CASE NO. 14

BEFORE THE OIL CONSERVATION COMMISSION OF
THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED FOR THE PURPOSE OF CONSIDERING THE REVISING, MODIFYING AND AMENDING OF THE EXISTING PRORATION PLAN FOR MONUMENT FIELD, LEA COUNTY, NEW MEXICO, DESIGNATED AS ORDER NO. 33 OF THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO.

I N D E X

TO TRANSCRIPT OF HEARING ON MARCH 1, 1940

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TRANSCRIPT OF PROCEEDINGS AT HEARING
STATE CAPITOL BUILDING
SANTA FE, NEW MEXICO
MARCH 7, 1940

Pursuant to Order of the Commission No. 243, duly made and entered, setting March 7, 1940, at ten o'clock A. M., for resumption of hearing in the above entitled matter, said hearing was convened at ten o'clock, A. M., of March 7, 1940, in the hall of the House of Representatives, Capitol Building, Santa Fe, New Mexico, the Commission setting as follows:

HON. FRANK WORDEN, Commissioner of Public Lands, Secretary
HON. A. ANDREAS, State Geologist, Member
HON. CARL B. LIVINGSTON, Attorney for Commission.

APPEARANCES:

NAME	COMPANY	ADDRESS
J. S. Noland	Barnsdall Oil Co.	Tulsa, Okla.
W.M.Fleetwood, Jr.	" " "	" "
R. D. Curtis	" " "	" "
E. A. Markley	" " "	" "
A. P. Loskamp	" " "	Midland, Texas
R. S. Christie	Amerada Petroleum Corp.	Ft. Worth, Texas
G. H. Card	Stanolind O. & G. Co.	Ft. Worth, Texas
R. W. Tesch	" " "	" " "
Rex E. Rader	" " "	Hobbs, N. M.
R. S. Dewey	Humble Oil & Rfg. Co.	Midland, Texas
Roy Yarbrough	Oil Conservation Com.	Hobbs, N. M.
Glenn Staley	Proration Office	Hobbs, N. M.
H. J. Summy	Reppolo Oil Co.	Midland, Texas
J. B. Kennedy	" " "	" "
N. B. Larsh	" " "	" "
S. P. Hannifin	Magnolia Pet. Co.	Roswell, N. M.
Ed. Downing	" " "	Kermit, Texas
J. O. Seth	Stanolind Oil & Gas Co.	Santa Fe, N. M.
A. M. McCorkle	" " " "	Ft. Worth, Texas
Lloyd L. Gray	Gulf Oil Corp.	Tulsa, Okla.
J. R. Graham	Tide Water Associated Oil Co.	Houston, Texas
E. W. Childers	" " " " "	Midland, Texas
N. E. Trumbill	The Ohio Oil Co.	Hobbs, N. M.
J. F. Wheeler	" " " "	Houston, Texas
S. G. Sanderson	Gulf Oil Corp.	Tulsa, Okla.
Russell G. Lowe	" " "	" "
M. Albertson	Shell Oil Co., Inc.	Houston, Texas
George W.Selinger	Skelly Oil Co.	Tulsa, Okla.
Edgar Kraus	Atlantic Rfg. Co.	Carlsbad, N. M.

Frank Gray	Anderson-Penhard	Hobbs, N. M.
Weston Payne	" "	Oklahoma City, Okla.
James W. Murray	Me-Tex	Hobbs, N. M.
Howard P. Holmes	Two States Oil Co.	Dallas, Texas
Delmar R. Guinn	Cities Service Oil Co.	Hobbs, N. M.
E. P. Keeler	Continental Oil Co.	Hobbs, N. M.
H. B. Hurley	" " "	Ft. Worth, Texas
Harry Leonard	Leonard Oil Co.	Roswell, N. M.
A. J. Holland	The Texas Co.	Hobbs, N. M.
Glenn Bish	Ohio Oil Co.	Hobbs, N. M.
D. D. Bodie	Cities Service Oil Co.	Hobbs, N. M.
D. R. McKeithan	Phillips Pet. Co.	Bartlesville, Okla.
D. R. Knowlton	" " "	" "
Paul N. Colliston	" " "	Midland, Texas
H. J. Kemler	Shell Oil Co.	Midland, Texas
R. G. Schuehle	" " "	" "
A. E. Willig	The Texas Co.	Ft. Worth, Texas

The meeting was called to order by Mr. Frank Worden, who announced that Governor Miles would join the Commission in a short time. Mr. Worden then called upon Mr. Livingston to read the notice of hearing.

BY MR. LIVINGSTON: This notice of hearing will consist in the reading of Order No. 243 of the Commission, which was published as notice of this hearing, and the reading of the order will explain itself -- skipping the heading of the order: (Reading)

"WHEREAS, the hearing called by the Oil Conservation Commission of the State of New Mexico for the purpose of considering the revising, modifying and amending the existing proration plan for Monument Field, Lea County, designated as Order No. 33 of the Commission, heretofore recessed to February 5, 1940, could not be heard on said date by reason of conflict with the hearing on the Cole Bill before the Sub-committee of Interstate and Foreign Commerce held in Washington, D. C., and

WHEREAS, a written notice, so advising and unofficially designating March 7, 1940, at ten o'clock A. M. for the resumption of said hearing, was sent by first-class mail to each of the parties who had made appearance in the case herein,

IT IS THEREFORE ORDERED by the Commission that said unofficial notice is confirmed and March 7, 1940, at ten o'clock A. M., Santa Fe, New Mexico, is set for the resumption of said hearing.

IT IS FURTHER ORDERED that this order be published as

notice of said hearing as prescribed by law.

DONE at Santa Fe, New Mexico, this 20th day of February, 1940."

And the publication was made as provided by law, and the purpose of this order was to retain jurisdiction of this case by setting a new date, the new publication and setting of new date by order of the Commission.

BY MR. WORDEN: Gentlemen, the Commission is ready to proceed with the recessed hearing.

BY MR. LIVINGSTON: Gentlemen, for your information, the testimony ended, at the hearing on December 9th, with Mr. R. D. Curtis being interrogated.

BY MR. SETH: There is some question as to whether that testimony is part of this new hearing. I suggest the testimony already taken be made a part of this hearing.

BY MR. FLEETWOOD: We would also like, in the interest of expediency, to ask that all other hearings before this Commission, in engineering matters, that the minutes be considered as part of this hearing, with the understanding that if there is any omissions in the other hearings, Barnsdall will be glad to fill those omissions, taking them up one at a time. If there is no objection, we would like that to be so considered.

BY MR. WORDEN: There are no objections.

R. D. CURTIS,

being called as a witness and being first duly sworn to tell the truth, the whole truth, and nothing but the truth, was examined by Mr. Fleetwood, and testified as follows:

DIRECT EXAMINATION

Q Mr. Curtis, you are the same R. D. Curtis who was testifying in this matter on December 9, 1939, when the meeting recessed here until today, were you not?

A I am.

Q To connect up that testimony, I will ask you if you didn't, in a general way, testify that you were a petroleum engineer in the proration department of the Barnsdall Oil Company, and

that your duties consisted in keeping in touch with Lea County pools, particularly Monument, New Mexico, and that you have access to all their records on proration affecting that field?

A I did.

Q You were preceded by the first witness, Mr. Card, of Stanolind. Without going into the testimony he presented, I will ask you if the summation I gave is not what you, generally, testified to?

A It is.

Q Your testimony ended with the request that you outline the present proration plan now in force in the Monument Pool in Lea County?

A Yes, sir.

Q Will you now outline that plan?

A The present plan of proration in the Monument Pool provides for the allocation of the pool on the basis of 80% acreage and 20% bottom hole factor.

Q Does that mean that four out of five barrels allocated to the pool are distributed on the unit or acreage basis, and that one out of five is distributed under the formula to bottom hole pressure?

A Yes, sir.

Q Mr. Curtis, as engineer, have you had under your direct supervision and authority the preparation of five bottom hole pressure maps which we have with us today, and which we will use as exhibits?

A I have.

Q Did you obtain that information reflected on those maps from the official records of the Conservation Commission of the State of New Mexico office?

A Yes, sir.

Q Mr. Curtis, I show you what has been marked "Barnsdall's Exhibit No. 1", and ask you to identify that.

A Exhibit No. 1 is a bottom hole pressure survey map of the Monument Field, Lea County, New Mexico, as of April, 1936.

BY MR. FLEETWOOD: We offer this in evidence, if the Commission please.

(The exhibit is placed on map stand)

Q Mr. Curtis, will you get up there at the board and just explain to the Commission more in detail what that exhibit is, what it shows, and what your conclusions are from that exhibit?

A Exhibit No. 1 is a bottom hole pressure survey map of Monument field as of April, 1936. The Monument Pool is located in Townships 19 and 20 South, Ranges 36 and 37 East. This is a map of the first official bottom hole pressure survey made in the field, and made under the direction of Mr. Staley's office. At this time there were 89 wells within the field, 77 of which were included in the first pressure survey.

The highest bottom hole pressure reported was 1506 pounds; the lowest pressure reported 1122 pounds, or a difference between the highest and the lowest of 384 pounds. The average pressure of all wells surveyed was 1430 pounds.

On this map the bottom hole pressures as recorded in this survey of 1936 are entered under each well. The color legend is this: All wells appearing in the red areas have pressures of 1300 pounds or less. All in the green areas cover a range from 1300 to 1349 pounds. The purple areas cover a range from 1350 to 1399 pounds. The next area, the yellow, from 1400 to 1449. The next higher, the blue, covers a range from 1450 to 1499. And the orange range covers those pressures above 1500 pounds.

The Monument Pool was opened by the Amerada Petroleum Corporation on March 3, 1935, when they drilled the No. 1 State D, located on the NW¼ NW¼ of Sec. 1, T. 20 S., R. 36 E. From the date of the discovery until the date of this survey, or approximately one year, there were 88 more wells completed in the pool. During that same period every well in the pool received a flat top, or 100% to acreage allowable. In the early part of 1936 the Barnsdall Oil Company felt that a proration plan based on 100% acreage was not equitable within the pool, and petitioned the Commission to change the method of allocation. As a result of that hearing, held in February,

1936, Order No. 22 was issued. This order changed the method of allocation within the field from 100% in the field based on acreage, to 80% acreage and 20% to bottom hole pressure factor. This survey which, as I mentioned before, was the first or initial survey made in that pool under Order No. 22 -- pardon me -- this survey was made for the purpose of administering Order No. 22.

Prior to discovery of this field, we feel that the entire reservoir was in equilibrium, that is, throughout the reservoir on a common plane or level the same pressure existed. We see that a year later, under a proration plan of 100% on acreage, we have in the pool great differences in pressure, and when we have those differences in pressure we have drainage existing from the high pressure to low pressure areas. In other words, one man's oil is being drained by another man. Barnsdall felt that Order No. 22 did not give enough to the pressure factor, and petitioned the Commission for a re-hearing. This re-hearing was held in June, 1936, and as a result Order No. 33 was issued by the Commission. This modified Order No. 22 but slightly, the percentage on acreage still being 80% and the percentage to the pressure factor still being 20%.

Q Mr. Curtis, did I understand that prior to the discovery of the field by the Amerada it was generally thought that on the same plane, in the ground, in the reservoir, all pressures were the same?

A That is right.

Q And oil was not migrating?

A No, it was not. The gas was above the oil, then the oil and the water below that.

Q You say on that map shown there, about a year later, wells having been drilled and produced under a flat top allowable, these pressure differentials set up?

A That is correct.

Q Did you say that all of the wells in the blue areas come within the same range of pressures?

A I did.

Q What is that?

A 1450 to 1499 pounds.

Q Does that mean that between that range there is no drainage between wells in that area?

A No. That color is used for pressures from 1450 to 1499 pounds, so that there will be pressures within the blue range that may vary as much as 49 pounds of each other.

Q Do you have any knowledge of the potential ability to produce at that time?

A Yes, sir. At that time, April, 1936, there were wells in the pool which were tested. Incidentally, most operators make an initial potential test of some sort. There were wells in the pool capable of producing at the rate of 30,000 barrels a day. Other wells, less than 100 barrels per day. Incidentally, the Lea County flat top allowable given Monument was somewhat over a hundred barrels per day, so we have a situation of some wells being allowed to produce to capacity, and other wells, with a high potential range, being severely restricted.

Q A 100 barrel well was allowed to produce up to its capacity, wide open, and a twenty or thirty thousand barrel well was shut down to that point?

A Yes, sir.

Q And is it your opinion that drainage existed?

A Yes, pressure differentials set up and caused drainage from one property to another.

Q Could that have been remedied prior to April, 1936?

A Yes, I believe it could have been.

Q How?

A If an allocation formula had been used that kept the pressure as near equal as possible throughout the field.

Q Mr. Curtis, will you identify what the reporter has marked "Exhibit No. 2"? Tell what it is?

A Exhibit No. 2 is a bottom hole pressure survey map as of April, 1937 of the Monument field.

BY MR. FLEETWOOD: We would like to offer that in evidence, if the

Commission please.

Q Will you explain to the Commission what Exhibit No. 2 shows, and what your conclusions are from that exhibit?

A Exhibit No. 2 is a map showing the results of the bottom hole pressure survey made by the Hobbs Proration Office in April, 1937. Incidentally there were surveys made in July, 1936, October of 1936, and January of 1937. These were all official surveys. We, however, did not make maps of them. This shows the yearly period starting with April, 1936.

At this time there were 359 wells in the Monument Pool, or an increase over April, 1936, of 270 wells. Included in the survey of April, 1937, were 310 wells, with the highest recorded pressure being 1483 pounds per square inch, and the lowest recorded being 753 pounds per square inch, or a difference between the highest and the lowest of 730 pounds. The same color legend was used on this map as on Exhibit No. 1, and was used throughout on our exhibits.

This map shows the results of one year's operation under a proration formula based on 80% acreage and 20% bottom hole pressure factor. Inspection of the map shows there were still great differentials in pressure within the pool. The application of this formula may have done some good, but it is apparent that if the bottom hole pressure factor in the formula had been greater, we probably would not have had the great bottom hole pressure differentials existing in the pool. We still felt at this time there was drainage from one property to another.

Q Was that drainage still the result of differences in pressure?

A It is.

Q Where does that drainage occur?

A Between the high pressure areas and the low pressure areas. Oil will drain from a high pressure area to a low pressure area.

Q Does that mean there was drainage between wells in the same color area, as well as the different colors?

A Yes, it may be possible, within an area, that the pressure may vary as much as 49 pounds to the square inch.

Q This exhibit (indicating another map on map stand) has been marked "Exhibit No. 3", and I will ask you to again identify that so that it may be admitted in evidence.

A Exhibit No. 3 is a bottom hole pressure survey map of the Monument field as of April, 1938.

BY MR. FLEETWOOD: We ask that it be admitted in evidence.

Q Will you again explain what that map shows and what your conclusions are?

A This is another bottom hole pressure survey map of the Monument field made from the official survey by the Hobbs Proration Office, made in April, 1938. There was a survey made in September, 1937, but, as I mentioned before, we took the yearly interval beginning April, 1936. At this time 468 wells had been drilled in the Monument field, or an increase, since April of 1937 of 109 wells. In the survey of April, 1938, 425 wells were included.

The maximum pressure recorded was 1433 pounds per square inch, and the minimum 862 pounds per square inch, or a difference between the highest and lowest pressure of 571 pounds per square inch. The average of the 425 wells included in the bottom hole pressure survey was 1341 pounds. This survey was made one year after the survey shown on Exhibit No. 2, and still shows great differentials in pressure existed within the pool, with resulting drainage from one property to another.

BY MR. SELINGER: Will you give, from Exhibit No. 2, the average bottom hole pressure?

A 1385 pounds.

BY MR. FLEETWOOD:

Q Once again will you identify what has been marked "Exhibit No. 4, so that it may be admitted in evidence?

A Exhibit No. 4 is a bottom hole pressure survey map of the Monument field of April, 1939.

BY MR. FLEETWOOD: We ask that it be admitted.

Q Will you explain Exhibit No. 4 to us?

A Exhibit No. 4 is a similar map, made in a similar manner as the other survey maps made, and shows the bottom hole pressure survey made by the Hobbs Proration Office in April, 1939.

At this time there were 484 wells in the field, or an increase over April of 1938 of 16 wells. In other words, during the year between April, 1938 and April, 1939, there were only 16 wells completed in the pool.

In this survey there were 438 wells, that is, in the bottom hole pressure survey, with a maximum bottom hole pressure of 1451 pounds, and a minimum of 824 pounds, or a difference between the two of 627 pounds. The average of the 438 wells included in the survey was 1320 pounds per square inch.

At this time we find but little difference in the pool, in that there are still great differences in pressures, with resulting drainage from one property to another.

Q Mr. Curtis, here is Exhibit No. 5. Will you identify that one for us?

A Exhibit No. 5 is a bottom hole pressure survey in the Monument field as of November and December, 1939.

BY MR. FLEETWOOD: We ask that it be admitted in evidence, if you please, sir.

Q Will you explain that to us, Mr. Curtis?

A This is a map showing the latest bottom hole pressure survey by the Hobbs Proration Office, and was just completed in the early part of January. We have shown it as November and December because the bulk of the work was done then.

There were 493 wells in the field, only nine more wells than are shown in April, 1939. In other words, the field is, for all practical purposes, fully developed.

The maximum pressure recorded in this survey is 1397 pounds per square inch; the minimum pressure recorded is 525 pounds per square inch, or a difference between the highest and lowest pressures recorded of 872 pounds per square inch. The average for the 445 wells which were included in this survey was 1300 pounds per square inch.

On this map, as well as on the others, we still find great

differences in pressure in the reservoir. Since April, 1936, the allocation to the field has been based on the 80% acreage and 20% bottom hole pressure formula, and today, as shown back on the earlier maps, we still have great differences in pressure, with resultant drainage from one property to another.

Q Mr. Curtis, as I understand Exhibit No. 1, it is the result of a bottom hole pressure survey made prior to Order No. 22 or 33, and shows the result of 100% acreage, is that right?

A Yes, sir.

Q Exhibit No. 2 shows the bottom hole pressures as under Order No. 22 for about three months, and under order No. 33 the rest of the period?

A Yes, sir.

Q The next exhibits, Nos. 3, 4 and 5, as I understand, are the results of the application of Order No. 33?

A That is right.

Q That has never been changed from that year on?

A Yes, sir.

Q And that is the 80% acreage, 20% bottom hole pressure?

A It is.

Q That red area shows wells which have bottom hole pressure of 1300 pounds or less?

A Yes, sir.

Q That is the lowest pressure area shown?

A That is the lowest we have used.

Q Will you explain why the relative amount of wells shown in the red area increase all the way across from Exhibit No. 1 to Exhibit No. 5?

A The red area should increase because it includes all pressures below 1300 pounds per square inch, and as withdrawals are made from the field, the whole field average is going down, so naturally there would be more wells in the red area.

Q Is it your opinion the wells in the red area have, or have not, drained oil from other wells?

A Yes, because there have been differentials in pressure. Those in the red area have lower pressures than the green; those in

purple area have higher than the green.

Q What has been the practice as to bottom hole pressures? How often are they taken?

A Bottom hole pressures have been taken by the Hobbs Proration Office, and are static bottom hole pressures after a 24 or 36-hour shut-in period, at a sub-sea datum of 250 feet, or a point 250 feet below sea level.

Q Is it possible there are wells on some properties that are less permeable and would require a longer time to show the highest bottom hole pressure? Would it be necessary, perhaps, to shut some wells in longer than others to get the maximum pressure in them?

A It might be necessary in some cases. There may be some wells which, after being shut in, would not reach the maximum build-up pressure within 24 or 36 hours.

Q As an engineer, would you say any such operator should be given a longer time, or should the pressure be taken the same as the other wells?

A No, he should be given an opportunity to reach the maximum pressure.

Q I notice across here (indicating) the field stops abruptly at this south boundary, as shown by the heavy black line.

A That line is shown on Exhibits Nos. 3, 4 and 5, and it is called the Monument-Eunice difiding line. A hearing was had before the Commission, I believe in May of 1937, and as a result of this hearing an order was made by the Commission setting this boundary line, effective August 1, 1937, as the boundary line between what is known as the Eunice Pool and the Monument Pool. Prior to that an engineering committee had set the boundary at a point three-quarters of a mile south of the line later set by the Commission's order.

Q You don't mean, by carrying the maps in that way, that line is the place where this field stops?

A No, sir.

Q It is simply an official designation, which you have been using?

A No, the area north of the line -- the wells north of the line

are included in the Monument field proration schedule.

Q I noticed when you told the number of wells in the field, you then told the number of wells in which the bottom hole pressures were recorded. As I recall, the number of wells with recorded pressures was less than the number of wells in the field. Is there any explanation of that?

A Yes. There may have been a few new wells in there which were completed shortly after the survey was made. Also, in low pressure areas there is always a good number of wells in which no pressure was taken because such wells had low bottom hole pressure and would receive only that portion of the allowable allotted to acreage, or an 80% flat top.

Q What did you say that now the average field bottom hole pressure is?

A 1300 pounds.

Q The average?

A An average of the wells included in the survey, or 445.

Q Under Order No. 33 do all wells with a pressure under 1300 pounds get the same allowable, if they can make it?

A No.

Q Explain why?

A Under Order No. 33, the average of the three lowest pressures in the field, or 80% of the highest recorded pressure, whichever of those two happens to be the highest, is used. The working of the order has been such that 80% of the highest pressure has always been used. In February, of 1940, the maximum pressure recorded was 1397 pounds. 80% of that was 1118 pounds. In the operation of the formula, every well with a pressure of 1118 pounds per square inch or less is allowed an 80% flat top allowable, or 47 barrels -- or 38 barrels, unless incapable of making that much, and then it is allowed what it will make.

Q You mean that any well that can make 38 barrels is allowed to make that?

A Yes.

Q What is the highest allowable any well can get?

A 52 barrels.

Q It ranges from 52 barrels down to 38 or less?

A Down to 38 or less. There may be some wells that make considerably less.

Q As an engineer can you tell whether even with a one-pound difference in bottom hole pressure, that will cause oil to migrate from an area of greater pressure to an area of lesser?

A You would have a pressure differential which would be very slight.

Q Suppose you have a difference of 872 pounds, as your map shows, between the highest and the lowest pressures. Would there be migration from the high to the low in a case like that?

A Yes, there will be migration from the high pressure area to the low pressure area.

Q With that great difference, would the migration of oil be extensive?

A Yes, you would look for it to be.

Q Is it your opinion as an engineer that on all five of these exhibits there is shown drainage of oil from one man's property to another that has been going on from the beginning of the field and is going on today?

A That is my opinion.

Q What is the remedy you propose for that?

A The remedy is the use of a bottom hole pressure factor of greater than 20%. In other words, a proration schedule which would give less to acreage and a greater percentage to the bottom hole pressure factor.

Q Would you suggest to the Commission just exactly how that be done?

A As I recall, we suggested before, back in 1936, a formula giving 25% to acreage and 75% to bottom hole pressure factor. That would give you, over a period of time, ordinarily uniform pressures throughout the pool.

Q Do you make that recommendation now?

A I do.

Q Do you think it is needed more, or less, now than in 1936?

A It has been needed all along. Probably more now than then, since the pool is now fully developed.

Q Would the enactment of such a formula be considered by engineers as a perfect solution?

A No, it might not be a perfect solution. In other words, engineers recommend that the most perfect plan would be a plan of 100% bottom hole pressure.

Q Is it possible that in giving 75% to bottom hole pressure, some wells might decline very rapidly, or too rapidly?

A They would decline less than under the present formula.

Q Would it be difficult to adjust any differences that might crop up on a 25%-75% basis?

A No. The plan would work so that a high pressure well which, for some reason, was given too much allowable, would be lowered perhaps during the following survey period, and between that period and the next would have less allowable, so that the over-all during the year would average.

Q Can you tell whether it is possible to accurately determine the amount of oil in place under each tract in the Monument Pool?

A I believe we could roughly determine it, but I don't believe an accurate enough estimate could be arrived at for allowable within the pool. Fortunately we do have two factors capable of accurate measurement, and that is the acreage of each well and its static bottom hole pressure. In the absence of other factors for the proper estimation of reserves, we have these two factors just mentioned which, if applied to the proration formula, should keep uniform pressure throughout the pool with but little drainage between tracts.

Q Do I understand you correctly that your thought is in this recommendation that since we cannot ascertain accurately the amount of oil under each property, that applying this bottom hole pressure formula would stop drainage, and thereby every man's oil would stay beneath his own property?

A Yes, I believe that is true.

Q Have you calculated what the minimum allowable on this 75-25 basis would be?

A In February it would have been 25% of 47 barrels, or an increase of twelve barrels a day.

Q In your opinion will twelve barrels a day repay lifting costs in the Monument Pool?

A I believe on an average it will pay a reasonable lifting cost.

Q Would that minimum be a constant minimum, or would there be a chance to get a greater one?

A No, in some cases it would be on a temporary basis. I man might get the twelve barrels on one survey, and on the next pressure period the next man might get it.

Q In conclusion, Mr. Curtis, you recommend that the Commission's Order No. 33 be modified so that the formula will be 25% on acreage and 75% bottom hole pressure factor?

A I do.

BY MR. FLEETWOOD: That is all.

CROSS EXAMINATION By Mr. Kraus:

Q Will you tell how many barrels of oil have been withdrawn from the Monument field between the dates of the first survey and the dates of the last survey?

A The figures I have show that as of December 1, 1939 -- this is a rough figure, was 31,950,000 barrels from discovery, and as of January 1, 1936 -- the earliest day I have is April, 1936, the map there, was 56,000 barrels.

Q So about 30,000,000 barrels have been produced between these two dates?

A Yes, sir.

Q With that amount of production, do you, as an engineer, believe a drop in bottom hole pressure, average for the field, of 130 pounds is an indication, in a general way, of good operation or poor operation?

A I think, in a general way, it shows good operation through the field. A pressure drop that has amounted to -- what did you say?

Q 130 pounds?

A Merely an eight pound pressure drop for one million barrels of oil produced.

Q In a general way, you would not feel there had been much waste?

A Not a tremendous amount of waste, no.

CROSS EXAMINATION By Mr. Seth:

Q Would you mind pointing out on the map the location of the Barnsdall leases? I understand they are all in one body?

A Yes, sir. The Barnsdall Cooper lease is located on the E½ E½ of Sec. 12, T. 20 S., R. 36 E., and the W½ W½ of Sec. 7, T. 20 S., R. 37 E., and consists of 320 acres.

Q Eight wells?

A Yes, sir.

CROSS EXAMINATION By Mr. Dewey:

Q You indicated in your formula you would reduce the formula on some of the lower units to a possible 12 barrels per day?

A That is what it would do; in a flat top allowance of 47 barrels, which was made in February, 1940 -- I say 12 -- it is a little over eleven, but the Proration Office always carries whole figures, so I called it twelve.

Q I wonder if you have calculated the allowance Barnsdall would have under the same condition?

A No, I have not made the calculation; I could make it.

Q It would be rather interesting to know what they would have.

CROSS EXAMINATION BY Mr. Seth:

Q Those maps indicate the low pressure areas are particularly along the south line, the line between Monument and Eunice?

A That shows a low pressure area, yes, sir.

Q Can you explain that?

A My explanation of that is that those wells probably have had, under the present proration formula, a larger allowable than they should have had.

Q Isn't that a very tight area?

A I understand it is.

Q You are not familiar with conditions there?

A Not personally familiar. However, I have always understood that some wells were very difficult to complete in that area.

Q A tight area, or one of low permeability extends along there?

CROSS EXAMINATION By Mr. Bays:

Q Would you have the Commission prorate Monument so that all pressures would be uniform? So that all pressures would become uniform?

A So that they would be more nearly uniform.

Q If they were completely uniform you think there would be no drainage?

A I think if the pressures were completely uniform there would be no drainage.

Q Is there quite a variation in permeability in the field?

A Yes, I think so.

Q Would you think a man that had a barrel of oil in a highly permeable area would be entitled to the same pressure as a low permeable area?

A I think every man is entitled to produce the oil under his land.

Q Do you know the relationship of permeability and energy requirements for bringing the oil to the bore hole?

A There will be more energy required in an area of low permeability.

Q You were present here when Dr. Muscat produced his formula which shows the energy requirements are directly in proportion to the permeability of a well?

BY MR. FLEETWOOD: I don't want to be highly technical, and we want that record to be part of this hearing --

Q Do you know that to be a fact? He has testified as a petroleum engineer.

BY MR. FLEETWOOD: All I want is an agreement by all that the Hobbs record be made a part of this record. We want it in -- we would prefer to have it a part of this record.

BY MR. BAYS: Wasn't the Hobbs hearing the previous hearing?

BY MR. FLEETWOOD: It was, and we would be glad to have it made a part of this record.

Q I will ask if you can answer that question?

A It will take more of an engineer than I am to tell that.

Q Isn't it directly in proportion?

A I believe it is in the formula -- I am not certain.

Q If a man had a barrel of oil in a tight area the relationship

would be ten to one -- it would require ten times as much energy?

A It would take more.

Q It would take ten times as much, based on this formula?

A Yes.

Q Where would he get that energy?

A In the gas dissolved within the oil; possibly with the occlude gas; possibly some free gas.

Q If he used more energy would he have a drop in bottom hole pressure?

A No, I don't believe that necessary.

Q Why would he need more bottom hole pressure if -- I would like to know why you would like an equalization of bottom hole pressures if they have nothing to do with reservoir energy?

A There is a great deal of reservoir energy, probably more than will ever be needed to move the oil there.

Q Will you explain to the Commission why, if a man has a barrel of oil in a tight area, it requires ten times as much energy to get it out?

A He may not have as much oil under his property.

Q I did not say that. How will he produce his barrel of oil and use ten times as much energy without a drop in bottom hole pressure? If you equalize bottom hole pressure you will keep that man from producing his oil.

A No, if you equalize it, he will get more oil.

Q How can you equalize -- if you restrain him from using that, you reduce the out-go.

A If he reduces the pressure in the well, on static pressure tests, and is given enough time to get the maximum build up around the well, he may not have as much oil under his property. Certainly there is much energy in the reservoir, certainly more than enough to move the oil to the well and up to the surface.

Q You want to say he can use ten times as much energy, and still have the same bottom hole pressure?

A He may use more energy --

Q (Interrupting) And still have the same bottom hole pressure?

A In lifting it?

Q Use ten times as much energy to get his oil.

A Not getting his oil, he may have less to get.

Q That is not the question. How can he use ten times as much energy to get one barrel of oil as is needed to get a barrel of oil in some other well, and not have a drop in bottom hole pressure?

A Nevertheless I still think the pressures should be maintained as near equal throughout the pool as possible.

RE-DIRECT EXAMINATION By Mr. Fleetwood:

Q Mr. Curtis, do you find you are alone in believing in these engineering principles you have advocated here this morning?

A No, sir, I have known and heard of a number of other engineers who have advocated the same principles.

Q Mr. Curtis, the Honorable Hiram M. Dow, of this state, advised by Judge J. O. Seth and Carl Livingston, wrote a paper which was published by the Mineral Law Section of the American Bar Association, and in that paper he states, "the taking of bottom hole pressure measurements permits a more accurate control of the reservoir energy" --

BY MR. SETH: Mr. Dow is not an engineer.

BY MR. FLEETWOOD: He is a very eminent New Mexican whose opinion I value very highly.

Q Do you, as an engineer, agree with Mr. Dow, Judge Seth and Mr. Livingston?

A Yes, sir, I think their conclusions are self-evident.

Q In that same volume published by the American Bar Association, Mr. Robert E. Hardwicke, an attorney and engineer of Fort Worth, Texas, who has frequently appeared here in this state, stated "the creation of low pressure areas causes dissipation of reservoir energy and also causes damaging encroachment of salt water thereby bringing about underground waste, which is another way of saying that the ultimate recovery from the pool will be less than it would have been if efficient production practices had been used." And he also says, in the same paper, "the property of one operator must not, in effect, be given to another by a discriminatory method of allocation which results in drainage which is not off-set by counter

drainage". Do you agree with engineer and lawyer Hardwicke in that respect?

A Yes, sir, I agree with him.

Q On July 19th and 20th, 1939, here in Santa Fe, the Interstate Oil Compact Commission held a meeting, at which time Governor Dow stated, "There are three ways of measuring waste in an oil field: the rate of drop in bottom hole pressure, gas-oil ratios, and irregularity of water encroachment". At the same meeting Colonel Ernest Thompson, of the Texas Railroad Commission, stated: "We have found that certainly there is a direct relationship between the flow and bottom hole pressure reaction". Also the Advisory Committee on Economics to that Commission, a committee composed of Mr. deGolyer, Mr. Sachs and Mr. Pogue, reported that one of the two principles which embody the fundamentals of conservation are "equity amongst competing interests be done by operating wells in such manner that cross drainage is minimized, The several properties in a single pool shall be so produced that the development of pressure differentials within the reservoir is minimized." Also another gentleman, not an engineer, Senator Clint Small, of the State of Texas, stated: "It seems funny to look back and to think that we ever had an idea to allow a poor well to produce as much as a good one. We cannot say that because each of you has holes in the ground you are entitled to produce the same amount of oil."

Mr. Curtis, I have read a lot of excerpts here, and I will not ask you to comment on each of them. Do any of the quotations differ, or interfere with the principles of engineering you have been advocating, or are they in agreement with those principles, in general practice?

A I believe they are in agreement. These gentlemen have stated in a much better fashion than I have, the same principles.

Q According to the minutes of a meeting of the Hobbs Engineering Committee, held in Santa Fe on June 11, 1936, a report was made to Mr. Glenn Staley by a special committee composed of Mr.

E. H. Wahlstrom, of the Stanolind, Mr. R. S. Christie, of the Amerada, Mr. Lloyd Gray, of the Gulf, Mr. J. E. Heath, of the Sun Oil Company, and Mr. Colin Rae, of the Skelly. In this report these gentlemen, after stating their reasons for not recommending to them the use of potential factors, flowing pressure, build-up pressures, and thickness of pay formations as elements in a proration formula applicable to the Monument Field, stated that acreage should be considered, and that static bottom hole pressure, defined as 24-hour shut-in bottom hole pressure "is the best known factor to prevent drainage across property lines. It is also an index as to the proper functioning of the producing reservoir, thus serving to promote conservation." Do you believe these gentlemen, Mr. Wahlstrom, Mr. Christie, Mr. Gray, Mr. Heath and Mr. Rae, were correct in that report?

A Yes, I believe they were correct in that report, and they also expressed the opinion of a large number of engineers.

Q Do you know who Mr. J. E. Wooten is?

A Yes, sir.

Q Will you tell the Commission who Mr. Wooten is?

A He was, in June, 1936, employed by the Stanolind Oil Company as division engineer, out of the Fort Worth office.

Q On June 12, 1936, Mr. Wooten testified at a hearing before this Commission with reference to Order No. 22, covering the Monument field, as follows: "Any method employing bottom hole pressure would have to be in operation for some length of time to determine how pressures range, going up or down or equalize. As long as bottom hole pressures are included the plan can be modified from time to time as desired." Also, "One hundred per cent bottom hole pressure is the most desirable plan". And "To select the plan at the start of a field, I would select the 100% bottom hole pressure. I think bottom hole pressure would attain results that are desired in the plan, that is, to prevent physical waste." Mr. Wooten was asked "Why do you think 100% bottom hole pressure better than Order No. 22?" And Mr. Wooten answered, "It would

prevent waste over a long period of time." Mr. Wooten was also asked, "You answered your questions that it was true the nearer we approach 100% bottom hole pressure, the more we would give to bottom hole pressure, just that much nearer we would come to the point of minimizing to the smallest degree drainage across property lines?" And Mr. Wooten answered, "That is true." Mr. Selinger, of the Skelly Oil Company, asked: "What was your statement in regard to the effect of placing the Monument Field strictly on a 100% bottom hole pressure?" Mr. Wooten responded: "100% bottom hole pressure would tend to equalize pressures, and I think fundamentally 100% bottom hole pressure is correct."

Mr. Curtis, do you find yourself in agreement with Mr. Wooten's statements?

A I think Mr. Wooten is absolutely correct in his testimony.

Q On February 25th and 26th, 1936, here in Santa Fe, at a hearing before this Commission, Mr. Jack Rankin, of Repollo, testified it was correct to say "A unit allowable plus some sort of allocation on bottom hole pressure would be desirable, provided you give enough weight to minimum allowable." Mr. Rankin also testified: "In order to be scientific, to be secure from the tendency of drainage, we should have a plan to equalize bottom hole pressures," and "As far as the method is concerned, I rather favor the static bottom hole pressure," which was advocated as a plan. He also stated that he believed that a beginning along those lines should be made by assigning a small value to bottom hole pressures and increase their values as rapidly as conditions justified. Do you agree with Mr. Rankin's basic idea?

A Yes, sir. The only objection I had at that time, the time of the hearing, and ever since, is that we have just been crawling along. I believe a plan giving more to bottom hole pressure factor should have been made earlier in the life of the field.

Q As an engineer, very definitely I want you to answer one final question. I want to read to you from the opinion of a three-judge federal court, dated February 20, 1940, in the Humble

and Rowan Nichols case in Texas, and I want you to tell what you think of this statement of the federal court: "The evidence here, however, is that even with a pumping well, production can be profitably continued on five to ten barrels per day. We can think of no good reason why a higher allowable should be fixed for non-marginal wells when to do so would take three-fourths of the distributable oil on a basis which is neither according to the productive capacity of the well nor according to the amount of oil on the leases. To distribute three-fourths of the allowable on a flat basis per well without regard to oil reserves of the leases, of the productive capacities of the wells, which constitutes the value of the property, is unreasonable, and therefore in violation of the Constitution and the statutes." What do you think about that?

A Not being a lawyer, I cannot say that the procedure is unconstitutional. However, as an engineer, I certainly agree with the court that to distribute three-fourths of the field allowable on a flat basis per well or unit, without regard to the oil in place, certainly is contrary to engineering principles, and is unreasonable, in my opinion. Here in the Monument field we actually distribute more than 75%, or 80%, on a flat acreage basis.

Q At the Seventh midyear meeting of the American Petroleum Institute, on June 2, 1937, Mr. Langdon L. Foley stated "Some fields have been prorated on the basis of acreage * * * * for example, Monument Field in New Mexico, has 80% of the allowed production based on acreage and 20% according to reservoir pressure. The allocation according to acreage presumes that one acre is as good as another, which is not always the case.

Are you also in agreement with Mr. Foley?

A I am.

Q Mr. Curtis, do you know who Mr. C. V. Millikan is?

A Yes, sir.

Q Mr. Millikan is Chief Production Engineer of the Amerada Petroleum Corporation in Tulsa, is he not?

A Yes, sir.

Q What interest has the Amerada Petroleum Corporation in the Monument field?

A The Amerada has 103 production units out of the 483 in the field, or approximately 20% of the units in the field.

Q Mr. Curtis, I ask you to examine this exhibit (handing witness a printed pamphlet which has been marked "Barnsdall Exhibit No. 6). Will you examine Exhibit No. 6 and identify it?

A Exhibit No. 6 is a reprint from the transactions of the American Institute of Mining Engineers, 1933, 103 of Petroleum Development and Technology, and is entitled "Reservoir and Bottom-hole Producing Pressures as a Basis for Proration". This paper was written by C. V. Millikan.

Q Of the Amerada?

A Yes, sir.

Q Turning to page 3 of that paper, will you read what is marked there?

A (Reading) "Maintenance of uniform reservoir pressures is the most equitable method of prorating. If the reservoir pressure in a field is maintained uniform at all stages of depletion, there will be no migration of oil and gas from the drainage area of one well to that of another. At any stage in the life of the field each well will have withdrawa the same proportion of its recoverable reserves as any other well.

"When allowed production is allocated on the basis of decline of reservoir pressure, some tentative distribution must be made. A method which considers the rate of production seems most logical. The tentative allocation, however, need not be established with the accuracy that is necessary when the proration is based on the capacity of the wells to produce. The allowable would be adjusted when the next set of closed-in pressures is taken. Wells which have a greater decline in

reservoir pressure than the average in the field will have their allowed production correspondingly decreased while the allowed production of those in which the reservoir pressure had declined less than the average will be proportionately increased. These periodic adjustments will equalize the reservoir pressures of the various wells to the end that a uniform decline of the reservoir pressure in the field will be maintained. When the field is exhausted each well will have produced the same proportion of the original oil and gas content in the reservoir within the drainage area of the well as the total recovery of the field is to the total original oil and gas content of the field."

Q Now, Mr. Curtis, as an engineer, would you say that the application of those principles advocated by Mr. Millikan is similar to the advocation of the principles you have been advancing here this morning?

A They are.

Q Would you, as an engineer, say that the law of the State of New Mexico, which reads: "The rules, regulations or orders of the Commission shall, so far as it is practicable to do so, afford to the owner of each property in a pool the opportunity to produce his just and equitable share of the oil and gas in the pool, being an amount, so far as can be practically determined and so far as such can be practicably obtained without waste, substantially in the proportion that the quantity of the recoverable oil and the gas under such property bears to the total recoverable oil and gas in the pool, and for this purpose, to use his just and equitable share of the reservoir energy." You believe the application of Mr. Millikan's principles, or the principles advocated by Mr. Millikan would obtain this result, giving every operator an opportunity to produce his proportionate share of the oil and gas and use his share of the reservoir energy?

A Yes, sir, I believe it would come very near to obtaining this result.

RE-CROSS EXAMINATION By Mr. Seth:

Q Do you intend to tell the Commission that in that Humble and Rowan Nichols case 75% of the allowable was allocated on a unit basis?

A Not on an acreage basis, as I understand.

Q You know well that what the courts condemned was an allocation on a per well basis?

A They mentioned units in their argument.

Q You know what the court condemned was giving 75%, or the same proportion to a well on one-tenth of an acre as to one on ten acres?

A That may be so. I am not certain.

Q You are not certain of what?

A I don't know whether they used a unit or well.

Q Are there any units in East Texas?

A Acreage is taken into consideration.

Q The court condemns the 74% on a per well basis, didn't they?

A Yes, sir.

Q In that 75% one well, even on an area where there were seven wells to a half acre, each well would get as much as a well on ten acres?

A Yes, sir, it will, but the number of acres is taken into consideration under any formula.

Q 25% of it?

A I believe it is.

Q What the court condemns is not the taking of acreage into consideration, but the 75% on the per well basis?

A It may have been.

Q You testified, on the first round, that you could not determine the amount of oil in place with any degree of accuracy?

A I said you could not determine it with any degree of accuracy, but I wish to explain that for the purposes of allocation, it would be difficult to cover all units in the field so that all operators would be agreeable to that determination.

Q You know it varies widely?

A Yes, sir.

Q And you know it cannot be determined with any degree of accuracy?

A That was my statement.

Q The acreage is the only definite factor, except bottom hole pressure, that might be used as a corrective factor?

A As I recall, I said you have two factors which can be accurataly determined, one being acreage and the other static bottom hole pressure.

Q You wouldn't content that bottom hole pressure is a measure of oil in place?

A Not necessarily.

Q That will leave acreage as the only factor that could be accurately determined as bearing on the oil in place?

A With unit spacing, if you had differentials in pressure you would have drainage from one man's property to another.

Q But pressure does not indica-te the oil in place?

A Not necessarily.

Q The only definite factor in the field is the acreage as indicating the oil in place?

A Acreage is used as one of the factors in determining oil in place.

Q I asked, isn't that the only definite factor you have?

A Yes, sir.

RE-DIRECT EXAMINATION By Mr. Fleetwood:

Q You don't mean that each 40-acre tract has the same amount of oil in place as every other 40-acre tract?

A No, sir.

Q Then it is not in the size of the tracts that the differences exist, because they are all the same?

A Yes, in the Monument field we have one well to each forty acres. Each and every unit is the same size. No matter what plan is used, in acreage each and every unit is aloke.

Q And anything giving acreage as a factor is the same as a minimum allowable?

A Yes, sir.

Q Is it your testimony that just as long as pressure differentials

exist, the oil will drain from one man's property to another's?

A Yes, sir.

RE-CROSS EXAMINATION BY Mr. Selinger:

Q What position do you hold with the Barnsdall Oil Company?

A Proration engineer.

Q As such, are you familiar with the holdings of the Barnsdall Oil Company in all states where they have production?

A With most of the prorated wells. Some wells in what is called the stripper areas I am not familiar with.

Q As I understand your testimony, the only two factors on which you have accurate information are acreage and bottom hole pressure?

A I believe that is what I said.

Q Those two factors are considered under the present order by the Commission?

A They are.

Q You are familiar with the weight given each of the two factors?

A Yes.

Q On your suggestion of 25% to acreage and 75% bottom hole pressure, you told the Commission it would approach a minimum allowable of twelve barrels, is that right?

A I said that is the case for the month of February, 1940.

Q In other words, on that acreage factor, a small well on the edge would participate in the acreage allowable estimated at approximately twelve barrels?

A Yes, sir.

Q If the allocation on the per well allowable decreases, that minimum allowable is liable to decrease?

A That is true.

Q It might be the minimum allowable would get as low as seven or eight barrels?

A It might be possible.

Q In that particular case it will?

A I said it might be possible.

Q You recommend to this Commission what amounts to a minimum allowable per well, or per unit?

A Per unit.

Q In this state a unit is how many acres?

A Forty.

Q Have you recommended a margin allowable in other states where the Barnsdall Oil Company has holdings?

BY MR. FLEETWOOD: We object to that as incompetent, irrelevant and immaterial. This question is in regard to fields in other states.

BY MR. SELINGER: If I don't tie it in I will agree to have it deleted.

BY MR. WORDEN: I think you should confine your question to the Monument area.

BY MR. BAYS: Practically all the papers quoted from has to do with the East Texas field where they are allowed to drill seven wells to an acre.

BY MR. FLEETWOOD: No objection was made. If anyone had objected we would have agreed to have that evidence stricken.

BY MR. SETH: We move that all the evidence read as to some other pool be stricken?

BY MR. FLEETWOOD: We agree that anything we have offered that has reference to other pools be stricken.

BY MR. SELINGER: My question, the quotation I had in mind has a bearing on the Monument Pool.

BY MR. WORDEN: Since we have agreed we are going to strike the evidence as to other fields, we will confine everything to the Monument area.

BY MR. SELINGER: That is the point I was getting down to, whether the experts had known of other pools that had other considerations.

BY MR. WORDEN: The Commission feels we should confine the testimony to the Monument Pool. Inasmuch as those quotations were offered here, and the counsel who offered them has agreed that they be stricken, we will confine the testimony to the Monument Pool.

BY MR. SELINGER: Your Honor is striking the opinion read by Mr. Fleetwood?

BY MR. WORDEN: That is my understanding, that all the testimony offered in regard to other pools than the Monument Pool will be disregarded.

BY MR. FLEETWOOD: The Commission's ruling is the testimony Mr. Curtis gave with reference to quotations referring to pools other than the Monument Pool will be stricken, but that the quotations referring to the Monument Pool directly will not be stricken?

BY MR. WORDEN: Anything directly pertaining to the Monument Pool, that has any bea ring directly on that pool will not be stricken.

BY MR. SELINGER:

Q So that you recommend to this Commission that the minimum allowable in the Monument Pool be placed at twelve barrels per unit?

A It would have been in February under the recommended plan.

Q It would have been in February, 1940?

A Yes, sir.

Q What would the per well allowable for March be?

A I don't know what it is. If you can tell me what the allowable is, I can take that and figure it.

Q In February the minimum allowable was twelve barrels per forty acre unit?

A Yes.

Q Would that have the effect of having a lower minimum allowable in the State of New Mexico than in other pools?

BY MR. FLEETWOOD: Same objection, if he refers to pools outside of the state, or inside the state other than Monument.

Q As compared with other pools in the State of New Mexico.

BY MR. FLEETWOOD: No objection.

A I expect the order written by the Commission would apply only to the Monument field. This says Order No. 33 applies only to the Monument field.

Q That is not the question. The question is, would it have the effect of having a lower minimum allowable than other pools in the state?

A Other pools in the state are operated on other plans.

Q Would the effect be that the minimum allowable under your plan would be less?

A The minimum allowable would be less.

RE-CROSS EXAMINATION By Mr. Bish:

Q Mr. Curtis, are you aware of the fact there has been several packers set in the Monument Pool to conserve gas?

A Yes, sir, I am.

Q In your opinion, does that reflect, after setting the packer you take the bottom hole pressues, does that bottom hole pressure reflect through the pressure in the reservoir?

A Not necessarily so. At the previous hearing held in December I believe there was a committee recommendation made at that time by Mr. Kraus for the taking of pressures in packer wells.

Q In your opinion as an engineer, should there be an adjustment made for packer wells at Monument?

A Yes, sir, operators should not be penalized because he has set a packer.

RE-CROSS EXAMINATION By Mr. Seth:

Q Will you come over to your Exhibit No. 5 for a minute? Does the Barnsdall area lie in the $W\frac{1}{2}$ $W\frac{1}{2}$ of Sec. 7? Is that what you stated?

A Yes, sir, the $W\frac{1}{2}$ $W\frac{1}{2}$ of Seven and the $E\frac{1}{2}$ $E\frac{1}{2}$ of 12.

Q Now that shows the bottom hole pressures at the last survey, I believe in November and December, 1939?

A Yes, sir.

Q Take your No. 3, which is the northermost well of the eastern tier. What is the bottom hole pressure?

A 1350 pounds.

Q What is the bottom hole pressure of the offset well, the Anderson-Prichard, immediately east?

A 1360 pounds.

Q The offset well to the east is ten pounds higher than your well?

A Yes, sir.

Q Take the one immediately south, your No. 2?

A 1355 pounds.

Q And the offset well, the Anderson-Prichard No. 1?

A 1360 pounds.

Q Then the offset well is five pounds higher. Take your No. 7, what is that pressure?

A 1352 pounds.

Q And the offset well to the east?

A 1359 pounds.

Q Seven pounds differential. Take your No. 6.

A 1352.

Q And the No. 6 Anderson-Prichard immediately east?

A 1358 pounds.

Q On all four of those wells, your east offset had higher pressures?

A Yes, sir.

Q You contend Barnsdall is draining oil from the wells to the east?

A Yes, sir, wherever there is a difference in pressure there will be drainage.

Q Take the offset to the south, Continental No. 1, what is the pressure?

A 1367 pounds.

Q And your well to the north of that?

A 1352.

Q Your pressure is 15 pounds lower than the offset well. Come over here to your No. 8 in Sec. 12, what is that pressure?

A 1350.

Q And the one immediately south, the Amerada No. 1?

A 1355 pounds.

Q And the one immediately west, the Amerada No. 6?

A 1365 pounds.

Q The Amerada well is 15 pounds higher than your No. 8?

A Yes, sir.

Q Come up here to the next one, Amerada No. 3?

A 1330 pounds.

Q And what is the pressure of your well immediately east of that?

A 1356 pounds.

Q And the next one, the Amerada No. 2?

A 1360 pounds.

Q And yours immediately east?

A 1357.

Q And the Amerada No. 1?

A 1356 pounds.

Q And your well?

A 1356.

Q And the Skelly State, what is that?

A 1362 pounds.

Q Except in a few instances your wells had some five to 13 pounds lower pressures than the offset wells?

A Yes, sir.

Q And you think you are draining a lot of oil from your neighbors?

A We may have for a period. However, we will have less allowable because we have less pressure than our neighbors.

Q When will that happen?

A This new pressure survey was placed in effect on the proration schedule in February, 1940.

Q This difference in pressure, your wells being lower than the offset wells, will that continue for some time?

A Here they are higher than the offset (indicating).

Q Not to the west on this map, they average ten pounds difference. You were draining from your west offsets?

A Yes, there was a pressure differential across there.

Q And if you increased the bottom hole pressure formula to twenty pounds difference, or to some higher figure, it would increase the drainage?

A No, sir, you would give the wells with the higher pressure more allowable.

Q It wouldn't increase the drainage?

A No, those with the lower pressure would get less allowable.

Q You are way above the scale that would take the minimum in the application of your formula, that was eleven hundred something?

A 1118 pounds.

Q You are above that?

A Yes, sir.

Q You would get a higher allowable for that percentage?

A We would get a somewhat higher allowable. Those offsets with higher pressures would get more than we would.

Q Your drainage would continue if you get a higher allowable?

A No, it would tend to equalize it.

RE-DIRECT EXAMINATION By Mr. Fleetwood:

Q On the question of the offset wells, is it your opinion as an engineer that we are entitled to drain any oil from our neighbors?

A Not unless the offsets, by counter drainage, were making it up.

Q You don't contend that Barnsdall is entitled to drain from anyone else?

A No, sir. If we are in a low pressure area, we would drain from the high pressure area. We are not asking for anything we consider out of line.

Witness dismissed.

BY MR. FLEETWOOD: We do not have any further testimony or questions at this time.

BY MR. WORDEN: We will recess until 1:30 o'clock this afternoon.

Pursuant to recess taken, the hearing was convened at 1:30 o'clock, P. M. The hearing was called to order by Mr. Worden, and the following proceedings were had:

BY MR. FLEETWOOD: This fine New Mexico air reminds me of two more questions we would like to ask Mr. Curtis, with your permission.

BY MR. WORDEN: Proceed.

R. D. CURTIS,

recalled by Barnsdall for further re-direct examination:

BY MR. FLEETWOOD:

Q Mr. Curtis, we may have created the impression this morning that our sole interest in this proposed formula was the result simply of a matter of principle, and I admit that may be an important interest. I want to ask you if some difficulties and inequities which Barnsdall has suffered will be corrected or benefitted by the application of this formula, and if so, just what would be the nature of that benefit?

A Yes, I have figured what the allowable would be, and Barnsdall would gain six or seven barrels per well, or about, approximately 58 to 60 barrels per lease.

Q Judge Seth asked you as to the offset properties, some of which had slightly higher bottom hole pressures, ranging from five to thirteen pounds, and you testified there would doubtless be some drainage from those leases to our leases?

A Yes.

Q Is that the important thing in this picture, and if not, what is the important thing?

A The important thing is the equalization of pressures, where you wouldn't have the present great differentials. We have pressures ranging from 1300 -- nearly 1400 pounds on down to 500 pounds, and maybe less on some wells which are not included in this survey.

Q Is evening up the spread from 500 to 1400 pounds the vital thing, evening up the present great differentials in pressure?

A That is right. We would like to see the next survey show a more even distribution of pressures throughout the pool.

Witness dismissed.

R. G. SCHUEHLE,

being called as a witness, and being first duly sworn to tell the truth, the whole truth, and nothing but the truth, was examined by Mr. Seth, and testified as follows:

DIRECT EXAMINATION

Q Please state your name?

A R. G. Schuehle.

Q What is your profession, Mr. Schuehle?

A Petroleum engineer and geologist.

Q By whom are you employed?

A Shell Oil Company.

Q Will you state briefly your training and experience as a petroleum engineer and geologist?

BY MR. FLEETWOOD: Unless you want to go into that, I will be glad to admit his qualifications.

Q Your training has included geology as well as engineering?

A That is right. I have had advanced work in geology.

Q Are you acquainted with the Monument Pool in Lea County?

A Yes, I am.

Q Were you present when the discovery well was brought in?

A Yes, I was present when the discovery well was brought in.

Q When was that?

A May, 1935.

Q Have you been familiar with that pool ever since?

A I have been directly in charge of engineering and geology work in the field since the beginning.

Q And you are familiar with all of the wells and all development in this pool?

A Yes, I am.

Q Will you give an account of the stratigraphy of the field, if that is the right term?

A Yes, I will do that.

Q Have you a map of that?

A I have a cross section I would like to use.

(Cross section placed on map stand and marked "Shell Exhibit No. 1")

Q Mr. Schuehle, this diagram, Shell Exhibit No. 1, was that prepared by you or under your direction?

A Yes, sir.

Q Will you explain to the Commission just what that means?

A I am using part of that -- several parts or zones on that cross section to illustrate the strata of the field. Oil, gas and water are accumulated in the Permian lime formation, and that is the most important formation which is present in the field, and I will spend most of the time discussing it rather than the limestone formation.

The top, indicated by the uppermost green band, and that is overlain with anhydrite, and as you penetrate the limestone formation, you first find it composed of a series of crystalline and sandy limestone zones. The uppermost zone penetrated in the limestome section is persistent throughout the field, a horizon of sandy, dense limestone indicated on this cross section by these green gands. The green means sandy limestone. I wish to explain that the entire section, from here down to here (indicating on cross section) is sandy limestone.

Q That means between the two uppermost green lines?

A That is right.

The next segment, between the next two green bands, is pure crystalline limes --

Q Between the second and third bands going down?

A That is right. It contains a certain amount of sandy limestone greatly improved. The next has been designated the Sandy phase and incompasses this area (indicating). You will notice it is a zone in which we have angular green lines, indicating the present lenticular formation underlying that. For the moment we will ignore that. The brown color in the section, underlying the lowermost green phase is a pure crystalline limestone body.

Q To get that definitely, above the uppermost green line is anhydrite?

A That is true.

Q Between the first and second green line, reading from the top

to bottom, is sandy lime?

A That is right.

Q Between the second and third green lines is white crystalline limestone?

A That is right.

Q And between the third and fourth green lines is a body of sandy lime with lenticular formations in it?

A It represents a formation or horizon of crystalline lime with some minor amounts in the second, and the lower is pure.

Q While it may not be right in point here, on Exhibit No. 1, the line at the bottom represents the water, is that true?

A That is right.

Q And the heavy brown line that runs through the third and fourth green lines, what does that represent?

A That represents the uppermost limits of the oil accumulation.

Q Is it the contact between the oil and gas?

A That is right.

Q Could you state in what direction that cross section runs?

A It is an east-west cross section, through the middle of the field, approximately.

Q Will you take up the structure of the pool?

A At the present known informations shows we have an east-west dip over the limits of the field. On this particular section, this (indicating) is the extreme eastern well, and this is the extreme west well. That is as far as we have control at the present time. From the closure we have a dip from both flanks.

BY MR. SETH: We offer in evidence Shell Exhibit No. 1.

Q Will you get the other maps you want?

(Witness places a map on the map stand). (Marked Shell Exhibit No. 2).

What does Shell Exhibit No. 2 represent?

A A north-south cross section through the long length of the Monument field. I wish to present and show the same conditions are present throughout the field, on a north-south line, as I have shown on Exhibit No. 1. You will notice also a certain degree of dip to the south and a smaller degree of

dip due north.

Q Do these green lines mean the same thing as on Exhibit No. 1?

A Yes, the color and lines are identical.

Q Will you state, these various lines up and down the exhibit, what do they represent, wells?

A Each line represents a well.

Q On the wells, in places there are small dots. What do they mean?

A We have triangles here, and one triangle means the casing point.

Q It means that below that point the well is not cased?

A That is right. There are other smaller lines, and when all such data as presented on the section is compiled, we have the structure outline of the zone by contours on this map.

Q On Exhibit No. 3?

A On Exhibit No. 3, they are the black waving lines.

Q What is the contour interval?

A 20 feet on this map.

Q Does the contour represent the top of the formation as you have shown it?

A The contour of this so-called upper sandy phase.

Q Do you want to discuss the contour of the structure?

A That would be commonly termed anticlinal.

Q With some minor closures?

A The contour shows to minor closures, one in 19 S., R. 36 E. -- R. 37 E., instead; and another closure located -- the predominate or main closure in T. 20 S., ranges 36 and 37 E.

Q Anything further you want to state?

A I be ieve it is quite obvious.

Q Porosity -- what do you show with respect to porosity?

A Porosity in the Monument Pool is extremely erratic, as we all know. It has been found to occur predominately in the pure crystalline lime phases. Over geologic time we know there is a certain degree of porosity throughout, but it has been found, by tests and experiments in various wells, as far as the producing life of the field is concerned, effective porosity is found only in the pure crystalline phases. Under those con-

ditions, we find in the Monument Pool three zones in which effective porosity is present, indicated as Zone 1, extending between the second and third green lines, and the second zone which occurs between the third and fourth, and the third zone underlying the lowest green zone.

Q That is, between the green and the water?

A Between the green and as far down as the water.

Q Is there at the present time, in your opinion, any intercommunication between the three "pays", as you might call them?

A Other than through bore holes, there isn't any communication between the so-called zones.

Q In a natural state, before wells were drilled, the bore holes making no connection, you believe they were not connected for any practical purpose?

A As far as the life of the field goes, that is right.

Q Has your detailed work shown you anything as to permeability?

A Yes, in addition, permeability is very erratic. One measure of permeability, and solely permeability, we have found on examining the map, the potential range is very erratic. Just picking any particular well, I find a well here has a potential of 744 barrels a day, whereas over in this area (indicating) a mile away, the potential is 3504. There are extreme variations in permeability. There is another point we found in studying porosity in the field, that porosity apparently is more effective laterally.

Q Do you mean porosity or permeability?

A Permeability -- pardon me -- is more effective parallel to the bedding planes than to the vertical.

Q That means oil will flow more readily laterally than it will up and down?

A That is right. I might now point out that very little movement of fluid takes place vertically. Practically all of the movement is laterally.

Q Is that all on the matter of porosity? If it is, take up the accumulation of oil.

A Having covered porosity in a rather brief manner, we have found after various tests on wells and checking samples, extremely

detailed work, that oil has accumulated when porosity permits as high as 175 feet below sea level, and not any farther. I wish to state that was the original top oil accumulation, and the original water accumulation occurred immediately below, 340 feet below sea level. In other words, you have a horizontal oil column found wherever porisity would permit the oil to be accumulated. Now, gas is found immediately overlying the oil.

To go back to structure for a minute, I mentioned we had an anticlinal fold. Oil, gas and water are accumulated in the lenticular formation, accumulated there in a trap formed by deformation, and sealed by the overlying anhydrite, and the limits of the oil accumulation, the ultimate limit of the oil accumulation was when the anhydrite intersepted the oil column. However, as I stated, within the oil column, or within the limestone formation -- pardon me -- the structure has not compelled the accumulation of oil. That is indicated in this manner: we have this green formation, (indicating on map) meaning a sandy limestone, dense and impervious. The brown is oil accumulation, the upper line indicating the upper limit. We have further found evidence of some oil, of a non-producible quantity, the oil showing around the bore hole down at the same point in the highest permeability section. That is indicated, the impervious structure, by this line across the green. We have, therefore, keeping in mind this zoning affect and the fact that lateral permeability greatly exceeds vertical permeability, we have been able to set up definite zones, and during the exploitation of a well those can be followed. We have been able to outline these zones and locate a well so that we may intercept the permeable zone within the oil column. If you should be drilling a well, and are unfortunate enough to find this entire interval entered by you there dense and impervious, with porosity tight and erratic, find a dense zone in the crystalline lime which you find throughout this interval, you would be very unfortunate to have a dry hole or a very small well. Therefore, since we have these zones in the field, and we have barriers separating this zone from this. I

point out this well on the extreme north end --

Q (Interrupting) Exhibit No. 2 you are referring to?

A That is Exhibit No. 2. I think it would be preferable to use No. 1 at the present moment. You will observe the same picture continues through the field, making the extreme -- this is the east-west cross section (Exhibit No. 1) -- making as the extreme west well, I believe, Shell Foster No. 2. You will observe it encountered oil accumulated entirely within the so-called first zone. The same thing happened in the next three wells -- all of the production from within the first zone. Then go to the center part of the field and select, for example, a well, here, I believe Gulf Graham - State 4F encountered oil accumulation only within the lower horizon, this zone, which carries oil in place in the so-called second zone being above the gas-oil contact; thus, keeping in mind we have an absolute barrier in this green phase and this green phase (indicating on map) -- that is, little production in this zone (indicating). This zone (indicating on map) is also oil bearing in places, it has prolific wells, is also separated from the other two by a dense, impervious barrier. We have three separate reservoirs within the Monument Pool between which no intercommunication exists other than through the bore holes. To show conditions --

Q (Interrupting) Let me take this first -- I don't know that the Commission exactly understands. This area between the two upper green lines marked "Main Sandy Phase", is not oil bearing?

A It is not.

Q Between the second and third, marked "First Zone", between the second green line and the third green line, that is oil and gas bearing?

A That is right.

Q This heavy brown line which runs across this cross section, marked "Original Gas-Oil Contact", that represents the top of the oil?

A Originally.

Q In this zone marked "First Zone, between the second and third

green lines, all above the brown line is gas?

A That is right.

Q And this zone has oil only where it extends below the brown line?

A That is right.

Q At the north, the middle, and again at the extreme south?

A That is right.

Q Come down between the third and fourth green lines, the "Second Zone", that is also oil bearing?

A That is also oil bearing.

Q Where that projects above the brown line, it is gas bearing only?

A That is correct.

Q Below the lowest green line it is again oil bearing?

A That is correct.

Q The "Third Zone"?

A That is right.

Q And beneath that is the water?

A That is right.

Q When you speak of wells penetrating the zones, you mean this (indicating first zone), or this (indicating second zone) or this (indicating third zone)?

A That is correct. Since we have three zones, and you have probably noticed the zones overlap, in which wells may produce from one, two or as many as three zones colored on this map --

Q (Interrupting) That is Exhibit No. 3?

A Yes. I wish to make a statement at the present time. Although I stated a well has penetrated the first, second and third zones, I am stating that all three zones produce at one and the same time in the same well, the porosity variations may be such that only one zone produces in a well. However, it is possible that should the porosity be developed, then the well might produce all zones. On this map, Exhibit No. 3, the colors show the groups of wells producing from the various zones.

The blue shade, shown on the extreme flank, means wells that have penetrated only the first zone within the oil column,

or this area right here (indicating on map).

The yellow are wells that have penetrated the first and second zones within the oil column. We will use as an example the Texas-American Insurance Company No. 1 well. It penetrated the first and second zones within the oil column.

The orange color, this small area here (indicating) and another area here (indicating) are wells so located that they have been able to penetrate all three producing zones within the oil column. We might make an example of Shell-State D No. 1. You see the illustration of this particular well (indicating on Exhibit No. 2).

So not only are there three separate reservoirs open in the field, each having its own variations of porosity and permeability, but you have overlaps, or six types of wells to make a further complication, making it rather impossible to determine what reservoir characteristics apply, and if so, of what value they are.

To make it a little more clear, and to show the exact relationship between this map and the cross section, I have another exhibit I would like to present.

(Witness produced map marked "Shell Exhibit No. 4).

Q Will you please explain Shell Exhibit No. 4.

A Yes. That is a three dimensional presentation of the north half of the Monument structure. This entire exhibit presents the field from the so-called range lime --

Q (Interrupting) You mean the range lime shown on Exhibit No. 3?

A The range lime shown on Exhibit No. 3, yes. Shown here by colors having the same meaning as on the cross section, a generalized section through the field. Here is the first Sandy Phase --

Q (Interrupting) When you speak of "here" that does not get into the record. You are speaking of this mark?

A The uppermost green section represents the main sandy phase. The next section, this white portion here (indicating) ignoring the brown, is the first zone. This solid green is the so-

called lower sandy phase. And then this (indicating) represents the lenticular or second producing zone. We have three wide so-called beds through there. The third zone is from here (indicating) on down.

We have here on this line an oil well, the Amerada Hanley No. 1, located on this map in the yellow, on the zone map, and it has penetrated and produced in the first and second zones, the oil accumulation within the first zone and able to penetrate the second. This particular well, the Amerada Hanley No. 1 is producing from two horizons, the first and second.

Then, showing a different degree, we have another well located, the Ohio Barber No. 3. That well is producing from the second and third zones.

Near the middle of the exhibit is the Repollo Phillips No. A2, producing only from the third zone.

Q The upper part of the exhibit, above here (indicating), what is that?

A The blank contours on here represent contours on the north. they have been distorted somewhat due to perspective, the blue here being shown on this particular well, Shell Foster No. 1, located over here in the blue area, seen here in the blue area, produces solely from the first zone. The same color value meaning the same zoning.

Q On this map, Exhibit No. 4, you have immediately below the top lower sandy phase, or representing the second zone, you have drawn substantially parallel lines. Does that mean the same thing as that represented by these lines (indicating)?

A Yes, sir.

Q You don't mean the sandy lime and the lime are laid down parallel?

A No, that is merely an idealized representation and is drawn parallel, and are continuous throughout the zone as shown.

Q This heavy brown line or mark, is that gas?

A Above that is gas.

Q And the line along the bottom of the picture?

A Means water.

Q The only area that produces oil is between the brown line

and the water?

A That is right.

Q Below this area (indicating) is a gas cap?

A That is right.

Q Turning to Exhibit No. 2, across this area marked "Lower Sandy Phase" are well bores, are some brown lines. What does that mean?

A Because this lower zone shows some effect --

Q (Interrupting) You don't mean the lower zone do you?

A No, the second zone shows some effect of lenticularity, this color, brown, through the well bore indicates a good oil showing, a good oil bearing porous sand. That particular well. We have not attempted to evaluate the oil accululation between the wells, and have shown it only in this particular well.

Q In this so-called second zone, the lenticular zone, is oil sometimes found in substantial quantities?

A Yes, some very prolific wells have been completed in that zone.

Q Do wells producing from the same zone always function alike?

A No, definitely not. Previously I have mentioned you have variations of permeability within zones, between layers. In other words, the porosity, I would say from this first zone, indicated by the second and third lines in this cross section, does have the same porosity value, not permeability. Through there there are little layers varying within themselves.

Q The same is true of the other zones?

A The same is true of the other zones.

Q And vary between zones?

A Apparently also there is considerable variation between zones.

Q What effect in the functioning between zones is the fact that there is more permeability laterally than vertically, does that have an effect in the operation of a well?

A Definitely. Now, as I have said before, the movement of fluids have been laterally, coming in this manner, the vertical porosity is small -- relatively small, and since there is the zoning effect, the movements of fluid have all been parallel to

bedding planes, which would be apparently parallel to this green line in this zone. The result has been the water movement has been very erratic at the present time, and the gas movement is erratic, varies. The gas-oil content at the present time in the oil columns is very disturbed.

Q Have you a water map which shows that?

A Yes, I have. (Witness produces map which is marked "Shell Exhibit No. 5).

BY MR. SETH: We offer in evidence Shell Exhibits Nos. 2, 3 and 4.

Q Will you please explain Shell Exhibit No. 5, Mr. Schuehle?

A Each colored unit represents a unit at the present time producing water. The various colors means different percentages. The blue, zero to 5% water; yellow is 5% to 15%; the orange -- an example is the Skelly well, State No. 1 -- runs 15% to 30%; the purple, over 30%.

As you will observe, there is no uniformity of water encroachment, and there is not any uniformity of time of encroachment; it is scattered heterogeneously across the field. That is due primarily to lateral movement. If you have a lateral movement, if this well is securing production in the upper area, in here --

Q To what well are you referring?

A Gulf No. 3 -- I don't recall whether it is a water well -- I am using it as an example. This well, when it is producing, the oil moves in this manner --

Q Parallel?

A Parallel with the bedding planes, the water drive will function up to 100 feet either side, and the movement, also parallel, of the gas does the same thing. If disturbed, it moves downward along the bedding planes, which accounts for the extreme difficulty we have had in setting packers.

Q That appearance of water is very erratic?

A Extremely erratic, yes. And exactly what you would expect in a reservoir of this kind.

Q What is the energy in that Monument Pool that produces the oil?

A The energy is both gas and water.

Q This gas cap, would you say an area north of this brown line, and between it and the second green line, you say is gas?

A That is right.

Q About how thick is that, roughly?

A It is possible to find gas over an area of as much as -- assuming a small amount of gas found immediately at the top -- you would say the ultimate limit, in the vicinity of 500 feet.

Q That gas lies in the portion of the second zone which extends above the gas oil contact?

A That is right.

Q You say the field is operated under both water and gas drive?

A Yes, it does. Some layers can be identified definitely as gas drive, at least, in parts, and others water drive, in parts.

Q The pool varies?

A Yes, sir.

Q Would you say some were almost entirely gas drive?

A Some are almost entirely gas drive, and some very nearly water drive.

Q Which is the more efficient? Are you able to compare them? Which produces the most energy?

A That would depend entirely on the porosity and permeability.

Q And which force would equalize quicker under shut-in conditions, gas or water?

A Gas equalizes more rapidly.

Q You have stated, Mr. Schuehle, that in your opinion the field was originally divided into three zones in which gas and oil were found?

A That is quite right.

Q You mean, that is as far as your investigation discloses?

A That is right.

Q There might be fractures causing intercommunication?

A There may possibly be some fractures.

Q Have you seen any evidence of it?

A I have seen no evidence of it.

Q The zones are connected through the well bores, I believe you stated?

A Quite right.

Q By that you mean a well, whose casing point is above the contact between the oil and gas, the bore hole going down permits gas --

A (Interrupting) It could exert pressure on another zone.

Q How many wells in the pool or field are there through which that pressure might be exerted, roughly?

A Roughly, it would be through all wells within the yellow, purple and orange, about 250 to 300.

Q There are now 250 to 300 openings through which there may be intercommunication between zones?

A That is quite so.

Q Does that permit the gas in the large gas cap in the first zone to exert its pressure on the oil in the other zones?

A That is quite possible, yes.

Q Now, Mr. Schuehle, when a well is shut in and builds up bottom hole pressure, may that indicate that it has more ready access to the gas cap?

A It may indicate that.

Q It does not necessarily indicate a water drive is coming in and building up the pressure?

A In some areas it would probably be water drive. It depends entirely on the well and the zone you are considering.

Q And you could not fix any uniform rule throughout the pool, could you?

A No, you couldn't.

Q Would that build-up of bottom hole pressure when a well is shut in have any relationship to the recoverable oil in place?

A None whatever.

Q You stated that gas pressure equalizes much more rapidly than water?

A That is right.

Q Gas travels through openings in lime much more quickly than water?

A That is quite right.

Q If a well builds up quickly, it might mean it had direct

connection with the gas cap?

A That is right.

Q And had no relationship whatever to the oil in place?

A None whatever.

Q An increase in the present bottom hole factor at Monument might give a well an advantage that merely had direct connection with the gas cap?

A That is quite right.

Q You could not lay down any rule generally applicable that would apply to bottom hole pressure?

A None whatever. We have a complexity of reservoirs at Monument, none of which function like the others.

Q And the bottom hole pressure does not mean anything?

A Bottom hole pressure does not mean anything in reservoirs of this character.

Q In the bottom hole pressure, is there any evidence of water coming in from the sides?

A Oh, yes. I might cite a particular well, Shell Foster No. 2. That well is producing from the first zone only. I believe you will find that well on this cross ~~x~~ section, Exhibit No. 1, if I am not mistaken, it is this particular well (indicating). The original water level is immediately below -340 feet. That particular well found oil at -326 feet, and is producing in excess of 30% water. That well, completed approximately 12 months ago, found the horizon at that time was water bearing above the original oil-water contact. Whereas the next well immediately east, Shell-Foster No. 1, produced in the same horizon, the same total depth, which is somewhat higher on the structure, probably in the same zones open at the same total depth, that well is water free. Water moving up structure has reached this point, climbing progressively in this manner, and will ultimately reach Shell-Foster No. 1. At the present time we can expect to state the horizon or layer in which the water might appear.

Q And you stated a while ago that the oil, water and gas moves more easily laterally, following the bedding planes of the

structure?

A That is right.

Q A well of high pressure may be drawing oil horizontally from neighboring leases?

A That is it, oil going from one to the next, moving laterally.

Q Mr. Schuehle, is there any definite factor in the Monument Pool which, in your judgment, can be used for proration other than acreage?

A None whatever. It is the only one that can be determined.

Q Porosity cannot be determined?

A No, sir. Bottom hole pressure means absolutely nothing, because of the different types, the extreme complexity in the structure.

Q And the same well may have three different phases?

A That is right.

Q Mr. Schuehle, would you recommend any increase in the percentage now allowed for bottom hole pressure?

A Definitely not.

Q Your recommendation would be that there be no increase?

A That is quite right.

Q What do you feel about continuing the present formula?

A Since there is a faint possibility there may be a slight degree of intercommunication and at the present time have some intercommunication, both in honesty and in fairness, I think you may be able to use a small bottom hole factor, but certainly it should not be increased.

CROSS EXAMINATION By Mr. Fleetwood:

Q Mr. Schuehle, you do say there is drainage between the various zones?

A No, I didn't say there is drainage between zones. I said there isn't between wells, as far as we know.

Q Why is it you want to give 25% to bottom hole pressure?

A I did not say 25%; I said 20%.

Q You want to give 20%?

A That is ample.

Q Why do you want to give that much?

A In case, because we cannot see between the bore holes, there may be some small degree of fracture and a very small tendency to equalize pressure.

Q There may be drainage?

A Very slight, if any.

Q I believe you advised the Commission in your best judgment acreage is the only factor we could properly consider in a proration formula at Monument?

A That is right.

Q If every acre has the same amount of oil beneath it, is that a good system?

A Yes, sir.

Q And if every acre does not have the same amount, it is not good?

A If we knew that every acre does not have, it would not be, but we do not know.

Q It is your opinion that at Monument every acre does have the same amount of oil as every other acre?

A I am not in position to state.

Q You have an opinion?

A Information is so controversial, there are so many factors present, such a complexity, that an answer to that now could not justifiably be made.

Q You don't want to tell your opinion?

A I am glad to tell it.

Q And that is?

A I have studied this reservoir in such detail, over a period of time that I find I am not able to judge.

Q You have not formed an opinion?

A My opinion is that it is a section of such complexity that it is just impossible to answer that question.

Q Mr. Schuehle, I understood, from this complex testimony, that you stated there were at least three separate and distinct zones, one almost entirely separate from the other two?

A That is right.

Q What is the basis of that?

A I know that to be the case from very detailed, careful study of numerous wells. We are able to find these dense, non-productive layers throughout these layers, when the well is drilled to depths sufficient to encounter such zones, it is present.

Q At various depths?

A At various depths, depending on the structural position.

Q How is it you know the third and fourth green lines is wholly impervious and furnish a sealed space or barrier between the zones? How do you know that?

A A detailed study of these cross sections show a relatively few number of wells -- more or less present in all wells. On examining them further, you will find sandy zones at relatively uniform depths in every well placed where logically you would expect to find them.

Q You used a word in your testimony that I am not familiar with, that is, lenticular. The best I understood that was that there were streaks of porosity?

A That interrupts non-continuous areas, areas that may not be continuous.

Q Various types and degrees of porosity?

A That is right.

Q And I believe you said that exists between the third and fourth green lines?

A I said those green lines represent lenticular bodies of sand. I was discussing the presence of sandy limestone that has porosity varying through it.

Q Is there varying porosity and permeability in the third and fourth green bands?

A Within the band itself?

Q Yes, this one here (indicating on map) Are the porosity and permeability both varying, or are both of these remarkably porous or permeable?

A It depends on how you use the terms. Over geologic time there was a certain degree of porosity, intercommunication, but during the production life of the field that porosity is not effective.

Q You say that the oil was laid down on that horizontal plane?

A No.

Q You say it is not?

A It is now. It is accumulated.

Q I will say accumulated, in that horizontal band?

A Originally.

Q In order to do that it had to go through non-permeable structure?

A Certainly.

Q But it took a long time to get through?

A That is true.

Q We are not going to be so long taking the oil out, so we disregard that?

A We can disregard that because it is ineffective.

Q From what zone is the most oil produced?

A All three zones are open in the field.

Q I was curious to know which zone produces the most oil. Roughly, just in a general way. I will not hold you to the number of barrels.

A That is pretty well divided, as shown by the zone map there.

Q Now, Mr. Schuehle, in any one of the three zones, looking back over on this Exhibit No. 3 cross section -- the north and south cross section -- Exhibit No. 2. Suppose for the moment that in any one of those zones there are differences of bottom hole pressure, would there be drainage from well to well, or property to property, within that zone?

A If they were connected.

Q In the same zone?

A I stated that within the zones there were layers.

Q That is right.

A If two particular wells were open in the same layer, the identical layer, with different bottom hole pressures, that would cause migration.

Q From the high to the low?

A From the high to the low.

Q You think the majority of wells within any one zone are intercommunicating within that zone?

A Not necessarily.

Q I concede it would not be necessary, but what is your judgment?

A Frankly, there are so many porosity variations and so many layers open -- if you want to refine the point to where it would group wells producing in the same zone and the same layer, it becomes ridiculous -- you get to the point where you have two wells here, and two wells here --

Q (Interrupting) In the same zone?

A This proposition presented here can be refined to an almost ridiculous point.

Q Mr. Schuehle, maybe you can enlighten us further: ordinarily speaking, in one production zone or reservoir, disregarding the known theories relative to Monument, within any ordinary zone or horizon where there are differences in bottom hole pressure, does drainage exist between two wells?

A When there are proper conditions of permeability and porosity, there will be movement of fluid from high to low.

Q Those conditions do usually exist?

A In Monument?

Q Yes, those conditions do usually exist?

A Not in limestone.

Q So in limestone fields it does not necessarily follow there is drainage from high to low?

A That is right, because of the barriers.

Q An impervious, cementlike dam?

A That is right.

Q That is very frequently the case?

A Extremely.

Q You know of very few reservoirs in limestone?

A That is too general a statement; I would not care to say.

Q Do you know of other fields where there is little drainage?

A Yes, any limestone produces the same effect.

Q There will be no drainage between zones?

A Not when it is entered.

Q So that there would not be intercommunication?

A I said --

Q Ordinarily do they communicate, or not?

A You would have to cite specific examples, and I would answer you.

Q Can you tell what would be the adverse effect of giving more weight to bottom hole pressure factor in a formula?

A In the first place, attempting to prorate numerous reservoirs, under varying conditions, there are gas drives of all degrees and water drive, you can't make a bottom hole pressure factor that would work because you cannot determine the facts.

Q What we should do is divide this field up into three or four or half a dozen areas, and prorate each separately?

A Suppose you difide it up into three areas, it would not work, because I said you could refine that point to a ridiculous degree, you would not know where to stop, you might have to prorate each one on a different basis.

Q You say there are three reservoirs. Wouldn't it be proper to prorate them separately?

A No.

Q What pressure, in general, do the most recently drilled wells have? Is it higher or lower that the early wells?

A Naturally lower.

Q Why?

A Some degree of depletion has taken place.

Q On all three zones?

A Naturally.

Q Is that not because of intercommunication?

A No, certainly not. There is no intercommunication between zones.

Q Now, Mr. Schuehle, you said, and I think properly, that bottom hole pressure is no indication of oil in place?

A Quite right.

Q You stated that a well which obtains pressure as a result of the presence of gas, or the gas cap, builds up pressure more rapidly than under water drive?

A I admit that statement.

Q You see any objection to giving wells which rely on water pressure a longer time in which to build up?

A Yes, I do, because you do not know, and you will not be able to find out until too late, whether you have water drive or gas

drive.

Q I thought we knew, in certain wells we had water drive?

A I showed water drive, but I did not say it was the main source of energy.

Q That water drive on Exhibit No. 1, is that the result of higher or lower bottom hole pressures than the field average?

A That usually, as I recall, is lower than the average.

Q Around the edges the bottom hole pressures are generally lower?

A No.

Q Generally speaking, that is not true?

A You can't generalize here.

Q I am asking if it is not more apt to be the case?

A That may be due to many causes.

Q In that end of the field (indicating) you have low and you have high. Most of the low pressures are around the edge of the field isn't it?

A I would not want to make that generalization.

Q You would not say that is not true?

A I am not prepared to go into that.

Q You think there is any drainage between properties going on in this field?

A When you have lateral movement it is rather hard to prevent drainage.

Q So what is your conclusion? There is migration of oil?

A There is some.

Q There is some?

A That is right. It may be compensated, it may be moving from a property that is getting it from some other property.

Q The ideal thing would be for every man to keep the oil under his own tract?

A Naturally.

Q That is not occurring at Monument?

A We don't know.

Q Didn't you just say there was some migration?

A I said it might be compensated.

Q There might be compensation for the drainage?

A Certainly.

Q Would you say some of the wells are producing from two or three zones at one time?

A Yes, some do.

Q That connects those zones?

A Through the bore holes there is some connection.

Q After all, wells in the field are holes in the ground through which there is some connection?

A You are interpreting my statement.

Q I don't want to interpret.

A I said wells have penetrated as many as three zones within the oil column. I immediately went on to say further that did not mean that every individual well produced in all three zones.

Q I jotted down a note that you said there were 250 to 300 wells the bores of which permitted intercommunication. Did I misunderstand you?

A No, that is right.

Q So wouldn't those 250 to 300 wells, with an average of a 7-inch opening --

A (Interrupting) Six to seven inch.

Q Would they permit intercommunication between zones?

A Yes, some degree.

Q And there may be some fracturing, although you did not see any evidence of it?

A That is right.

Q Is the permeability and porosity of the three zones greatly varying?

A Extremely varying.

Q Except in this impervious strata that is not true?

A Your degree may be extreme, but the entire range is very small, and therefore you can eliminate it.

Q Do you know why some wells, which you refer to, were drilled so as to take in only one or two zones, and others to take in the entire oil column?

A You mean all three zones?

Q In all three zones?

A Naturally the point is, I should say, a number of wells were drilled before this setup was recognized to its most completest extent.

Q When did engineers and geologists recognize this to exist?

A That has been gradually increasing since the inception of the field.

Q If you had -- let us suppose the State of New Mexico had leases, and you, as an engineer and geologist, told them they were located in Zone No. 1, and all around wells were drilled, and you told them they were drilled in No. 2 and No. 3, and that Zone 2 and 3 did not communicate with No. 1. Would you give them the advice that they could sit idly by and they need not drill offsets on their lands; that there was no danger of their lands being drained?

A I don't suppose I would give such advice, but I would not give it from an engineering standpoint. I would probably say it would be better to go ahead and drill.

Q Why keep on drilling if there is no danger of drainage?

A The legal profession does not know that condition exists, so they presuppose that there would be drainage. That condition does exist but the courts do not know it.

Q If you knew that all these wells were drilled right up to your property line, you would not hesitate to advise your client that he need not drill here because he would not be drained?

A If I was working there and found that condition as you suggest, I would say, from an engineering and geological standpoint that drilling was unnecessary because you would not suffer drainage, but there are other factors that keep you drilling.

Q You would not tell him he would not be drained?

A It depends entirely on conditions I found there.

Q It follows than, dosen't it, Mr. Schuehle, if we may assume an idealistic view of the thing, if we could shut Zone 3 off, and never touch it, could we produce all of the oil from Zones 1 and 2, and with the sealed dam above Zone 3, that the oil in Zone 3 would never migrate into Zones 1 and 2, and the reservoir pressure would never be lessened as a result of

producing the oil from Zones 1 and 2?

A Do you mean if we had been able to foresee this early, understand the setup before any wells were drilled, and had been able to drill down and stop the wells above Zone 3, and never enter it?

Q That is right.

A Then you have a barrier other than as I mentioned the possibility of fracture.

Q But if you knew you did not have that. Outside of that?

A Then you could.

Q Would you be pretty certain that no oil would migrate from that zone?

A That is right.

Q And you would be equally certain the reservoir pressure would never be decreased in Zones 1 and 2?

A State that again.

Q Decreased in Zone 2&1, if you are certain it would not be?

A Not of any importance.

Q None at all. It is impervious?

A Effectively so.

Q And you would be equally certain the reservoir pressure in Zone 3 would not be decreased?

A Yes, I think you can say so if it were never opened, if you permitted it to remain in a natural state, then you could exhaust the upper zones.

Q And it not be distrubed?

A Yes.

Q Does not water encroach in all zones?

A It is encroaching all over the field.

Q You don't mean it is going through this impervious zone?

A I think not.

Q Then it is encroaching on all zones?

A Water is tending to replace all the oil that has been withdrawn from the reservoir or reservoirs.

CROSS EXAMINATION By Mr. Christie:

Q Mr. Schuehle, what is the geological formation, the so-called formation here?

A Permian limestone.

Q What geological name does it have?

A We are calling it Permian limestone.

Q What is the geological formation of your No. 2 zone?

A The whole section technically is a formation, and that is refined to horizons, those formations, or layers, so the entire limestone section is a formation.

Q All three zones are producing from the same geologic formation?

A That is right.

RE-CROSS EXAMINATION By Mr. Fleetwood:

Q One more question. The official records of the Proration Office of the State of New Mexico, quotes Mr. Edgar Kraus, as follows: "One reservoir in Cooper, Eunice and Monument are present and that although several porous zones may exist, that the gas, oil and water accumulation cuts across such stratigraphic zones, and that therefore the gas-oil contact and the oil-water contact are essentially horizontal planes, irregularities being due to differences in porosity near such contact. With such a picture of the reservoir it must be plain that there is communication between zones, and therefore there must be drainage between zones. Whether such drainage is rapid or slow depends upon local conditions." That is dated June, 1936. Do you disagree with Mr. Kraus?

A In some parts he is quite right. In one part, however, I do not agree. I agree with the zones, that is the same theory presented here. He is quite right about having intercommunication during geologic time, I am sure he is correct there.

Q The quotation states "is" communication there.

A I don't agree with the present drainage.

Q Mr. Wahlstrom, of the Stanolind Oil & Gas Company, testified here before the Proration Commission on January 20, 1936, stating: "I agree with Mr. Kraus' statement, under each one of these fields you have these porous horizons. However, they are connected vertically and in communication, and as the gas,

oil and water contacts are found, they have relation of depth which would practically convince you there is this connection or you would not have found oil, gas and water in that relation. I am assuming here that there are not any particular zone or strata pays, they are all intercommunicating. We have several specific examples in each one of these fields that show definite intercommunication in wells 1320 feet apart." Would you say Mr. Wahlstrom also was mistaken?

A Of course, you must realize those statements were made early in the life of the field. Little development had taken place. They had not been able to get the zoning effect. It had not been evaluated to the degree we can evaluate it now.

Q You think later developments --

A (Interrupting) They had a very good start on the right track.

Q Further development have shown the error of their ways, in some respects?

A Their statements, so far as active intercommunication at the present time is concerned, I do not agree with them.

Q And similarly, Mr. Schuehle, the procurement of additional information in the future may altar your opinion?

A That field at the present time is so nearly completely developed, we might say we have so much knowledge and information at the present time, that any changes would be in minor details.

Q In other words, this is the latest, and perhaps the best and last engineering and geological theory that will be advanced?

A That is quite right.

Witness dismissed.

GEORGE H. CARD,

being called as a witness, and being first duly sworn, was examined by Mr. Seth, and testified as follows:

DIRECT EXAMINATION

Q Stat e your name please.

A George H. Card.

Q Are you the same Mr. Card who heretofore testified as a witness for Barnsdall?

A I testified back at the Monument hearing in December.

Q What is your profession?

A Petroleum engineer.

Q How long have you been engaged in that profession?

BY MR. FLEETWOOD: We will admit his qualifications.

Q Mr. Card, we have had a lot of talk here about the movement of fluids. Do you agree with the theory advanced that oil moves from a high pressure to a low pressure area?

A Yes, under certain conditions.

Q What are those conditions?

A In a reservoir having uniform permeability.

Q Are there any limestone fields with which you are familiar that have uniform permeability?

A No.

Q What is the situation at Monument? Is it a limestone field?

A It is a limestone field, yes, sir.

Q Does it have uniform permeability?

A No, it does not. It varies widely.

Q In a limestone field of varying permeability, what is the effect of equalizing the bottom hole pressure at the well bore?

A With two adjacent wells, one well having a permeability much higher than the permeability of the other unit, the pressure gradient of the well having low permeability would be much steeper than the well having higher permeability, therefore the drainage area of the well having the high permeability would move into the unit having low permeability, and would drain the oil from the unit having low permeability.

Q Could you illustrate that with a sketch of some kind?

(Witness draws a sketch, marked Shell Exhibit No. 6).

A You take the dividing line between the units, the vertical line, the wells being an equal distance from the dividing line. This would be the shut-in pressure at the bore hole of the two wells being equal.

Q Will you indicate the high permeability well with an "H"?

A This one would have low permeability; this would have high.

Q You have indinated that by the words "Low" and "High"?

A Yes. We would assume production, or recovery, so as to equalize the bottom hole pressure at the bore hole of the wells as this line here (indicating). Then the pressure gradient away from the bore hole of the low permeability well would be rather steep, whereas the pressure gradient of the well having high permeability would be much less, and would intersect this well over here (indicating);on this unit the slope, this drainage, would of course be greater because over here in this area is low permeability, so that the drainage area of this well is moving over into the unit of low permeability and draining part of its oil.

Q The slanting lines, under the word "Low" and under the word "High" represent the pressure gradient?

A Yes, pressure.

Q Somewhat in the nature of a curve, rather than a straight line?

A When the wells are flowing it is more of a curve.

Q Roughly, in a straight line?

A This represents the shut-in pressure.

Q The slanting line from the well under "Low" that represents the pressure gradient of the low pressure well?

A Low permea bility. We assume the pressure is equal at the two wells.

Q The low pressure well, the pressure gradient is much more steep. Is that due to the fact -- was that due to the fact that the low permeability takes more pressure to get the oil out?

A That is right.

Q In the high permeability well it takes less energy to get the oil out?

A That is true.

Q In the high permeability well it reaches farther away from the bore hole than in the low permeability?

A Not necessarily. It does until it intersects the drainage area of the other well.

Q Oil moves much more easily through the ground -- in other words, in the high permeability well gets this drainage, it may reach over into the unit on which there is low permeability, or on which the low permeability well is located?

A That is true.

Q And take oil from that unit?

A That is true.

Q And the oil ta ken from that unit is not moving against pressure, but the high pressure is bringing it to the well?

A Yes, the higher pressure here.

Q And forces it to the well?

A Yes, sir.

Q And might rob its neighbor of low permeability?

A Yes, sir.

Q Now, Mr. Card, referring back to another matter: If we assume intercommunication between the different producing zones, due to interconnection of the zones by the wells, or by any fracturing that may possibly exist, is there any assurance that such movement of oil and gas can be prevented by means of bottom hole pressure?

A No assurance.

Q Makes it impossible to adjust production capacity satisfactorily by bottom hole pressure?

A I should say so, yes.

CROSS EXAMINATION By Mr. Fleetwood:

Q Mr. Card, did you say you had to have uniform permeability before oil would drain from a high pressure area to a low pressure area?

A Yes, uniform permeability with very slight variations.

Q I believe you followed that statement by saying in no limestone reservoir you know of does oil migrate from high bottom hole pressure areas to low bottom hole pressure areas?

A

A No, I did not say that. I said I did not know of any limestone fields of uniform permeability.

Q So you do not know of any limestone fields where there is migration of oil from a high bottom hole pressure area to a low bottom hole pressure area?

A If you have uniform permeability between those wells, and had differences in pressure, it is expected you would have migration.

Q So that if you lack uniformity in permeability in lime production fields, you do not know of any limestone field where oil migrates from high to low pressure areas?

A In most limestone fields permeability varies so widely you would assume it would be impossible to show migration.

Q You don't know of any limestone field where there is migration from high to low pressure areas?

A I don't know of any.

Q You state that generally, weighting the bottom hole pressure factor in a field would cause migration of oil from low bottom hole pressure areas to high?

A I don't understand what you mean by "weighting".

Q Giving 20%, as you recommend, as against 75%, you do not believe oil will migrate, or come from the low to the high?

A I said between two wells, if you have uniform permeability, there is a possibility of drainage.

Q What is your judgment as to drainage going on in the Monument field?

A It is very hard to say.

Q What is your judgment -- I will strike that question. Assume it is going on and is draining from the high to the low -- or from the low to the high pressure areas?

A You are talking about the shut-in pressure at the well bore, or the pressure when the well is flowing?

Q Whichever you testified to.

A I don't know what the pressure line is between wells.

Q Suppose there is a well with 1350 pounds bottom hole pressure here, and suppose that across the line is a well with 1000 pounds bottom hole pressure; is there supposed to be drainage

going on, and if all those things are true, which way would the drainage be, from low to high, or high to low?

A You would have to know where the drainage areas intersect.

Q You are not sure it always goes on from low to high?

A Oil will migrate from high to low where you have uniform permeability.

Q Referring to your sketch --

BY MR. SETH: May I interrupt, and have that marked Exhibit No. 6, and introduce it in evidence?

Q Referring to Exhibit No. 6, as I understand that is a drawing of a well log and beneath the word "High" that means the well is in a fairly high permeability area?

A Yes, sir.

Q In other words, oil moves through the formation with considerable ease?

A Yes.

Q And the well beneath the word "Low" is in a low permeability area, "tight", as they call it, and the oil does not flow with much ease?

A That is right.

Q Did I understand that if both wells had equal static bottom hole pressure, and were allowed the same production per day --

A (Interrupting) No, I said they were produced so as to give them the same bottom hole pressure. I did not say the same production.

Q They have been produced so as to give them the same bottom hole pressure?

A That is right.

Q I will begin about equalization: Ajust the proration so as to give the same allowable, so we get two wells with the same bottom hole pressure, two wells with the same allowable, one in a high permeability area and one in a low. Under such conditions, is it your opinion oil will migrate from the low to the high?

A Yes, if the pressure were graded back so that it would be less in the high permeability well.

Q Oil would go from the low permeability section to the high, no

matter whether the bottom hole pressure was even or not?

A What do you mean, "even"?

Q Just as you take it at Monument?

A Shut-in, at the bore hole?

Q Is that the way it is taken at Monument?

A Yes, sir.

Q How would oil migrate under those conditions?

A I do not understand.

Q We will start all over again. You have two wells, one in a low, and one in a high permeability section.

A Yes.

Q Both have the same static bottom hole pressure; both have the same allowable per day. Is it your opinion there would be drainage from one property to the other?

A Let me see what you said -- you adjust the allowable on these wells so you have brought the bottom hole pressure equal, then you are going to give the same allowable for the next period?

Q Start the period with the same bottom hole pressure and the same allowable, will there be drainage from one property to the other?

A Under conditions as exists there, it shows the high permeability well would take it from the low permeability well.

Q We will start all over again. I will pencil in this very lightly so that you can take it off. I have written in that each of those wells have 1,000 pounds static bottom hole pressure, and I have written that each of the wells have an allowable of 30 barrels per day; if they are produced under that assumption, will there be drainage between the wells from one to the other?

A The next time you take the bottom hole pressure --

Q (Interrupting) Get this out of the way first so I can follow you: Will there be drainage from one to the other?

A Here is the thing: take the next pressure survey, and your high permeability well will probably have a higher pressure than the low.

Q Will there be drainage from one to the other, with the same pressure?

A The drainage reaches back farther into the area in one than the other.

BY MR. SETH: You mean to say they have the same permeability?

BY MR. FLEETWOOD: No, sir. We have the two wells Mr. Card has been testifying about. I will start the routine once more.

Q We have a well in a low permeability section, and one in a high permeability section. Both have the same bottom hole pressure and the same allowable. Will there be drainage from one property to the other?

A Under those conditions as I have written them up, I would think there would be drainage.

Q I want to know, under the conditions I am stating, whether there would be drainage?

A The drainage area of the high permeability well would reach back into the low.

Q Would oil from that property migrate to the other property?

A I should think so.

Q Is that right?

A Yes, under the conditions I illustrated there.

Q Under the conditions I have stated?

A You mean will the oil move from the low to the high permeability area?

Q I don't know.

A I should think it would.

Q It would move from the low to the high if they have the same bottom hole pressure?

A Your high permeability well would be producing longer.

Q Would there be migration of oil from one to the other?

A You would have to know how much the allowable was, how far back it goes, how far the oil moves to the bore hole.

Witness dismissed.

BY MR. SETH: That is our case.

A. P. LOSKAMP,

being called as a witness, and being first duly sworn to tell the truth, the whole truth, and nothing but the truth, was examined by Mr. Fleetwood, and testified as follows:

DIRECT EXAMINATION

Q State your name.

A A. P. Loskamp.

Q You are a geologist with the Barnsdall?

A Yes, sir.

Q Stationed at Midland, Texas?

A Yes, sir.

Q And do New Mexico fields in which Barnsdall have interests come under your immediate supervision?

A They do.

Q How long have you been in touch with the Monument field?

A Ever since the discovery.

Q Have you had access to the data, facts and field records accumulated by Barnsdall?

A I do.

Q Have you studied them to the best of your ability?

A Yes.

Q Were you educated as a geologist?

A I was.

Q Tell where.

A At Syracuse and Sanford.

Q How long have you been practicing the profession of geology?

A About 17 years.

Q How long have you been stationed at Midland?

A 12 years.

Q How long have you been in touch with the Monument field as geologist for the Barnsdall Oil Company?

A Ever since its discovery.

Q Did you hear the testimony presented this afternoon by Mr. Schuehle, of the Shell Oil Company?

A Yes, sir.

Q Are you in general accord with the opinions which Mr. Schuehle expressed on the witness stand?

A With some of them. Some are contrary to my ideas of reservoir conditions.

Q Point out to the Commission what particular point, or points, you hold a different professional opinion than those advanced by Mr. Schuehle.

A It seems quite probable there are zones of production, porous zones. They are awful hard to trace, especially from well samples, the information is very poor. It is quite likely there are three, or more, zones, but it has been my opinion, and still is, that these zones have vertical movements between zones, and that the reservoir, for all practical purposes, should be considered as one reservoir.

Q I understand you to mean it is your opinion that they are interconnected, and are not separate and sealed off one from the other?

A I believe there is connection between zones, if the zones are present.

Q Would it follow, or would it not follow, if there is a high bottom hole pressure area, and a low bottom hole pressure area in another place, that there would be a tendency for the oil to migrate from the high bottom hole pressure area to the low?

A I am not qualified as an engineer. However, that is my idea of the migration of oil, from the high to the low areas, and that they had a certain migration over the reservoir.

BY MR. FLEETWCOD: You may cross examine.

BY MR. SETH: No cross.

Witness dismissed.

E. A. MARKLEY,

being called as a witness, and being first duly sworn to tell the truth, the whole truth, and nothing but the truth, was examined by Mr. Fleetwood, and testified as follows:

DIRECT EXAMINATION

Q Mr. Markley, you are Chief Geologist for the Barnsdall Oil Company?

A Yes, sir.

Q How long have you held that position?

A Five years.

Q Prior to that time were you a geologist with that company?

A Yes, sir.

Q For how long?

A 16 years.

Q Where did you receive your education?

A The University of Kansas and California.

Q And you have been practicing geology how many years altogether?

A About 18 years.

Q As Chief Geologist, with Barnsdall, does your duty include supervision of geology looking to the accumulation of data and information in the various fields in the states in which the company is active?

A Yes, sir.

Q Have you had contact with the Monument field in Lea County, New Mexico?

A Yes, sir.

Q Has that been of a general supervisory nature?

A That is right.

Q And have you had access to the data so accumulated?

A Yes, sir.

Q And have you attempted to study the data to the best of your ability?

A I have.

Q You heard Mr. Schuehle, of the Shell Oil Company, testify as to the zonal pattern which he thinks exists in the Monument field?

A I did.

Q I would like to have you tell the Commission what your opinion is, in a general way, as to those matters.

A My opinion is that there are differences in degree of porosity. Those differences are recognized. Those harder, more dense, less porous streaks are known to exist in the field, but it is a matter of degree. We do not believe those impervious zones, or non-porous zones would prevent the migration of oil from one zone to another.

Q You think if the zones exist, they are interconnected and communicating?

A I wouldn't think that could be proven.

Q What is your judgment? In other words, do you believe there are three, or more, zones, and that each one is sealed off and separate?

A I believe zones are there -- we recognize three zones as being zones in which porosity is less than it is in a sandy zone and the pay section,- that portion which is occupied by the oil production.

Q Do you think the zones are connected?

A Yes, sir.

Q Would it necessarily follow that with high pressure areas and low pressure areas, would that result in migration of oil from high pressure areas to low?

A I think it would.

Q I may have misunderstood Mr. Schuehle, but according to him, the zones laid down were about as if a concrete wall had been laid down horizontally between the zones. Is that your opinion?

A No, sir. That is, the samples, the showings of the logs was that there was porosity present, in these particular logs.

Q You think they are intercommunicating?

A I think they are intercommunicating. I think the evidence shows the fact that there is intercommunication between the separate zones. Certainly there is no evidence that would prove, in my opinion, that there is not drainage possible within the so-called zones.

CROSS EXAMINATION By Mr. Seth:

Q You mean the zones are connected now by wells, bore holes? The various "pays" are connected by the bore holes?

A That is true too. That was brought out by Mr. Schuehle's testimony, that there are some 250 bore holes connecting the zones.

Q Can you give some maps or data as the basis of your opinion?

A No, sir, our opinion is based on development in our own wells, where we found extremely porous conditions existing,

and we are firmly of the opinion that migration of oil not only is possible, but does take place between wells in sections as porous as the one mentioned.

Q Have you made any study of the field as a whole in an effort to determine whether the zones are separated by an impenetrable wall?

A No, sir, we never have made that study.

Q You have never made a study outside of your own wells relative to the zonal pattern of that field?

A No, sir, we have never made a detailed study.

Q Your opinion is based on tata which your company has in their office?

A Based on the nature of the reservoir, with the common water level which originally existed, a sub-sea datum of -350 feet,- I believe the testimony was it was -340 feet. We all agree within those limitations originally pressures were equalized throughout the reservoir. We find, as indicated on this map, that the so-called impervious zones, which are supposed to separate the oil in each zone, do have a degree of porosity and saturation.

Q In the second zone?

A In this zone supposed to prevent the migration of oil in the reservoir from this zone.

Q Did you do the field work yourself?

A I have been in the Monument field.

Q Once?

A One time, on one of our wells, only once.

Q All of your testimony is based on what has been reported to you?

A That is right, but it comes under my direction.

Q You have not examined cuttings of the wells personally?

A Not personally.

Q Not throughout the field?

A No, sir.

Q Your opinion is just an assumption?

A It is an opinion that has been concurred in up until recently I think by the majority of geologists familiar with this area.

Q How many years was that oil leveling off in there, how many, many years has it taken that oil and water to level off?

A I am not that good a mathematician.

Q Couldn't it level off in this unlimited period of geologic time just through one small opening?

A You mean this horizontal zone of production which cuts across the stratigraphy? Couldn't it level off through one small opening?

Q One small opening?

A Not knowing how long it has taken, I don't think that question could be answered.

Q You know it has been long enough that one small opening could have leveled the whole thing off?

A In my opinion, sir, no.

RE-DIRECT EXAMINATION By Mr. Fleetwood:

Q Mr. Schuehle stated there are some 250 to 300 well bores which, at least in his opinion, connected the three zones he spoke of vertically?

A Yes, sir.

Q You recall one of the first Barnsdall wells could have made 25,000 or 30,000 barrels a day?

A 28,000 barrels.

Q Through one six or seven inch hole?

A That is right.

Q You think it is unimportant that 250 to 300 such holes interconnect these zones?

A I think that is very important.

Witness dismissed.

BY MR. FLEETWOOD: We rest.

BY MR. SETH: We rest.

BY MR. LIVINGSTON: Those who wish to submit briefs or statements in the Monument hearing may do so by the 23rd of March.

Whereupon the Commission adjourned.

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C E R T I F I C A T E

I hereby certify that the foregoing and attached seventy-six pages of typewritten matter, numbered one to seventy-six, both inclusive, are a true, correct and complete transcript of the shorthand notes taken by me at the hearing in the above entitled case on the 7th day of March, 1940, and by me extended into typewriting.

Witness my hand this 12th day of March, 1940.

Esther Barton