a general area where that exists.

Q You mean by that that they are 100 percent flooded out?

A Yes.

Q That part of the area shown in blue?

A Yes, sir. The water comes up the flange of the reservoir and follows along the top of the structure until it gets to a particular well where we find that it does not make 100 percent water. Of course, we can't say it is all flooded out,there, but somewhere west of that it is all flooded out.

Q That is based on an engineering interpretation?

A Yes, sir.

Q Before you move on from that, does the information shown on Exhibit M tend to prove or disprove that there are two separate reservoirs or sectors to the Denton-Devonian Field?

A I think it shows that there are two sectors here.

Q In what way?

A If you will notice we have got our zero water level line coming around and meeting the barrier here at this point. Again, here and other places in between those two points have been touched by the water moving into the reservoir from here on up to here (indicating), a larger segment of that barrier has been touched by the water moving into the reservoir. At this point, for example, this is 300 feet of water in there, and the wells on the east of this aren't making --

Q (Interrupting) You mean east of the barrier?

A East of the barrier.

Q Drawn on the map?

A Yes, sir, east of the barrier drawn on the map are not making water. There is not a Devonian well that I know of offsetting this barrier that makes as much as ten percent water. Now, quite a few of the wells at varying places in the field make small percentages of water, but these wells have a tendency to do that throughout their life, and when you get real water movement into the well, it will usually be indicated by a water percentage higher than ten percent. None of these wells have that water percentage.

Q Now you are talking --

A (Interrupting) None of the wells east of the barrier have that water percentage.

Q In other words, this exhibit M shows that wells along the barrier in the west sector are making water, and immediately across the barrier in the east sector, they are not making water?

A That is correct.

Q Which would tend --

A (Interrupting) Or such a small amount.

Q Which would further substantiate that the barrier does exist?

A Yes, sir.

Q One other question before you leave this Exhibit M. Does the water influx as shown by this exhibit indicate any abnormal condition, or any unusual condition to take into consideration in the life of the Denton-Devonian Pool?

A No, sir, it doesn't. This is very satisfactory water encroachment for a reservoir that has water movement.

Q Would you consider it normal or abnormal?

A It is normal and from what I can see, it is pretty efficient. To help give to further illustration to the way the water is moving into the reservoir, we have prepared three cross sections. These cross sections are marked on Exhibit M at this point, this is --

Q (Interrupting) Now wait. Is that the most southerly point?

A Well, that's the most southerly cross section that we have.

Q That's a cross section --

A (Interrupting) AA to AA Prime, and it runs through the south half of the Section 11 of the field. We prepared that cross section to illustrate conditions at that particular point. We prepared a second cross section in the north half of the Sections 2 and 3. It goes across the west sector of the reservoir.

Q That is in approximately the center of the Denton-Devonian Field?

A Yes, center of the west sector. It illustrates conditions at that particular place. About one-half mile north of that we placed a third cross section, CC to CC Prime, noted on here on Exhibit M, to illustrate conditions at that point. We can turn back this map later if anyone wants to refer to it. This is Exhibit N shown on Exhibit M as cross section AA to AA Prime. On this map we have marked sub-sea intervals shown by horizontal lines; we have shown five wells completed in the Devonian; we have outlined by a line beginning on the west into this cross section and continuing upward to a peak about the middle going down to the bottom on the east

end is the top of the Devonian formation. At the bottom line here is the original water-oil contact. It is not taken to mean the bottom of the Devonian formation, since the Devonian formation may be somewhat uneven in places in the field, and, of course, in other places it dips below the water-oil contact.

Q Does this cross section show the water influx in relation to the original water-oil contact?

A Yes, sir, it does. This line drawn diagonally through the west half of this cross section indicates the water influx in that part of the west sector. That is actually the water-oil contact at that point. Then, beginning from the east sector the same line starts at about the original water-oil contact and increases in height and then comes down to a lower point in the middle. Now, I would like to point out some features of this cross section. One of them is an illustration, and one of the methods we used in picking out where the water is in the reservoir. That is shown on the Ohio Denton Number 13. It shows perforations at the top of the Devonian and these perforations making 100 percent water. We assume that since no oil is coming out there that the water-oil contact is at least that high. Incidentally, the information shown on here is fairly recent. The perforations were making 100 percent in November or were capable of doing so.

One more thing that could be added about that well is that it has been worked on from time to time and in each case, as it was plugged back, water was found in the next set of perforations immediately above. The next one to the east illustrates how we

selected a water-oil contact. That well isn't a well that has perforations on that, in a well producing less than 100 percent water. That is the Ohio's Denton Number 5. Here is one well drilled a little bit into the top of the reservoir that isn't making any water, that is the McAllister Denton A Number 1. Points through that area were taken from our contour, contour map, or our water influx map and are shown by stars along these points. The Ohio Denton Number 6 is the next one to the east and it has been worked over, plugged back to a higher set of perforations and not making any water at this time. This one here on the east is the Atlantic Dickerson B Number 3, which is making a small amount of oil and a small amount of water. As you might expect, that doesn't have much section on that, like that one.

Q Before you leave that Exhibit, does that Exhibit show the thickness of the Devonian formation with relation to the water influx?

A Yes, sir, you can see you have a lot of oil left in here. You can see that although quite a bit of water has come in, there is still a great volume of the reservoir.

Q The top line represents the top line of the Devonian formation?

A The top of the Devonian formation.

Q The bottom line?

A The supposedly water-oil contact at this time. The reason that is higher is that you have a lot of pay here, and yet the surface development, or the number of wells per section in this

area is the same as in part of the reservoir where the reservoir is thinner, consequently here the water hasn't had to come in over as much of the reservoir. I would like to turn back to the previous exhibit, Exhibit M again, and simply summarize what we show here on Exhibit N. On cross section AA to AA Prime, you see that along the west flange the water has come up to a peak, as we show it here on Exhibit M -- I mean on Exhibit N. Then it drops off, it drops off to a point that is not zero by our contouring, and continues on eastward and then rises again until it gets to the point between the Atlantic Dickinson B Number 3, and the Ohio Denton Number 6, then it starts dropping off again. Now, that shows how water comes in from the southeast side of the west sector, and from the west flange of the west sector, as well as from the south end of the west sector.

The next cross section is BB to BB Prime, labeled Exhibit O, constructed in the same manner as Exhibit N. Here you see that the reservoir is a lot thinner as indicated by this line beginning on the west side of the cross section and continuing diagonally to the middle and going across approximately level. It's bounded on the east side by this barrier that we have discussed previously. A line that joins the line showing the top of the Devonian formation and starting west of the well labeled Shell Argo Number 1 is the line that shows the water-oil contact during October. That point for that well was selected by noting a percentage of water that the well is making and applying that percentage to the producing interval and selecting the water-oil contact in the interval. Here is

an instance where a well did not go all the way into the reservoir, and consequently didn't get any water. That well is the Skelly-New Mexico F Number 4. You see we have zero contour at that well, or possibly a little east of it. The Skelly New Mexico F Number 1 is the well on the east end of this cross section. That shows that the well was perforated down to the original water-oil contact at a minus 8915. Now, Skelly has assured us that this well is not making water or at least if it is, it is a very small percentage of water. It has always been that way, so that's a point that we think indicates that water is not moving in from the bottom of the reservoir right there. It's a point that I think -- It is a condition that is common to most of the Denton Field, water does not move in from the bottom. It tends to come in from the west side of the west sector and the southeast side of the west sector, and from the south end of the west sector, and the east side of the east sector.

The last cross section that we have is labeled CC to CC Prime, and is Exhibit P. This shows what can happen, or does happen in this reservoir and you have a pretty good permability. You have a thin section with normal surface development and one well per 40 acres. Water has to come in to replace the oil that has been taken out and here it shows that it is pretty well all the way across at that point to the barrier, separating the west sector from the east sector. Very likely this water movement started very much as the water movement indicated on Exhibit O, but at this point it has progressed all the way across and some of the wells are still producing water from the top of the Devonian, and in that

small area, or, in my opinion, would indicate a bottom water drive at those points. However, the original source of water was a movement from the west side of the field.

Q Now, Mr. Tomlinson, have all of these exhibits which you have referred to, from A to P, inclusive, been approved by the Denton Engineering Committee?

A Yes, sir.

Q Are they all in accord with respect to the information shown by these exhibits?

A Yes, sir.

Q Are they all in accord that proper concept is that there are two definite sectors or different reservoirs to the Denton Field?

A Yes, sir.

Q And that should be taken into consideration in any study that is made of the field?

A Yes, sir. That point was covered specifically before the June, 1956 hearing, and before that hearing we all agreed that we would present separate sets of data for the east and west sectors of the reservoir.

Q Has the Engineering Committee reviewed all these exhibits at a recent meeting?

A Yes, sir.

Q Were practically all of the operators in the field represented on that Committee?

A All except two. One of those has not taken an active interest, since they have a small interest in the field; the other

expressed their agreement in a telephone conversation with us. All others, I believe, have agreed to the presentation of these exhibits.

Q In the study made by the Denton Engineering Committee and your independent study of the entire situation, did you find anything which would indicate that the present rate of production is causing, or tending to cause waste in any respect?

A No, sir, I didn't.

MR. HINKLE: I would like to offer in evidence at this time, Exhibits A to P, inclusive.

MR. PORTER: Any objection to the admission of these exhibits? They will be admitted.

Q Now, Mr. Tomlinson, as a result of the study made by the Engineering Committee and your independent study of this whole situation, have you arrived at any conclusions that you desire to make to the Commission in connection with this matter?

A I have several conclusions,, and I would like to give them. All of the evidence conclusively confirms that there are two segments in the Devonian Field, or two separate reservoirs that act independently. I believe that this should be taken into consideration when compiling information concerning field performance, otherwise the results wouldn't mean anything. All evidence at the present time indicates that preventable waste is not occurring. Pressures in the east sector of the reservoir have shown the tendency to level out when compared to past trends. However, this levelling didn't occur at quite as high pressure as we had expected last spring. Possibly that may be due to a small inaccuracy in our fluid data in the field. We have fluid analysis and that we have

used. They may not be quite accurate as to the saturation pressure. That would be a likely source of explanation for the lag in the levelling out tendency we have observed. However, it is levelling out now. From the first stages of development in the east sector, material balance calculations have shown that the water influx has increased with lower pressures in that area. Whether or not future water influx rates will be enough to prevent significant pressure declines in this sector can not be positively identified with the information -- I say identified, I mean predicted with the information that has been obtained between the April and October, 1956 surveys. At the present time, however, we think that the east sector is performing satisfactorily and without waste. The west sector also continues to perform satisfactorily at the present rate of production. The principal drive mechanism continues to be water influx with a small amount of propelling energy supplied by expansions of fluid in the reservoir. The pressure in the west sector has almost levelled out at 3,972 pounds. Based on the information we have now, the present rate of production will never cause the reservoir pressure in that sector to reach the saturation pressure. Water continues to enter the west sector on all sides except the side next to the east sector. It's entering in a normal effective and efficient manner. In our opinion the continuation of the present rate of production will result in good efficient recovery. Any reduction in the present rate of production, in our opinion, will result in less recovery, and would constitute waste.

Q Mr. Tomlinson, based upon those conclusions, do you have

any recommendations to make to the Commission with respect to this matter?

A Yes, sir, I recommend that the same top allowable be continued for the east and west sectors in the Denton Field.

MR. HINKLE: That is all at this time.

MR. PORTER: By the same top allowable, Mr. Tomlinson, do you mean the depth factor as applied to the normal unit allowable?

A Yes, sir, that's what I mean by saying top allowable.

MR. PORTER: Does anyone have a question?

CROSS EXAMINATION

By MR. MANKIN:

Q Mr. Tomlinson, I believe that you indicated that you felt the mechanism on the west half was progressing satisfactorily and that there was very little water entering near the eastern edge of the west sector, in other words, toward the barrier, is that correct?

A Along the barrier, there isn't here, well, a considerable area that there is no water production in, and then we have some, of course, where water has moved in in the past from the west and is now being produced from wells next to the barrier, but our feeling is that is coming in from the west side principally, although some is entered from the southeast side of the field, Mr. Mankin.

Q How do you account for in your exhibit where the two west wells on that cross section show about the same water in the October survey as was shown in the exhibit which you presented in June, which was Atlantic's Exhibit Number 25?

A Yes.

Q And the water stayed about the same in those two wells, but

in the third well, Atlantic Dickerson D Number 6 it has increased from less than ten percent to better than 75 percent, how do you account for that if there is no water influx toward the east edge of the west sector?

A By that statement I don't mean that water can't effect the wells on the east side of the west sector. As a matter of fact, the fact that this well has increased in water percentage --

MR. HINKLE: (Interrupting) What well?

A Atlantic's Dickerson D Number 6, shown on Exhibit P, the fact it has increased in water percentage after these other wells had been making considerable quantities of water, indicates that water moved in from these other two wells over to that well on the east side there. That is the D 6.

Q Then you don't think that indicates that there is some bottom water concerned here rather than edge water?

A Well, as I explained when I went over this Exhibit P before, this is acting very similar to a bottom water drive when the water enters all the way across the bottom from the west sector, goes all the way across the bottom and meets the barrier on the other side, on the east end of this cross section, then if there is any oil left in there, the only way for it to go is up. So, it has to act as a bottom water drive in that particular instance. But originally we believe the water did move in from the west.

Q Then you would state that in addition to the edge water movement, that you likely might have some bottom water movement?

A I think the source of the water is still the edge. However, the source of the water as this, well, as these, I say, of course,

would be coming from the bottom, but the source of the water at that particular point I believe would still be the west edge.

Q How do you account for the two wells not having changed on your Exhibit P, essentially, so as to the percentagewise of water from last June until the October exhibit, and yet it has increased from practically nothing to 75 percent, on your third well on the right of Exhibit P?

A Exhibit P shows that there is some water that is trapped on the Devonian formation. When you have a large section of the reservoir like this, as shown on, say, Exhibit N, water can move in from the side there and sweep all before it. Here on Exhibit P the top of the Devonian is a barrier to the upward migration of oil or water. That oil has to be produced before the water can move up there and it is taking a longer time. Horizontal movement of water, as I have explained before, is governed by the thickness of the reservoir, the number of wells completed in relation to the thickness and withdrawal. In the thin section of the reservoir, that horizontal movement would be fairly rapid until it gets as far as it can go, and then it has to produce the rest of the oil out. In other words, referring to Exhibit P, the movement of the water between the edge of the reservoir and the Dickerson A-34 Number 2 was influenced not only by the production of 34 -- 2, but by the production of all the wells to the east of it that are in the west sector, and a number of wells in the reservoir also. That makes a more rapid horizontal movement than when it starts coming up from the bottom and then you don't get as nearly as rapid vertical movement.

Q Isn't the west sector greatly sensitive, that is, sensitive as to the amount of oil production and the rate of water production? I'll refer you back to your exhibit showing the rapid increase of water in the west sector as shown in your exhibit E. It jumped in September from 23 and a half percent to 34 and three-tenths percent, which is, by far, the greatest increase that you have experienced in the west sector. How do you account for that?

A Well, I don't see very much oil production increase there between September and October.

Q Well, there isn't. I was wondering why the increase, is it just the normal influx of water?

A I think that is one of the principal reasons. I would also imagine it was due to the bottom hole pressure survey, pressure testing that was performed during October. Now, field production practices are such that water percentages are taken at fairly regular intervals by most of the operators, but there may have been some lag in taking water shake-outs, or water measurements on individual wells. When you have a survey coming along that requires every well to be tested, I believe that you will get up to date water percentages, very likely the water percentages immediately before that 34 percent noted in October should have been a little higher.

Q That's just what I was going to bring up. Actually, possibly the September water production had been higher had you tested it earlier?

A Yes, had we performed the GOR survey in October.

Q The next question is this, Mr. Tomlinson. At the June hearing the east sector showed a pressure at that time of 2628 pounds which was about 30 pounds below the bubble point. Is it not true that now there has been an additional of about 258 pounds drop below the bubble point at this time?

A What did you say the pressure was in the other survey?

Q 2628 pounds, which I believe was about 30 pounds below the bubble point.

A Are you referring to Exhibit F or are you referring --

Q (Interrupting) I was referring back to Exhibit 14 of the June hearing, as related to the present bottom hole pressure.

A I don't believe that we should compare those two pressures for this reason, that the east sector pressures were obtained by using a map that shows the differential along the west side of the east sector. In other words, an upper differential as it approaches a pressure of the west sector. When you do that you artifically contour in some pressures that really don't belong in the east sector. When you weigh those volumetrically they give an erroneous pressure. What you should do is contour them separately and weight them volumetrically to find out what you mean. To compare those pressures, I think the figure that you would be interested in would be the one shown on Exhibit E, which is labeled -- which is on the tabulation, labeled oil and water production rates for the Denton-Devonian Reservoir, east sector. That pressure is 2,535 pounds, and that compares with the one that we obtained in the same manner in October, of 2,405 pounds. Well, we believe that's a much better way of looking at the pressures.

Q Do you know if there has been any wells abandoned since June of 1956, due to going completely to 100 percent water production?

A There have been none abandoned that I know of. However, there's one that probably will be fairly soon. It is shown here on Exhibit N. That well was in about the same shape during June, and there has been very little change in the condition of the well, however, for all practical purposes it is depleted.

Q Is the well to which you refer the Atlantic Denton Number 13?

A Ohio Denton Number 13.

Q I mean Ohio Denton Number 13.

A Yes.

Q Is it not true that in June it shows less than 10 percent water production, and is now 100 percent, or not?

A If we showed it like that it is erroneous.

Q Atlantic's 25, of June, '56 indicated less than 20 percent.

A For this one?

Q Yes.

A Now, that well was shut in at that time, I believe. It possibly wouldn't have been shown as a well making anything. If you are speaking of the map that we had colored in, the pie shaped graphs by each well, the reason for leaving that one off was because it was shut in. I don't think it was producing. It really had no status.

Q So it had no status at that time?

A No.

MR. MANKIN: That is all I have.

MR. PORTER: Anyone else have a question of Mr. Tomlinson? Mr. Nutter?

By MR. NUTTER:

Q Mr. Tomlinson, you were just mentioning that Exhibit Number 25, and the June hearing in which you had the little pie shaped drawings by the well. In this hearing, did you prepare a similar exhibit?

A No, sir, we didn't. We felt that that did not show the movement of water in the reservoir as well as what we presented here today. In the interest of keeping down the number of exhibits, we left that out and substituted the Exhibits M through P.

Q If you had prepared such an exhibit, would it have shown material change in the way the pies were sliced?

A I expect it would. It should have because this is water drive reservoir, and we expect water to keep coming in. Some wells that started to make water didn't make them before, and the water percentage should increase and from time to time we will lose a well.

Q You were also referring to Exhibit F a minute ago. Do you mean that on your Exhibit F, which illustrates oil and water production rates for the east sector, are the bottom hole pressures for April and October comparable, they are weighted the same way?

A Yes, sir, they are weighted the same way. The last, I believe the last five or six points on that tabulation shown on Exhibit F have been obtained by recontouring pressure maps with a concept of two reservoirs.

Q Those are all the pressures that are shown with the stars

beside them?

A Yes, sir, they are volumetrically weighted.

Q I note that there is a decline of 148 pounds in the bottom hole pressure and the GOR is still the same. The bottom hole pressure in April was below the bubble point for the reservoir, wasn't it?

A I think that's due to two factors, or possibly three factors that I could mention. One is that there is always a lag in increasing bottom hole pressures because when free gas comes out of solution in a reservoir, as it passes through the bubble point or saturation pressure, the gas tends to stay in the reservoir until a certain gas saturation is reached, and a certain amount of it comes out of solution. Until that time occurs, you wouldn't see much free gas movement, and wouldn't expect them to go up. It varies for various reservoirs, but I'm told by people that I know have investigated that aspect of reservoir performance, not in relation to this field, but others, it can be as high as 15 to 10 percent saturation before that occurs.

Q There is a possibility that the reservoir has not been saturated with the free gas, resulting in a higher GOR at this time?

A That is one thing that could have happened. Another thing is that we might be a few pounds off, I say as much as a hundred pounds off in out saturation pressure from the data that we have gotten from our fluid analysis. We have four fluid analyses in the field, the operators have them. We think they are pretty good, but there could be a small error there. A third thing could be, and I think has significant bearing, here, is that all pressures we

have been reporting are at a common datum in the field at minus 8200 feet, and that datum works very well for a mean datum for the west sector, but as you have noted from structure maps, the examination of those, the east sector is a lot lower than the field average. There is a possibility that we should have a different field datum for that area. It's possible that it could be, the field datum could be moved down by, say, as much as two or three hundred feet, and if it were 300 feet and that would add approximately 100 pounds to the pressures that we have reported here. Consequently it wouldn't be as far below saturation pressure as it would seem by looking at the tabulations and graphs that we show.

Q Mr. Tomlinson, your Exhibit I for the east sector has a running GOR that is, it shows a GOR for each month, and not necessarily just the months that you have taken tests. What is that GOR based on production?

A Just a second now, that's the graph labeled east sector performance versus time, I think.

Q Yes, I was referring to line Number F on there.

A All right. This data is obtained from Form C-115 reported to the Commission rather than from GOR surveys. I think that is what you were getting at, that we don't take GOR surveys every month, but gas is metered in the field and the operators report gas-oil ratios to the Commission, and those ratios have been used throughout all of our work, rather than the survey ratios. Now, we think that ratios that are obtained from day to day and account for all the gas produced have a lot more chance of being accurate than, say

an instantaneous test taken on a survey.

Q Well, in a production GOR like that, what would account for the drop in the GOR such as the east sector experienced from August to October?

A The only thing that I can suggest there is that there have been several changes similar to that in the past. a lot of them due to seasonal variations. There are temperature correction charts, I understand, used in measurement of gas, that are corrected for a mean average pressure, and I think that is part of a seasonal trend. You'll notice a somewhat, a kind of a seasonal trend through the summer months of 1955 and a seasonal trend in 1954, where it dropped off at the latter part of the year. Why the drop is quite that much, I couldn't tell you.

Q Still on the same Exhibit I, I note that oil production as illustrated by Curve Number A and water production as illustrated by Curve Number B, both showed a marked change in September and October of 1955. Do you think there was any connection between those two? That was the month in which your oil production dropped way down, and the following month your water production went way up.

A I don't think there's any connection between the water percentage curve. I think probably at that point there would, say, be more wells making water, or a normal increase. I doubt if the east sector could be affected, the rate would effect water production much there, under any circumstances.

Q The reason I asked you that question was because you have

a marked increase in water production that month and it has been up high ever since.

A Here is a point to consider there, if I am not mistaken, we had a GOR survey that fall, or at least -- maybe you can correct me, maybe we didn't, but one thing might be considered, that some of the operators had tested their wells at that time. Of course, the oil production changed, on line A of the Exhibit I it shows a decrease during the time of the refinery fire. That was in September, I believe. Right after that production started up at just about what it was before.

Q Shortly thereafter we had increased production to make up back allowable, too. I was wondering if that might not have effected it?

A In my opinion it wouldn't.

Q You don't think so?

A No.

Q Mr. Tomlinson, in your opinion, is the Denton-Devonian reservoir a homogenous reservoir, with the same permeability and porosity throughout?

A No, sir.

Q Are there bands or layers of porosity and permeability that may not be interconnected with each other?

A Well, of course, I suppose that you are referring to something else besides the barrier we have shown down through the middle of the field.

Q Yes, I was referring to each separate reservoir, and asking

whether there might not be some layers of porosity?

A I think there will be layers of porosity, or small segments of the reservoir that might not be very effectively connected to the other parts of the reservoir. I don't think those are anything to be alarmed about in this particular instance, because I think every reservoir has something of that nature in it. Very rarely in this part of the country do you see a reservoir that is homogenous.

Q I was wondering if it would be possible, if you had two of these bands or layers of permeability stretching down below the oil-water contact, both going up the structure, now, I was wondering if it would be possible for water to migrate up one of the layers of porosity and not another, which might account for high water-oil ratios in one well and low water-oil ratios possibly in an offsetting well?

A I think that that possibly would occur, or could occur, but I don't think that the information that we have here shows that it did. I would like to show you one thing on Exhibit M. This is a reasonable contour of those points that we have selected for the water-oil contact, and we found, you would think that if such a thing as you were saying had occurred, you would find a number of places here where the well over in here (indicating) was not making much water, and the one here making a lot. Say it is completed in a different interval. The only anamoly we have on this that we were able to find in the west sector and that is the only one important in this respect is on Gulf's Chamberlain D Number 2, I believe that well is. Wait a moment -- No, that would be, I beg

your pardon, that would be D Number 1. That well is just drilled into the top of the reservoir right at the very top of it, and makes water. It doesn't fit the inner scheme of contours, but that is the only anomaly that we had that we couldn't account for. We thought we saw anomalies when we were making the map; in the process of making it it looks like every once in awhile we can see an anomaly, but after we considered, fixed the water-oil contact by the three methods that I have explained, you could account for each water entry, each point that we have. So, for that reason, I don't believe that that is occurring to any significant degree.

Q What is the status of that anomaly well up there in Section 26? I believe it was Magnolia's Pope Number 10.

A Yes. Well, that is in the east sector. What I was saying just then, I meant to apply to the west sector only, but on Exhibit M, when you speak of the east sector, I believe there's -- This is still an anomaly, the well has been worked over. Do you remember last year, or last June it was we talked about it and it was making a large volume of water, quite a bit of oil, too. I think it was a top allowable well at that time. I understand now that they have worked on the well to eliminate some of the fluid production, or eliminate water production, and now it still makes water. It's not quite a top allowable well. I understand that they haven't completed their work on it yet. It still is an anomaly in my opinion. We left it out, didn't consider it because we knew there was something that was wrong from the first there, and, for example, it had a higher bottom hole pressure. It had a bottom hole pressure that

was equivalent to many wells in the west sector, and surrounded by the offset wells that were many hundreds of pounds lower.

On this east sector we don't have nearly as many control points to depict water entry as we have on the west side. We think that this is a general picture of the way water is coming in, but we show it here to make the map complete, and not for the same purpose we showed the water contours on the west sector. That is, we intended for the west sector to show a pretty accurate picture of where the water is. Here you have to use some imagination.

Q I would like to ask one more question, Mr. Tomlinson. I think a moment ago during your testimony you stated that if the rate of production were lowered on the west sector, that it would cause more stock tank oil to be left in the ground in the long run. Would you elaborate on that a little bit, please?

A Yes, sir. What would happen would be that the formation volume factor would change so that in those areas that were flooded by water coming into the reservoir, that oil that's left there, and there's going to be some oil left there, even if you get a pretty good sweep efficiency there is going to be some oil left as residual oil. Now that residual oil will have a less favorable formation volume factor, but by the fact it has been compressed and not allowed to expand as it would have if it had been taken to a lower pressure before the water swept by it, you see. Another way would be, to illustrate that would be to say that if you can imagine a small segment of the reservoir, even as small as, say a person's hand, that contains a little bit of oil at, say four to five hundred pounds, when water sweeps through that, let's assume

that it takes 50 percent of the oil out. Let's say it sweeps through and takes 50 percent of the oil out and leaves half of it. If you left that oil in the little segment of reservoir -- expand and push out of the pores more of the oil, you would have less left in there when the water went by it, you see.

Q I don't see it.

A Does that make it clear?

MR. NUTTER: I will accept that. That is all of the questions I have. I would like to compliment Mr. Tomlinson on his exhibits. I like the cross section. You have done some good work.

A Thank you very much. I think the Engineering Committee should also share your compliments.

MR. PORTER: We will take a short recess.

(Recess.)

MR. PORTER: The meeting will come to order. Does anyone else have a question of Mr. Tomlinson? Mr. Mankin?

MR. MANKIN: I have another question, Mr. Tomlinson.

By MR. MANKIN:

Q Your production curves and all of your data that you have presented here today indicated production through October, is that correct?

A Yes, sir.

Q Do you feel that with the production increases that have been affected by increases of allowable for the Denton, as well as the other pools, beginning with December and increasing in January and increasing again as anticipated for February, that the west

sector with a very sensitive rate of production will be hurt, or there will be any oil by-passed by the greater increase of oil production during these three months that I have mentioned?

A I don't believe it will hurt. I think it will be helped, because it will tend to lower bottom hole pressures in that sector and we feel that lower bottom hole pressures in the west sector are necessary to obtain a more favorable formation of volume factor in that side of the reservoir. In referring to sensitivity of the reservoir, we don't feel that it is sensitive. At least not very sensitive, probably to a very small degree, if any.

Q You don't feel then that the west sector is any more sensitive, ratewise, than the east sector?

A It is sensitive from the pressure standpoint. I think the higher rate will obtain a higher bottom hole pressure there.

Q Then you feel that the increased production will not lower the pressure, the bottom hole pressure enough to either by-pass any oil, or it certainly will still be above the bubble point?

A It will certainly be above the bubble point, and I don't think it will effect the by-passing of oil.

Q You don't feel there will be any wells prematurely temporarily abandoned because of increased rates?

A No, sir.

MR. HINKLE: I would like to ask one additional question.

RE-DIRECT EXAMINATION

By MR. HINKLE:

Q Will you refer again to Exhibit I?

A Yes, Exhibit I is the plot of east sector performance versus time.

Q On your cross examination it was pointed out that there had been a rather rapid increase in the rate of water production occurring in October, 1955.

A Yes, sir.

Q During the recess, did you check into that matter and have any further explanation?

A Yes, sir, there was an interesting point brought up and we thought we would like to look into it. It has been found that at that time I think some 21,000 barrels of water was produced in the east sector during the month, I believe it's November the first month that is significant. Now, 20,995 barrels produced, we found that one well produced all that water, or nearly all of it, 18,390 barrels water came out of the Magnolia Pope Number 10, and that's the month it started making water. We have pointed out before that that is an anomalous well, and was particularly so at that time, and up until the time that they worked on it recently and it had a much higher bottom hole pressure than other wells around it, indications were that it had a crack that extended down into the water-oil contact, or something like that connected into the perforations. When it started making water, it started making a large amount of water. I doubt very much that you could draw any conclusions from that increase in water production from the east sector and apply it to the east sector, because it all came out of the Magnolia Pope Number 10, or nearly all of it.

Q Had the water production from that well been disregarded in connection with this particular graph, it would still have been continuing in a level curve?

A I think it would have been very near the bottom, at approximately the point shown for August and September of '55 of around 2,000 barrels.

MR. HINKLE: That's all.

MR. PORTER: Anyone else have a question? You may be excused. (Witness excused.)

MR. HINKLE: That was all the witnesses we have.

MR. PORTER: Any other witnesses in this case? Anyone desire to put on further testimony? Does anyone have a statement to make?

MR. COUCH: Terrell Couch, for the Ohio Oil. The Ohio joins with the Atlantic in the recommendation that the allowables not be reduced in the Denton-Devonian Pool at this time.

MR. PORTER: Thank you, Mr. Couch. Anyone else?

MR. MALONE: Ross Malone, for Gulf Oil Corporation. Gulf has participated on the Engineering Committee and is in general agreement with the conclusions that have been presented by Atlantic. Gulf would like to join in the recommendation of Atlantic that there be no reduction in allowables in either sector of the Denton-Devonian Pool.

MR. HENDERSON: R. Henderson, Sinclair Oil and Gas Company. Sinclair has had occasion and opportunity to examine the exhibits as presented here by Atlantic today. We wish to concur with

Atlantic in the recommendation the allowable not be reduced in the Denton-Devonian Pool.

MR. PORTER: Anyone else?

A MR. EVANS: C. T. Evans, with Magnolia. We would like to go along with Gulf's recommendations that the allowable not be cut. We would like to further recommend that Denton-Devonian be reviewed in six months, at the end of the bottom hole pressure survey, and that all wells be included in the survey.

MR. SETH: Oliver Seth on behalf of Shell Oil Company. Shell has made an independent examination of the characteristics of the Denton Field and has also followed and considered the material presented at this hearing. Shell has a direct interest in this particular field as well as its general interest in matters of this character. The conclusion arrived at by Shell was that from its own data that there was no, should be no change in the present method of allocation, that no change can be justified at the present time. It is believed that the field behavior should be watched as much as any other field, and Shell intends, regardless of the action of the Commission, to continue its study of the field. And further, to participate in the Field Engineering Committee's work from here on out. The results of the work as indicated by Shell, is similar to those indicated by Atlantic and we would like the record to show that Shell concurs in the recommendations as made by Atlantic.

MR. PORTER: Mr. Hinkle?

MR. HINKLE: If the Commission please, I think the evidence

which has been introduced in this case conclusively shows that the present rate of production is not causing waste of any character whatsoever, and that the recpmmendation of the Atlantic and the other operators in the field should be followed and there should be no change in the current rate of production, and that the top allowable with the deep well factor should be considered.

I think,too, that the recommendation made by your own staff member, Warren Mankin, at the conclusion of the last hearing should be followed in that this case should be concluded at this time and not carried over and be hanging fire, continuously waiting on six months periods for new surveys.

I think that you can safely rely upon the Denton Engineering Committee in connection with this matter. They are going to continue their study from now on, and I think they will be the first to call the attention of the Commission to anything that does develop which might in their opinion, cause waste, because they are all vitally interested in obtaining the greatest ultimate recovery from this field, and I think they want to operate it with that in view.

So, we believe that the case should be terminated at this time, because the Commission, or any operator would have the right in the future, to come in and request a review of the matter. There's no need to hold it open another six months for another survey. We urge the Commission to dismiss it and continue the present rate of allowable.

MR. GURLEY: The Commission Staff would like to concur in

the motion of Atlantic to dismiss the case.

MR. MORGAN: Mr. Chairman, I move that the rules of the formal Commission be adopted and made the rules of this Commission.

MR. MECHEM: Second the motion.

MR. PORTER: With reference to case 1052, it is the decision of the Commission to dismiss the case. As you know, we brought this case on for hearing in June of 1956. We recognize that the Denton Pool is one of the most important pools in the state; it produced up to this time, about 32,000,000 barrels of oil, and presently producing about 90 percent of the state's total output. So, it is important though that it does bear watching. When this matter came to our attention concerning the water production, which we thought should bear watching, we called on the operators to come in for a show-cause hearing, or to show why the allowable should not be reduced. Of course, upon the evidence that we had at that time, in June, it was the decision of the Commission that we could not make a reduction at that time, and it's the feeling of the Commission that that condition still prevails.

Now, of course, as we have in the past, we intend to keep this pool under very close observation, and if it is felt that it is necessary, if it is felt that the pool is being injured by higher allowables, the matter will be the subject of a future hearing. Case 1052, therefore, will be dismissed.

STATE OF NEW MEXICO)
:
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Court Reporter, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission at Santa Fe, New Mexico, is a true and correct record to the best of my knowledge, skill and ability.

IN WITNESS WHEREOF I have affixed my hand and notarial seal this 31st day of January, 1957.

Ada Dearnley
Notary Public - Court Reporter

My Commission Expires:
June 19, 1959