BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico
March 25, 1958

IN THE MATTER OF: Case 1327

TRANSCRIPT OF PROCEEDINGS

VOLUME 1

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In the matter of the rehearing requested by Skelly Oil Company, et al., for reconsideration by the Commission of certain portions of Case 1327, Order No. R-1092-A - application of Texas Pacific Coal and Oil Company for an order immediately terminating gas prorationing in the Jalmat Gas Pool; or in the alternative, revising the Special Rules and Regulations for the Jalmat Gas Pool in Lea County, New Mexico.	Case 1327

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

TRANSCRIPT OF HEARING

MR. PORTER: The meeting will come to order, please. This is a special hearing of the Commission for the purpose of a rehearing in Case 1327.

MR. PAYNE: In the matter of the rehearing requested by Skelly Oil Company, et al., for reconsideration by the Commission of certain portions of Case 1327, Order No. R-1092-A - application of Texas Pacific Coal and Oil Company for an order immediately terminating gas prorationing in the Jalmat Gas Pool; or in the alternative, revising the Special Rules and Regulations for the Jalmat Gas Pool in Lea County, New Mexico.

MR. MALONE: May it please the Commission, Ross Malone of Atwood and Malone at Roswell. I'm appearing in this rehearing for the purpose of presenting testimony on behalf of the following companies: Continental Oil Company, Atlantic Refining Company, Pan American Petroleum Corporation, Tidewater Oil Company, Cities Service Oil Company, Humble Oil and Refining Company, Shell Oil Company, Sinclair Oil Company, Amerada Petroleum Corporation, Texas Company, and the Standard Oil Company of Texas. All of these companies are united in opposing the inclusion of deliverability as a factor in the proration formula of the Jalmat Gas Pool. I'm authorized to say in addition that Skelly Oil Company, while not a member of the group which is presenting this testimony, is in agreement with the conclusions and recommendations which the group will make. I failed to include Samedan Oil Corporation, which is likewise a petitioner and a participant.

As the Commission will recall, it was at the suggestion of the Commission that these companies undertook to consolidate the presentation of testimony and the cross examination of witnesses in an effort to expedite and facilitate this hearing in its earlier phases, and it is in pursuance of that suggestion of the Commission that they are united at this time for the purpose of presenting testimony. Each of the companies for whom I'm speaking in this regard has its own representatives here and will speak for itself at the conclusion of the hearing.

I want to point out, however, that the position of the respective companies in applying for the rehearing insofar as the issues that are raised in the rehearing and their position on them, is as stated in the respective petitions. I mention that for the reason that the petitions are not identical. All of the companies do not subscribe to each of the propositions which I will present, but some of the companies subscribe to all of the propositions, and the particular companies which do support them is apparent from the petitions that each company has filed for a rehearing in this case.

With the hope of expediting the hearing, I would like to very briefly state the testimony which the Jalmat operators propose to present to the Commission. As the Commission will recall, in Order No. R-1092-A, Finding No. 5 of the Commission was as follows:

"That the Applicant, which was Texas Pacific Coal and Oil Company, has proved that there is a general correlation between the deliverabilities of the gas wells in the Jalmat Gas Pool and the gas in place under the tracts dedicated to said wells. And that the inclusion of a deliverability factor in the proration formula for the Jalmat Gas Pool would therefore result in a more equitable allocation of the gas production in said pool than under the present gas proration formula."

The testimony which will be presented with relation to that particular finding, and most of our testimony, will be directed to that, will be in an effort to show that apparently the Commission

concluded that there was a similarity or that the reserves which were testified to by Texas Pacific Coal and Oil Company as well reserves were the same as the recoverable gas in place under the tract which the statutes requires be considered in the protection of correlative rights, and the testimony will be directed to show that that conclusion, which as we view it could have been the only basis for the finding which the Commission made, in fact resulted from a misapprehension of the application of the testimony of Texas Pacific, and that it is not supported by sound engineering principles or by the testimony in the case.

We will further present testimony designed, we hope, to show that rather than a more equitable application resulting from the allocation resulting from the application of this formula, there will be set up a tremendous amount of drainage as between tracts, with the result that there will be irreparable injury to the correlative rights of a large number of the operators in this pool, injury which amounts to many, many dollars.

Finally, the testimony will be directed to show that as an inevitable result of the order as it has now been issued, economic waste and physical waste occurring undergound can be expected to result. We realize that in coming before the Commission on rehearing we are sort of arguing with the umpire about a decision, and that's not a very good place to be. Sometimes you get thrown out of the ball park when you do that. Nonetheless, in the best of

spirit and we hope of being helpful to the Commission in the decision, that is one of the most important questions the Commission has ever dealt with.

We have two witnesses, Mr. Robert Liebrock and Mr. Henry J. Gruy and we'll ask they be sworn at this time.

(Witnesses sworn.)

MR. MALONE: Mr. Leibrock, will you take the witness stand, please?

ROBERT M. LEIBROCK

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

DIRECT EXAMINATION

By MR. MALONE:

Q Will you state your name, please?

A Robert M. Leibrock.

Q You live in Midland, Texas, Mr. Leibrock?

A Yes, sir, that's correct.

Q You testified in this case at the time of the original hearing on behalf of the Jalmat Operators Group, did you not?

A Yes, sir, I did.

Q And I believe at that time you testified that you were a consulting petroleum engineer and had been engaged for some years in that business at Midland?

A Yes, sir, that is correct.

Q What was the name of your firm, Mr. Leibrock?

A Leibrock, Landreth and Campbell.

MR. MALONE: I assume that the witness' qualifications are acceptable to the Commission?

MR. PORTER: Yes, sir, they are.

Q Mr. Leibrock, you've heard the brief opening statement which I made, and you heard the testimony of Mr. Keller at the hearings

on December 9th and 10th relating to the so-called reserves as to which Mr. Keller found a correlation with deliverability, did you not?

A Yes, sir, I did.

Q You have also read the order of the Commission in which there was found that there was a general correlation between the deliverabilities and recoverable gas in place under the tracts in the Jalmat Pool, have you not?

A Yes, sir, I have.

Q Have you prepared an exhibit which is designed to demonstrate the inapplicability of reserves computed by the so-called material balance equation to a determination of the recoverable gas in place under a particular tract?

A Yes, sir, I have.

Q Will you refer to that exhibit which for the record has been identified as Operator's Exhibit 1-R, the "R" designating rehearing?

(Operator's Exhibit No. 1-R marked for identification.)

A Yes, sir, I will. By way of introduction of our Exhibit 1-R, I would like to remind the Commission that during the course of the testimony offered by Texas Pacific, they repeatedly referred to the use of the material balance method of estimating reserves. Now there's nothing peculiar about the material balance equation, either you have enough information to solve it or you don't. It's

nothing more or less than the name implies. You simply take the material produced from a well, in this particular instance gas, relate it to the pressure drop associated with that production, and the gas that's moving either to or away from the lease that you are attempting to conduct the material balance on, and that's the procedure that should be followed in conducting a material balance calculation.

Now in their approach to the analysis of individual leases and their reference to the material balance calculation, it's our position that they did not conduct a material balance calculation simply because they did not include all the material involved in the analysis of an individual lease. With that background, I would like to refer to our Exhibit No. 1-R.

As indicated at the top of this Exhibit No. 1-R, it is designed to show the limitations of the material balance equation or the inapplicability of the material balance equation as used by Texas Pacific as in other or individual leases within the reservoir, in the reservoir or individual lease.

Beginning on the left-hand side, we have Case 1, in which we have three tanks, Tank A,B, and C. All three are the same size, they all contain gas at an initial pressure of 1,000 pounds, and we haven't produced any gas out of any one of the three tanks. Now the only difference in the physical set-up of these three tanks is the size of the outlet. Briefly and roughly, the size of the outlet in Tank A is approximately twice the size of the

outlet in Tank B. The size of the outlet in Tank B is roughly twice the size of the outlet in Tank C. Now we open these valves simultaneously.

Q Mr. Leibrock, do I understand that there is the same quantity of gas in each of the tanks at the outset?

A The tanks are the same size and the gas is at the same pressure in each case, yes, sir. Now in the case of Tank A, we open up the valve along with the valves on Tanks B and C, and we reduce the pressure down to 500 pounds in each tank, at which time we have produced a million cubic feet of gas. The results of this production is shown in graphical form on the right-hand side of each of the tanks. In other words, as the pressure drops from a thousand to five hundred pounds in each case, we produced one million cubic feet of gas, the only difference being that it takes longer, of course, to produce the gas out of Tank C than it does out of Tank A, because of the variation in the size of the outlet, because of the variation in the deliverability of the three tanks.

Q Now I want to be sure that I understand you concerning that exhibit, Mr. Leibrock. You say that you produced each one of those tanks down to 500 pound pressure, is that correct?

A Yes, sir, that is correct.

Q Because of the difference in the size of the exit from the tank, the time that is required to do that varies, as I understand it?

A Yes, sir, that is correct.

Q But you ultimately reach the same point with each tank; that is, each tank has produced the same amount of gas down to 500 pounds per square inch of pressure?

A Yes, sir, that is correct.

Q Will you proceed?

A You can see that in this particular case, if you plot the pressure --

Q (Interrupting) Excuse me just a minute. You have referred to the fact that you have plotted a pressure decline curve over here for each of these tanks?

A Yes, sir, I have.

Q Is that the material balance equation that was used by Texas Pacific in the determination of the so-called reserves in the Jalmat Pool?

A Yes, sir, as I understand their procedure, that is.

Q All right.

A So in each case down to 500 pounds pressure we produced a million cubic feet of gas. The only difference being that it takes longer to produce the gas out of the tanks with a smaller opening, so that for each case where we solve graphically the material balance calculation as Texas Pacific did, we get an indication of two million cubic feet down to zero pressure, the amount of gas contained in each of these three tanks.

Now I would like to point out that if Case 1 were analogous

to the situation that exists in the Jalmat reservoir, then Texas Pacific would be perfectly justified in their approach to the problem, but Case 1 is not analagous to the situation that exists in the Jalmat reservoir, because in order for it to be analagous with each tank representing a lease within the reservoir, there would have to be an impermeable barrier within the reservoir itself coinciding with the fence lines or the lease lines on the surface. I don't think that situation exists, and if it doesn't exist then this situation Case 1 is not analagous to the conditions that exist in the Jalmat reservoir. So with that background, I would like to go on to Case 2.

Now in Case 2, we have an identical setup with one exception. We have the same three tanks containing gas at a thousand pounds before any one of the tanks has produced any gas. The one difference is that we have tied these three tanks together with a fairly large pie as indicated on this drawing. Now in this particular case we opened the three valves over here simultaneously, keeping in mind all the time that the three valves vary in size, Tank A approximately twice as big as Tank B, Tank B approximately twice as big as Tank C. We haven't changed anything, the only difference, we have tied the tanks together with this pie. We open the three valves simultaneously and produce a volume of gas, at which time we shut the valves on the tank, that would be similar to shutting in a field for bottomhole pressure survey. It happens at the time we shut the valves in, we have a

pressure of 500 pounds on our system. I would call your attention to the rather remarkable difference that exists in Case 2, as compared to 1. Here Tank A with the large valve and highest deliverability this time has produced down to 502.3 million feet of gas, whereas previously it produced only one million cubic feet of gas, the reason being simply that it had the highest deliverability. In other words, down to 500 pounds it has produced three tenths of a million cubic feet of gas more than it contained in the beginning.

Tank B, on the other hand, which has a smaller outlet, down to 500 pounds has produced six-tenths of a million cubic feet of gas with an indicated ultimate recovery of 1.2 million cubic feet of gas, or less than the tank contained initially.

Now Tank C on the other side, which has the smallest valve and the lowest deliverability, has produced only one-tenth of a million cubic feet down to 500 pounds, with an indicated ultimate recovery of only two-tenths of a million cubic feet, whereas it had an indicated recovery of two million cubic feet, or over ten times as much.

I would call your attention to the fact that the only reason for this condition existing is the variation in the size of the outlet of these three tanks. This recovery relationship that we have plotted opposite each tank is in no way related to the volume of gas initially contained in the tank. It reflects one thing and one thing only, the deliverability represented by the

size of the valve on each of these three tanks.

Q Now where did the additional gas that was produced out of Tank A, you said that Tank A in this situation has produced more gas than there was in the tank to begin with?

A Yes, sir.

Q Where did that gas come from?

A It's apparent that the gas produced out of Tank A, that is, out of the outlet in Tank A, must of necessity been drained from Tanks B and C.

Q Is it also true that some of the gas that was produced through Tank B has come from under Tank C?

A Yes, sir, that is correct.

Q I mean out of Tank C?

A Yes, sir, that is correct.

Q Now, as between Case 1 and Case 2, which is applicable to the individual leases in the Jalmat Pool, which are owned by the individual operators who are producing them?

A I think it's apparent that the Case 2, the setup that we have depicted under Case 2 is analagous to the situation that exists in the Jalmat reservoir where gas is free to migrate across lease lines.

Q And that is true,even at the expense of repetition, because of the fact that there isn't any iron curtain between these leases, is that correct?

A Yes, sir, that is correct.

Q With the result that the gas which is shown by the extrapolation of a curve based on pressure and production in Tank A does not reflect the recoverable gas in place in Tank A but reflects the drainage which occurs in addition, and the gas which comes through the outlet in Tank A from the other tanks?

A Yes, sir, that is correct. It not only does not reflect any, does not give any indication of the recoverable gas contained in Tank A initially, but there is absolutely no relationship between the gas that it will ultimately produce and the gas contained in Tank A.

Q Now, Mr. Liebrock, if you took these three extrapolations out here and assumed that each one of those represented the reserve of the tank which it is opposite, what would you conclude as to the reserves of Tank A, Tank B, and Tank C through the extrapolation of that pressure decline curve?

A Well, simply from extrapolation of the pressure production decline curve, you would conclude that the ultimate recovery down to zero pressure for Tank A would be about 4.6 million cubic feet, or over twice as much gas as it could possibly have contained initially.

Q Now, does that same thing occur when you applied the so-called material balance equation to a particular lease as Texas Pacific did in this hearing?

A Yes, sir, it does. When you attempt to apply the material balance calculation without inserting in the material balance

calculation all the factors that should be properly considered, then you can't help but get this.

Q The factor you are referring to is the gas which migrates into the lease itself because of the higher deliverability of that lease?

A That's right, in the case of Tank A the gas which migrates into the lease, in the case of Tank B and C, the gas which migrates away.

Q Now, Mr. Liebrock, you referred to the fact that the difference that we have in these three tanks is the difference in the size of the outlet and you mentioned the fact that that was comparable to the difference in the deliverability of three gas wells, is that correct?

A Yes, sir, that is correct.

Q Now is there any relationship whatever between the size of that outlet and the amount of recoverable gas in place in that tank?

A Absolutely no relationship between the size of the outlet and the recoverable gas in place in the tank, no, sir.

Q If you insert a deliverability factor in aprorationing formula in a gas field, do you not insert a factor which has no relati onship whatever to the recoverable gas in place?

A Yes, sir, that is correct.

Q And does not the New Mexico Statute say that as between owners in a particular pool, prorationing shall be on the basis of

the recoverable gas in place in the tract?

A Yes, sir, that is correct.

Q Is there anything further you would like to tell us about that exhibit?

A I think there's just one thing further; that is worth mentioning, and that is, if you apply the material balance equation to this entire system, as it should be applied, for example, if you take the total production from all three tanks, 2.3 million plus six tenths of a million plus one-tenth of a million, down to 500 pounds and apply the material balance calculation properly, then you will come up with an accurate indication of the total gas in place in the entire system, which would be analagous to an entire closed reservoir, and that is the proper way to apply the material balance calculation and is in fact the only way to apply the material balance calculation.

Q If I understand what you are saying, it is that that equation could be applied to the entire Jalmat Pool because there is no drainage back and forth across the exterior lines of that pool?

A That is correct.

Q But that it cannot be applied to an individual lease because effect must be given to the drainage, which cannot be done?

A That is correct. You are not making a material balance when you extrapolate this curve along the straight line as we have done here, and Texas Pacific has done along a number of leases in the Jalmat; you are assuming that that well will ultimately

recover that much gas if conditions in the future are identical to the conditions that were identical in the past, which puts a rather severe qualification on their material balance method of determining reserves or anything else.

Q Let me ask you if it would be a fair statement to say, first referring to finding No. 5 of the order in this case, which is that it has been demonstrated that a general correlation exists between the deliverabilities and recoverable gas in place, would that be the equivalent of saying on this exhibit that a general correlation exists between the size of the opening on the tank and the amount of gas in the tank?

A Yes, there very definitely is a correlation between the size of the opening and the gas that you would produce from the tank.

Q You misapprehend my question.

A I am sorry, there would be no relationship between the size of the opening and the recoverable gas in place.

Q And to say that there is a correlation between the deliverability in gas wells and the recoverable gas in place in the tract is equivalent of saying that there is a correlation between the size of the opening and the amount of gas that there is in one of those tanks?

A Yes, sir, that is correct.

Q Is there any correlation or relationship whatever in that regard?

A No, sir, there is not.

Q The size of the opening could be doubled,trebled, or quadrupled and it wouldn't change the amount of gas in that tank?

A Yes, sir that is correct.

Q Have you made an attempt to apply the conclusion which is demonstrated by that exhibit to actual situations existing in the Jalmat Pool?

A Yes, sir, we have. I think it's fairly obvious that an exhibit of this type without supporting data from the field wouldn't be as useful as it would be if we could find field examples which depict this sort of thing, and that is the purpose of our second exhibit.

Q Will you refer then to Operator's Exhibit 2-R?

(Operator's Exhibit 2-R marked for identification.)

Q What is disclosed on that Exhibit 2-R?

A Well, as indicated by the title on this exhibit, it's to demonstrate the fallacy of computing individual lease reserves by the material balance or by the graphical solution of the material balance equation as Texas Pacific applied it.

In other words, they have determined or contended that there is a general relationship between their reserves and deliverability, and if there is also a general correlation between recoverable gas and deliverability, then there must necessarily be some relationship, according to their testimony, between the reserves and recoverable gas in place.

We have previously, from our first exhibit, demonstrated the fallacy of that line of reasoning, and here by actual field examples, we can demonstrate further the fallacy of that type of approach.

Q What three wells are involved in Operator's Exhibit 2-R?

A We have the Continental Oil Company Lynn B-26 No. 1, Continental Lynn B-26 No. 2, and their Lynn B-25 No. 2.

Q What is the relative position of those three wells in the Jalmat Gas Pool?

A They are adjacent tracts. Their acreage is contiguous between the three.

Q Will you proceed?

A Beginning over on the left-hand side, we have the pressure production data indicated for Continental Oil Company's Lynn B-26 No.1.

I might add that I have a pressure point here initially which has not been colored in and which I will add from my records. This indicates that as of August 1950 this well had produced somewhere just under 7,000,000,000 cubic feet of gas, at which time you had a pressure drop of approximately 40 pounds.

Now, at that time, if you had drawn a line from the original pressure through the pressure points that you had at that time you would have had an indicated ultimate recovery of 118,000,000,000 cubic feet.

Q Will you take this red pencil and put your initial pressure point on there, please? Was that pressure point just left off by the draftsman in drafting? A Yes, sir.

Q It is shown on the smaller exhibits that have been distributed?

A No, sir, I don't believe it does.

Q Yes, it is.

A At any rate, at this particular time, utilizing the procedure employed by Texas Pacific, you would have estimated an ultimate recovery from this well of around 118,000,000,000 cubic feet, but at that time you had some additional development in the general area, with the result that the position of the pressure production decline curve was altered rather severely, as you can see from the red pressure points here, so extrapolating a line --

Q (Interrupting) You say that position was altered, but

explain just what the dropping of that -- what causes that line to drop?

A Well, this is caused by additional withdrawals in the general area of the field. In other words, the production from the offsetting wells which were drilled about this time resulted in a departure from the previously established pressure curve. In other words, at this time this well was draining a tremendously large area because there weren't any other wells around, but with the drilling of additional wells it completely upset the drainage pattern of the B-26 No. 1, with the result that you got this rather substantially different pressure production decline trend, and you can see that from this trend you would indicate an ultimate recovery of about fifteen and a half billion cubic feet, which is a rather substantial reduction from the estimate that you arrived at earlier. That is reflected by nothing more than the production from other wells in the area.

Q Now, Mr. Liebrock, if Texas Pacific had undertaken to determine the so-called reserves of this well in August, 1950, in the manner that they determined the reserves under the various tracts in the Jalmat Pool in this case what conclusion would they have come up by the extrapolation of that curve?

A They would have concluded that the ultimate recovery would have been in the neighborhood of 118,000,000,000 cubic feet.

Q Then if they had redone that same thing at a current date,

what would be indicated as the reserves under that tract?

A 15.5 billion cubic feet.

Q That's about one-eighth of what the original extrapolation indicated, isn't it?

A Yes, sir, that is correct.

Q Had the recoverable gas in place under that tract changed other than as it might have been affected by the production from the well itself?

A No, sir, during the course of the history depicted here, the recoverable gas in place underlying the acreage assigned to the Lynn B-26 No. 1 had not changed except for a small amount of production.

Q The difference from 118,000,000,000 MCF to 15,000,000,000 MCF results entirely from a change in the producing pattern in the general area around the well, did it not?

A Yes, sir, that is correct.

Q And the reserves which were computed by the material balance equation, shown in this case by Texas Pacific, were all subject to that same effect on the basis of production in the pool over the period, were they not?

A Yes, sir, that is correct, except of course as we said previously, they did not make a material balance calculation to determine the recoverable gas in place under that tract. They did one thing and one thing only, nothing more, nothing less, they extrapolated pressure production history, which gives a figure that is in

no way related to the recoverable gas in place, it couldn't possibly be.

Q Will you proceed to Continental Lynn B-26 No. 2 and state what extrapolation of the two curves on that well would indicate?

A Yes, the Continental Lynn B-26 No. 2 was drilled a little later. It was drilled at about the time recovery from this well had been around six to seven billion cubic feet. We have an indicated initial pressure here of around 1200 pounds with an established pressure production decline curve initially as shown by these points.

If we had extrapolated pressure production history as of August, 1951, we would have come up with an estimated 5.25 billion cubic feet down to 100 pounds, but at this particular time, due either to additional development or to higher withdrawals from this well, or lesser withdrawals from the offset wells, the pressure production trend on this lease was established. This very short break in trend could have been caused by nothing else than the effect of offset production, which clearly demonstrates that you must of necessity have tremendous movement of gas across lease lines. That is the only way in the world you can upset a pressure production decline trend. So you see at this point from August, 1951 up to the present, you get an indicated ultimate recovery of almost twice as much as you would have estimated back here.

Q To be sure I understand you, if the basis of computing

reserves used by the Applicant in this case had been used in a hearing before this Commission in August 1951, and the reserves of this well had been computed on that basis, it would have indicated approximately five and a quarter million MCF of ultimate production from that well, is that correct?

A Yes, sir, that is correct.

Q If they came back before this Commission this year dealing with exactly the same well and used exactly the same process for computation, they would have gotten twice the reserves that were originally indicated, is that correct?

A Yes, sir, that is correct.

Q And that indicates the fallacy, as I understand it, of the attempt to use this equation in determining the gas, recoverable gas in place under a particular tract in the Jalmat Pool?

A Yes, sir, that is correct. Nothing in my way of thinking could demonstrate it any more conclusively, obviously both of these answers couldn't be right as to recoverable gas in place, and if either one happened to be close, it would be purely accidental.

Q Will you proceed to Continental Lynn B-25 No. 2?

A This is a plot of the pressure production history on the Continental Lynn B-25 No. 2 which offsets the Lynn B-26 No. 2. Now, in this particular case we can draw a fairly good straight line through the pressure production history, but the main reason for plotting this particular data on the graph is to indicate that

despite the fact that you can draw a straight line through these pressure points, that in itself is no indication that this well is simply draining the area which is assigned to the well. It may be draining more, it may be draining less, and here again, if it happens to be draining only the area assigned to the lease it would have to be accidental.

Q Now, tying this exhibit in to your tank exhibit which was Operator's 1-R, is there any way of determining from which one of these three connected tanks the gas that would be reflected by this curve was being produced? A No, sir.

Q It could be coming from the tank at the top - the tank in the middle, or the tank at the bottom, couldn't it?

A Yes, that is correct. It's obvious from our plot on Lynn B-26 No. 1 for a long period of time it was draining an area much larger than the area assigned to the well.

Q Assuming on these three tanks that each one of them is owned by a different operator, the result would be that tank A would be given credit for reserves which did not belong to that operator because they were not located under the tract assigned to the well, is that correct?

A Yes, sir, that is exactly correct.

Q Is there anything further in connection with that exhibit?

A No, sir, I believe not.

Q Now, Mr. Liebrock, in the light of your testimony as to the

total lack of relationship between the so-called reserves obtained by this method used by Texas Pacific and the recoverable gas in place under the tract which the New Mexico statute says that the operator is entitled to recover and his correlative rights must be based thereon, is there any relationship between the deliverability of the well and that recoverable gas in place?

A No, sir, I do not think that there is any relationship between the deliverability and the recoverable gas in place. From our first Exhibit 1-R we demonstrated by a hypothetical example why there shouldn't be, and by continuing the application on to the field examples in 2-R, we have demonstrated from field data why there should not.

Q Now, have you made an attempt to further test that situation by applying the proration formula which will result from the order issued by the Commission to wells that are located in the Jalmat Pool?

A Yes, sir, we have.

Q In an effort to see how that relationship would develop?

A Yes, sir, we have.

Q And have you in connection with doing that given consideration to the porosity and permeability conditions which are found to exist in that pool?

A Yes, sir, as we testified previously, we had access to core data on approximately five wells, and we have studied that data to determine the relative importance of permeability and porosity,

and all the things we have been talking about here. In other words, permeability has been mentioned a lot, porosity has been mentioned a lot, and we have made a further investigation to determine just how these various parameters enter into the determination of recoverable gas in place, and how they enter into the determination of the ability of a well to produce.

Q Would it be a fair analysis to say that changes in the permeability are roughly the equivalent of the size of the opening you had in these tanks? A Roughly, yes.

Q And that it has no relation to the amount of gas that there is in the tank?

A Yes, sir, no acceptable relationship between that and the recoverable gas you have in place in the tank.

Q Now, with reference to porosity, what part does it play in determining the recoverable gas in place? Is it a factor, and if so, is it an important factor?

A Yes, sir, if you take a unit or a given volume of reservoir rock, porosity is the most important single factor entering into the determination of recoverable gas in place.

Q Would it be a fair statement to say that the porosity is just the storage capacity of the rock?

A Yes, sir, I can't think of a better way to put it.

Q You said that is the greatest single factor in determining how much gas there is in place under a particular tract?

A Yes, sir.

Q All right. Will you proceed now to the exhibit which examines the relationship between those?

Q You are referring now to Operator's Exhibit 3- R?

A Yes, sir, that is correct.

As we just stated, for a given volume of reservoir rock porosity is the most important single factor that enters into the determination of the storage capacity. At the same time, permeability is the most important single factor in determining the ability of the rock to give up gas.

Q Is it also the most important single factor in deliverability?

A Yes, sir. Beginning over on the extreme left-hand side of this exhibit, we have here plotted the red points that are shown. These red points are average permeability values for each one percent increment of porosity change. This is data which is normally plotted on a semi-logarithmetic graph paper, but for clarification we have plotted it on a linear scale in both directions. You will see the relationship, the best average relationship we could draw between the points indicated here.

Now on the same graph we have super-imposed this 45 degree line here which is roughly the relationship that would be required in order for permeability to reflect storage capacity of the reservoir rock. Now to elaborate a little more on that, when you get an increase tenfold in porosity at the same time you get a tenfold increase in permeability.

Q That is, that is what you would have to get if permeability reflected the recoverable gas in place?

A Storage, yes, sir, that is correct. This is the relationship that you would have to have but which you do not. Here with a twenty percent increase in porosity, you would have to have a twenty-fold increase in porosity, you would have to have a twenty-fold increase in permeability, roughly, for permeability to reflect storage capacity of the rock. You do not have that relationship. You have this relationship that we have plotted here, which as you can see very readily differs extremely from the forty-five degree relationship that would be required, so we have shown here in bar graph form the significance of this type of analysis and what it means; for example, starting here where we have a permeability of one millidarcy, we have a porosity of twelve percent. Where we have a permeability of four millidarcies we have a porosity of fifteen percent, reading directly off of the appropriate curve here. Where we have a permeability of twenty millidarcies right here where we have a porosity of nineteen percent. So you can see the porosity here over the range that we have investigated varies from twelve percent to nineteen percent.

Q That, Mr. Liebrock, is the storage capacity of the rock that you referred to earlier, is it not?

A Yes, sir.

Q That varies within what percentage?

A Porosity varies from twelve percent to nineteen percent.

Q That is the principal factor in the recoverable gas in place specified by the New Mexico Statute?

A Yes, sir, that is correct.

Q All right.

A So to sum up the results of this analysis, for a fifty-eight percent variation in porosity, from twelve percent to nineteen, taking the difference from twelve to nineteen and referring it to twelve,for fifty-eight percent variation in porosity, there is a corresponding two thousand percent variation in permeability. Now that reflects this and nothing more, that while you have a very slight variation or a minor variation in storage capacity, you have a tremendous variation in permeability. This is just from analysis of the rock itself, before it's been fracked. This is a variation you have before you have done anything to the rock in the way of fracturing. Now let's take a look at it for a minute to see what would happen if we went in and fracked some of the wells. I don't think there's any question but that under a frack program in a field as large as Jalmat that you would tend, without a doubt, to expand, to result in a greater spread between the effective permeability that we have indicated here, so that instead of a two thousand percent in permeability you can easily wind up with a four thousand to six thousand percent variation.

Q Now, Mr. Liebrock, when you do that frack job, do you increase those green bars down there, which is the storage capacity of the rock?

A No, sir, and that's the next thing to discuss. In increasing the effective permeability of the system, you do not alter the

storage capacity of the rock. In other words, we are not in a position to alter the storage, we can't put any more gas in the reservoir, but we can alter tremendously the ability of the wells in that reservoir to deliver gas. You have already got a tremendous spread, and with fracking it is going to be even more severe.

Q When you put deliverability in a gas proration formula, are you giving effect to this tremendous permeability range which has no relation to the porosity range, which is the storage capacity of the tract?

A Yes, sir. You very definitely are, and the calculations that we have shown over here on the right indicate why, because as we said previously, for a given thickness or given volume of reservoir rock, permeability is the greatest single factor in determining the ability of a well to produce. For example, and this is nothing more than a sum-up of what we have already said, but for a permeability of one millidarcy and for the thickness we have used here, you would have a productivity as against 500 of 127 MCF per day, whereas for a permeability of twenty millidarcies you would have a productivity of 2,540 MCF per day just by varying the permeability, an increase of two thousand percent, just as we have shown here. In the formula which is used for determining recoverable gas in place, permeability is not even a factor, admittedly it enters into some extent in determining the abandonment pressure of a well, but it is not an important factor and Texas Pacific apparently believed that because they extrapolated

all their pressure production down, you have curves down to 100 pounds. This formula for calculating recoverable gas in place, the factor that is the greatest and most important single factor, namely, permeability, doesn't even enter into the determination of recoverable gas in place. When the two most fundamental factors, such as porosity and permeability, one entering into one formula and not in the other and vice versa, how could there possibly be any relationship between recoverable gas in place and the ability of a well to produce.

Q Mr. Liebrock, to look a little further at the effect of giving effect to this range in permeability by including deliverability in a gas proration formula, you've said there was a range of about two thousand percent in permeability in the Jalmat Pool, with a range of only fifty-eight percent in porosity, is that correct?

A Yes, sir, for the example that we have taken here, we have investigated the permeability range which would result if we had a range in porosity of twelve to nineteen percent, but you will recall previously from our study within our area of investigation we didn't find this much porosity variation, but we have this much permeability variation from the deliverability of the well.

Q Does a deliverability factor in a proration formula inevitably give a proportionately greater allowable to the well, so that the two thousand percent increase in permeability is reflected

in the allowable, where only a fifty-eight percent difference exists in the storage capacity of the rock?

A Yes, sir.

Q And hence in the recoverable gas in place referred to by the Statute?

A Yes, sir, that is correct.

Q Is there anything further in connection with that exhibit, Mr. Liebrock?

A Yes, sir, there's one thing that I would like to add before leaving this particular exhibit. I would like to quote and read directly from an article which was just called to my attention last night. It appears in the March, 1958, issue of the Petroleum Engineer. The title of the paper is "Predicting Reservoir Performance from Core Analysis." The paper starts on B-95. I'm reading an excerpt from page B-100 under the sub-heading "Permeability and Porosity Relationship". This paper was written by Mr. Ben A. Elmdahl, who is head of Elmdahl Engineering Company in Houston, Texas, and formerly associated with Core Laboratories. He has had an opportunity to observe porosity and permeability relationships on a tremendous number of sandstone cores.

"For any given geologic formation with intergranular porosity and permeability, there is a direct relationship between these factors over a specific range of porosity. This relationship is such that at a certain lower limit of porosity, a formation becomes permeable and from this point both factors increase in a

semi-log manner(a 3 percent increase in porosity usually affords a 10 fold increase in permeability)." I would like to repeat that. "A 3 percent increase in porosity usually affords a 10 fold increase in permeability."

Q May I interrupt to ask how that relates to the increase you found in this particular pool?

A Yes, sir. I'm calling your attention to the fact that we investigated the permeability variation for a porosity variation of twelve percent to nineteen percent so that we investigated a seven percent range of porosity and for our seven percent range of porosity we observed a two thousand percent variation in permeability, which ties in very closely with what Mr. Elmdahl quotes in his paper. I might say that he's talking about dirty sands and when I say dirty sands I have reference to sands which have a relatively high concentration of shaly material. I think without a doubt from my discussions with engineers and geologists that the Jalmat sand reservoir comes under the classification of a dirty sand. He is talking about exactly the same type of sand lithologically that I'm talking about here.

I would like to continue this quote, I will have to read back. "This relationship is such,that at a certain lower limit of porosity a formation becomes permeable, and from this point both factors increase in a semi-log manner until an upper limit of porosity for the formation is reached. At this point permeability becomes independent of porosity and may continue to increase while

the latter remain constant,"while permeability remains constant. That's exactly what you would suspect from --

Q (Interrupting) You misread that, I believe.

A While porosity remains constant.

MR. CAMPBELL: We would at least like to have it read properly.

MR. MALONE: Would the witness read it again, please?

A Yes, sir. I'm reading the last sentence where I misread. "At this point permeability becomes independent of porosity and may continue to increase while the latter remains constant." That is, while porosity remains constant. That is exactly what you would anticipate from the graphical relationship that we have shown here. When you get up in the higher porosity ranges where the shaly content of the formation is less of a factor, then you can get tremendous increase in permeability with a minor variation in porosity, with a minor variation in storage capacity.

Q Does that mean, in effect, a tremendous increase in allowable where deliverability goes in the formula, when there is a very minor increase in recoverable gas in place?

A That is correct, with virtually no increase of recoverable gas in place, so I think that is significant from the standpoint of fracking, too, you would be working on the up end of the curve so when you materially increase the permeability of your formation you can do it over a tremendous range without increasing the storage capacity; so for all practical purposes permeability and

porosity has no reasonable relationship as far as this field is concerned.

Q Would you just have a seat now for a moment, Mr. Liebrock? You testified on behalf of the operators in the original hearing in this case, or in the December hearing of the case, with reference to a study which you made on a portion of the Jalmat Gas Pool.

That study related to a determination of the recoverable gas in place by a pore volume calculation or so-called volumetric calculation of the recoverable gas in place under the individual tracts; what was the area that was included in that study?

A It was an area of approximately 11,000 acres.

Q Approximately 11,000 acres?

A Yes, sir, that is correct.

Q In the Jalmat Pool?

A That is correct.

Q At that time you testified in substance that you felt that was an acceptable unit of the Pool on which to base a study such as you made, and that you had not made a study of the entire Pool or a pore volume calculation on the entire Pool because of the inadequate time that was available for that purpose. You recall your testimony in that regard?

A Yes, sir, I do.

Q You proposed to testify further with reference to some of the information that was disclosed in that 11,000 acre study, did you not?

A Yes, sir, I did.

Q Now, since the meeting or since the hearing in December, have you expanded the pore volume study to include the entire Pool?

A No, sir, we have not.

Q Have you made a further study of some aspects of the entire Pool in determining whether or not you would be justified in expanding your study?

A Yes, sir, we have.

Q What did the further study which you made disclose in this regard?

A Well, at the time of the last hearing we fully intended to expand the study, our pore volume study to the entire field; however after we reviewed the additional information, we found that we had deliverability data on approximately fifty percent of the wells outside of our original 11,000 acre area, whereas we had deliverability data on eighty-seven percent of the wells within the 11,000 well area that we had previously studied.

Q Let me be sure I understand you. If you had expanded your study to include the rest of the Pool, you would have only had deliverability information on half of the wells in that additional area?

A That is correct, approximately half.

Q Would that have very materially reduced the value of the study for the purposes for which it was made, so far as the additional

area in the Pool was concerned?

A Yes, in my opinion it would have materially. We could not have supported any conclusions or recommendations that we might have arrived at on the basis of expanded study to the same extent that we could support our conclusions on the small area where we had adequate information. It boiled down to the case of having adequate information on a portion of the Pool and insufficient information on the remainder of the Pool.

Q Were there any other factors that entered into the decision not to expand this study to the entire Pool?

A Yes, sir, realizing that we did not have sufficient information on the area outside of the original area studied, and at the same time taking into consideration that it would require approximately a thousand man hours of work, we could not recommend to the operators that the study be expanded, because we could not give them any assurance that we could come up with anything that we could support to the extent that we could support it in the smaller area.

Q This resulted from the absence of adequate data on the wells outside the 11,000 acre area?

A Yes, sir, that is correct.

Q Now, have you prepared a net pay map and an isobar, a pressure map covering the 11,000 acre area which was the subject of your study, to which you testified in the December hearing?

A Yes, sir, I have.

Q Will you refer to that exhibit, please?

A Yes, sir.

Q You are referring now to Operator's Exhibit 4-R, is that correct?

A Yes, sir, that is correct. Referring first to the map on the left-hand side of the Exhibit 4-R, we have indicated a bottom-hole pressure map for the 11,000 acre area which we studied. The boundaries of the area are indicated in red on the map.

Q Your left or the map's left are you talking about?

A On this side of the map.

Q What is shown there?

A This is the net pay map, I am sorry. Correction, on the left-hand side of the map we are referring to the left-hand side of the exhibit, we are referring to the net pay map. Now, the procedure followed in estimating net pay for this area has been previously discussed. However, I might mention briefly that we made use of the core data which we previously had reference to in previous hearings, and all of the available logs in this area relating them first to the cored intervals and then expanding the study to include the entire area, with the result that you see indicated here on this net pay map.

Now, on the right-hand side of this exhibit we have a bottom-hole pressure map of the same area, the area again being outlined in red. The pressures here have been corrected to bottom-hole conditions, and are based on measurements taken within three months before or after January 1st, 1957, which was the last complete,

really complete pressure information that we had.

Now, you can see the results of our contouring of the pressure data in this area.

Q Now, what generally does that pressure data indicate?

A Well, the pressure data indicates that within the area studied we have very little variation, relatively little variation compared to other places in the field. For example, a fair indication would be a variation of 100 pounds say from 900 to a thousand pounds.

Q Now, a small variation in pressure as between wells in an area of that kind indicates what, if anything, with reference to communication and the migration of gas back and forth between leases?

A Any time you see a pressure plateau of this type such as covers our area study, then you can immediately conclude that there is excellent communication throughout the reservoir, throughout that portion of the reservoir.

Q What do you mean by communication?

A I mean simply that gas is extremely free to move across lease lines depending on the withdrawal rate from individual wells, just as our first exhibit, our Case 1-R, the second case, our Exhibit 1-R, the second case where we showed that gas was free to migrate from tanks B and C to tank A. This is analogous gas, is free to migrate at will throughout this area.

Q It will indicate that you had a large pipe between the tanks

shown on Exhibit 1-R? A Yes.

Q You have referred to the fact, Mr. Liebrock, that there is a relatively small variation between the pressures which you find in this area? A Yes, sir.

Q And that in some other areas of the pool much larger differences exist? A That is correct.

Q For the purpose of the study which you are making to compare deliverabilities in wells to the net pay or to the recoverable gas in place, is it a more favorable or a less favorable condition to have uniformity in pressures such as exist here?

A It is a much better study where you have uniformities of pressure within a given area because it is in these areas that the migration will be greatest, it is in these areas where the migration of gas across lease lines will be maximum. It is in these areas where correlative rights is subject to damage.

Q (Interrupting) It is where they will be damaged as a result of the migration of the gas if an unfair proration formula is used? A Yes, sir.

Q Is there anything further in connection with the Operator's Exhibit 4-R?

A Yes, sir. I would like to elaborate a little more. I think it ties in with what you have just said, and it also ties in to statements by Texas Pacific earlier that this is an extremely poor area to study because there's very little variation in pressure

and because there is only approximately a three-fold variation in net pay.

I believe they said it was a poor area because if you have little variation how can you evaluate differences. As a matter of fact, I can't think of a better area in the whole field to evaluate differences. We have better information here than any other place. It is only logical that the competent engineer will take the area where he can properly evaluate it.

I might point out that while we have only a three-fold in net pay and a small variation in pressure, we have a forty-three fold variation in deliverability, and not a great deal of variation in pressure and net pay thickness, then how can there be any correlation. For example, if we have very little variation in these factors, then we shouldn't have very much variation in deliverability, but we have a forty-three fold variation in deliverability, so as a practical matter and taking into consideration the availability of data and the procedure that any engineer could follow, I can't think of a better place to investigate the applicability of the proposed deliverability formula.

Q Now, have you made a study to determine what will actually happen as between wells if a deliverability formula is used on the wells in this area in relation to the recoverable gas in place which measures the correlative rights of the operators in that area?

A Yes, we have.

Q Will you refer to that study, please?

The exhibit to which you are now referring is entitled Exhibit Showing Absence of Relationship Between Reocverable Gas In Place And Deliverability Allowable, is that correct?

A Yes, sir, that is correct. In reviewing this area and the type of information available, it occurred to us that perhaps one of the clearest ways to depict the tremendous variation you have across lease lines would be to run cross sections at several points through the field.

First we have prepared cross section A, A_1 which runs from Tidewater King No. 1 on the north to the Amerada State LMT No. 2 on the south. On this exhibit we have shown the order of magnitude of variation in recoverable gas in place expressed in MCF per acre for the various wells that are included in this cross section.

Now, for the same wells we have shown the deliverability which would result from, we have shown the allowable which will result from the adoption of the deliverability formula. So the result is indicated here, we have approximately a 40% variation in recoverable gas in place between these wells shown on cross section A, A_1, but for the same wells we have approximately a 460% variation in the allowable under the deliverability formula.

Q Now, Mr. Liebrock, let me be sure I understand what you mean by that. Do you mean that considering those wells and comparing the wells as between each other that are shown on your cross section A, A_1, that there is a variation in the recoverable gas in

place of how much?

A Forty percent, approximately.

Q But that applying the allowable formula that would result from the Commission's Order R-1092-A, there would be a variation in allowable of how much? A Approximately 460%.

Q That's as between those individual wells that are shown on A, A_1? A Yes, sir, that is correct.

Q Now, when you get a roughly ten to one variation in allowable as between wells which have a substantially equal amount of gas under the tract, or recoverable gas in place, what is going to happen so far as drainage is concerned?

A Well, sir, there is only one thing that can happen, you must of necessity have tremendous drainage across lease lines.

Q That means that the well that gets the tremendously high allowable because of the injection and deliverability in the formula does not necessarily have any higher recoverable gas in place, is that correct?

A That is correct. It does not necessarily have any higher recoverable gas in place, but it will recover a much greater portion of the total gas in place in the area than it's entitled to.

Q Whose gas is the owner of that well going to be recovering?

A Well, from the various offset tracts.

Q It's going to be recovering somebody else's gas besides his own? A That is correct.

Q Does or does not that relate directly from the injection of a deliverability factor in the proration formula when there is no correlation between the deliverability and the recoverable gas in place? A Yes, sir.

Q All right, would you proceed with the description of that exhibit?

A I will continue on to cross section B, B_1 which is a west-east cross section extending from the Texas Pacific State A No.1, 37 on the west to the Gackle King No. 1 on the east.

Q That's an east-west cross section, isn't it?

A Yes, west-east.

Q Or west-east?

A Yes. Now, on this particular cross section we have approximately 110% variation in recoverable gas in place as we have shown here, whereas for the same wells we have approximately a 470% variation in allowable under the deliverability formula. So here again, you have the same pattern which will result in migration of gas across lease lines. It must of necessity result in migration across lease lines, it just simply can't help resulting in it.

Q Those individual bars each indicate an individual well which you have labeled on that exhibit, do they not?

A Yes, sir, that is correct.

Q And the green bar up above indicates the recoverable gas

in place under that tract? A That is correct.

Q The red bar down below indicates the allowable that the well will receive under the present Commission order?

A That is correct.

Q Now, if there was a general correlation between deliverability and recoverable gas in place, what would you find with reference to the relationship between the green bar on any well and the red bar?

A If there was a general relationship you would find that the length of these two bars would tend to coincide much closer.

Q And comparing the upper and lower bars, the green bars up above and the red bars down below, what would you find?

A You would find the same order of magnitude of variation, instead of the tremendous variation you would have a variation much less than the order of magnitude indicated here.

Q Well, what, if anything, does it demonstrate in your opinion as to the existence or non-existence of any correlation between deliverability and recoverable gas in place which the statute says the operator is entitled to receive?

A Well, sir, in an area which lends itself better to the type of study that needs to be made than any other area of the field based on the availability of data, it proves conclusively that there is no general relationship between recoverable gas in place and the allowable which would result under the deliverability formula.

Q What if anything does it prove with reference to the drainage that is going to result from injection of that deliverability formula into the gas proration?

A Well, sir, when you study the results of these bar graph analysis in conjunction with the pressure history in this area and the net pay thickness in this area, you can conclude but one thing, no one could conclude anything else that there must of necessity be tremendous movement of gas across lease lines. You can't have variation of this order of magnitude without upsetting correlative rights tremendously.

Q Now, will you refer to your cross section C, C_1?

A Cross Section C, C_1 is patterned after the others and extends from the Gulf Janda I No. 2 on the north to the Continental Lynn B-26 No. 4 on the south. Here we have a variation in recoverable gas in place of approximately 85%, and for the same wells we have a variation in allowable under the deliverability formula of approximately 360%. So the pattern here is easily the same as the pattern on the other two cross sections.

Q These wells likewise are offsetting wells that are going to be draining each other if one well gets a greater allowable in relation to its recoverable gas in place than its adjoining well, is it not?

A Yes, that is correct.

Q Is there anything further that you would like to state in

connection with that exhibit?

A Well, there are two or three things that might be worth mentioning. We have called attention to a couple of wells here, first the Gackle King No. 1 which is the easternmost well in cross section B, B_1 which would have a monthly allowable of approximately twenty-one million under the existing formula, or under the acreage formula as compared to approximately one hundred three million under the deliverability formula.

Q You say the allowable of that well would increase from twenty-one million to a hundred three million?

A Approximately, yes, sir.

Q Under the new proration formula?

A Yes, sir. Approximately a five-fold increase.

Q And that is offsetting a well which is the Gulf Janda H that has a recoverable gas in place that compares how to that well?

A Well, they are practically identical, one I would say has a recoverable gas in place of approximately 32,000 as against 33,000 for the Gackle King No. 1.

Q So that with approximately equal recoverable amounts of recoverable gas in place, this Gackle well is going to get a five-fold increase in allowable as compared roughly, as compared to the Janda well? A Yes, sir, roughly.

Q Those are adjoining wells, are they not?

A Yes, sir, they are.

Q What's going to happen to the gas under the Gulf Janda well when that allowable hits?

A Well, I think it's apparent, --

MR. CAMPBELL: Is Gulf a party to this rehearing?

MR. MALONE: I don't know whether they are or not. I'm not representing them.

MR. CAMPBELL: If Gulf is not a party, it seems to me it is immaterial.

MR. MALONE: If the Commission please, we are making a study, we are presenting evidence of a study in the Jalmat Pool from information available in the Commission's files as to the wells. To suggest that we have to limit our study to the wells that belong to the people we represent is a new concept that so far as I know has never been injected in this Commission before, and I hope never will be. I might say we are referring to some Texas Pacific wells also, and I don't represent them either.

MR. PORTER: The Commission feels that it's immaterial as to the ownership of the wells in the area involved.

Q Will you proceed?

A That is the extent of my comment on this thing. I think it is apparent that a portion of the gas underlying the Gulf Janda H Lease will migrate to the Gackle King No. 1.

Q Is it your opinion as an engineer that that would occur?

A Yes, sir, it is.

MR. PORTER: Mr. Malone, let's take a ten minute recess.

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Malone, would you proceed with your witness?

Q Mr. Liebrock, before we leave Operator's Exhibit 5-R, will you refer again to that exhibit and point out any wells indicated thereon which have extreme ranges in deliverability in relation to the recoverable gas in place as related to offset wells?

A Yes, sir, referring first to cross-section C-C', I think it's worth pointing out that the Continental Lynn "B" 26 No. 4 has a deliverability allowable of approximately sixty MCF per month per acre, which is the lowest allowable in the cross-section of the several wells included in the cross-section, whereas the same well has the highest calculated recoverable gas in place of approximately 41,000 MCF per acre. By the same token, in cross-section A-A', the Amerada State LMT No. 2 has a deliverability allowable of approximately 65 MCF per month per acre, and it is the well with the lowest allowable in the several wells included in the cross-section, whereas it is the well with the highest indicated recoverable gas in place, approximately forty-six to forty-seven thousand MCF per acre.

Q I understand, then, that under the order of the Commission it would be permitted to produce less than any of those adjoining wells, whereas it has the largest recoverable gas in place?

A Yes, that is correct.

Q As to the first well that you testified to, that it has the

smallest allowable and the largest recoverable gas in place of any of the wells in that group?

A Yes, sir, that is correct.

Q Mr. Liebrock, did you prepare the bar graph comparing deliverability to recoverable gas in place on fifty-eight wells in the test area which was attached as an exhibit to the petition for rehearing of a number of the operators?

A Yes, sir I did.

Q Do you have a larger scale version of that exhibit available?

A Yes, sir, I do.

Q Will you refer to that exhibit, please? What is the title of the exhibit to which you are now referring?

A The title of this exhibit, or the purpose of this exhibit is to show the absence of correlation between the deliverability and recoverable gas in place within this area which we studied. On this exhibit we have plotted deliverability in order of increasing deliverabilities. In other words, we have gone through, beginning with the well having the lowest deliverability, which is around 470 MCF per day, to the well having the highest deliverability, which is approximately 19.4 million cubic feet per day.

Q Is there a point up there just above --

A (Interrupting) There's a point and it is covered up but it is there.

Q That is the deliverability of the last well shown to the right on the bar graph?

A Yes, sir. You recall that we mentioned previously that within this area we had approximately a forty-three fold variation in deliverability.

Q To be sure that I understand what this exhibit reflects, what does the green bar indicate as to each well?

A The green dot?

Q The green dot, rather.

A The green dot indicates the deliverability for each well in the fifty-eight well area.

Q What does the red bar indicate?

A The red bar indicates the recoverable gas in place for the same well.

Q For the same well?

A Yes, sir.

Q So that the relationship between the deliverability and the recoverable gas in place as to each well is shown by the green dot and the red bar respectively?

A Yes, sir.

Q Do you have available the information that you can identify each of the individual wells that is shown on here, if that should be of interest to anyone?

A Yes, sir, I do.

Q All right. Now what does that exhibit show with reference to the correlation, if any, between deliverability and recoverable gas in place in these wells?

A Well, it shows that there is no relationship, no correlation between recoverable gas in place and deliverability. For example, if there were any relationship, if there were any general relationship between recoverable gas in place and deliverability, the height of these red bars would coincide much more closely or approximate much more closely the deliverability increasing values as we have shown along here. As you can see, as we proceed from left to right, we don't get any indicated increase in height of the red bar which reflects recoverable gas in place. For example, here, the well which has the highest deliverability in the area has a reserve of approximately 30,000 MCF per acre. Well, there are any number of wells through here that have that much reserve or more with substantially less deliverability, so there is absolutely no correlation between recoverable gas in place and deliverability.

Q Now what is the range of deliverabilities that you found to exist in this group of wells?

A The deliverabilities in this area vary from 450 MCF per day to 19.4 million MCF per day, a forty-three fold variation, approximately.

Q A forty-three fold variation in deliverability?

A Yes, sir.

Q And if those deliverabilities are placed in the proration formula in accordance with the present order of the Commission, will effect be given to that forty-three fold variation without

relation to the recoverable gas in place?

A Yes, sir, it will. For example, here, the second well in our cross section has a very low deliverability, has approximately 500 MCF per day deliverability, yet it has nearly 55 MMCF per acre recoverable gas in place. It will be penalized severely; whereas on the other end of the scale we have a deliverability of over nineteen million, this well has an indicated recoverable gas in place of somewhere around thirty, so it's obvious that it's recovery will be increased tremendously, even though its recoverable gas in place is no greater than any number of other wells in the area.

Q Now, if a correlation did exist between deliverability and recoverable gas in place, what would you find with reference to a line drawn from the tops of each of those bars in relation to the line that's formed by those dots which go across showing deliverability?

A Well, sir, if a general relationship existed, you would find when you connected the top of the bar that they would increase gradually from left to right just as the green points representing deliverability increase.

Q Does there seem to be any such increase there?

A No, sir, I can detect none.

Q Now, if that situation exists and the wells, some of the wells shown in here are offsetting wells or offset each other, what, if anything, will be the result of the proposed deliverability

formula so far as migration is concerned?

A Well, sir, it's apparent, I believe, that it will tend to result in a substantial migration of gas across lease lines with the extent that correlative rights cannot possibly be protected. In some instances this migration will be very substantial.

Q Now, have you made a study in an effort to determine with respect to particular wells just how substantial that migration or how substantial that drainage or loss of reserves will be under the deliverability formula?

A Yes, sir, I have.

Q Will you refer to that study, please?

A Yes, sir.

Q You are referring now to an exhibit marked Operator's Exhibit R-7 and entitled Showing Leases Which Will Suffer Migration Loss Under Deliverability Formula, is that correct?

A Yes, sir, that is correct.

Q Will you tell us just what the study that you have made and the results that are shown on this Exhibit?

A Well, sir, you will recall from our previous exhibit showing the distribution of reservoir pressure throughout the area studied, that we had no tremendous variation in reservoir pressure, the order of magnitude being 100 pounds. The results of our analysis of this study indicates that there will be under the proposed deliverability formula appreciable migration of gas across lease lines over and above what it would be under the acreage formula. The results of our study for the area are shown on this exhibit. Beginning here I might just read off the tracts involved. For example, here we have --

Q (Interrupting) Just a minute, let me clarify one thing. You have not listed on this exhibit all of the wells in this area that you are studying, have you?

A No, sir, we have listed only those wells and tracts which we calculate will suffer migration loss if the deliverability formula is adopted.

Q That is under the formula as now authorized by the Commission?

A Yes, sir.

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Q You have listed the wells which are going to suffer drainage and tabulated the amount of drainage they'll suffer and the value of the gas? A That is correct.

Q All right, will you proceed?

A Just for example, you can see the order of magnitude of variation. We have a maximum migration loss for one lease here of about 3.4 billion cubic feet ultimately. We have some leases which exhibit a very slight loss, for example down here the Texas Pacific Coal and Oil State A No. 30, a very slight loss. I might read down the line just a few. Texas Pacific State A-1 No. 22, Texas Pacific State A No. 21, State A-1 No. 31, State A-1 No. 33. The Continental Lynn B-26 No. 2 is a lease which will suffer a rather substantial migration loss, the Amerada State LM "T" NO. 5.

Here is another well that will suffer a migration loss, the Olson E King which will have a loss of 2.875 cubic feet.

Q You say that that lease is going to suffer that loss. Do you mean that the operator and royalty owners will not receive that gas which they are entitled to receive under the present proration formula?

A Under the acreage formula, yes, sir.

Q Now, who will receive that gas if this deliverability formula goes into effect, who will produce it?

A Well, the gas will be produced by other tracts in the area

which are presently shown in white.

Q You have colored some tracts in the area on the right-hand side of the exhibit, what do those colors indicate?

A Well, we have simply divided it into three groups and classifications, everything colored in green on the map will have an estimated loss of less than one billion ultimately. Tracts colored in brown will have a loss between one and two billion ultimately. Tracts colored in pink a loss of over two billion ultimately.

Q Now, when you say ultimately, what do you mean?

A I mean at the time of depletion of the area.

Q You mean between now and the time that the pool is completely depleted?

A Yes, sir.

Q Now, how did you go about computing the figures that are shown on this exhibit?

A Well, as I stated previously, we have an area that lends itself particularly well to a study of this type. In fact, I think that this particular area lends itself better to this particular type of study than any other area of the field. Not only because we have sufficient information, but because of the minimum variation in pressure throughout here. As I stated previously, any time in a reservoir of this type where you see very little pressure variation, then you immediately conclude that you have rather substantial movement of gas laterally in the reservoir. With that

as a background, and using that type of information, we have distributed the total recoverable gas in place in this area according to the acreage formula, that is we have broken down the total recoverable gas in place the way we think it would be, the way we calculate it would be under the acreage formula and the way we calculate it would be under the deliverability formula. From those two sets of figures we have determined the values that we have indicated here.

Q So that that loss in ultimate recovery is a loss, as compared with the present proration formula, that has been in effect for the last four years as compared to the proposed deliverability formula authorized by Order 1092-A?

A Yes, that is correct.

Q What do you find in that regard in terms of revenue loss which would be sustained by some of the individual leases that are going to be drained under this formula?

A Well, we have made a very simple calculation by estimating that the gas price will be ten cents over the remaining life of the field.

Q Let me ask you whether you consider that to be a conservative estimate so far as gas price is concerned?

A I believe, sir, that it would be conservative.

Q Do you know prices in excess of that that are being paid in the Permian Basin?

A Yes, sir, I do, substantially in excess.

Q Prices range up to sixteen cents at least, do they not?

A Yes, sir, they do.

Q All right. In your computation, based on ten cents per MCF, shows what?

A It shows utilizing the total estimated loss of 53 billion cubic feet for the tracts that converted in terms of revenue would be five million three hundred seventy-five thousand dollars for the tracts shown here.

Q Do I understand then that the effect of the change being made in the formula will be to distribute to different operators and royalty owners in this studied area, five million three hundred seventy-five thousand five hundred dollars, which they under the present formula are entitled to receive?

A Yes, sir, that is correct.

Q Percentagewise how much of a redistribution of wealth does that accomplish by this Order R-1092 A?

A This represents a redistribution of approximately twenty percent of the estimated future recovery from the area studied.

Q So that the estimated future recovery in gas during the remainder of the life of this pool is how many dollars, approximately?

A Five point three million.

Q No, the estimated total.

A The total would be somewhere around twenty-five million.

Q This represents approximately what percentage of the entire Jalmat Pool? A This area?

Q The studied area.

A The studied area represents, oh, some fifteen, twenty percent of the total field. I can check that figure.

Q If that same redistribution of wealth occurs over the entire pool, how much in dollars would be redistributed among the operators and taken away from persons entitled to receive it under the present formula if the proposed formula continued in effect?

MR. CAMPBELL: I'm going to object to that question. There is no testimony here that that same situation exists in other areas of the field. There is not even an indication that it does by this witness.

MR. MALONE: I agree to that, and if you wish to object to the mathematical calculation, we'll withdraw the question.

Q Is there anything further in this exhibit that you would like to point out, Mr. Liebrock?

A No, sir, I believe not.

Q All right. Would you return to the witness chair, please? On the previous hearing there was testimony, I believe, both by you and on cross examination by witnesses from Texas Pacific Coal and Oil Company as to the fact that in the event deliverability goes into this formula, a fract race in Jalmat will inevitably occur, and there was testimony as to the average cost of fracting wells.

Have you made a study since that time in an effort to obtain a realistic figure as to the cost of fracting each well, the average cost of fracting wells in the Jalmat Pool?

A Yes, sir, I have.

Q What figure, in your opinion, is a fair average cost for the fract operation that would be required on each well?

A Well, sir, utilizing additional information, and further reviewing the data available since the last hearing, I feel that a value of $10,000 will be a representative average figure.

Q How many wells, if you know, in the pool are not shown to have been fracted heretofore by the records of the Oil Conservation Commission?

MR. CAMPBELL: If the Commission please, at this point, for the record, I would like to offer an objection to any testimony relating to the economic aspects, economic wastes aspects of this hearing. I take the position I don't want to renew this every time it comes up in the event the Commission overrules me, that is why I'm making it now, that the only basis that this Commission has in the statutes to consider cost economic loss is in relation to well spacing and in preventing the drilling of unnecessary wells. Our statutes does not define waste as economic waste. I believe that costs that are involved to individual operators are not material to this hearing in any respect for that reason and I object to any of the testimony as to that phase of the hearing.

MR. PORTER: Mr. Campbell, the Commission has decided to overrule your objection.

MR. CAMPBELL: Will the record show that my objection goes to all testimony relating to economic loss or economic waste in connection with this hearing.

MR. PORTER: Let the record so show.

Q I believe that the question, Mr. Liebrock, was whether or not you know the number of wells as shown by the Commission records in the Jalmat Pool which are not shown to have been fracked in their completion?

A Yes, sir, our review of the Commission records indicated that there are at least 283 wells which have not been fracked, at least where there is no record of them having been fracked.

Q Now, will you state whether or not in your opinion it will be necessary for the owners of wells which have not been fracked to do so in the event the deliverability formula is adopted?

A Yes, sir. I think it will be necessary for them to frack the wells to see what kind of an increase they can get, yes, sir.

Q What is the reason it would be necessary?

A In order to prevent the drainage of their gas across lease lines to wells which have higher deliverability and therefore higher allowables under the deliverability formula.

Q Now would you state briefly, Mr. Liebrock, how a frack job is accomplished on a well such as the Jalmat well?

A Well, there are various approaches that might be used. I

would suspect that where the company conducting the frack job feels that the condition of the well is such that they can inject large volumes of sand and oil, that they will conduct large volumes, high injection rate frack treatments by going down the casing.

Q Is that the normal way of carrying out a frack job?

A Yes, sir.

Q Is it carried out under high pressures?

A Yes, sir, relatively high pressures.

Q What pressures on the casing occur in the course of such a frack job?

A Well, sir, I think it's reasonable to expect that the type of frack jobs performed in this field would result in wellhead injection pressures of around two to three thousand pounds.

Q Per square inch?

A Yes, sir.

Q When was the first gas well in the Jalmat Pool drilled, if you know?

A I believe it was September of '29.

Q Are there in the Jalmat Pool a number, a large number of old wells that have had casing in them for a long time?

A Yes, sir, there are.

Q Taking that condition into account, will you state whether or not in your opinion the widespread fracking or attempts to frack wells in the Jalmat Pool would or would not result in underground waste?

A Yes, sir I think there is a definite possibility that it would.

Q How would that occur, in your opinion?

A Well, sir, I think that in old wells where the casing is old, the operator who decides to perform a high injection rate frack treatment runs the risk of rupturing his pipe and bursting it, and possibility of water coming in from above, or if the pipe is all right, I think in the great number of the open holes, the operator runs the risk of fracking down into water, with the result he would have the invasion of the well bore with water, and to a certain extent,the surrounding formation.

Q Would you elaborate a little, please, on what you mean by fracking down into water?

A Well, sir, I think it's commonly accepted fact that the directions taken by the fractures resulting from imposing high pressure on the formation,take off in various directions. I think it has been positively established that some of these fractures extend in a vertical direction, and if they do extend in a vertical direction then there is a possibility of them fracking downward into water.

Q Would that result in physical waste?

A Yes, sir, in those instances where water came in from the bottom portion of the formation and invaded the reservoir surrounding the well bore, the recovery of gas from that area would be less than it would have otherwise.

Q Now, you have referred in your testimony to the range of increases that would result in the allowables of individual wells if this new formula goes into effect. Can you give us some examples of the increase in allowables in particular wells that would occur under the new formula?

A Yes, sir, I can cite a few. We could take the proration schedule and cite a great many, but I have selected here a few that might be of interest. Beginning first with the Cities Service Clausen "C" No. 1, under the acreage it would be an allowable of 41.2 million a month, whereas under the proposed deliverability formula it would have an allowable of slightly over two hundred million a month.

Q That's an increase from 41 million to 200 million a month?

A Yes, sir. The Clausen, the Cities Service Clausen "C" No. 3, an increase of 41 million to 172 million a month. The Continental Stevens B-18 No. 1, an increase from 20.8 million to 82.5 million. The Gackle King No. 1 from 20.8 million to 108.6 million. Finally the Western Natural McDonald State No. 3 from 20.8 million to 111.8 million. They're varying degrees of variation throughout the field.

Q Now, have you made a study of the location of some of these wells as to which you have just testified with relation to water encroachment in this Pool?

A Yes, sir, I have.

Q Will you state whether or not in your opinion the increase

of allowable in any of those wells will result in physical waste if the allowable provided by the new formula is applied?

A Yes, sir, we have given particular attention to the Cities Service Clausen wells on the west side of the field.

Q Why did you give particular attention to those wells?

A Because our analysis of the reservoir performance over there demonstrates conclusively in our opinion that you do have some influxion of water and that you have sufficient volume of water in contact with the gas over there to provide some of the energy which is contributing to the expulsion of gas.

Q How in your opinion then would physical waste occur in the event this increase in allowable is taken from those wells?

A Well, sir, in the instance of these two wells where the allowable would be increased from approximately three to five fold I think that it could very easily result in premature invasion of the formation by water.

Q In other words, it would be a condition which would be conducive to early fingering of the water into these wells?

A I have discussed this matter with the engineers who are particularly familiar with these wells and that is also their opinion.

Q Now, you have heard testimony in this case, Mr. Liebrock, to the effect that the acreage formula which is now in existence or which is in existence till Order R-1092-A was issued, has been in existence since January 1st, 1954, or a period of some

four years?

A Yes, sir.

Q Assuming that during that four-year period there have been sales of properties from time to time, loans made to operators from time to time, and sales of royalty interests from time to time, will you state whether or not a change at this time in the proration formula would adversely affect the persons who entered into such transactions during that four-year period?

MR. CAMPBELL: If the Commission please, I would like the record to show that I object to that question upon the ground that it's immaterial inasmuch as no operator acquires a vested property right in allocation formula.

MR. PORTER: Mr. Campbell, the Commission will sustain your objection.

MR. MALONE: If it please the Commission, for the record I would like to make a tender of proof so that the proof which we propose to make by this witness would be in the record in the event of a review of the proceeding.

MR. PORTER: You may proceed, Mr. Malone.

MR. MALONE: Come now the Jalmat operators and make the following tender of proof upon the objection of Texas Pacific being sustained by the Commission. If permitted to do so, the operators would show by this witness that it is a common procedure to purchase properties and royalties, and for banks and financial institutions to make loans on the basis of the period of months required

to pay out the purchase price of the property or the amount of the loan, as the case might be; that such transactions are concluded on the basis of the existing proration formula, and that a change to the formula authorized in the Order 1092-A would adversely affect the parties who so entered into those transactions.

The operators would further show by this witness if permitted to do so that during that period operators have pooled their properties to form units under the acreage allocation formula, which units were advantageous to the parties under the acreage formula and would not be advantageous to the parties under the proposed formula, but that having contractually agreed to do so, they cannot now rescind the units which they made upon reliance on the Commission's prior order.

MR. PORTER: Mr. Malone, the Commission will deny the tender of proof.

Q Mr. Liebrock, based upon the study which you have made of the Jalmat Pool, will you state whether or not in your opinion there exists any correlation, general or otherwise, between the deliverabilities of wells in that pool and the recoverable gas in place under the tracts assigned to the well?

A No, sir. From my study there is no indication that such a correlation, general or otherwise, exists.

Q Will you state whether or not there exists in your opinion any correlation or constant relationship between reserves in the Jalmat Pool as computed by Texas Pacific Coal and Oil Company witnesses in this case and recoverable gas in place under the tracts assigned to the wells?

A No, sir, from my study there does not.

Q Will you state whether or not in your opinion there is any basis for assuming, or it can be assumed as a valid engineering concept, that a relationship exists between deliverabilities and recoverable gas in place if it be conceded that a relationship exists between deliverabilities and reserves computed by material balance calculation?

A No, sir, even, if I understand your question correctly, even if there is some indication of a correlation between deliverability and reserves computed by the material balance calculation as

applied by Texas Pacific, even if there is some relationship of reserve there, there is no reason to believe that can be extended further to conclude that there would be a relationship between deliverability and recoverable gas in place.

Q Have you found anything to indicate such a relationship exists? A No, sir.

MR. MALONE: If it please the Commission, I think I'm through with this witness, if the Commission is thinking of adjourning for lunch, unless something else occurs during the noon hour while I check my notes.

MR. PORTER: The Commission is thinking of recessing for lunch. Suppose we take a recess until one-fifteen.

(Recess.)

AFTERNOON SESSION

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

MR. MALONE: If it please the Commission, as sometimes happens I thought of a couple more questions during the noon hour.

Q Mr. Leibrock, you testified this morning to an estimated $2,830,000 cost of the frack rates which you felt would result from injection of deliverability into the Jalmat gas proration formula. I did not ask you whether as a result of that expenditure the ultimate recovery of gas from the Jalmat Pool would be appreciably increased.

A No, sir, I do not think there will be an increase of any consequence.

Q Now, I would like to refer you again to Operator's Exhibit 7-R, which shows the migration which you anticipate will occur if the change in formula contemplated by the present order is made. You testified that the drainage which is reflected by this loss in ultimate recovery and revenue loss was a loss as compared to the production that would be expected under the present acreage formula, is that correct?

A Yes, that is correct.

Q Did you, in connection with making these computations, also compute the drainage loss that would occur under the acreage formula as compared to recoverable gas in place, or a perfect formula if one could be devised?

A Yes, sir, we did.

Q What was the extent of drainage loss that occurs under the present acreage formula as compared to perfection?

A It is approximately 25 billion cubic feet.

Q In dollars that would amount to what?

A To approximately 2.5 million.

Q Then if I understand you, under the present formula the deviation from perfection or a perfect formula that occurs under acreage results in drainage of about two and a half million as compared to a drainage of $5,375,000 under the proposed deliverability formula--

A Yes, that is correct.

Q -- is that correct? Did you also compute the deviation of the deliverability formula from perfection? That is to say, the drainage that would occur in this area as compared to the recovery if a perfect formula could be devised?

A Yes, sir, we did.

Q Approximately what did that amount to?

A Approximately fifty billion cubic feet.

Q Approximately fifty billion cubic feet, so that the deviation from perfection of the deliverability formula is approximately the same as the deviation from the present acreage formula, is that correct?

A Yes, that is correct.

Q That is the change that will occur if the formula as proposed goes into effect?

A Yes, sir, that is correct.

MR. MALONE: That's all.

MR. PORTER: Does anyone have a question of Mr. Liebrock?

MR. CAMPBELL: Yes, sir.

MR. PORTER: Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Liebrock, since the last hearing before this Commission on this matter, what data have you studied that you did not have available at that time?

A We have made a more comprehensive study of the data that we had available at that time.

Q Have you had any additional data that was acquired or available to you since that time that was not available to you at the time of the last hearing?

A Well, sir, I believe we had the core analysis that you had available and admittedly I had it at the time of the hearing, but I hadn't had a chance to study it at the time.

Q Then your answer is that so far as new data is concerned available since the last hearing, you have had none, is that correct?

A I can't state definitely that I haven't had any new data at all. I would have to review my files, but that is substantially correct.

Q What might you have had?

A Some additional deliverability data on a few wells that I

didn't have at that time, but that is substantially correct, I don't have much additional information that I didn't have then.

Q Your study, your concentrated study of the Jalmat area at the time of the last hearing was confined to the fifty-eight well area, was it not?

A Yes, sir, except I would like to clarify just a little. We referred to it as a fifty-eight well area, it is an area that contains approximately 11,000 acres and sixty-seven wells. Of the sixty-seven wells we had data on fifty-eight, that is, deliverability data.

Q I believe you testified that that contained fifteen to twenty percent of the total acreage within the Jalmat Gas Pool?

A I said this morning, I mentioned a figure like that, but I would have to check it to be sure.

Q But the area that you have been referring to here today which you have studied, the 11,000 acre, sixty-seven well area if you please, is the same area you studied prior to the time of the original hearing, is it?

A Yes, sir, that is correct.

Q Have you had any additional data available to you within that area since the time of the last hearing?

A No, sir, I don't believe so.

Q For the purposes of the evidence that you have offered here today relative to that area, you had the same data available and made the same types of calculations, or used the same assumptions

for your calculations as you did at the prior hearing, is that correct?

A Well, sir, I don't know whether that's true or not. I don't know exactly what assumptions you have reference to.

Q You will recall, Mr. Liebrock, at the last hearing, that I questioned you as best I could about the basis for some of your conclusions with reference to your determination of recoverable gas in place within this area?

A Yes, sir.

Q You testified at some length there with regard to the five cores that you had studied?

A Yes, sir.

Q With regard to, I believe, the thirty-eight logs that you had studied?

A Yes, sir.

Q With regard to the assumptions that you made with reference to porosity and connate water, do you recall that testimony?

A Yes, sir, but I want to clarify one thing there. I don't quite agree with you on the use of the word "assumption". I don't believe I made any assumptions, in the sense that you are talking about.

Q Well, it may not, what I was referring to was,I believe your testimony that using the data you had available, you then -- "extrapolate" is probably not the word, but you used that as average within the area to the extent that you testified at the

last hearing, it's in the record.

A Yes, sir, I think I can answer that question a little better. As you recall, we had some porosity data on the south side of the field and on the west side and to the north, and we also had one core analysis within the field and have those core data based on the criterian we used for estimating net pay, we didn't come up with an appreciable variation in porosity so I think when you say assumption of porosity for the whole area, it implies that the quality of the data wasn't sufficient to justify using that value.

Q That is the point I want to make. I am not trying to change your testimony from the original hearing.

A Yes, sir.

Q What I want to ask you is this. Have you had any data available or have you made any different approaches insofar as the recoverable gas in place in this area is concerned, for the purposes of your testimony at this hearing, that you did not use at the last hearing?

A Are you questioning me simply from the calculation of the recoverable gas in place?

Q Yes.

A Yes, there hasn't been any change, we calculated it the same.

Q You had stated, Mr. Liebrock, the reason you did not extend your study outside of this 11,000 acre area since the last hearing is that data was not available and time was not available,

is that correct?

A Well, principally data, sir.

Q You testified that you had available deliverability data on only fifty percent of the wells outside of this 11,000 acre area?

A Approximately.

Q What effort did you make to obtain additional deliverability data beyond the fifty percent that you say was available?

A We had made what I consider to be a pretty exhaustive search of the files and records and the various sources at the time we made our first study, and I believe from my contacts with the various engineers that I worked with that they came up with all the deliverability data that was available. There may be data in the files of various companies that we did not have, but I thought that we made a reasonable and determined effort to get it in the first place, and so I didn't feel there was, that any further effort on my part would be very fruitful from the standpoint of turning up a tremendously large volume of additional information. I feel confident that is the case.

Q Did you investigate to determine whether the Oil Conservation Commission had in its files deliverability test data beyond the fifty percent to which you referred in your testimony? Did you check the files of the Commission?

A Not since the first time, no, sir.

Q Did you check the files of the Commission the first time?

A Yes, sir, in Hobbs.

Q Did you check the files of the Commission in Santa Fe?

A I would have to talk to a number of engineers that I worked with. I am not sure, I don't know whether we did or not.

Q How many actual deliverability, well deliverability tests did you have available to you within the 11,000 acre area by number?

A Fifty-eight.

Q Out of the sixty-seven?

A Yes, sir.

Q How many did you have available to you outside the 11,000 acre area?

A Well, sir, eliminating the marginal wells, somewhere around one hundred forty, fifty, something like that.

Q Do you believe if you had available to you deliverability test data on all or almost all of the wells within the 11,000 acre area, your study would have been more thorough?

A I'm sorry, I didn't quite get that.

Q Speaking now of the 11,000 acre area, if you had studied deliverability test data on more than the fifty-eight wells within the sixty-seven well area, would your study have been more complete?

A To the extent that sixty-seven is more complete than fifty-eight.

Q Would that same thing have been true if you had had more than fifty percent of the deliverability data on the wells outside

of that area available to you, could you have made a study of that other area?

A I don't know whether we could have or not. Deliverability data was one of the things that entered into the decision, however, I might add also that I don't feel that the quality of reservoir data in general, outside of the fifty-eight well area and the surrounding area, is as good as it is in the area that we studied, so that is one factor, but that is not the whole question.

Q Now, Mr. Liebrock, is there any gas proration formula that will prevent migration between properties so long as there are not impermeable barriers between properties?

A As a practical matter, I don't think it would be possible to devise a formula which would completely eliminate migration, an acre foot formula perhaps would be close to realizing that objective.

Q So that the best allocation formula would be the one that more closely minimized or minimized to the greatest degree the possible migration between properties, is that not correct?

A Yes, sir.

Q Have you made any effort to determine or analyze the drainage situation in this pool outside of the 11,000 acre area on the 100% acreage formula?

A No, sir. We haven't made any quantitative approach to the problem. Any engineer looking at the data would have some ideas qualitatively of what might be taking place.

Q Are you acquainted with the variations in pressure in this Jalmat Pool areawise? A Yes, sir.

Q Generally? A Yes, sir.

Q Are you acquainted with the fact that generally speaking the areas of lower pressure lie in the southern portion of the Jalmat Gas Pool? A Yes, sir.

Q Is it a correct engineering principle that migration of oil or gas is generally from the high pressure to the low pressure

areas?

A Well, sir, that's a question that you can't give, it doesn't lend itself to the type of answer that you are looking for. In other words, it doesn't lend itself to a simple answer. I would be glad to answer the question taking the time that I feel would be required to answer it. I think it is a good question, but you can't just say yes or no to that question because there is a yes answer depending on certain conditions and no answer depending on certain other conditions. I would be glad to take the blackboard and explain that.

Q No, I don't want you to do that. You say there is not an engineering principle, a general principle, that movement of oil or gas by way of migration is from high pressure to low pressure areas?

A Yes, sir, generally that's right, where you have a pressure differential and you are familiar with the reservoir conditions and you know that that pressure differential must of necessity reflect migration, that is true. But pressure differential quite frequently can reflect something else. It can reflect a combination of a great many things as to characteristics of these reservoirs. For example, an extremely sharp pressure gradient could indicate the presence of a permeability barrier. It could, due to precise pressure, indicate an impermeable barrier where no gas was moving across. There would be an apparent movement of gas, but actually it wouldn't be necessary.

Q Do you have any reason to believe that Jalmat contains any such impermeable barrier?

A I have good reason to believe that Jalmat has such a tremendous variation in permeability.

Q We are not talking about permeability. We are talking about pressure.

A Well, it's all related. You said barriers, didn't you, sir?

Q Yes.

A Well, permeability and barriers are associated normally where you have low permeabilities you have in effect the result of a barrier. In other words, you may have conditions in the Jalmat reservoir where gas is free to move to a limited extent but where the migration rate is extremely small, even though the pressure gradient may be extremely high. The point I'm trying to make is that pressure gradients are not indicative of volumes of migration movement. You see what I mean?

Q Of volumes, have I asked you about that? I asked if there was a relationship, that is where the migration in any reservoir is generally from the high pressure to the low pressure areas. As I understood you answered yes were these qualifications that there might be other factors affecting it?

A Yes, sir, and I didn't finish giving you all the qualifications.

Q You have also testified that there are considerable variations

in pressures throughout the Jalmat Gas Pool?

A Yes, sir.

Q Does it not follow that a reduction in allowable in the low pressure areas might tend to minimize that migration?

A Well, sir, that's getting right back to just exactly what I was talking about, whether or not it would tend to minimize the migration depends upon the freedom of movement of gas from the high pressure area to the low pressure area, so --

Q (Interrupting) Aren't you talking about the degree or the volume rather than the fact of movement, if there is movement, if this is one reservoir there is movement, is there not?

A Yes, sir. Yes, sir. But the volume of movement is important, if the volume of movement is small, then it is inconceivable that adoption of a different formula could have any significant effect on a distribution.

Q The only basis that you have for assuming either well, the area that you have studied, you have already conceded has a complete movement almost you have assumed 100% movement in some of your exhibits?

A Yes, sir.

Q Have you not?

A Yes, sir.

Q Mr. Liebrock, you stated in connection with your Exhibit 3-R, which was the approach to the relationships between porosity and --

A Yes, sir.

Q (Continuing) -- and permeability, that the greatest

single factor in determination of gas in place is the porosity, is that your statement?

A Yes, sir. I said for a given interval of rock, yes, sir.

Q And previously and also at this hearing you have testified that pressure in this area you studied is relatively uniform?

A Yes, sir. That is correct.

Q Is the porosity in your opinion, or variation in porosity, the most important part of the variation in gas in place insofar as your study of the Jalmat Gas Pool is concerned?

A No, sir. In the area I studied?

Q Yes. A No, sir.

Q What is the most important factor?

A Well, sir, as we stated previously, we didn't observe appreciable variation in porosity in that area, so the only other factors that enter into the pore volume calculation is the pressure and the pay thickness.

Q What about the pressure and pay thickness, don't they have a bearing on the gas in place? A Yes, sir.

Q To what degree?

A We have a formula where we indicated the various factors that entered into the calculation.

Q Then your calculation on your Exhibit 3-R, and I may have misinterpreted your conclusion, I got the impression that you reached the conclusion that porosity and permeability were not closely

related, and that therefore the gas in place in deliverability were not closely related. Had you taken into consideration pay thickness and pressures as additional factors in gas in place it might alter that conclusion, might it not?

A Well, sir, we have taken those things into consideration in our calculation of recoverable gas in place. We varied the net pay thickness to the extent we have indicated on our map. We varied the pressure to the extent indicated on the map, and I think that I properly evaluated all the factors that should be considered in calculating recoverable gas.

Q Now, with regard to your testimony concerning the fracturing of these wells and the frack race that is going to result, in your opinion, if deliverability becomes a part of the allocation formula in this pool, I believe you testified in answer to a question by Mr. Malone after lunch that in your opinion these costs would be incurred without any appreciable or consequential increase in ultimate recovery. What do you mean by that?

A Well, sir, I mean simply that I don't feel that over the life of the field, the life of the reservoir, that the additional fracking work as it applies to the reservoir as a whole, will result in a substantial increase in the recovery of gas. In other words, I don't think that the productivities for the field as a whole will be increased enough to result in a substantially lower abandonment pressure. However, I did not assume in that statement that it

wouldn't change the recovery appreciably from individual wells, the wells where you are able to materially improve the productivity by fracking, you perhaps would, it's just going to result in a redistribution of recoverable gas in place that we have testified to previously.

Q Well, you apparently believe there will be some increase in ultimate recovery as a result of any fracturing that may take place?

A Well, on an individual well basis I think that is where you will see the big increase.

Q I am asking you about the pool. Have you testified that there will be no increase in ultimate recovery, or not very much?

A I don't think there is, will be of any consequence.

Q What do you mean by consequence, will there be some?

A Yes, sir.

Q With regard to the individual wells that you have used in your exhibits, your horrible examples, did you consider in connection with those wells that the completion data on the wells in relation to each other?

A No, sir, we considered only the data that appears on the exhibit.

Q Did you consider in the Continental wells, for example, whether or not those wells had tubing?

A No, sir, we did not.

Q Whether or not any of the wells were open hole completions?

A No, sir, except that of course we were aware that these conditions existed.

Q The circumstances with regard to comparisons between wells would be affected to some extent by those factors, would they not?

A Yes, sir, it would perhaps be affected to some extent, but that would be a minor consideration compared to the fracking changes that might result, or the changes that might result in productivity from fracking.

MR. CAMPBELL: That's all.

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

MR. HOWELL: I have a few questions. Ben Howell, representing El Paso Natural Gas Company.

By MR. HOWELL:

Q Mr. Liebrock, the 11,000 acre area which you selected for your study is probably the best area in the entire Jalmat Gas Pool, is it not?

A You mean from the standpoint of deliverabilities or recoverable gas in place?

Q Well, let's take them one at a time, from the standpoint of recoverable gas in place, it is probably the best area, is it not?

A Well, of course, any answer that I might give would be highly qualified, because as I stated previously, we haven't had an opportunity to calculate; we don't have sufficient data to make a study of the reservoir.

Q Well, from the standpoint of deliverability and the actual production that is taking place today, the group of wells that you studied were among the best in the Jalmat Pool, are they not?

A Well, sir, I haven't compared them to the other wells in the field.

Q Are you unable to answer the question, or did you look at the wells that you studied in comparison with other wells in the field as to their capacity to produce?

A Yes, I have a list of deliverabilities on all the wells where we were able to obtain deliverability, and I know that the

highest deliverability well or one of the highest is in this area. Having found that we couldn't extend our gas in place study to the remainder of the field, then we didn't make the same comparison outside of the fifty-eight well area, or the 11,000 acre area that we made here, so it is difficult for me to make a comparison or answer your question without having to qualify it, because I just haven't looked at it.

Q The pressures in this area are better than the pressures in the major portion outside your study, are they not?

A Yes, sir.

Q The best pressures in the field are in this area?

A Generally speaking, I believe that's true, yes, sir.

Q Do you have any information as to the relative dates of development between this area and other portions of the field?

A No, sir, but I know that I could get it.

Q Did you give any consideration to that in making your study?

A Yes, sir, you'll recall from our Exhibit 2-R we commented at length on the effect of early development on the performance of that well and the effect of migration to and from that well and we certainly considered it.

Q Did you consider the volumes which had been produced in other portions of the field?

A In what respect did we consider?

Q In making your studies, did you give any consideration to the extent of completion in the other portions of the field?

A No, sir, only to the extent that you can make some qualitative conclusions simply from looking at the pressure, but I haven't related the pressures and recoveries in the field as a whole, no, sir.

Q Now then, referring to your Exhibit R-7 which is behind you, I note that you have colored certain leases or sections, let us say, tracts of land, to indicate that those sections will lose gas reserves in your opinion?

A Yes, sir.

Q To what point do you expect those reserves to go?

A Sir, would you rephrase the question?

Q No, perhaps you can tell me where the reserves are going from there?

A Oh, yes, sir. I think that they will be, from our study of this area I think it will result in a redistribution for the most part within the area.

Q Will the reserves from the flanks there under your estimate move to the center of the field?

A Well, sir, it is difficult for me to predict what will happen in the future because the pressure distribution will be upset to some degree by the allocation formula that you use in the future, and the fact that you might have a thousand pounds pressure here and nine hundred here, it doesn't necessarily follow that the same pattern will hold for the future. I can't qualitatively predict, or even on the edge leases here qualitatively tell what

might happen.

Q Do you assume that the loss of reserves will go from the lower pressure areas to the higher pressure areas?

A Generally, yes, sir, in a continuous reservoir.

Q And so you base your conclusion on the drainage going to the high pressure areas?

A No, sir.

Q I thought I just asked a question there, that question, and you stated that you did anticipate the movement of reserves from the low pressure areas in your plat there to the high pressure area?

A I am sorry, I misunderstood your question. Certainly I wouldn't anticipate that.

Q Where do you expect that to go?

A I think that the reserves, the recoverable gas in place that we have calculated for this area will be redistributed almost in direct proportion to the withdrawals that will result under the new allocation formula. I think the very fact that you have a minimum amount of pressure variation dictates that that will be the case.

Q Do you expect any of the reserves to migrate outside the area of your study?

A No, sir, I don't expect an appreciable volume,percentage-wise, I do not expect -- there of course will be some migration across our red boundary line, but the percent of migration that's taking place within this area as a whole will be much larger than any

migration that's occurring across the lease line.

Q As a matter of fact, there will be migration regardless of that formula? Whatever formula may be used, the actual production will result in migration, will it not?

A To some degree.

Q Yes.

MR. HOWELL: That's all.

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

By MR. UTZ:

Q Mr. Liebrock, I believe you stated earlier in answer to Mr. Malone's question, also Mr. Campbell's question, that you didn't feel there was enough deliverability information available to study the area outside this small area that you have studied?

A Yes, sir.

Q Are you familiar with our four-point method test that we run in Jalmat?

A Yes, sir.

Q Do you consider that deliverability information?

A Yes, sir, we utilized a great many of those in our study.

Q Do you know how many of those tests are in, how many wells have been tested by the four point method?

A As of right now?

Q Yes, sir.

A No, sir, I don't.

Q What percentage of wells reported would you think would be an ample amount of deliverability information to have studied the area outside of this area, small area?

A Well, sir, assuming for the moment that the quality of our other reservoir data is as good as we have in this area we have studied, then if we could get percentage-wise close to what we had in the 11,000 well area, then I think it would be sufficient.

Q What I'm asking you is not about the other reservoir area, but about the deliverability information which you said was one of the reasons for not studying the area?

A Yes, sir.

Q Would eighty-five percent of the wells being tested, would deliverability information be ample as far as deliverability is concerned?

A Yes, sir, I think so, other things being equal.

Q Would it surprise you to know that we have eighty-five percent of those wells tested?

A No, sir, at this moment it wouldn't.

Q At the time you made your last study, would it surprise you to know that you had probably over seventy-five percent of the wells tested and the information available?

A No, sir I wasn't aware of that.

Q If you had known that, would that have made any difference in your decision not to study the area outside of your picked area?

A Well, sir, it certainly would have been a factor.

Q For your information, it appears that you didn't know at the time you made the first study that there was that much information available, and as of now there is eighty-five percent of them available. Now your reserve studies kind of put me in a quandary. There are about four factors in the volumetric reserve calculation, is that right, that are reservoir factors that are important to the calculation?

A Yes, sir.

Q Could one of those be porosity?

A Yes.

Q Could one be connate water?

A Yes, sir.

Q Where did you get your connate water and porosity information to calculate the reserves that you show on your Exhibit 5-R, I believe it is?

A We use the average porosity figure that we indicated previously.

Q From the five cores that you indicated in the last hearing?

A Yes, sir.

Q Three of those cores were outside of this area, were they not?

A Yes, sir, I believe so.

Q Two of them inside the area?

A Maybe four out and one in.

Q You applied those average figures to each well that you

calculated the reserves on, or each tract?

A Yes, sir, that is correct.

Q Those two factors, if you use the same porosity and the same connate water for each well, you couldn't hope to show much variance in reserves, could you, if you used the same factor on each tract?

A We indicated that we didn't have any reason to believe that the porosity would vary.

Q What reason did you have to believe that that porosity that you used was applicable to each tract that you calculated reserves on?

A In my study of sand reservoirs all over this country, it has been my experience that the porosity of sandstones don't vary to the extent they do in limestone, and that over tremendous areas you can have rather appreciable variation in permeability, but the porosity may not vary over two percent. When I found five core analyses, I came up with the range of sixteen to seventeen percent porosity, roughly, I felt that with a great deal of confidence that I could use an average porosity figure. I feel in all sincerity and I know from my experience that I did not introduce appreciable error in these. I can cite field after field of sandstone fields from my own files to support my position on that matter. Now if my average porosity did not vary, and I have good reason to believe it doesn't, then I don't believe that the use of an average interstitial or connate water value introduced appreciable error in the calculation. That is based on my experience,

not only in this field but every sandstone field that I have ever analyzed.

Q Does porosity vary vertically throughout the section?

A Yes, it does.

Q Is it very consistent?

A No, it isn't very consistent.

Q Do you think there may be a chance of it varying quite a bit among the tracts you calculated the reserves on?

A The average, no, sir, I very definitely do not.

Q Two of the other most important factors in calculating reserves by your method is pressure and net pay, is that right?

A Yes, sir.

Q How did you arrive at the net pay on these various tracts?

A From the logs that we had available primarily radioactivity logs.

Q And your pressures are determined by actual bottomhole pressures?

A Surface pressures corrected to bottom-hole conditions, yes, sir.

Q Pressures didn't vary a great deal in this area, did they?

A No, sir, as I indicated previously, the pressures varied approximately one hundred pounds, maybe a little more.

Q You think that a hundred pound variation in pressures is representative of the whole pool? A No, sir.

Q Do you know what the variation of pressures is throughout the Jalmat Pool?

A Yes, sir, roughly, yes, sir, I don't know the value on the lowest well or the value on the highest, but I have a pretty good

knowledge of the order of magnitude of variation.

Q Would there be a pressure, in your opinion, as high as 1,060 pounds?

A Yes, I'm sure there would be.

Q Do you know of any pressures as low as 350 pounds?

A Yes, sir.

Q That is quite a bit more than 100 pounds, isn't it?

A Yes, sir, it is, but if you don't mind I would like to point out that that is not the test of determining the applicability of a formula.

Q How does pressure affect reserves?

A Well, it enters into the pore volume calculation in direct proportion.

Q In other words, are you telling me that 333 pound pressure, everything else being consistent, would have the third of the reserves of a thousand pound pressure?

A Oh, roughly.

Q Is the pressure directly related?

A Yes, sir. That's what I just said.

Q That is quite a bit more in the variation of pressure than you get in your small area?

A Yes, sir, that is not the point.

Q All right. I would like to know the point.

A The point is simply this, that where you have, even though

you have only one hundred pound variation in pressure, and even though you only have a 3.5 fold variation in porosity, or excuse me, in net pay thickness, you have a forty-three fold variation in deliverability. Now, you have this variation in an area of the field where it's pretty obvious from the pressure map that migration is going to be the most severe. Where would you attempt to determine the order of magnitude of migration in this field other than this area, even assuming for the moment that the quality of all our reservoir information was equal throughout the field, any engineer approaching this problem would immediately recognize from the pressure distribution that this is the area where migration is going to be extremely severe and this is the area that you would center on. Areas where you have sharp pressure gradients are not indicative of tremendous volumes of gas movement, they are indicative of a tight reservoir rock.

That is my point, you can't find a better area in the field to investigate the applicability of this formula or any other formula than this area. The quality of your data is a lot better here, I might say all of it, your pressure data, I have a lot more confidence in the pressures that I read in this area than I do any other area in the field.

When you mentioned the pressure of 350 pounds, I don't know whether that is a good pressure or not. It may not be built up, it may be 450 pounds, but in this area I am confident that we have a

lot better quality pressure data and everything else than we do in any other portion of the field. So if the deliverability formula doesn't meet the test here where we have got good data, how can it possibly meet it any other place. That's my whole point.

Q What you are actually saying is that you don't know too much about the rest of the field but you do know quite a bit about this area?

A Yes, sir, it's very obvious that we know a lot more about this area than any other portion of the field, but I would like to point out further that I think all of us know more about this area because we have more data that we can rely on in this area. I don't think any of us know as much about the rest of the field as we do this area, if we make a general concerted effort to understand it and analyze it. I would like to add one other thing, if you don't mind.

Q Go ahead.

A In my study of oil fields and gas fields over the country where you have a tremendous aerial extent and where you have the pressure variations that you observe in this field, it isn't common practice to attempt a field-wide study. You generally study your reservoir by areas, you can learn a lot more about them and you can come up with conclusions and recommendations that are a lot better supported if you will study your reservoir by areas than if you attempt to lump the whole thing together and arrive at some broad

conclusion based on overall performance. Nothing could be more misleading than to throw the whole reservoir in one study and attempt to arrive at some conclusion and recommendations.

Q How would you prorate the pool?

A Sir?

Q Don't we prorate the pool on an entire pool basis?

A Yes, sir, and that's one of the difficulties.

Q Would you suggest breaking the pool down in smaller areas?

A For study I definitely would.

Q For proration, we are talking about proration formula.

A Well, I haven't gone into the field-wide study of proration, but for study, to get some idea of what you might do, I would certainly break the field down into areas, and I believe every reservoir engineer would break the field down into several areas to study, I feel confident that they would.

Q Would you have available the actual reservoir calculations for each of these tracts shown on Exhibit 5-R?

A Yes, sir, I believe we do. They were out at the noon hour. I believe they are back now.

Q Well, I don't mean to put them in now, but would you make those available to us? A Yes, sir.

Q I would like to go into Exhibit 1-R very briefly with you, you made a comparison, at least I understood that you did. Were you comparing a tank with so much pressure in it to Jalmat reservoir?

A No, sir, I'm comparing it in Case 2, I'm comparing it to a lease in the Jalmat reservoir. In Case 1, sir, I can't compare it to a lease because it is not analogous to the situation we have in the Jalmat reservoir.

Q That is the point I want to clarify in my mind.

A Yes.

Q There is no permeability barriers or anything in that tank, is there?

A No, sir.

Q It is completely homogenous?

A That's right.

Q You are not saying that Jalmat reservoir, is that homogenous then?

A No, sir, it is not a matter of homogenity, it is the matter of developing a case that is analogous to the reservoir.

Q Are you comparing a valve on a tank with the availability of gas to a well bore?

A I'm comparing it to the deliverability, yes, sir, of a well.

Q Well, would the availability of gas to the well bore affect the deliverability?

A The permeability of the reservoir, yes, sir, would affect the deliverability.

Q I mean if all the pay was open to the well bore as compared to half of the pay open to the well bore.

A Yes, sir, that would make a difference.

Q A difference in deliverability, wouldn't it?

A Yes, sir.

Q Let me ask this question, do you think that the vertical communication throughout Jalmat Pool is good?

A Well, sir, I don't know.

Q Would you suspect it to be shale lenses and so forth that would affect vertical deliverability?

A Yes, I suspect there would be.

Q Then in that case, if the well only had 50% of the net pay available to the well bore, the rest of the gas wouldn't be available for production, wouldn't be recoverable reserves?

A It wouldn't be available to that well, but it would be available to the offset well if he had it open.

Q I thought, that is what we are trying to get away. I thought you wanted to let the individual tract produce its own reserves.

A That's what we do want to do.

Q Then the answer to your question is simply if a well has only fifty percent of the gas available to the well bore, that he wouldn't getitsomebody else will?

A If the vertical communication, I didn't say that the vertical communication wasn't good. I said that I suspected that there were instances where there would be shale breaks that would prevent good vertical communication.

Q But you don't really know whether it's good or not?

A No, sir.

Q One more thing, I hate to bear on this point too long, we have already had two questions regarding it, but your statement that fracking a well will not increase ultimate gas recovery is a little confusing to me. I wonder if you would explain why you don't think that by having the well in good condition and having a little higher deliverability will not increase the ultimate recovery of gas from that well.

A I didn't say it wouldn't increase the ultimate recovery, but I don't think it will result in appreciable increase in ultimate recovery because you would have to increase the average permeability of your entire reservoir rock rather substantially in order to get the abandonment pressure down to a lower value and to a sufficient lower value to substantially increase the ultimate recovery.

Q Are you familiar with the producing characteristics of a Jalmat well?

A Well, I know I'm familiar with the ability of the wells that deliver gas based on the deliverability data I have.

Q Do you know whether or not you have substantial liquid problems?

A In some wells, yes, sir, I know you do.

Q In a well that you have substantial liquid problems and have to lift liquids of either water or hydrocarbons, what causes

those liquids to come to the surface?

A The entrainment in the gas, if I understand your question.

Q Isn't it the velocity of gas in the flowing string?

A Yes, sir. That's a factor.

Q And when your velocity falls to a certain point, then the well fails to lift liquids, is that right?

A I can imagine conditions where that would exist. I don't know though that that is a problem, a big problem in the field as a whole. But for a hypothetical question, yes, sir.

Q Well, by fracking a well and maintaining a mere velocity and flowing string, wouldn't you say that you would lift more of those liquids in a well at a lower pressure?

A Well, if we stay with your original problem now of a well that is making some liquids to begin with, some water, and we're having trouble getting it out because we don't have enough velocity as you say, and if this well is already making water, and I don't know where the source may be, but I would be concerned about fracking that well in the first place. I sort of suspect that if it might be bottom water and went in and fracked it, you would have so much water that regardless of the deliverability you would never lift anything. I suspect that you might junk the well.

Q In other words, you would be afraid of fracking into a water zone?

A I would be afraid of fracking into water in a number of wells

in this pool.

Q Do you think that fracking will open up more gas to the well bore?

A No, sir.

Q You don't think fracking will penetrate the parts of the reservoir that would not be otherwise penetrated?

A Fracking alone, no, sir, I very definitely feel it would not. I am almost positive that it would not.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question of the witness?

MR. HOWELL: Can I ask one more question here.

MR. PORTER: Yes.

By MR. HOWELL:

Q Referring to your Exhibit R-5, Mr. Liebrock.

Q Is the length of your bars there placed accurately?

A Yes, sir, I think they are.

Q Well, excuse me a minute. Do you happen to have a slide rule, or is there a slide rule in the house? Would you measure this bar and tell me what the reserves are for this well?

A Well, approximately 28,000.

Q MCF. In other words, you measure this bar and tell me what the reserves are for this well?

A Approximately 29,000.

Q Well, inasmuch as it is the same well, how did you happen to assign a million feet per acre different reserves?

A You mean in the bar height here?

Q Yes.

A You mean this difference right here?

Q Yes.

A Well, sir, that is obviously a slight error, but I don't.

Q It amounts to more than a million feet per acre.

A Yes, but percentage-wise it is not important, I think you will agree it is not.

Q I just wondered as to the reliability of your charts and the calculations made, and you have answered my question.

REDIRECT EXAMINATION

By MR. MALONE:

Q Would you say that your draftsman had ended this bar one row too soon?

A Yes, sir. I watched my draftsman put that tape on, and he was sure in a hurry at the time.

MR. MALONE: I would like to ask about two more questions, if there are no others.

MR. PORTER: Go ahead, Mr. Malone.

Q With reference to the deliverability data that was available at the time the study was made in preparation for the December 9th hearing, there seems to be some confusion about the amount of data that was available in Santa Fe, as compared to the amount of data that you had available to use?

A Yes, sir.

Q While it has not been so testified, Mr. Utz' question indicated that there might be available data on seventy-five percent of the wells outside of the test area?

A Yes, sir.

Q Now where did you check the Commission's files for this data?

A Well, I know that we checked the Commission files in Hobbs.

Q You had a working party of some ten or twelve engineers working on this for a period of two or three weeks, did you not?

A Yes, sir, that is correct.

Q You do know that all of the data that was available in the Hobbs office of the Commission was utilized?

A Yes, sir.

Q And in addition were checks made of the files of all of the

companies that were involved in this joint effort?

A Yes, sir, that definitely was my understanding.

Q So that in testifying that that was the extent of the deliverability data available to you, were you correct insofar as you then knew or now know?

A Yes, sir, I certainly was.

Q And if there was additional information available in Santa Fe, was that known to you at any time?

A No, sir, it wasn't.

Q Do you know what the practice as to the filing of this test data is with reference to whether it is available in Hobbs if available in Santa Fe?

A No, sir, except it was my understanding, and I didn't confirm it and I thought that any data that would be available anywhere would be in Hobbs.

Q The eight or ten engineers that were working with you work with the New Mexico Commission all the time?

A Yes, sir, a number of them do.

Q And you did have a detailed check made of every well file in the Hobbs office of the Oil Conservation Commission, did you not?

A Yes, sir.

Q Now, some implication existed in some of the questions with reference to the 11,000 acre test area which you studied and whether or not the conclusions which you reached there were necessarily applicable other places in the Pool. I would like to

ask you whether or not the purpose of your study of that area was to see how the deliverability formula would compare as to the wells in that area?

A Yes,sir.

Q Would the condition that may exist in other parts of the area affect how this formula is going to relate to the wells in this area?

A No, sir, it would affect in no way.

Q For that reason, was or was not the basis of your study perfectly adequate for the purpose that it was being conducted?

A Yes, not only was it perfectly adequate, but in my opinion it lent itself better to determining the applicability of any formula than any other area of the field, or for that matter, the field as a whole.

Q Mr. Liebrock, if the proposed formula will not work in this area, based on the study that you have made, and will result in this area in a redistribution of some five million dollars in ultimate recovery between operators, is there any reason to believe it will work any better in any other part of the field?

A No, sir, I have no reason to believe it will work any better in any other part of the field.

Q Does the fact that you did not study any other part of the field affect your conclusions as to what it will do in this part of the field?

A No, sir, not at all.

MR. MALONE: That's all.

MR. PORTER: Does anyone else have a question of Mr. Liebrock?

MR. MALONE: I would like to offer the exhibits. I believe I failed to ask the witness if the exhibits were prepared by him or under your direction. A Yes, sir, they were.

MR. MALONE: We offer in evidence Exhibits 1-R through 7-R.

MR. PORTER: Is there objection to the admission of the exhibits? They will be admitted. The witness will be excused.

(Witness excused.)

HENRY J. GRUY

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

DIRECT EXAMINATION

By MR. MALONE:

Q Will you state your name to the Commission?

A My name is Henry J. Gruy.

Q Where do you live, Mr. Gruy?

A I live in Dallas, Texas.

Q What is your profession?

A I'm a consulting petroleum engineer.

Q What is the name of your firm?

A H. J. Gruy and Associates.

Q And is its offices located in Dallas?

A Yes, sir.

Q You have not testified before the New Mexico Commission on a prior occasion, have you? A I have not.

Q Where did you receive your professional education, Mr. Gruy?

A I was graduated from Texas A. and M. College in 1937 with a B. S. degree in petroleum engineering.

Q Have you received any graduate degrees from that institution since then?

A Yes, sir, I was later awarded the professional degree of petroleum engineering which is a degree that can't be obtained by going to school alone, it's based on professional activities in the business.

Q How does it relate as compared to a Master's degree or Doctor's degree?

A It's lower than a Doctor's degree, but higher than a Master's degree.

Q What was your first employment as a petroleum engineer after your graduation from Texas A. and M.?

A I went to work for Standard Oil Company of Texas in Ward County, Texas as a field petroleum engineer.

Q For how long were you so employed?

A Until March of 1938.

Q By whom were you employed thereafter?

A By the Shell Oil Company as an exploitation engineer.

Q For how long did you continue in that position with Shell?

A I worked as an exploitation engineer with Shell in various districts and various capacities in South Louisiana, North Louisiana, Arkansas, Texas Gulf Coast area and East Texas until October of 1945.

Q Did you have occasion during that period to be dealing with gas reservoirs and gas reserves?

A Yes, sir, I certainly did. At the time that I left Shell I was district engineer in their East Texas District, and I was Shell's representative on the East Texas Field Engineering Committee and the Carthage Field Engineering Committee, and I was Chairman of the Engineering Committee for the Chapel Hill Paluxy Gas Cycling Unit, and I was a member of the Geological Committee for the Chapel Hill Paluxy Gas Cycling Unit.

Q Was the Chapel Hill Paluxy Gas Cycling Unit a gas unit of considerable size?

A Yes, it was a gas unit, it had approximately one hundred billion cubic feet of reserves, it wasn't a large one.

Q You referred to the Carthage Field in Texas, is that a large gas field?

A Yes, sir, that is a large gas field with about seven trillion cubic feet ultimate recoverable gas, it covers most of Penola County, Texas.

Q How many wells, if you know, in that pool?

A There are several hundred wells. I forget exactly how many

wells there are now.

Q After you left Shell in 1945 with what company were you associated?

A I was employed by De Golyer and Mac Naughton, a consulting petroleum engineering firm out of Dallas, Texas.

Q How long did you continue with the De-Golyer and Mac Naughton?

A I was with them for almost five years.

Q At the time that you left De Golyer and Mac Naughton, did you leave to establish your own consulting firm?

A I did.

Q What was your position with De Golyer and Mac Naughton at the time you left them?

A During my entire time with them I was in responsible charge of the reports that were made on the East Texas-Louisiana, Arkansas and Mississippi area, and I did most of the gas reserves and deliverability studies that were done by the company during that period.

Q At the time that you left De Golyer and Mac Naughton, had that firm been incorporated?

A Shortly before I left, yes, sir

Q What was the title of the person who held your post after the incorporation?

A Person that took my place and many of the men that worked with me, and some of the men that worked under me, were all made

Vice Presidents shortly after I left.

Q You have been active as a consulting petroleum engineer since 1950?

A Yes, sir.

Q Will you give us the names of a few of the typical clients of your firm?

A Well, I worked for a large number of major companies, independent operators, several branches of the Federal Government; some of the companies for whom we have worked are Atlantic Oil and Refining Company, British American, Warren Petroleum Company, Tidewater Oil Company, Seaboard Oil Company, Socony-Mobil Oil Company, H. L. Hunt, Clint Murchison, Rockefeller Brothers.

Q I think that's enough. During the period of time that you have been active as a petroleum engineer, and particularly in the gas field, in what states or areas have you had experience in making reservoir studies?

A Well, I think I have made reservoir studies in all major producing areas of the United States, in several areas in Canada, British Columbia, Alberta and Saskatchewan and Alaska and in all producing areas of Venezuela and some in Columbia.

Q Are you a member of any professional societies?

A Yes, sir, I am a member of the Association of Petroleum Engineers of the A.I.M.E. I am a member of the American Association of Petroleum Geologists.

Q What commissions have you had occasion to testify before

as an expert?

A I have testified before the Texas Railroad Commission and the Louisiana Conservation Commission and the Oklahoma Conservation Commission and the Montana Conservation Commission and the Federal Power Commission.

Q Have you had occasion to write any articles in the general field of petroleum engineering?

A Yes, sir, I have authorized several papers that have been published.

Q Have you written any papers on the particular subject of the methods used in the estimation of gas reserves in reservoirs?

A Yes, sir. I wrote a paper entitled Critical Review of Methods Used in the Estimation of Natural Gas Reserves that was delivered in 1947 before the Mid-Continent Section of A.I.M.E. in Tulsa, and before the Pacific Coast Section of A.I.M.E. at Los Angeles that same year.

Q That paper has been published?

A Yes, sir, it was published in the Transaction of A.I.M.E., 1948.

Q Is it still in distribution?

A We have had many requests for copies of that paper and we still get requests for copies of it. We had a request last month from Germany for copies of the paper.

Q Does that paper deal with the question which you understand

to be involved in this case as to the basis on which the reserves should be computed?

A Well, it deals with method of estimating reserves, yes, sir.

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

MR. PORTER: Yes, sir.

Q Tell us about when your first contact with this controversy was, Mr. Gruy.

A I learned of this controversy on Monday, March 10th when Mr. Liebrock called me.

Q Have you ever collaborated with Mr. Liebrock prior to this time or been jointly engaged in any undertaking with him?

A No, sir.

Q You do know his reputation as a consulting geologist in the field?

A Yes, sir, I have known him for many years.

Q In preparation for your testimony in this case have you reviewed the transcript of the testimony which has gone into the case up until this time? A Yes, sir.

Q What further studies have you made?

A Well, our staff plotted all the pressure production history that was available on all the wells in this entire reservoir and we made projection of that to show that the gas that was going to be produced by those wells under continuation of the same situation.

Q Now, have you had occasion to deal with gas prorationing

during the period of time that you have been in the engineering field?

A Yes, sir. Any time that we make a gas reserve and deliverability study we have to consider the proration formula in effect in order to see how the reserves in the reservoir are going to be distributed to the various tracts and what the future expected producing rates, what the future producing rates can be expected to be from the wells.

Q Based on your contact with the history of gas prorationing and its operation, will you briefly recount the part that potential or deliverability has had in proration formulas to your knowledge?

A Well, I believe any discussion of proration and proration formulas would have to start with oil proration, is where proration began and proration really had its beginning with the Yates Field and the East Texas Field when oil was in excess supply and some method was needed to reduce producing rates since wells had been producing at their maximum capacities, and the most obvious immediate way to curtail that production was a percent of capacity, and that is a proration formula that was adopted for both Yates and East Texas, East Texas being allowed to produce only 3.2% of the wells hourly potential.

Q When you say percent of capacity, is that the same as percent of potential or percent of deliverability?

A Well, capacity potential and deliverability are all measures

of a well's ability to produce. Now, when you say potential of a gas well, one usually thinks of the calculated absolute open-flow potential on the falacious assumption that you can get zero pounds at the bottom of the hole which adjusts to make a common measurement of all wells not restricted or affected by the different sizes of the casing or the size of the deliverability.

Deliverability is usually thought of as deliverability against some fixed back pressure or according to some formula such as a percent of the shutin pressure.

Q As the history of prorationing has developed, has the use of potential and deliverability increased or decreased in proration formulas to your knowledge?

MR. CAMPBELL: We're talking about oil and gas now?

MR. MALONE: Either.

A Well, as these proration formulas got tried out in the Courts over the land, and as people become proration officials and everybody becomes more cognizant of the necessity of protecting correlative rights, the use of potential factors in proration formulas for both oil and gas has declined so that they're very rare in new proration formulas.

Q Is that same statement true of deliverability and in gas proration formulas?

A Yes, sir. Now the last in Texas, the last use I know of a potential factor in a proration formula, was in the Carthage Field

where it was discontinued for several reasons, among them being the inability to make the tests in a comparable manner on all the wells so that everybody was satisfied with the deliverability test was one of the reasons that it was dropped out of the proration formula at Carthage.

Q Do you know of any recent gas proration formulas in new pools in which deliverability has been used as a factor anywhere in the Western Hemisphere? A I do not.

MR. CAMPBELL: What is the question?

REPORTER: Reading: Do you know of any recent gas proration formulas in new pools in which deliverability has been used as a factor anywhere in the Western Hemisphere?

Q I will qualify that by saying within the last two or three years.

A That's what I thought you meant, when you say new pools in the last year or so. I wouldn't classify the San Juan Basin as a new pool. I guess the definition of new might vary a little bit.

Q Are you familiar with the New Mexico statute defining correlative rights? A I think so.

Q I would like to read that statute to you to be sure there is no misunderstanding as to what it provides. For purposes of the questions I will ask you, will you please bear in mind that the New Mexico State Section 65-3-29 H provides as follows:

"Correlative rights means the opportunity afforded so far as

it is practicable to do so to the owner of each property in a pool to produce without waste his just and equitable share of the oil or gas or both in the pool, being an amount so far as can be practicably obtained without waste substantially in the proportion that the quantity of recoverable oil or gas or both under such property bears to the total recoverable oil or gas or both in the pool, and for such purpose to use his just and equitable share of the reservoir energy".

Now, will you bare in mind that definition of correlative rights in the further questions which I will direct to you? I would like to ask you, Mr. Gruy, whether or not it is possible to determine the recoverable gas in a tract or underlying a tract assigned to a well by use of the so-called material balance equation as applied to the pressure decline of that well?

A No, sir.

Q Can you show us why that isn't possible?

A Well, I'm not a very good artist, but I can maybe draw a picture. Now, I'm intending this to be a kind of a rectangle affair where this line would be comparable to the bottom of the pay and this surface here would be the top of the pay, and that this is just a segment cutout covering say a section of land, and that you have a well in each quarter section located here, here, here and there. We might assume then that these wells, although they have the same pay thickness and the same amount of gas in place under

their unit, assuming that each one of them is a fence line that goes along there.

MR. PORTER: You mean along the quarter section lines?

A That this is a quarter section and this is a quarter section, that is a quarter section. And that each one of them would have the same amount of fence, doesn't go on down there. If we would assume that this well has a deliverability of one, and this one two, this one three and this one four, and if we would then plot--

A If the man that has the slide rule wants to see if these are the same size, I am going to have to plead ignorance. If the production increases in that direction and pressure increases in that direction on the plot and that point there is the original pressure in that reservoir, we then start those four wells to producing according to their deliverability and the pressure is going to go down equally on all that, just like it has in Mr. Liebrock's 11,000 acre area, because there is good communication in there so that when the pressure reaches a certain point here, this well will have produced one -- make some lines on here, they are crooked lines but they are supposed to be straight. This one will have produced one down to this pressure, this one will have produced two, this would produce three, and that one would have produced four, and it's obvious then that even though the lines are straight and we don't have the kind of thing that he showed where you can see where this drainage situation changed in Exhibit No. 2-R, you can see where the drainage situation changed and where drainage happened in these two curves on the left.

Now on these (indicating), you can't see where the drainage has taken place, but if you extrapolate those down to zero pressure, you can see that your Well No. 4 is going to produce four times as much as Well No. 1, and the whole reservoir is depleted, so Well No. 4 has drained these other wells. So that by this method and this method alone you can't possibly tell what the recoverable gas in place is under a tract. You can tell how much it is going

to recover under particular conditions, but as I understand the Statutes as he read it to me, the proration is supposed to be in proportion as to what was down there in place, and it doesn't say when, but I imagine they meant initially, so that this certainly wouldn't do it.

Now I think I might be able to explain that a little more clearly to you and cover the thing in a little broader manner in another way.

Well, I want to draw some wells. I'll put these little things on them, that makes them gas wells. You can see I never was a draftsman. We'll assume that those are nine gas wells located out here in the Jalmat Field, and as I understand it, that they don't need to be in the center of the unit, so we'll say that this well's unit is there. Now the gas that is in place under that is what this man that owns this well is supposed to be entitled to produce in proportion, or to have a fair chance to recover. Now then, we'll put all these wells to producing at the same rate and we'll assume that the formation is uniform on there, and if they are producing at the same rate and the formation is uniform, this well will interfere with this well about half-way, and this well will interfere with this well about half-way between there, same here and same here (indicating), I can't measure half very close, and same here and same here and same here and same here, so as long as those wells are producing at the same rate this well's drainage area is right there (indicating), which is

not equivalent to the area that's under the unit.

Now while that's going on, let's look at the pressures over here (indicating), you have production increase in that way, pressure increasing that way, as long as those wells are producing at that same rate the pressure will go as a straight line if it started initially, it will be initially on a straight line slope like that as long as the wells are producing at that rate, if you extrapolate that curve to abandonment pressure it will tell you how much this well is going to produce or how much recoverable gas is in place under this area; not under the lease or the unit that's assigned to it, but under that area. Now then, assume that this well has a little bit higher deliverability than the other wells, and it increases its rate of production due to a change in the proration formula relative to the production of the other wells, we are going to keep them all the same. We are going to increase this one, as soon as we do that, the point of interference is going to be closer to that well, here closer to that well. How much closer, due to variations in the pay thickness and variation in the rate, if this one is greater it is going to move closer, since I haven't said how much greater. I don't have to measure, that's why I don't say. So the drainage area now is out here (indicating). As soon as that happens, that is reflected right up here in this little thing(indicating), so that this curve is flattened. Now at this time you estimate the reserve of this well and you assume this proration formula is going to stay in effect,after you estimate

it is going to do that, you estimate it is going to produce a whole lot more gas eventually than it does now.

If you are going to prorate it on the basis of reserves, it will get a lot more reserves, but we haven't changed the amount of gas under it originally, and they have never been consistent with what is reflected in that curve. Conversely, if you shut the well back to where it is producing slow, they will extend their drainage area toward it and you will get a reduced thing there, when you do, this becomes steeper. If it cuts back to the same place of course it will be the same slope it was, but if it cuts back inside the first, I have to make the last one steeper than the first one, or I haven't made a true correlation.

We have plotted up every well in this field and all the pressure production data that has been filed with the Commission, and we can see where those things happened with the relative producing rates and the relative takes of the well where those have been changed. Now Mr. Liebrock has picked out a couple of them here that are good examples of them, but the point that I wanted to make is that the reserves of a well which can be determined by a pressure production plot has no relationship to the recoverable gas in place under a unit assigned to it.

Q Now, Mr. Gruy, I would like to ask you whether or not in your opinion as an engineer there is any correlation,either general or otherwise, between the deliverability of a well and the recoverable gas in place in the tract assigned to that well?

A In my opinion there is no correlation between the deliverability of a well and the reserves in place under the tract assigned to that well, or the gas in place under the tract assigned to that well. Of course, you have got the fact that if you have got some deliverability there must be some gas in place under the well, but it doesn't hold at the other end of the scale because you can have no deliverability and still have a lot of gas in place under the tract, either through not locating your well at the right place or bad mechanical condition or tight spot or something of that sort.

Q Is there in your opinion any fixed or general correlation between the recoverable gas in place under the tract assigned to a well and the reserves which may be found by the extrapolation of a curve to be applicable to that well?

A The extrapolation of a curve like that, as I tried to demonstrate, reflects only the relative producing rate of that well with reference to its neighbors, and does not reflect the reserves in place. I don't want to say reserves, I want to say gas in place under its unit.

Q It is subject to being distorted by various conditions, is it not?

A That's right.

Q You have read the testimony in this case with reference to the extrapolation of the curves made by Texas and Pacific. Did you note anything in that condition that would have resulted in a distortion of the reserves as computed by them?

A Well, they computed their reserves in this manner, and assuming that the wells continued to produce in the same manner, I think the reserves are approximately correct.

Q But do they have any relation to the recoverable gas in place under the tract assigned to those wells?

A None whatsoever, and I don't think they said they did.

Q Have you read the Commission's order in this case?

A No, sir, I haven't read the Commission's order.

Q I would like to ask you, based upon your dealing with the gas proration formula, whether or not in your opinion stability in a gas proration formula, once it has been established, is desirable?

A I think it's highly desirable and I think stability in the oil and gas business, of course, maybe I'm prejudiced on this, but I would like to see stability in the oil and gas business. We know that proration brought stability to the oil and gas business to a greater extent than it had ever been known before.

Q Are transactions and engineering reports based upon proration formulas as they exist at the time they are made?

A Yes, sir.

Q Is there a marked effect on the transactions in those reports if there is a change such as the one proposed here, from an acreage to a deliverability formula?

A Well, the proposed change here would certainly redistribute the ownership of the gas in the Jalmat Pool, and it would certainly

affect any appraisals that were made, it would cause some that have been made in the past to be pretty far off.

Q Now, with reference to the testimony which you have heard in this case today by Mr. Liebrock and the exhibits which he has presented, you have heard the question directed to him with reference to the validity of the 11,000 acre area as a basis for the volumetric calculation study which he made and the conclusions which he drew from examining the deliverabilities of wells in that area. Do you have any comment as to the correctness and reliability or unreliability of what Mr. Leibrock has done?

A I think Mr. Leibrock has made a sound study and as sound a study as can be made under the conditions. I could find nothing technically wrong with it. Of course, we would always like to have more data.

Q In your opinion, if a study of the wells in that area indicated the complete lack of correlation which was indicated by these exhibits between deliverability and recoverable gas in place, you think there is any reason to assume that the condition will be materially better in the Pool as a whole?

A Well, even if it is, it is bad enough in this area to say that such a formula is not justified.

Q Is that your conclusion?

A Yes, sir.

Q Do you have any further recommendations that you would like to make to the Commission in connection with the question

here presented?

A I can't think of any that wouldn't be repetitious.

MR. MALONE: That's all.

MR. CAMPBELL: May I ask for a ten-minute recess?

MR. PORTER: You beat me to it. Ten minutes.

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Malone, I believe you have another question.

MR. MALONE: Thank you, Mr. Commissioner.

Q Mr. Gruy, you have heard the testimony with reference to a possible frack race that might result from the injection of deliverability into this proration formula, would you state whether or not in your opinion it is likely that that would occur?

A Oh, I think it definitely will occur.

Q Would you state whether or not in your opinion the fracking of all or a majority of the wells in this pool which have not been fracked would increase the ultimate recovery of gas from the pool?

A Well, the fracking, if highly effective as I expect it to be, would increase the deliverability of most of the wells in the field and would enable the field to be operated so that at economic gas production rates to a lower pressure than would otherwise be possible initial wellhead pressures were in the order of 1200 pounds, and we are talking about abandonment at about 100 pounds which would leave about eight percent of the gas in the reservoir at abandonment.

Now, if by fracking you can lower that pressure to abandonment pressure to fifty pounds, well, you would recover about four percent additional gas in this reservoir if there weren't any other factors involved. Now, there is some possibility that on the west where these wells are underlain by water, that wells will frack into water and waterlog some part of the reservoir, there's a possibility that if

wells near the water contact are produced at too high rates, that they will hasten the coning and fingering of water into those wells so that there will be some gas trapped in these water logged areas and behind the water logged fronts so as to render it unrecoverable there might be enough of that to completely eliminate this four percent, or there might not, I couldn't say, but there would be something less I think than four percent increased recovery due to this fracking.

MR. MALONE: I won't ask you if that exhibit was prepared by you or under your direction. I want to offer Exhibit 8-R in evidence.

MR. PORTER: Is there objection to Exhibit 8-R. It will be admitted.

MR. MALONE: That's all.

MR. PORTER: Anyone have a question? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q I want to say you are right about one thing, you are not much of an artist. A Thank you.

Q Mr. Cruy, did I understand your testimony correctly that you had available for your study the same data that Mr. Liebrock had available?

A Well, I think we did, we got it all from him I believe.

Q You don't know whether you got all of it or not?

wells near the water contact are produced at too high rates, that they will hasten the coning and fingering of water into those wells so that there will be some gas trapped in these water logged areas and behind the water logged fronts so as to render it unrecoverable there might be enough of that to completely eliminate this four percent, or there might not, I couldn't say, but there would be something less I think than four percent increased recovery due to this fracking.

MR. MALONE: I won't ask you if that exhibit was prepared by you or under your direction. I want to offer Exhibit 8-R in evidence.

MR. PORTER: Is there objection to Exhibit 8-R. It will be admitted.

A I don't know whether we got all of it, no, I sent one of my men out to his office to get the data. I was tied up somewhere else, he came back with a lot of stuff, but I couldn't say it was everything.

Q You studied that data for a period of fifteen days, as I understood you, since March 10th, is that correct?

A Yes. Along with my staff we studied it during that period of time, yes, sir.

Q Your conclusions with reference to the operation of this formula or the present formula in the Jalmat Gas Pool are based upon that study?

A That's correct, and my previous experience in the gas business, I think that the results would be practically the same almost anywhere.

Q You have never studied this particular pool for reserve purposes, have you?

A I have made estimates of reserves in this pool in the past. I have never studied the whole field until this time.

Q Do you consider that you have studied the whole field in this case?

A We plotted the pressure production history of all the wells in the field. We did not make a complete geologic study of the field. We did not make a complete geologic study of the field. We reviewed the holes that Mr. Liebrock had and reviewed his study of the 11,000

acre area, but I have not made what I would consider a comprehensive study of the entire field.

Q You stated that you had made a production history study of all the wells in the Jalmat Gas Pool, is that what you meant to say?

A All the wells in the Jalmat Gas Pool that have pressure production history reported in the records where we have plotted it up, some have one point and a large number of the operators' wells never had any pressures reported on them.

Q How many did you plot?

A I believe it was 307, I can check about that number.

Q What data did you use?

A We used the monthly production as reported to the Commission and the close wellhead pressures when they were reported.

Q Did you use any deliverability data?

Q We didn't use deliverability data in plotting the pressure of cumulative production curves, no, sir.

Q You stated in your testimony, Mr. Gruy, that to your knowledge there hadn't been any field's gas pools located recently, I think you said, in the Western Hemisphere with deliverability as a factor. Do you know how many of the prorated, what percentage of the prorated gas pools in the State of Texas are prorated on 100% acreage? A No, sir, I don't.

Q If I told you that that figure is less than 3% would it surprise you?

A Well, I wouldn't be surprised at any figure because I don't know how many are on straight acreage.

MR. CAMPBELL: That's all.

MR. PORTER: Does anyone else have a question of Mr. Gruy? Mr. Utz.

By MR. UTZ:

Q Mr. Gruy, do you think that all the wells in the Jalmat Gas Pool will produce gas down to the abandonment pressure of about 100 pounds without some remedial work?

A I imagine that some of those with the low deliverability will not produce at economic rates at 100 pounds. I think that possibly some of the high capacity wells will produce at economic rates at less than 100 pounds if compression or low pressure gathering lines are put in.

Q Then you are actually tying the ability of a well to produce to that abandonment pressure?

A In making precise estimates of reserves and projections for financing purposes and things, we don't use a blanket abandonment pressure in a field. We make not only a reserve estimate, but we calculate how much gas a well will produce each year in the future, and a high deliverability well we take to a lower pressure than we do the low deliverability well, because the high capacity well will produce at an economic rate of gas, a rate of gas daily sufficient enough to pay its operating costs and taxes to a lower pressure

than a low delivery well will. I haven't made enough of a study of this field to know what the variation in abandonment pressure would be, and since both parties in this suit had previously used 100 pounds abandonment pressure, why I used it too. I know that some of the wells will be abandoned at much higher and some of them will be produced at less than that.

Q In other words, you feel then that the better wells will produce down to a lower abandonment pressure?

A Yes, sir.

MR. UTZ: That's all.

MR. PORTER: Anyone else have a question?

MR. CAMPBELL: May I be permitted to ask a few more questions on the point I overlooked?

MR. PORTER: Yes, sir.

By MR. CAMPBELL:

Q Mr. Gruy, you answered my question with regard to the extent of your study that you had plotted production history on 307 wells in this pool. Do you have that data here?

A Yes, sir.

Q Would you produce it, please?

A I wish to correct my testimony. That is, the 379 instead of 307 that we plotted. Maybe some of the wells are not in Jalmat but the schedule we had said they were in Jalmat, and we didn't locate them all on there. This is it.

MR. CAMPBELL: We would like the opportunity to examine those records if it is agreeable.

MR. MALONE: Be glad for you to.

MR. CAMPBELL: That's all.

MR. PORTER: Mr. Malone.

REDIRECT EXAMINATION

BY MR. MALONE:

Q Are you familiar with the total reserves that were testified to by Texas Pacific's witness on the basis of that extrapolation of pressure curves in the Jalmat Pool and how they relate to the totals which you obtained from the extrapolation of those pressure decline curves?

A We haven't added up our total, except with respect to the 11,000 acre area.

Q That's the 11,000 acre area that was studied by Mr. Liebrock?

A Yes, sir.

Q How did the figures which you obtained in that area compare to the figures which were testified to by Mr. Keller in that area?

A I don't remember the exact numbers, but Mr. Keller's figures were about fifteen percent higher than Mr. Leibrock's gas in place at the same time, and my extrapolation showed about eleven percent

less than Mr. Leibrock's gas in place at that time.

Q Or a difference of twenty-six percent between the conclusion indicated by you and that reached by Mr. Keller on the extrapolation of the same information?

A Yes, sir.

MR. CAMPBELL: I didn't understand his answer that way. It may be correct but I would like to have it clear. Didn't you say there was a fifteen percent difference between Mr. Leibrock's and Mr. Keller's?

A Yes, sir, Mr. Keller's being fifteen percent higher than Mr. Leibrock's, mine being eleven percent lower than Mr. Leibrock's.

MR. CAMPBELL: Thank you.

MR. MALONE: That's all.

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

(Witness excused.)

MR. PORTER: Is that all the witnesses you have at this time?

MR. MALONE: That concludes the witnesses for the Operators Group. Before our case is closed, I would like to make a motion to amend our petition for rehearing in one respect. At the time the information on which those petitions was prepared, or at the time they were prepared, we did not have the transcripts before us; on a subsequent examination of the transcript we find that we referred to the case out of which Order No. R-520 grew as being the case in

which deliverability was considered by the Commission. We found that it actually occurred in the case which preceded the case out of which Order R-520 occurred. We would like to make an appropriate amendment. It doesn't have to be done now. I would like to reserve the right to make that amendment and also to modify our knowledge that Texas Pacific supported deliverability in the case to allege that they participated in the case and that it was urged, and we found that we were wrong in our assumption that that company had supported it.

MR. CAMPBELL: We have no objection to that amendment, of course. I might point out that the record in Case No. 582 is a part of the record in Case 673, so it's actually all one case in any event, insofar as the record is concerned. We are going to request at some stage of the proceedings here that that record, or if the parties do not wish to have the entire record in, that we be permitted to put in the record part of the transcript of that case, in any event, but we have no objection to the proposed amendment and we would like to see you take that part out about us supporting deliverability originally.

MR. MALONE: That will be entirely agreeable with us. I would suggest that we just agree that either party can insert in this record whatever portion of the record from those combined cases they may desire and we won't have to take the Commission's time in reading it into the record.

MR. CAMPBELL: We'll have to put it in in some manner.

We can argue it, use the pages for the reference and then argue it.

MR. MALONE: That is what I had in mind.

MR. CAMPBELL: That's fine.

MR. PORTER: Mr. Malone, you didn't want any action on that at this time? You wanted the right to move later?

MR. MALONE: That is correct. I understand Mr. Campbell is agreeable, so we can stipulate to that.

MR. PORTER: Does anyone else among the applicants in this hearing have testimony to present?

MR. DUTTON: If it please the Commission, Sun's representatives are in the unenviable position of having to put on a case following the president of the American Bar Association and Rockefeller brothers engineers. I have been unable to do anything about that, so at this time I would like to introduce our evidence.

We have one witness.

(Witness sworn.)

MR. DUTTON: If it please the Commission, I would like to make the following preliminary remarks prior to introducing Sun's testimony. It is Sun's position that field rules should fulfill two requirements: first, they should act to prevent waste; second, but of equal importance, they should provide each mineral interest owner an opportunity to recover the hydrocarbons beneath his property. A near ideal statement of Sun's position on this matter is contained in paragraph A of Chapter 65, Article 3, Section 14, of the New Mexico Statutes, of which I now request the Commission

to take administrative notice. This paragraph reads as follows:

"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 or gas, or both, in the pool, being an amount, so far as can be practically determined, and so far as can be practicably obtained without waste, substantially in the proportion that the quantity of the recoverable oil or gas, or both, under such property bears to the total recoverable oil or gas or both in the pool, and for this purpose to use his just and equitable share of the reservoir energy."

It is significant that the equitable share which the Statute requires that each owner be afforded an opportunity to produce is defined to be in the proportion that the quantity of recoverable hydrocarbons under such property bears to the total in the pool. Such language would seem to preclude allocation upon a basis that ignores the volume of gas under the property assigned to the well.

Sun's case will be directed to a showing that the deliverability of the well has no relation to the volume of gas under the property assigned to such well.

WILTON C. STURDIVANT, JR.

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

DIRECT EXAMINATION

By MR. DUTTON:

Q Would you state your name, please?

A Wilton C. Sturdivant, Jr.

Q By whom are you employed?

A Sun Oil Company.

Q In what location?

A Dallas, Texas.

Q Have you testified before the New Mexico Oil Conservation Commission before?

A No, I have not.

Q Would you give them a brief resume of your educational and professional background?

MR. CAMPBELL: We would be glad to agree he is qualified unless you prefer to have him do it.

MR. DUTTON: That's fine with us.

MR. CAMPBELL: We will accept his qualifications. He works for your company.

MR. DUTTON: If that is fine with the Commission, or would you prefer to hear his qualifications?

MR. PORTER: I think we should have a brief statement.

Q Would you proceed?

A I graduated from Texas A. and M. in 1939 with a degree of Bachelor of Engineering, Chemical Engineering. Shortly thereafter I was employed by Magnolia Petroleum Company as a junior engineer,

and with the exception of four and a half years spent in the last war have worked in the petroleum industry. There is another exception; I did work for a railroad for one year. During the approximately fourteen years I worked in the petroleum industry, I have worked in the capacity of field engineer, area engineer, district engineer, and in the classification of senior petroleum engineer. During approximately two years of that time I had as a duty the computation of gas reserves for the Sun Oil Company. During approximately eight years of that time I have as an incident to my other duties, have computed and monitered reserves.

Q Mr. Sturdivant, are you a registered professional engineer?

A Yes, I am.

Q In what State?

A Texas.

Q In what branch?

A Petroleum and Natural Gas Engineering.

Q Does the Jalmat Pool come under your general area of supervision as a senior petroleum engineer in the reservoir engineering section?

A It does.

MR. PORTER: The Commission will accept his qualifications.

Q Mr. Sturdivant, you have indicated that you have been associated with the gas department of Sun Oil Company. In your duties in the gas department, were you involved in computing gas reserves?

A Yes, I was.

Q Did you compute these gas reserves on both a tract basis and a reservoir basis?

A Yes, I did.

Q How did you arrive at the recoverable gas in place under the various tracts?

A Recoverable gas in place under a tract is computed as the production of the acreage, the net feet under the tract, or if available the net acre feet as determined by isopac, the porosity, the connate water content of that porosity, and the formation volume factor of the gas within that porosity.

Q Did you ever use an extrapolation of a cumulative production versus pressure curve to determine recoverable gas in place?

A Yes, we have used that method.

Q Under what circumstances?

A Well, we use that method as a monitering or check system to see if the well is recovering the gas that's under the tract assigned to it.

Q Would you use this extrapolation to determine the gas in place under the tract assigned a given well?

A No. No.

Q Why not?

A It doesn't apply. The pressure production extrapolation is an indication of the gas in place in the area being drained by the well, which does not necessarily coincide with the gas in place

under a tract assigned to a well.

Q Mr. Sturdivant, in your two years of computing gas reserves for Sun Oil Company, which I think we are using synonymously with recoverable gas in place, were you ever faced with calculating reserves in a field in which the data was sketchy or less than what you would prefer it to be?

A Frequently.

Q In this event would you resort to the use of an extrapolation of the cumulative production versus pressure in a particular well to determine the recoverable gas in place under the tract assigned to that well?

A No, I would not.

Q For what reason?

A The method just doesn't apply, as I said.

Q One other thing, Mr. Sturdivant. Are you familiar with who is substantially in control of Sun Oil Company?

A Yes, I am familiar with that.

Q Who is that?

A Mr. J. N. Pugh is chairman of the Board.

Q During the two years you were in the gas department and in the area under your supervision if Mr. Pugh wanted an estimate of what the reserves of gas were in that area, where did his request end up?

A Well, after going through several more important people, it ended up on my desk.

Q He used your estimates of reserves, is that correct?

A As far as I know, he used them.

Q Has Mr. Pugh much money?

A Far more than I have.

Q Perhaps, in your opinion, is he on the level with Mr. Rockefeller?

A Well, I'm not too familiar with that level.

MR. CAMPBELL: If this is going to be a contest of that kind, we give up, if the Commission please.

Q Mr. Sturdivant, what in your opinion should an allocation formula accomplish?

A An allocation formula should prevent waste and assure equity of correlative rights among property owners.

Q What do you mean by insure equity?

A To assure equity is to give each property owner the opportunity to recover that which is under his own property.

Q What goes into determining what is under his own property?

A The computation of what goes into determining the gas under a given property is the acreage of the property, the net feet of porous rock under the property, the average porosity within that net rock, the connate water content of that average porosity, and the formation volume factor of the gas within the porosity.

Q Does deliverability go into that calculation?

A No, it has no place in that calculation.

Q You mentioned formation volume factor. How do you define formation volume factor, or what do you mean by it?

A Formation volume factor, as I have been accustomed to use it, is the volume occupied by a standard cubic foot of gas at reservoir conditions.

Q What is it a function of primarily?

A Pressure, temperature and the specific gravity of the gas.

Q In the Jalmat Field, specifically, what is it primarily a function of?

A Well, it varies from place to place in the Jalmat Field primarily as does the pressure. The temperature and the specific gravity of the gas throughout the pool I believe can reasonably be thought of as being constant.

Q From a practical standpoint, would you say that other things being equal, the gas in place, or let's state it this way, it is the gas in place under a given tract easily proportional to the pressure existing under that tract?

A Yes, that is approximately true.

Q Specifically referring to the Jalmat Field, in your opinion and for determining the proportional relationship between tracts, could pressure be substituted for the formation volume factor that you previously mentioned as entering into the volumetric calculation?

A Pressure could be substituted for this formation volume factor in computing the comparative amounts of gas under tracts which are side by side, presuming them to have equal acreage, porosity connate water and net thickness.

Q And comparative, is that in your opinion connate proportionately?

A Yes.

Q As used in the statutes?

A Proportionately as between tracts.

Q Thank you. Of the five factors that you mentioned as entering into the determination of recoverable gas in place under a tract, and for which you now indicated that from a proportional

standpoint, you may substitute pressure for formation volume factor, which in your opinion, or could be made available and are capable of uniform interpretation in the Jalmat Field?

A Well, certainly acreage can be determined uniformly, bottom-hole pressure can likewise be determined uniformly, and possible acre feet or net thickness under each tract. I say possible because there would be a question of agreement of opinion among various people as to the net effective thickness under their own tracts.

Q Mr. Sturdivant, have you familiarized yourself with allocation as proposed in Order 1092-A?

A If that is the order number pertaining to this hearing, yes.

Q What does it involve?

A It involves acreage and deliverability.

Q Do you know how deliverability is proposed to be determined for the purposes of this order?

A Yes, the instructions on determining that deliverability are set out in a memorandum of the Commission, the number of which I don't remember at the moment.

Q Does the deliverability as so determined under this order for any given well have any relation to the gas in place under the tract assigned that well? A No, it does not.

Q Why not?

A Well, this deliverability is a somewhat arbitrary function

of the capacity of the well to produce. That capacity of the well to produce in turn is a function of the penetration of net pay, the amount of net pay exposed to the well bore, the permeability of the formation in the neighborhood of the well bore, the viscosity of the gas, and the pressure difference available to drive the gas into the well bore.

Q As proposed by this order, is there any arbitrariness in the manner in which the pressure differential that is suggested to be used in calculating this arbitrary?

A Yes, I believe it has been. Well, I know that it has been fixed at the pressure difference between the shutin pressure or bottom-hole pressure and 80% of that number. The 80% is arbitrary but it is applied equally to all wells.

Q What volume of gas does deliverability affect, if any?

A Well, deliverability, the deliverability of a well determines the drainage area of a well together with the rate of production of nearby wells, deliverability is related to the volume of gas in the drainage area of a well.

Q Is this volume subject to change according to the manner in which the various wells are being produced?

A Yes, the drainage area of a well will vary as the well and its neighbors are varied in their relative production rates.

Q Mr. Sturdivant, have you studied Sun's wells within the Jalmat Field?

A Yes.

Q Are there any variations in deliverability among our holdings? A Yes, there is.

Q What is the range of this variation?

A Well, sir, it is approximately two to one.

Q Mr. Sturdivant, to your knowledge --

A Correction.

Q Excuse me.

A As I review my notes, here it is closer to five to one.

Q Mr. Sturdivant, to your knowledge has Sun Oil Company lost any allowable on the latest reschedule from any of these wells?

A No, it hasn't.

Q They have lost no allowable from the one having the deliverability of a fifth of the maximum well, is that correct?

A That is correct.

Q Has Sun had any problem in keeping their wells on scheduling and on allowables?

A Well, there seems to have been an administrative problem, in that we found it necessary to have almost monthly correspondence to insure that our wells are produced at rates which will secure our allowable.

Q But to date, or at least to the date of the last balancing period, there has been no problem in the well having the lowest deliverability making its allowable, is that correct?

A No, the wells have been able to keep up with their allowables.

Q Mr. Sturdivant, were you in the hearing room when the questions relative to the effect of a pressure gradient existing across the field, particularly with reference to migration of fluids was brought out earlier today?

A Yes, I was here.

Q Mr. Sturdivant, in your opinion would an allocation formula based upon deliverability necessarily tend to eliminate that pressure differential? A No.

MR. DUTTON: That's all we have.

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

CROSS EXAMINATION

By MR. CAMPBELL:

Q You stated, I believe, that after the summary of your attorney with reference to the proper consideration in an allocation formula, or he stated that any formula which ignores the amount of gas in place under a tract, I don't know if the word was "ignored" or "omits", or what it was, is not a proper allocation formula, is that your opinion?

A Well, it would be less desirable than other allocation formulas.

Q Do you think that a one hundred percent acreage formula gives any consideration to the recoverable gas in place under a tract?

A Yes, it does.

Q In what respect?

A The use of acreage is at least a partial attempt to relate allowables to the gas in place under a tract, whereas deliverability bears no relation to the gas under a tract.

Q Would a formula which gave consideration both to acreage and deliverability have a tendency to make that same sort of recognition?

A If both were included in a formula, the deliverability might offset the acreage or it might bring the total formula more nearly in line with what the gas in place under a tract would deserve. It would, however, be a matter of coincidence.

Q Mr. Sturdivant, you stated that in your experience in estimating the recoverable gas in place under a particular tract, that you used the volumetric method on a specific well. That method does not measure exactly the amount of gas in place under that tract, does it?

A Well, the method would measure it exactly if all the factors were exact.

Q Are the factors ever exact, as a practical matter?

A As a practical matter, it is never exact.

Q As a matter of fact, any time you depart from the size of the bore hole itself you are getting into the realm of uncertainty, are you not, in any type of calculation of reserves?

A We don't use the size of the bore hole in the calculation.

Q I am talking about the information you obtained as a result of the drilling of the hole.

A If I understand your question correctly, you are indicating that the core gathered from the bore hole is not necessarily a representative sample of the entire rock underneath a tract?

Q Yes.

A That, of course, is true, because the sample is too small.

Q So that any measurement of recoverable gas in place is not an exact measurement?

A It cannot be --

Q (Interrupting) Unless you mine it and measure it in that manner?

A That is true. To know it exactly you would have to dig it up, that is the tract, not the hole.

Q Mr. Sturdivant, I think you indicated that in the Jalmat Gas Pool, in addition to acreage which could be reasonably distributed in your opinion, and of course is on a straight acreage factor, that the pressure factor, that there was sufficient data that it might be spread on an equitable basis as a factor in determining the opportunity of a person to recover the recoverable gas in place under his tract, didn't you say that?

A Yes. Pressure can be determined fairly accurately, I should say reasonably accurately and with sufficient accuracy, though, that various parties can agree on it; further, it can be determined and redetermined as time goes on and adjustments made for the variation in pressure. Saying it another way, practically it can be handled.

Q Then if pressure were included, it would improve the formula in your opinion?

A It would.

Q Now you have stated following that that you see absolutely no relationship between recoverable gas in place and deliverability?

A I see no relationship between recoverable gas in place as determined by pressure production extrapolation, and that gas in place under a given tract.

Q Well, now, isn't pressure a factor in a deliverability determination?

A Of sorts, sir, it is.

Q To the extent that it is of sorts, isn't there some relationship, regardless of how small or great you believe it is?

A There is a relationship.

Q It isn't exactly correct to say there is no relationship between the two?

A Between which two?

Q Between deliverability and recoverable gas in place, inasmuch as pressure is a factor in determination and you say pressure can be determined?

A I said pressure can be determined and in speaking of that pressure, I speak of the static pressure, that static pressure is as laid out in the rules of the Commission to be taken on a well that is shut out by a certain method in calculations made to a static pressure. The pressure involved in deliverability is not that static pressure, but the difference in the squares between that pressure and a pressure equal to eighty percent of that pressure raised to a power, so you see we have two pressures involved. We're working on the difference in the squares.

Q You left me there. I will have to talk to my engineers.

A Well, I might simplify my remarks to say this, that although static pressure does enter into the calculation or estimation of reserves in place under a tract by the volumetric method, and under a drainage area by the pressure production method, or we have called it here the material balance method, the extent to

which the static pressure is related to the nth power of the difference of the squares between the static and the other pressures is so far-fetched that I cannot describe it.

Q It's too late to pursue that any further. How many wells does Sun have in the Jalmat Gas Pool?

A Three.

Q Have you made any study of recoverable gas in place under your own wells?

A Yes, we have.

Q Is there a difference between the wells?

A A difference in the gas in place under the tracts assigned to the wells?

Q Yes, under your method of calculation.

A There is a difference in the amount of gas under each of these tracts.

Q Yes, that's what I asked you.

A Yes.

Q You think a hundred percent acreage formula gives recognition to that as between those wells?

A Partial recognition, yes.

MR. CAMPBELL: I think that is all.

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

By MR. UTZ:

Q Mr. Sturdivant, I believe you stated that your range of

deliverabilities on Sun Oil tracts was the ratio of one to five?

A Approximately, yes.

Q What is your reserve ratio?

A The reserve ratio is approximately one to four.

Q Deliverability ratio and reserve ratio is pretty close, then?

A Well, if you can say one to five and one to four are about the same, yes.

Q Is one to five, one to four closer than one to one, straight acreage? Straight acreage formula, you have a one to four ratio and the allowable for each tract would be the same, would it not?

A We have a one to two relationship under acreage. A one to four relationship between maximum and minimum gas in place under the tract, and a one to five ratio between maximum and minimum deliverability of the wells. Do I make myself clear?

Q No, you didn't. I lost you on the one to two ratio.

A One of our wells has eighty and the other two have one hundred sixty acres assigned.

Q I am talking about per acre, not tract reserves.

A I have been talking about tract reserves.

Q I should have asked you the question in a little different manner, perhaps. Is per acre reserves among your tracts one to four?

A The per acre reserves under the tract of the extreme ratio of one to three, approximately, that is between the highest per

acre reserve and the lowest per acre reserve, with the other one in the middle, naturally.

Q On a straight acreage formula, you would receive the one to one ratio of allowable, would you not, instead of the one to three which your per acre reserves?

A On a per acre basis we would receive one to one.

Q Yes. So there's quite a difference between the one to one and comparing one to three than there is between the one to three and one to five, isn't there?

A That's right.

Q So with the straight acreage formula in your particular company's case be further from allowing you to recover the proper reserves under your tracts than deliverability?

A Yes.

Q In calculating your reserves for your company, how do you arrive at the connate water and porosity for your individual tracts?

A You are speaking of these Jalmat Field wells?

Q Yes, sir, the reserves we are talking about here.

A The connate water figure I used was derived from a publication of the Roswell Geological Society and is, I suppose, to the best of their knowledge representative of the average in the field. This, of course, is a very limited evidence, but it was the only evidence or data that I had. The average porosity under each tract was given to me by our staff geologist in Roswell. I do know that he had available to determine that logs on each well and a core

analysis on one of the three.

Q Micro-logs?

A I believe they are radioactive logs in two cases, and a micro-log in the third, if I remember correctly. I can't be sure.

Q Then you make reserves for your company on the basis, reserve estimates for your company on the basis of average water and sometimes average porosity figures?

A In this field, yes. In general, we make use of the best information that we have, and if we have sufficient information to use a different average porosity or connate water content under one tract as opposed to another, we do that. I might be able to answer your question by simply saying that we make what we think is the best use of all available data.

Q Has that method proved to be satisfactory as far as you are concerned?

A This is the only method available to compute gas in place under a tract.

Q As your average figures, then?

A Yes.

Q Have those figures proven to be accurate as far as your recoveries are concerned?

A The only way in which we can prove or disprove the estimates of recoverable gas as calculated by the volumetric method is on a field-wide basis and in comparison with either the total field experience after it's all over with or on a material balance basis

as applied to the entire pool.

Q Is it your opinion that the straight acreage formula in your particular case causes less drainage than the deliverability formula?

A Less drainage within the Jalmat Pool.

Q Less drainage from your tracts.

A Well, our tracts are separated and we would have to compare them with adjacent tracts owned by other folks to establish drainage from or to our tracts. We haven't the data to do that, and we haven't been able to do it.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question of the witness? Mr. Malone.

By MR. MALONE:

Q Did I understand you to say, Mr. Sturdivant, that you had experienced an administrative problem in making certain that your wells produced the allowable allotted to them?

A I said, or should have said that my company has experienced that problem.

Q And who determines whether or not those wells do produce the allowable in that regard?

A Well, I can only quote things said to me, but I understand that the amount of gas taken from a well is under an allowable set by the Commission, but whether or not the gas allowable of a well is taken from the well during the month in which it is assigned is

at least in part under the control of the pipe line company.

Q And your problem then has been with the pipe line company?

A Both with the pipe line company and with the Commission, I believe.

MR. MALONE: That's all.

MR. PORTER: Does anyone else have a question of Mr. Sturdivant?

MR. DUTTON: I have a few on redirect.

MR. HOWELL: I have one other question here.

MR. PORTER: Mr. Howell.

By MR. HOWELL:

Q Do you have any copies of the correspondence that you had with your administrative problem?

A No, sir, I don't.

Q Did you write that correspondence yourself?

A I did not.

MR. HOWELL: I move that the testimony be stricken as hearsay.

MR. PORTER: The Commission orders that the testimony concerning this correspondence and other administrative problem be stricken from the record.

Does anyone else have a question now? Mr. Dutton?

RE-DIRECT EXAMINATION

By MR. DUTTON:

Q Mr. Sturdivant, some of the questions directed by Mr. Campbell went to the accuracy of the information obtained from a well bore in determining the hydrocarbon in place within a field. To your knowledge, and within your experience, is that matter that is commonly done in the industry that the well information is what is relied upon to establish the data from which volumetric calculations are made?

A It is customarily done in the industry, and it is done of necessity.

Q Is there any other information generally available except that information obtained through the well bore?

A No.

Q In your opinion as an expert engineer, is it both logical and practical to use the information from the well bore in the manner in which it is being used?

A Well, it is not only practical, it is inescapable, it is all you can do.

Q Mr. Sturdivant, with respect to the recoverable gas in

place being a function of either deliverability or the extrapolation of the cumulative production pressure curve, the question that was directed to you was in general. I would like to rephrase it and relate it to the recoverable gas in place under the tract assigned to the well and then ask you if either of the methods have any engineering reasoning behind them.

A The method of computing gas in place, which is what we are calling here the volumetric method, that is acres times thickness times porosity times minus one connate water times volume factor can be and is applicable to the computation of reserves in place under a given tract. The estimation of recoverable gas from a well which is gained by the extrapolation of the pressure production history of that well is applicable only as to an estimate of the amount of gas in place in the drainage area of that well. Since the drainage area of a well seldom coincides with the tract assigned to the well, the two methods can not calculate or estimate the same thing.

Q In your estimate as an engineer in the preservation of equity, should the gas in place under the tract assigned to a well be considered rather than the gas contained in the drainage area of the well? A Yes, it should.

MR. DUTTON: Thank you.

MR. PORTER: Any further questions? The witness may be excused.

(Witness excused.)

MR. PORTER: Does this conclude the testimony by the Applicants in this case?

MR. MALONE: It does so far as the Operators Group is concerned.

MR. PORTER: The Commission will recess the hearing until nine o'clock tomorrow morning.