Case No.

1755

Application, Transcript, Small Exhibits, Etc.

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:

CASE 1755

TRANSCRIPT OF HEARING

SEPTEMBER 16, 1959

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
September 16, 1959

IN THE MATTER OF: Application of El Paso Natural Gas Company for an amendment of Rule 112-A of the Commission Rules and Regulations. Applicant, in the above-styled cause, seeks an amendment of Rule 112-A of the Commission Rules and Regulations to provide for administrative approval of dual completions utilizing retrievable-type packers.	Case 1755

BEFORE:

Honorable John Burroughs
Mr. A. L. Porter
Mr. Murray Morgan

TRANSCRIPT OF HEARING

MR. PORTER: The hearing will come to order, please. The Commission will consider at this time Case 1755, and I would like to call for some appearances.

MR. SETH: If the Commission please, Mr. Garrett Whitworth, El Paso Natural Gas Company, El Paso, and Oliver Seth for the Applicant.

MR. N. R. REESE: Mr. N. R. Reese, MWL Tool and Supply Company.

MR. COOPER: John Cooper, Haliburton Cementing.

MR. PORTER: John Cooper, Haliburton.

MR. VERITY: George L. Verity for Southern Union.

MR. WHITE: L. C. White of Gilbert, White and Gilbert on behalf of Texas Company, Incorporated.

MR. BUSHNELL: H. D. Bushnell in association with Jason Kellahin, appearing for Amerada Petroleum Corporation.

MR. SPERLING: J. E. Sperling appearing for Magnolia Petroleum.

MR. LOAR: William R. Loar for Sunray Mid-Continent Oil Company.

MR. KASTLER: Bill Kastler from Roswell, New Mexico appearing on behalf of Gulf Oil Corporation, for the purposes of making a statement only.

MR. PAYNE: Mr. Commissioner, the Staff may present testimony in this case.

MR. WHITWORTH: El Paso has three witnesses to present in this case to be sworn, Mr. John Mason, Mr. Ed Coel and Mr. John Muse.

(Witnesses sworn.)

MR. WHITWORTH: At the outset El Paso would like to make the following opening statement. The purpose of this application is to leave to the discretion of the operator of the multiple completions in the State of New Mexico the matter of determining what type of production packer should be used, and to allow for the administrative approval of these multiple completions when the operator has exercised that discretion by certifying that the production packer selected, whether permanent or retrievable, is sufficient to effectively separate the producing zones.

In the application El Paso has suggested the wording of amendments to Rule 112-A, II (d) and Rule 112-A, V (d) in order to effectuate this purpose.

After considerable reflection, El Paso has decided that the suggestion for the adding to these rules a certification that the production packer used will satisfy the requirements of applicable rules as set out in Paragraph 4 of the application should read in the manner that has been distributed to the Commission and Staff this morning rather than as set out in Paragraph 4 of the application.

At this time we request that the Commission accept what has been submitted this morning to the Commission, the way Paragraph 4 should read, be accepted as amendments to the application.

MR. PORTER: Is there objection to this amendment as offered by counsel for El Paso?

MR. WHITE: Could we find out what the amendment is?

MR. PORTER: I thought it had been circulated, Mr. White.

MR. WHITWORTH: We will defer a request for ruling on this until the first witness has testified, because he will read the suggested amendments to the application.

MR. PORTER: All right, Mr. Whitworth, you may proceed with your first witness.

JOHN MASON

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

DIRECT EXAMINATION

BY MR. WHITWORTH:

Q Would you please state your name, by whom and in what capacity you are employed?

A John Mason, employed by the El Paso Natural Gas Company as a proration engineer.

Q Have you previously testified before this Commission as a proration engineer and an expert witness?

A Yes, sir, I have.

MR. WHITWORTH: We ask that the witness' qualifications be accepted.

MR. PORTER: They are accepted.

Q Mr. Mason, you are familiar with El Paso's application in this case, are you not?

A Yes, sir, I am.

Q You are familiar with the suggested amendments to the application?

A Yes, sir.

Q Would you read to the Commission the suggested amendments, please?

A In the application, in Paragraph III of the application we have proposed to revise Rule 112-A, II (d) in this manner: "The packer used to segregate the separate producing zones of the multiple completion shall be effective to prevent communication between all producing zones and may be either a permanent or a retrievable type production packer which shall be certified as adequate by the manufacturer or representative thereof as provided in Subsection V (d) of this rule."

Now, on the revised edition of this rule, which you have on a separate sheet, we are proposed to change the next to the last line of that paragraph to strike the words "manufacturer or representative thereof" and insert in its place "the operator", so that the operator will be the one certifying them rather than the manufacturer's representative.

We have a similar change in Paragraph IV of the application. In Paragraph IV we wish to strike the word "manufacturer or authorized representative thereof", and in its place insert the word "operator".

Q Would you state to the Commission the reasons for submitting these amendments?

A There are several reasons, the first one being that the operator or the manufacturer does not always have a representative at the well when the packer is being set. Also, at times they may sell these packers to an operator in groups of anywhere from two to any number to be used by the operator, as the

conditions warrant. Therefore the manufacturer has neither control nor knowledge of how these packers are being used. We originally inserted the words "manufacturer" because we felt that the Commission might place more reliance on the certification issued from the manufacturer, that the packer has been used under conditions for which it was designed. But after being advised by the manufacturers as to the reasons that I have just stated that they could not certify to this, or would choose not to, it has occurred to us that the operator should have been more properly designated as the one to accept this responsibility at the beginning, because it is against the operator that the Commission will have, more easily and readily have recourse in the event of false swearing or violation of the provisions of the rule.

Q You stated that you are familiar with El Paso's application. Would you state to the Commission El Paso's purpose in making this application?

A By this application we seek an order amending Rule 112-A, Section II, Subsection (d) and Section V, Subsection (d), which Rule 112-A is concerned with multiple completion wells. Section II deals with the requirements which must be satisfied in order to gain administrative approval before dual completion. Section V deals with all dual completions. As presently written the rule requires that in order to attain approval through administrative procedures to dually complete a well, that it is necessary for the operator to use a permanent-type packer. This permanent-type packer the Commission has defined in Memo 10-59 dated I believe May 26 of '59 as being non-retrievable, permanently set, preferably of drillable materials which may be run on an electric line and/or tubing, drillpipe and so forth.

Our purpose is to amend this application, is to amend the rule so that an operator may gain administrative approval to use either a permanent or retrievable-type packer and at the same time to provide a safeguard to the Commission which will assure them that an operator is using prudence and good faith in selecting a packer which will effectively protect commingling of fluids from the separate strata.

It is the position of El Paso that an operator should be able to exercise its own discretion as a prudent operator in selecting its completion equipment so long as we effectuate the broad objectives of the Commission in preventing waste and protecting correlative rights in the case of dually completed wells, so long as we prevent commingling of fluids from the separate strata.

We feel the Commission has adequate means of determining whether or not in the case of dual completions, whether or not there is effective separating, and further that the Commission has means of compelling remedial action in case there is communication between those zones.

Q You mentioned a certification to be made by the operator. Do you have a suggested form for that certification?

A Yes, sir, I do.

MR. WHITWORTH: We will mark that as El Paso's Exhibit No. 1.

(Whereupon the above referred to document was marked El Paso's Exhibit No. 1, for identification.)

MR. PORTER: At this time I would like to ask if anyone has any objection or is there any discussion of the Applicant's proposed amendment to the application? Let the record show that the application has been amended by counsel for the Applicant. You may proceed, Mr. Whitworth.

Q Mr. Mason, is there anything you would like to add to your testimony?

A We do have this proposed form to be used as a packer setting affidavit which the Commission already requires the affidavit in Subsection (d) of Section V of Rule 112-A. This is a form that is in use in other states, and we feel it would be adequate to satisfy the desires of the Commission. This affidavit in the first part gives merely a description of the person making the affidavit, who he is employed by, the type of packer that is being used in the well, and the well in which it is being used. Then the affidavit on the part of the operator is concluded by saying: "that the purpose of setting this packer was to effect a seal in the annular space between the two strings of pipe where the packer was set so as to prevent the commingling in the bore of this well, of fluids produced from a stratum below the packer with fluids produced from a stratum above the packer; that this packer was properly set and that it did, when set, effectively and absolutely seal off the annular space between the two strings of pipe where it was set in such manner as that it prevented any movement of fluids across the packer."

This is merely a proposed form which we consider to embody the provisions that should satisfy the Commission, and if there are any revisions or any other form that the Commission might choose, then we will probably be willing to go along with it. This is merely a suggestion.

MR. WHITWORTH: That concludes all we expect to show by this witness.

A I have one more thing I would like to add. We have a letter from Skelly Oil Company dated September 16, 1959 addressed to El Paso Natural Gas Company in Farmington, New Mexico to the attention of Mr. Lou Galloway. "Gentlemen: This is to advise that as an interested operator in the production of oil and gas in the State of New Mexico, we favor a change in this Rule 112-A, II (d) so as to provide the packer used to segregate the separate producing zones of the dual completion may be a permanent-type packer or retrievable-type production packer which may be approved administratively. Signed George L. Sellinger."

Q Do you have any other concurrences, Mr. Mason?

A We have some, but we anticipate that these concurrences will be made at the conclusion of our testimony.

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

MR. PAYNE: Yes, sir.

CROSS EXAMINATION

BY MR. PAYNE:

Q What is your definition of a production packer?

A That is a packer that is, well, I might add first, Mr. Payne, that we have other witnesses here this morning who are going to testify as to their experience in association with these type packers, and perhaps you could get a more satisfactory explanation from them, but I would be willing to give my explanation of it if you so desire.

Q Let me ask you this, is it the opposite of a testing packer?

A Often times a production packer will be used for, no, a packer that you run in the well will be used for the purposes of testing the well, also, if you are speaking in regards to tests that are required by the Commission; or are you referring to tests that are conducted in the completion of the well?

Q Well, what I'm getting at, I notice that your proposed rule says that you may use either a permanent or retrievable-type production packer.

A That is a packer that is run in the well, and it is in the well during the time that the well is producing its fluids during the normal life of the well.

MR. PAYNE: Thank you.

MR. PORTER: Anyone else have a question of Mr. Mason? You may be excused.

MR. UTZ: I have a question.

BY MR. UTZ:

Q Is it your intention, Mr. Mason, that packer leakage tests accompany this packer setting affidavit?

A Yes, sir. There are other provisions in Section V, I believe, 112-A, which require packer leakage tests, and there is a separate provision in Section V which is Subsection (d) which we have proposed, for which we have proposed this amendment, and that refers only to the furnishing of a packer setting affidavit, and this is something that we are adding in addition, or to make that more complete.

Q You couldn't very well swear to this until after you had run a packer leakage test?

A That is correct, and I believe the rule provides that it will be submitted with the separation packer leakage tests, the rules as written.

MR. PORTER: Anyone else have a question?

MR. WHITWORTH: I have one.

REDIRECT EXAMINATION

BY MR. WHITWORTH:

Q This suggested form for certification that has been submitted as El Paso's Exhibit No. 1, that was prepared by you, was it not, Mr. Mason?

A Yes, sir. I'll say it was prepared under my direction. It was copied from forms in use in other states in the industry.

MR. WHITWORTH: We ask that be accepted as El Paso's Exhibit No. 1.

MR. PORTER: You want to identify the packer setting affidavit as El Paso's Exhibit No. 1?

MR. WHITWORTH: Yes. The packer setting affidavit.

MR. PORTER: Any objections?

MR. MORGAN: I have no objection to it. I might suggest something to the witness, something about the exhibit.

RECROSS EXAMINATION

BY MR. MORGAN:

Q Do you propose this be signed by an officer of the company or the competent engineer?

A By the engineer who supervised the job for the company.

Q He is committing the responsibility of the company, is he not, when he does that?

A Yes, sir, I think so.

Q It doesn't appear to me that an engineer on the part of the company would be competent to subject the company to the penalties that would be provided for false affidavit.

A Well, I'm not sure what the rules of the Commission provide for there, whether the recourse would be against the company or the individual. I believe it's, I may be mistaken, but I believe it's for false swearing of the State of New Mexico, you are subject to a conviction of perjury.

Q The recourse would be against, only against the engineer then, not the company, is that right?

A Presumably, yes, sir.

MR. PORTER: Anyone else have a question? The witness may be excused. Call your next witness, Mr. Whitworth.

(Witness excused.)

MR. WHITWORTH: Mr. Ed Coel.

E D W I N J. C O E L

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

DIRECT EXAMINATION

BY MR. WHITWORTH:

Q Would you please state your name and by whom and in what capacity you are employed?

A Edwin John Coel, Superintendent Petroleum Engineering, El Paso Natural Gas Company.

Q You have previously qualified as an expert witness before this Commission, have you not?

A Yes, sir, I have.

MR. WHITWORTH: We move that his qualifications be accepted.

MR. PORTER: They are accepted.

Q You are familiar with El Paso's application in this case?

A Yes.

Q In your official capacity you have personal knowledge of the approximate number of multiple completions that El Paso has made in the past in the State of New Mexico?

A Yes, sir, approximately 158.

Q What percentage of these multiple completions would you say have employed retrievable-type packers?

A Approximately 72 percent.

Q What section of the state does El Paso have the majority of its multiple completion wells?

A The vast majority is in the San Juan Basin Area, Northwest Section of the state.

Q You are familiar with the range of temperature in these dual completions, are you not, Mr. Coel?

A Yes, sir. They're two-fold according to depth in that area, first range would be approximately 90 degrees Fahrenheit to about 120 degrees Fahrenheit. The second range would be in the neighborhood of 180 degrees Fahrenheit to 230 degrees Fahrenheit.

Q Are you familiar also with the magnitude of differential pressure with respect to these multiple completions?

A Yes, sir, they're likewise two-fold. Differential pressures occurring in one type of completion would range from five hundred to a thousand pounds per square inch, and in second type from one thousand to three thousand pounds per square inch.

Q Is it your opinion that retrievable-type production packers operating under the conditions that have been encountered and that are likely to be encountered in the State of New Mexico are just as effective to separate the producing zones as the permanent type production packer?

A Yes, sir.

Q On what do you base that opinion?

A On the use that we have had of them and the small number of failures that we could actually blame on the packer.

Q On the experience that El Paso has had in multiple completion wells?

A Yes, sir.

Q In these multiple completions has El Paso used various types and models of retrievable-type packers?

A Yes. Approximately three types, different types.

Q Do you have knowledge of the method by which these production packers are set?

A Yes, sir.

Q Would you explain that method to the Commission?

A It's getting a little technical there, but a general idea that all packer companies give out or make their recommendations as to the actual mechanical procedure in which retrievable packers should be set, some retention-type packers in which you may use a, employ a J tool to set the packer in place and then employ a pull with your tubing string to actually effect the set of the packer or a seat down type which would go the opposite direction, you would actually set the weight of the tubing string on the packer to hold it in place. That is just general.

Q In other words, these packers are set in accordance with recommended practices?

A They generally are.

Q By the manufacturer? A Yes, sir.

Q Is the packer setting made under the supervision of El Paso personnel?

A Yes, it is.

Q To your knowledge, what particular personnel supervise?

A Our petroleum engineers supervise each and every job of this type.

Q Is it your opinion that the Commission could formulate rules and regulations making companies responsible for the proper setting and use of retrievable-type production packers?

A Yes, sir. I think the Commission could definitely depend on us to adhere to the type rules they put out for that.

Q Would El Paso particularly be willing and able to make the certifications suggested?

A Yes, sir, we would, and I might add that we definitely would want to have the packer leakage test run prior to making the certification.

Q Do you feel that these suggested amendments to the rules that El Paso has made should be adopted?

A Yes, sir, I do.

Q Why?

A Mainly that we could and have in the past scheduled as many as one hundred dual completion wells in a year's time. If we were to elect to use retrievable-type packers in all one hundred of them, under the present rules we would have to have one hundred hearings.

Q Now, El Paso has made packer leakage tests with respect to all of these multiple completions that you have mentioned?

A Yes, sir.

Q What, in general, have these tests reflected with regard to satisfactory or unsatisfactory performance of the retrievable-type production packer?

A They have reflected a very satisfactory performance of retrievable-type production packer.

Q Do you have a recommendation to make to the Commission with regard to frequency of testing periods for packer leakage tests?

A At the present time the general rule is to run a packer or perform a packer leakage test once every calendar year. I think from the experience that we have had that that seems to be satisfactory.

Q Have any of these retrievable-type production packers ever been removed from a well?

A Yes, sir, they have.

Q Why have they been removed?

A Well, there have been several reasons. In many instances we have found that the point in the well in which they were set there had occurred casing damage which was definitely not attributable to the packer. In other words, it was there prior to the actual setting point, and in some cases auxiliary equipment has failed, to cause us to pull the packer in order to replace the auxiliary piece.

Q Has El Paso had any difficulty in removing one of the retrievable production packers?

A No, sir.

Q In the event that you could not pull one of the packers, what would you do?

A Well, it would incur a fishing job to get the tubing out of the hole, and if not successfully remove the packer to actually mill it out to get it out of our way.

Q To your knowledge has it ever been necessary to mill one out?

A Not for us, no.

Q If the relief requested by El Paso in its application here is not obtained, what effect would you say that would have with respect to El Paso Natural Gas Company?

A I think the effect would be the same as I stated a minute ago, that if we were to elect to run retrievable packers, that we would actually have to come to that many hearings according to the number of retrievable packers we would run.

Q How many hearings would you estimate that would take?

A Approximately one hundred if we ran that many.

Q What would you say are the chief advantages, if any, of retrievable-type production packers over a permanent type from the company's standpoint?

A The chief advantages are these: First, the initial cost is usually lower. Second, they are retrievable, therefore allowing you to have a full bore available for workover of a well, and third, being retrievable they are also salvageable. In other words, you can run the packer back in the same well or put it in another well.

Q Do you consider that should this application to amend the rules be granted, that that would have the effect of preventing waste?

A Yes, sir.

Q Do you think it would violate or prejudice correlative rights?

A No, sir.

Q Do you have anything else that you would like to add to your testimony?

A Yes, sir, just generally I do. First off, we are neither for nor against any type of packer, but we do feel that the operator should be allowed to choose and use equipment that has been engineered, designed and priced for whatever condition he happens to find. Our packer leakage tests will definitely have shown that any poor choice in this will be pinpointed immediately, and they do require that we would take remedial action immediately, and which we do.

MR. WHITWORTH: That's all the questions we have.

CROSS EXAMINATION

BY MR. PORTER:

Q Mr. Coel, you stated that the cost would be less for the installation of retrievable packers. Could you tell us approximately how much you would save?

A Yes, sir, if I could refer to notes for a second. Using one type of permanent production packer set on a wire line, the price, the actual setting price all around to us would be about $1238.00. A retrievable-type packer set in the same place would cost us approximately $400.00, as much as $800.00 can be saved in that particular instance.

Q Are these particular packers to which you refer manufactured by the same people, just different types of packers by the same manufacturers?

A No, these two. However, going on the same basis, using the same manufacturer of the first type would be around the same price, $1238.00. The second type, the retrievable would be approximately $578.00 in their case.

Q Anyway, it would still be less than half for the re-trievable packer?

A Yes, sir.

Q You also testified that El Paso had completed approximately a hundred, I believe you said an exact figure of 158 duals at this time employing three types of packers?

A Three types of retrievable packers.

Q Three types of retrievable packers. Have you also employed some permanent type packers?

A Yes, sir, we definitely have.

Q In these 158 installations have you experienced any packer failures?

A No, sir. We haven't as such. We have had failures, yes, sir, but we have yet to actually blame those failures on a packer at any time. We feel there were other circumstances which showed probable failure other than packer.

Q Are you in a position to state whether or not your company has had more or less difficulty with the retrievable-type packer as compared to the permanent or non-retrievable?

A Percentagewise they are almost the same, sir.

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

BY GOVERNOR BURROUGHS:

Q Does the price differential that you have quoted mean that that is the price in purchase of the packer itself or is that of the packers in place?

A That is of the purchase of it, and the equipment needed to set it.

Q Would there be a difference in the cost of the actual setting operation?

A Yes, sir.

Q In favor of which?

A Still in favor of retrievable, sir.

GOVERNOR BURROUGHS: That's all.

BY MR. MORGAN:

Q The failures that you referred to awhile ago, you didn't name them, but were some of them in the matter of setting?

A No.

Q You said you didn't feel it was the time?

A Something was in the setting, human error where a mistake was.

Q Manufacturer has nothing to do with the setting of the packer?

A No, sir, we often times employ the manufacturer to come out there and aid us with this. However, once the packer is put into our hands, it is actually considered our piece of equipment and whatever we do with it depends on how we use it, sir.

MR. MORGAN: That's all.

BY MR. PAYNE:

Q I believe you testified that most of your duals are in Northwestern New Mexico?

A Yes, sir.

Q You gave the temperature ranges in the Northwest?

A Yes, sir.

Q Do you know what the ranges are in the Southeast?

A Not exactly. But I'm given to the opinion that they are less than the extremes found in the Northwest.

Q Now, the extreme in the Northwest is 230 degrees, is that right?

A Just about.

Q Are you familiar with the Otis Engineering Corporations Model 12 JO hook wall packer?

A No, sir, I am not.

Q I might add that that packer is not recommended for maximum temperature in excess of 200 degrees.

A If I might add something, there will be many packers on the market that are not recommended for what may be considered extremes or normals either one, the course is up to the manufacturer to recommend what he feels that the operator can best use, and for the operator to definitely take what he knows to be the best.

Q Yet under your proposed rule, wouldn't you be allowed to use any permanent-type or retrievable-type production packer?

A Yes, sir.

Q Are you familiar with the Wilson L. V. hook wall production packer?

A No, sir.

Q How about the Lane Wells Company BOC hook wall valve-type packer?

A I have employed those.

Q Have you found them satisfactory?

A Yes, sir. They were not employed in dual completion wells the best of my knowledge, but they were employed as production packers.

Q Have you ever employed a Gúiberson tension set hook wall retrievable packer?

A Yes, sir.

Q In a dual completion? A Yes, sir.

Q Have you found them satisfactory?

A Yes, sir.

Q Now you gave the advantages of a retrievable packer. What are the disadvantages, or does it have any?

A I would say that in the case where we have employed them they have no disadvantages as such. In other words, in relation to another type of packer.

MR. PAYNE: That's all I have.

MR. PORTER: Mr. Nutter.

BY MR. NUTTER:

Q Mr. Coel, you stated that a permanent-type packer would cost you $1238.00 installed, and that a retrievable packer would be something like $540.00?

A Seventy I believe it was.

Q It wasn't too long ago that we had a witness from El Paso testify that permanent-type packer could be run in a hole for approximately $640.00.

A That is true.

Q Where does your cost come from?

A This is true in the one case I stated, I believe I qualified that as a permanent-type set on a wire line.

Q In other words, you picked the most expensive means to give us an example?

A Yes, sir, I did, in that case I did. It is possible to set a permanent-type packer on tubing or drillpipe where the cost of the packer would be only slightly higher than the retrievable, but auxiliary equipment required for it would run the price up to about $837.00.

Q Instead of the $640.00 that was testified to not long ago?

A Yes, sir.

Q You stated also that you have used some permanent-type packers. If they cost more, why did you use them?

A Retrievable-type packers have not always been available in the ranges that we wish to employ them, and we have in those cases employed what we thought was the best piece of equipment at the time.

Q There are some instances when the permanent packer might be more satisfactory or more desirable than the retrievable-type packer?

A Well, there have been. I won't say that there will be. There have been some instances. As I say, the retrievable packers are relatively new, we have been doing this type of work for many years. I am sorry, go ahead.

Q What are the principal zones of dual completions in the San Juan Basin?

A Well, principally I was speaking of the two zones, the

Pictured Cliffs and the Mesaverde as a combination, and also of the Dakota and Mesaverde as a second combination.

Q Is there any general correlation as far as El Paso's practices are concerned in using either one of these two types of packers for either one of the two types of zones?

A I am afraid I don't understand you.

Q It's my understanding, correct me if I'm wrong, that perhaps one combination of horizons might be more suitable for the use of one type of packer, and another combination of horizons might be suitable for a different type of packer. Is there any correlation?

A Not because of the horizons. It may be because of individual well conditions.

Q Well, then, individual well conditions do enter this too?

A Yes, very definitely do. It's best to pick what's going to make the safest and best completion for you at the time.

Q What well conditions could exist that would affect your decision?

A Oh, maybe an extremely large volume well that had a tendency to be very hard to hold and kill with mud might cause you to run in there with a wire line, a hole with a wire line, a permanent-type packer in order to set it and use it as a plug while you prepared your final completion. And consequently you also used this production packer later. That would be a condition.

Q Is there any general correlation between pressure differential and the selection of the type of packer?

A I don't think it is necessary. I think the packers are available for all types of conditions, sir.

Q This first combination that you mentioned, Pictured Cliffs and Mesaverde --

A Yes, sir.

Q Do you commonly select a retrievable-type packer for that type of dual completion?

A Commonly we do, yes, sir.

Q How about Gallup and Dakota?

A We have, yes, sir.

Q Have you selected permanent-type packers?

A Also.

Q Percentagewise now, do you use permanent-type packers more frequently in Gallup-Dakota than you do in Pictured Cliffs-Mesaverde?

A Well, percentagewise, yes, sir. There's also another thing to be added to that, to your question a minute ago as to the use of the permanent-type packers, since we were corrected in our misconception of what constituted a permanent-type packer, we have used definitely only permanent-type packers since the May order that you all put out, sir.

Q Another question, Mr. Coel, do the New Mexico Oil

Conservation Commission rules presently prohibit the use of a retrievable-type packer?

A No, sir.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question? Mr. Utz.

BY MR. UTZ:

Q Mr. Coel, I'm still a little confused on the cost of the packers. Let's attack it from a little different angle. Could you give me the range of cost of a permanent-type packer?

A Let me see here, Mr. Utz, if I can. Yes, sir, a range of approximately $767.00 to approximately $1238.00.

Q Does that include the tools for setting, and actual setting in the well bore?

A Yes, sir.

Q How about your retrievable-type packer?

A From $400.00 to approximately $578.00.

Q Does that include being set in the well bore?

A Yes, sir. In neither case does that include the rig time required.

Q I see. When you use a retrievable-type packer, do you use this packer for testing purposes also to run DSDS, fracting or any of your other operations?

A They have been used for acidizing, fracting, I don't recall using one of them exactly for drillstem testing though.

In other words, drillstem tests, referring to drillstem tests as being run in openhole, these are primarily packers for casing.

Q Yes, sir. You did use this same retrievable-type packer in your fracting operation?

A It has been and can be used that way, yes, sir. It's not a common practice, but it has been done.

Q Is there any danger of damaging your retrievable-type packer when you use it for fracting?

A I would think that if you put extreme loads upon that retrievable-type packer it certainly should be checked and perhaps redressed before employed as a production packer. However, in some cases it could be left right in place if it's found in the hole satisfactory.

Q How many times can you retrieve and reset a retrievable-type packer without being damaged?

A I don't know. It has been done as many as two and three times, but I don't know how many other times it could be.

Q When you retrieve a retrievable-type packer, do you usually dress it or repair it in any way before it is reset?

A Yes, sir, I believe it's common practice to definitely check it and if it requires dressing and so forth, it's usually done immediately.

Q It can be done then? A Yes, sir.

Q I believe you mentioned a combination of Mesaverde and

Pictured Cliffs and Dakota and Mesaverde, did you have occasion to have a combination of Dakota and Pictured Cliffs?

A We haven't as of yet. It's always possible though.

Q What would be, well, I might say that I'm thinking primarily of the West Kutz Area at this time, where you have as far as I know only Pictured Cliffs and Dakota. What would be the bottomhole pressures in both of those zones in that particular area, would you say?

A Someone will have to correct me if I'm wrong, but I'm under the impression that the Dakota is approximately 2300 pounds bottomhole pressure maximum in that area and Pictured Cliffs four to five hundred pounds, probably.

Q Your retrievable-type would operate satisfactorily?

A There are some on the market that we feel definitely would.

Q Not all of them?

A No, sir, not everything for sure. I don't know about that because there are some of them I'm not familiar with.

Q Do you not think under those conditions it might be advisable to specify the type packers that should be used under those particular conditions?

A No, sir, I think the operator should be certainly capable of selecting the proper piece of equipment. If he doesn't, the packer leakage test is going to show him to be wrong.

Q You think he would select the proper ones under these conditions?

A I think so. He certainly should.

Q You are speaking for El Paso only?

A Speaking for us, I think we would, yes, sir.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? Mr. Whitworth.

REDIRECT EXAMINATION

BY MR. WHITWORTH:

Q There are some permanent-type production packers that will not satisfy every conceivable condition, is that correct?

A I understand that is true.

Q Yet under the rules that are presently in effect, the operator has the right to select what type of permanent packer to put in a well and gain approval by administrative hearing?

A That is true.

Q Or administrative approval, rather.

A Yes, sir.

Q Actually the rules do not prohibit the use of a retrievable-type packer, but what is required before a retrievable-type packer may be utilized in a multiple completion?

A Well, first off we have, it has to pass a packer leakage test, it has to have all the other forms sworn to requested by the Commission and then brought before the Commission for hearing and approval.

Q Would you say that an operator exercising his discretion in a multiple completion could easily find a retrievable-type packer that would satisfy all conditions likely to be encountered in the State of New Mexico?

A Yes, sir, I would say that's true.

MR. WHITWORTH: That's all I have.

MR. PORTER: Any further questions? Mr. Payne.

RECROSS EXAMINATION

BY MR. PAYNE:

Q What type permanent packer is not satisfactory to effectively separate the two zones?

A I don't know the names. I have heard this, as I said, by hearsay, that there are some that are made in such a way that they are made for very light duty work.

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

(Witness excused.)

MR. WHITWORTH: Our next witness is Mr. John Muse.

J O H N F. M U S E

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

DIRECT EXAMINATION

BY MR. WHITWORTH:

Q Would you please state your full name and by whom and in what capacity you are employed?

A John Francis Muse with Baker Oil Tools. I'm the Chief Production Engineer.

Q Would you state to the Commission your scholastic qualifications and experience as an engineer?

A I attended the University of Arizona at Tuscon and graduated with a Bachelor of Science degree in metallurgical engineering. I was employed by the then Texas Company in Cutback, Montana as an engineering trainee, and as a junior petroleum engineer, and I went with Baker Oil Tools in 1951. being employed by that company in the Service Department for one year, then in the Engineering Department as a design engineer, project engineer, and then as chief production engineer, and in my present capacity for approximately a year and a half.

MR. WHITWORTH: We ask that the witness' qualifications be accepted.

MR. PORTER: The witness' qualifications are accepted.

Q In your testimony here today, Mr. Muse, are you speaking for other production packer manufacturers other than Baker?

A Yes, sir.

Q In a general nature?

A Yes, that's correct.

Q What particular production packer manufacturer?

A Well, I believe that I'm speaking in concurrence with Guiberson, Haliburton and Brown.

Q You have been selected to present your views with respect to retrievable-type production packers in order to facilitate the testimony in this case?

A Yes.

Q Rather than have all the other witnesses?

MR. WHITWORTH: I wish to state to the Commission that the other witnesses are available should the Commission wish to call them.

MR. PORTER: From other manufacturers?

MR. WHITWORTH: Yes, sir.

Q In your capacity with your company you have had occasion to become acquainted with the purpose and operation of a retrievable-type production packer?

A Yes, I have.

Q Are you familiar with the experience that various operators have had with the use of retrievable-type production packers throughout the State of New Mexico?

A In a general way, yes, sir.

Q What would you say are the characteristics of a retrievable-type production packer that differentiate it from a permanent type?

A A retrievable-type production packer has characteristics which may permit the sealing element and the holding elements or slips to become disengaged from the casing and then the packer may be removed from the well, whereas a permanent packer once set may not be removed from the well, that is the sealing element and holding elements are permanently fixed to the casing.

Q What is the retrievable-type packer designed to accomplish particularly?

A Retrievable-type packer is designed to accomplish zonal segregation or separation, isolation, confining the flow usually to tubing string.

Q Are you familiar with the conditions in the State of New Mexico under which production packers must operate?

A In a general way, yes, sir.

Q Are you familiar with the designing and operation of retrievable-type packers now generally in use in multiple completion wells in the State of New Mexico?

A Yes, I believe I am.

Q Well, now, in your opinion do you know of a major manufacturer of retrievable-type production packers that does not manufacture and sell a retrievable-type packer that should satisfy all the conditions that are likely to be encountered in multiple completion wells in the State of New Mexico?

A I don't know a major manufacturer, no, sir.

Q Do you know of any specific examples where retrievable-type production packers have been used and been shown to be satisfactory under conditions of temperature and pressure that are more extreme than are likely to be encountered in the State of New Mexico?

A Quite a large number of retrievable packers are currently in use, and to the best of my knowledge performing satisfactorily in conditions quite a bit in excess of those you expect to encounter here.

Q For the magnitude of temperature and pressures that have been encountered in New Mexico, do you have an opinion as to the operation of retrievable-type production packers if properly designed and selected as compared to the permanent type?

A Would you please repeat that?

Q Well, I'll state it this way, considering the magnitude of temperature and pressures that are likely to be encountered in the State of New Mexico, is it your opinion that if properly designed and selected, a retrievable-type production packer should be just as effective to separate producing zones as a permanent type?

A Yes, I do.

Q Generally speaking what are the methods by which a retrievable-type production packer may be removed from a well should it become necessary?

A Well, as I stated before, the sealing and holding elements of the packer are disengaged from the casing. This is accomplished by either mechanical manipulation of the tubing before pulling the tube, or in some cases hydraulic manipulation, or in some cases the tubing may just be removed from the well, just a string taken and the packer pulled out.

Q In dealing with production packers of both retrievable and permanent-type, how would you compare the demand in the oil and gas industry in general of retrievable-type production packers as compared to permanent type?

A Well, rather than get into quantities, I think I could say this, that if we as manufacturers would tell the industry tomorrow that we're no longer furnishing either one or the other type packers, I think the demand would be just as great either way. That is, I believe there is a need for both and I think I would say the demand is equal.

Q Did you say just about as many retrievable-type packers are used as permanent?

A I wouldn't have an opinion on that. I just don't have any knowledge.

Q Is it your opinion that once an appropriate retrievable-type production packer is properly run and set, if the conditions under which it's properly run and set do not significantly change, should that packer remain set and successfully separate the zones of production?

A Yes. Yes, sir.

Q For how long would you say?

A I would say an indefinite period of time.

Q Well, then, considering that, do you have any kind of recommendation to make to the Commission as to the frequency or necessity for packer leakage tests?

A Well, yes, sir, I do, only this, that pressure, let me say drastically changing conditions across the packer are more severe on the packer than sustained conditions or sustained loading. Therefore, considering the packer by itself, the less the packer leakage test would be run, the better for the packer. The conditions of changing pressures are more severe on any packer, permanent packer or retrievable packer either. Considering the packer by itself, you'd be better off not to test it at all. I know you would want to, but considering the packer, that's right.

Q You are familiar with El Paso's application in this case, are you not, as amended?

A Yes, sir, I am.

Q How does your company and production packer manufacturers of whom you are speaking, how do they feel about this application, do they oppose it or concur?

A No, we concur.

Q Have tests been made to your knowledge on retrievable-type packers?

A Yes, sir.

Q To determine their effectiveness to separate zones of production?

A Certainly.

Q Could you describe these tests to the Commission?

A Well, of course, ourselves and packer manufacturers thoroughly test our equipment. In a general way you subject the packer to, as near as you can determine, to the maximum conditions that the packer is going to be exposed to. We would set the packer under temperature and then expose the packer to pressure from above and below with reversals over a period of time.

Q Now, with respect to retrievable-type packers, particularly, what have these tests showed?

A Providing that the packer is properly designed for a given set of conditions, retrievable packer performs very satisfactorily.

Q Is there anything else that you would like to add to your testimony, Mr. Muse?

A Well, yes, I had two things I think. One is that I think as Mr. Coel brought out, and it's certainly true, there are tools which we make and other manufacturers make that are being used as permanent packers which would not satisfactorily do the job in the State of New Mexico. There are permanent packers that will. There are retrievable packers that won't and there are retrievable packers that will. It's my own opinion that it's pretty well up to the operating company even on permanent packers, although this is something that seems pretty straightforward, it's certainly true that he could select a permanent packer that would fail.

The other point I thought worth bringing out is something like H-40 and J-55 and N-80, and certainly N-80 would operate with a higher safety factor than J-55. However, it would be to the detriment of the operating companies and the industry as a whole to require companies to use N-80 where J-55 would adequately do the job. It seems to me personally that it's somewhat analogous on these retrievable packers.

Q When you say N-80 and J-55, to what are you referring?

A Casing. That's all I have.

MR. WHITWORTH: That's all we have from this witness.

CROSS EXAMINATION

BY MR. PORTER:

Q Mr. Muse, do you have any idea what percentages of the total permanent or non-retrievable-type packers Baker sells?

A Would you please rephrase that?

Q Well, your Baker model D is possibly as well known, maybe the best known permanent-type packer.

A Yes.

Q Would you have any idea what percentage of the total sales this Model D represents?

A Yes, sir, I do. I would rather not disclose that. I could tell you this, if my management I think would just as soon as I didn't, actually from a percentages standpoint -- this is dollar volume?

Q This is compared to all types of non-retrievable packers, not all manufacturers, not your particular company. I didn't make myself clear.

A I see. Well, I'd just take, you mean what percentage of the permanent packer business we have?

Q Yes, sir.

A I would guess, this is a wild guess, I would say ninety percent. That's my own opinion.

Q Would you occupy that same position in retrievable-type packers?

A Not by a long ways, no, sir.

Q I wonder if your company knows that you are down here giving this kind of testimony?

A Well, we make and recommend both types of equipment and we feel that there are definite applications for both, and we sell a lot of retrievable packers too. We wouldn't sell them and recommend them if we didn't feel they do a good job, and our experience backs us up, they are doing a good job.

Q Well, now, do you know conditions where retrievable-type packers would do a better job than the permanent-type packer?

A Yes, sir.

Q As a dual completion separator?

A I sure do.

Q Would you state some of those conditions?

A Well, in Texas and Louisiana, for instance, where they're dually and triplely completing these combined zones to the tubing, you get into situations where you just cannot do the job as far as tubing sizes, flow areas and volumes, you just cannot do the job, you just can't get as many strings of tubing involved with permanent packers as you can with retrievables.

MR. PORTER: Does anyone else have a question of Mr. Muse? You may be excused.

(Witness excused.)

MR. WHITWORTH: That concludes El Paso's testimony.

MR. PORTER: The hearing will recess until one-fifteen.)

(Whereupon a recess was taken until one-fifteen.)

AFTERNOON SESSION

MR. PORTER: The hearing will come to order, please. Does anyone else desire to present testimony in this case at this time?

MR. PAYNE: Mr. Commissioner, I would like to call one witness, Mr. Nutter.

MR. PORTER: Have Mr. Nutter come forward and be sworn, please.

(Witness sworn)

DANIEL S. NUTTER,

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

DIRECT EXAMINATION

BY MR. PAYNE:

Q Will the witness please state his name and position?

A Daniel S. Nutter, Chief Engineer for the Oil Conservation Commission.

Q Mr. Nutter, have you recently had mailed out a questionnaire to the various manufacturers of packers requesting certain information?

A Yes, sir. I'm not sure that we mailed them to all of the manufacturers of packers. However, we did find the names and addresses of eighteen manufacturers, and we sent this questionnaire to those parties.

Q Now, what was the information that you requested?

A The questionnaire requested certain information from the manufacturers of the packers as to the characteristics and features of the packers and their capability to be used in dual completions. The questionnaire has six items on it. No. 1 is the basic model number. No. 2 is the variations of the basic number that the manufacturer might have. No. 3 is the type of packer, whether it is hookwall completion, retrievable, permanent, or what have you. No. 4 is the question, "Is this packer recommended for permanent zone separation in dual completions?" No. 5, the maximum pressure differential for which you would recommend this packer. And the sixth item on the questionnaire is the maximum temperature for which you would recommend this packer.

Q Now, did you also furnish the manufacturer with an instruction sheet as to what sort of information you wanted to get on this?

A Yes, sir. We had a little sheet that was sent along with the questionnaire, as well as the cover letter and the instruction sheet for the completion of the packer questionnaire. Took each of these six items, one at a time, and explained exactly the information that was desired for that column.

Q Now, how many companies did you write to?

A We mailed out eighteen questionnaires.

Q And how many replies did you receive?

A We had eleven questionnaires returned.

Q Now, what general types of packers did the manufacturer report on?

A Oh, we have hookwall packers, and tension packers, and compression packers, and shorty packers and permanent packers. Just every kind of a packer you can think of was listed.

Q Have you added these up to determine how many different models were made by these eleven companies?

A Yes, sir. These particular eleven companies listed one hundred twenty-one different packers in their questionnaires.

Q And I assume that new types and models are being developed from time to time?

A Yes, sir. One of the companies, as a matter of fact, with the letter that they returned, their questionnaire brought that point out. "Although this is a complete listing of our packers which would conceivably be used for multiple completions in New Mexico at this time, we are constantly developing new ideas and concepts in packer materials and designs. As each tool is perfected, an addition would be necessary to keep this list current."

Q Is that letter from Halliburton?

A No, this happens to be from Brown Oil Tools.

Q Now, the information you received on this form, did it show that all permanent packers were recommended for zone separation?

A The answers to the questionnaires indicate that each of the permanent packers manufactured by the companies that returned the questionnaire stated emphatically that this permanent type packer is recommended for zone separation of the dual completion.

Q Now, did they all recommend the retrievable type packer --

A No, sir.

Q -- for zone separation?

A No, sir, they didn't.

Q In fact, some of them said they would not recommend it, is that right?

A Yes. That's an interesting point. Some companies will make what they call a hookwall production type packer, and they'll say this packer is recommended for zone separation. Another company might make a hookwall production type packer, and they'll say, no, this is not recommended for dual completions.

Q Was the pressure differential the same on each of these packers?

A No, there is a variation in -- a similiarly described packer will have a variation in the temperature or pressure differential for which the packer is recommended.

Q How, do you account for that?

A Well, either a difference in the packer itself or difference in the opinion of the man that answered the questionnaire, I would say.

Q Was the maximum temperature the same for the same models?

A No, sir. We had a range of temperatures there from 200 to 400 pounds, I believe it was.

Q And again you would say there was a difference in packer or difference of opinion?

A Yes, sir.

Q Now, Mr. Nutter, what holds a retrievable type packer in place?

A Well, most retrievable type packers are held by tension on the tubing string or by completion, the weight of tubing string sitting on top of the retrievable packer.

~~Q Only one set of slips?~~

A As far as I know, retrievable packers just do have one set of slips. Now, there are several slips in the set, but I would say that all the packers that I've had the occasion to inspect in the literature seem to have one set of slips pointing in one direction only.

Q And they have an auxiliary hold down device?

A Some of the packers are used in conjunction with some other type of hold down device to keep the packer from moving in the direction opposite the way the slips are pointed.

Q What holds a permanent type packer in place?

A A permanent type packer is set either by wire line, causing a discharge of an explosive element in the packer, which expands the slips and compresses the sealing rubber against the side of the casing, or it's set hydraulically to cause the slips to expand and set the sealing rubber against the casing.

Q But it has --

A It has two sets of slips, one pointed up and one pointed down to keep the packer from moving in either direction.

Q Do you feel that gives you better protection in both directions from movement?

A It appears it will, yes.

Q Is a retrievable type packer non-drillable?

A For all practical purposes, retrievable packers are non-drillable. It is my understanding that some of them are so designed that if they fail to retrieve that you can by pulling hard enough, pull the Mandral from the core of the packer itself, leaving a shell there that may be drillable. I think that all packers are probably malleable.

Q Now, isn't there a possibility that if you had to mill it out, you could lose the hole?

A Well, milling a packer is a very expensive operation, and if it was a marginal operation or a marginal well, there is a possibility of abandoning the well rather than going through the expense of milling the packer, yes, sir.

Q Now, in both flowing wells and pumping wells, you do have tubing movement, don't you?

A Yes, sir. In flowing wells you have tubing movement primarily due to expansion and contraction of the tubing as a result of temperature changes during the flow of the wells, and pumping wells, you would have tubing movemont to the reaction of the tubing string and the rod.

Q Do you feel that tubing movement would be more inclined to upset a retrievable type packer than it would as a permanent type packer?

A Yes. I would think whether it would upset it or not, it would constantly put a strain on the packer which might cause it to weaken.

Q Now, if I understand you correctly, you say that a retrievable type packer depends on the tubing weight to hold it in place?

A Yes, sir.

Q Now, as it contracts --

A That, as a compression type retrievable packer, it would depend on the tubing weight, yes.

Q Now, if you have a contraction, would there be less weight to hold the packer in place?

A Yes. It would stand to weight that as the tubing string cooled, it would shorten itself, and as it shortened itself, it would take some of the strain off of the packer itself and put more of the weight of the tubing string on the tubing head.

Q The tubing itself would weigh the same?

A The tubing would weigh the same, yes.

Q Now, do you feel that there is less chance of a packer moving or becoming unsituated due to tubing movement in a permanent type packer?

A Yes, sir, I think there is less chance for the packer to become unsituated. I also feel the permanent packers have a smooth bore on the inside of them, and the portion of the tubing that goes through the packer is equipped with O,rings,and this tubing can actually slide and move within the permanent -- within the body of the packer itself, if need be.

Q Now, Mr. Nutter, have you any packer literature which refers to the retrievable type packer as the second packer and where the schematics indicate that the permanent type is to be used for zone separation?

A Yes, sir, I have. I would like to call your attention to Baker Oil Tools catalog for 1959 in which they make this statement on Page 491. That the Baker multiple zone retrievable packers are designed primarily to be used as the upper packer of a two-packer installation. Now, the lower packer in a two-packer installation is the one that delivers you separation between the zones. So they said, to go ahead and conclude this, they say it is to be used as the upper packer of a two-packer installation in which the lower packer is a Baker drillable packer. In other words, they have made the statement in their catalog that the retrievable type packer is to be used in conjunction with permanent type packer, but they are depending on the permanent type packer for the separation of the zones. Also, their schematic diagrams reflect this sort of a hook-up all the way through their literature.

Q Mr. Nutter, do you have a reprint from an article that appeared in the Journal of Petroleum Technology in December of 1958, written by Althouse and Fisher with Baker Oil Tools, Incorporated?

A Yes, sir.

Q Would you read certain portions of that and we'll put the entire article in as Commission's Exhibit 1?

A I might mention Mr. Althouse is the manager of engineering and research for Baker, and Mr. Fisher is division mechanical engineer for that company. And in this article they have gone into the selection of multiple completion hook-ups going into tubing strings, all the other phases of the equipment that go into these dual completions. They do have a complete section on the packers themselves in the article. I'm quoting from the article.

> "Regardless of their individual design differences all packers used for multiple completions fall into two basic classes: permanent (drillable) and retrievable. Generally, either type can be used interchangeably or in combination throughout all multiple completion hook-ups regardless of complexity. Each has inherent advantages and disadvantages for each application."

In the permanent, then, that's the general statement under packers, and then they go into the retrievable packers and the permanent packers. In the permanent packer section they say:

> "These packers, sometimes referred to as retainer-type packers, are run into the well and set on electric conductor cable or on tubing. When these packers are set they become for all practical purposes a permanent, though drillable part of the casing. The smooth packer bore, which contains a flapper-type back-pressure valve at its lower end,"--

I might stray from the text of this article now, and mention this flapper valve. There is no means of maintaining separation of the zones in a dual completion when you've pulled the tubing and the packer on the well, when you have a retrievable type packer. However, if you have occasion to pull the tubing and you have a permanent type packer in the well, you pull the tubing, and the flapper valve automatically closes the opening through the packer, and you have separation maintained even while your tubing is out of the well. To get on to the article.

> "The permanent packer is characterized by two complete sets of opposed slips and a packing element that is confined by expanding retaining rings that back up the expanded packing element and improve its high pressure, high temperature performance.
>
> The permanent packer offers two prime advantages from the standpoint of multiple completion applications: (1) the permanence and reliability of its pack-off particularly under high pressure, high temperature conditions, and (2) the flexibility provided by a removable tubing string. A third advantage, its prime disadvantage in some installations, is that it is designed to be removed by drilling out. Under many conditions where an operator might be concerned over the amount of steel in the hole, known drillability might outweigh questionable retrievability. Recent progress in the development of special packer milling tools has greatly improved the drilling-out operation."

Now, we'll offer, too, the advantages and disadvantages of retrievable packers.

> "The prime advantage of the retrievable packer is its retrievability. This is a desirable feature in any completion, particularly so in many multiple completions where access for truly extensive workover can only be provided by complete removal

of the packer. Loss of retrievability, of course, can be a decided disadvantage.

Although it is subject to controversy, field preferences seem to indicate that the permanent packer is capable of providing a better, longer lasting pack-off particularly under exceptionally rigorous conditions of pressure and temperature than retrievable packers. One of the possible reasons for this could be that the permanent packer does not have to make any design concessions to provide for retrievability."

I believe that's all for that article.

Q Let me ask you this, Mr. Nutter. How can communication occur in a dual completion other than by way of the packer?

A Well, there is probably four ways that you can communicate in a dual completion. One would be through the packer or leakage in the packer. You could have communication between the pipe due to a faulty cement job. You could have communication in the tubing, a hole in the tubing, or a leak in the collars, and you could have communication in the wellhead itself or the tubing head, the hanger. Those are the only four conceivable means of communication that I can think of in a well.

Q Now, does the packer leakage test that is required by this Commission indicate whether communication is occurring by any of these means?

A Yes, sir, it would, --

Q Now, how often --

A -- provided the communication is substantial enough to be detected on the packer leakage test.

Q How often do you think these packer leakage tests, or what we will refer to as a communication test, should be taken.

A I think with a packer that is not subject to the strains and tensions that retrievable packers are subject to, can probably get along with the test of once a year, maybe. But I think any packer that has this retrievability built into it should probably be tested more often, granted you may take the test. You may have a good seal when you install the thing, but these constant strains and tensions that are on the packer may cause that thing to leak, and it should probably be tested more often, perhaps six-month intervals in the case of a retrievable type packer.

Q Now, I notice in the article you read, the main advantage of the retrievable type packer is retrievability. Is that so that you can conduct an extensive major workover?

A I suppose so, yes.

Q Now, isn't it true that most workovers, we'll say the majority of the workovers that are done, can be done through the tubing?

A A large number of the workovers can be done through tubing, yes.

Q Do you have any further comments or any recommendations you would like to make to the Commission in regard to this case?

A Yes, sir. As I stated, we had one hundred twenty-one packers mentioned by eleven returned questionnaires. How many more packers there are in existence, I don't know; probably another hundred and twenty-one, anyway. We've made a conscientious effort to try to find out what all these various packers are. We obviously haven't been able to find all of them. I have in my hand here an application for a dual completion for an operator in which he has a schematic diagram, that he is going to run a Guiberson C-1 or C-I production packer. Now, I diligently searched the literature of the Guiberson Company, their 1959 and '60 catalog, and I can't find any Guiberson C-1 or C-I packer in this literature. I find that they have a type C formation packer. I certainly don't think this operator is going to put a formation packer in there, I don't know, but without knowing something about this packer, I don't know whether we should approve this thing administratively.

Q Now, assuming the Commission decided to approve El Paso's application, do you think it would be a good idea to have the operators, at least for a time, send the literature on the proposed packer?

A Well, if we don't have the literature, we are going to have to know something about it. Actually, we have no quarrel whatsoever with retrievable packers; we just feel that under the majority of the conditions the permanent type packer will do the job, and under some of the conditions the retrievable type packer may do the job. Under other conditions, maybe some of the retrievable packers will do the job and some of them wouldn't. Mr. Whitworth, Mr. Mason, Mr. Cole all went into this idea that they felt that the Commission should leave it to the discretion of the operator, the selection of their equipment. Well, I agree one hundred percent with them. Now, we have never said that a retrievable type packer could not be utilized for a dual completion. We only want to be sure that the place where it is used is suitable for that type of packer. We don't want to interfere with an operator's prerogative of using and employing equipment that will adequately do the job. providing that such selection would not prevent waste and protect correlative rights of any neighboring operator.

Q Is there some way that the operator can furnish us information that you need in connection with the application for administrative approval?

A I think when you come up with a new type of packer that we've never encountered before, and there is probably hundreds of them, that the only way that you can examine the installation, check the equipment, explore the pressures, the temperatures, and such, that you must know about a well in order to know the suitability of that packer for the well. The only way you can do that is to have a hearing, be able to ask the questions and get the evidence.

Q Of course, if it does prove unsatisfactory, that would be discovered by the packer leakage test, wouldn't it?

A Well, you might know that you didn't have an adequate setting the first time you ran the test, or the first test may be good, and then the packer may fail after you completed the test.

Q Do you have anything further you would like to offer?

A I don't believe so.

Q Would you have that designated Exhibit 1, that article?

MR. PAYNE: Mr. Commissioner, we move for the introduction of Exhibit No. 1.

MR. PORTER: Without objection, Commission's Exhibit No. 1 will be admitted into the record.

Anyone have a question of Mr. Nutter?

CROSS EXAMINATION

BY MR. REESE:

Q Mr. Nutter, are you familiar with the Brown BP-4 packer?

A As a matter of fact, I'm not positive that I am. I think I have used that packer myself in the field, Mr. Reese.

Q I believe you stated that these retrievable packers were not -- could not be used for treating and isolation where the tubing was removed? That there would be communication where you retrieved or brought your tubing out?

A Yes, sir, I stated that in the installation where you remove the tubing and the packer, you wouldn't have any separation of the zones when you had the tubing and the packer out of the hole.

Q In connection with this, the catalog, I'll read you this statement and ask you if you are aware of it.

"For dual gravity packing and other treating techniques to either or both zones in a dually completed well, where a bridge plug is needed for zone isolation, the BP-4 has proved highly satisfactory and very economical after using both a squeeze tool and bridging plug. This vertical tool can be left in the hole for a parallel completion."

Were you aware of this?

A Yes, sir. I knew that that packer could be left in the hole.

Q And you weren't testifying about that packer, then, when you were talking about packers that could not maintain the separation?

A Well, I stated, Mr. Reese, that when the packer was pulled out of the hole, you wouldn't have anything to separate the zones. Now, I think if this packer were pulled out of the hole, there wouldn't be any separation.

Q When a permanent packer is pulled out, is it separated?

A There is no separate --

Q When you pull a packer out, there is nothing to separate?

A That's right.

Q So that really wouldn't be an objectionable feature to the retrievables?

A Well, does the Brown BP-4 have a flapper valve on it?

Q No, it has a tubing plug.

A Of course, a tubing plug can be run in a permanent type packer too, but in the interim, from the time you pull your plug out until you run your plug in, the flapper valve is closed.

Q Mr. Nutter, are you aware of whether or not any of these flapper valves are removed before the permanent plug?

A Yes, sir. I understand that sometimes operators do pull that flapper off of there.

Q Now, I believe you also stated that there was on these retrievable packors only a single set of slips that engaged the wall of the casing?

A The ones that I have recently inspected had one set of slips.

Q I call your attention in the Brown catalog to the Brown SOS J-7 packer, and ask you if that does not have two sets of slips?

A Yes, sir, I would say that it appears that this packer has two sets of slips that are operated by hydraulic pressure.

Q Thank you.

MR. PAYNE: What was that packer again, Mr. Reese?

MR. REESE: Brown. Brown SOS J-7.

Q (By Mr. Reese) I'll also ask you, Mr. Nutter, if you are able to say, that the Brown SH-16 has two sets off slips?

A No, sir, I don't know how many sets it has.

Q Will you examine this blueprint of the HS-16 and state whether or not it has two sets of slips?

A Yes, sir. It has an upper set pointing down and a lower set pointing up.

Q So that from your engineering viewpoint that packer would be as effective as a permanent type?

A I'll say it has as many slips as a permanent type packer.

Q I believe you also stated that these retrievable packers could not be drilled?

A I said that some of them couldn't. Some of them, the hard center portion, the Mandral in the packer can be pulled out. You might say "pull the guts" out of the packer and then drill the shell out of it.

Q I'll call your attention again to the Brown Tool catalog in discussing the Brown dual packer, wherein the statement is made that the entire packor, except the stem is drillable in cases of extreme emergency.

A Yes, sir, that's the part that I was talking about. The stem can be pulled out, but it says here that the entire packer, except the stem, is drillable. I don't know if the stem can be pulled out in that packer or not; I suppose it can.

Q Are you familiar with the practice in the adjacent states on retrievable packers --

A No.

Q -- as to whether or not they require Commission hearings or not?

A No, I'm not aware of what the rules are in the other states on that.

MR. REESE: I believe that's all.

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

Mr. Verity?

QUESTIONS BY MR. VERITY:

Q Mr. Nutter, if I understand your testimony, you say that in some situations you think the retrievable type packer would probably leak --

A Yes, sir.

Q -- but you can see that in some situations the retrievable type packer would be all right for zone separation for dual completion?

A Yes, sir.

Q I believe you also stated that you also thought it was not the prerogative of the Commission to determine the mechanics of operating a lease, right?

A I said I didn't think the Commission would want to interfere with the prerogative of the operators.

Q So, doesn't that bring us to this; that it merely becomes a question of what is an adequate test, so that there is no leakage between the two zones?

A An adequate test and to know that there is no leakage, and also the assurance that leakage wouldn't occur after you have taken the test.

Q Well, if the Commission does not desire, and I'm in complete accord with Southern Union that they shouldn't, if they do not desire to supervise completion of wells or dually completed wells, and actually it seems to me from your testimony and otherwise, that what the Commission really wants to know is that there is not going to be leakage between the two zones?

A That's the whole purpose of having a packer in the well.

Q Then, if we admit here that some retrievable packers are adequate to seal off the two zones, then isn't further conversation and testimony with regard to retrievable packers really beside the point in this hearing?

A The question arises, Mr. Verity, which packer is suitable for which zones, whether you have some retrievable packer.--

Q That gets back to supervision, how we are going to complete?

A It gets back to the question, are we going to have permanent separation of the two zones.

Q Well, if we admit, which I thought we did at the start here, that in the proper situation retrievable packers will separate the two zones, then it seems to me that we come right back to the fact that the only thing the Commission is interested in is knowing that a test has been made and adequately often enough that there is not going to be communication of the oil?

A That is correct.

Q Well, then, isn't the only thing to be determined by this hearing, is how often the leakage test needs to be made?

A Maybe the leakage test ought to be made very frequently with some packers in some holes.

Q Well, this is the only question that we really need to determine here, isn't it?

A If you've got separation of the zones, that's all you need.

Q That's all the Commission needs to know, is that there is separation?

A That is correct.

Q So, actually doesn't the hearing resolve itself into the determination of that one question?

A Well, I don't know. That wasn't what the application was for.

MR. VERITY: That's all.

REDIRECT EXAMINATION

BY MR. PAYNE:

Q Mr. Nutter, do you know every type of packer that is made?

A No, sir.

Q Are you familiar with a majority of them?

A I'm afraid I'm not, no, sir.

Q If you have an application for administrative approval, would you know if the packer was of the type that would achieve separation?

A No, sir, I probably wouldn't.

Q You feel that probably you should have a hearing on this so that you could determine whether this packer was adequate to do the job?

A I believe so. I would like to know a little about it anyway.

Q Well, to get back to this question of Mr. Verity's as to how often a packer leakage test should be taken, do you think that perhaps, whether or not El Paso's application is granted, packer leakage tests ought to be taken every six months?

A I think on retrievable packers, they certainly should.

Q Why is that?

A Because, like I said previously, retrievable packer is subject to strains and movement, and can yield to them more readily than the permanent type packer can, and by yielding to them, it is more likely that you will have communication.

Q So, you feel it wouldn't be discriminatory to have six month packer leakage tests on retrievable type packers and annual packer leakage tests on permanent type packers?

A No, I don't believe it is discriminatory.

MR. PAYNE: I believe that's all. Thank you.

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

MR. VERITY: One more question.

QUESTIONS BY MR. VERITY:

Q Mr. Nutter, couldn't a rule be written here to the effect that where administrative approval had been requested, if there was no doubt about the packer, that then administrative approval could be granted, and if there was doubt about it, the Commission on its motion should set it down for hearing? In other words, couldn't we allow, where there is no question about the retrievable packer being adequate, that administrative approval be granted, but if the Commission felt there was a question about it, only in those circumstances would a hearing be held?

A Mr. Verity, that is the present rule that we have, in my opinion. In other words, we don't have any doubt about the permanent type packer, but we have doubt about the retrievable type.

Q But on retrievable type packers, you request hearing?

A Yes, sir.

Q But if there was no question about a retrievable type packer, that no hearings be held?

A Well, there might always be a question.

MR. PORTER: Does anybody else want to ask the witness a question before we excuse him again? Witness may be excused.

(Witness excused)

MR. PORTER: Does anyone else desire to present testimony? Any statements?

MR. DAVIS: Sid Davis with Atlantic Refining Company. I have a letter from our Chief Engineer. I'll read it to Mr. Porter.

"The Atlantic Refining Company would like to go on record as concurring with El Paso Natural Gas Company's application, as amended, to revise Subsections II (d) and V (d) of Rule 112-A of the Rules and Regulations, New Mexico Oil Conservation Commission. The application relates to the type of production packer required for administrative approval of multiple completions.

Our experience, gained through shop testing and field usage, indicates that retrievable production packers presently available from all major packer manufacturers are just as effective as permanent type drillable packers for isolating production zones at pressure differentials up to 6000 psi and at temperatures up to 300°F."

I would like to add one point. Atlantic Refining Company has spent thousands of dollars on packer testing. We have tested probably between thirty-five and fifty retrievable, drillable, all kinds, and I feel -- I mean that's my responsibility with our company, seeing that we have adequate tools, and I for one, would not recommend retrievable, drillable or otherwise for a well if I felt it wasn't adequate.

MR. DAVIS: Earl Davis, Guiberson Corporation. I also have a letter directed to you.

"This Corporation, a manufacturer of retrievable hookwall packers concurs with the application as amended and submitted to the State of New Mexico Oil Conservation Commission by El Paso Natural Gas Company, relating to the usage of such type packers."

And it goes on further to introduce myself, being qualified to testify on Guiberson's behalf. Signed, Executive Vice President, Alex P. Smith.

We've also passed the test that Mr. Davis here mentioned as the other manufacturers of retrievable packers.

MR. REESE: On behalf of Brown Tool Company and MWL Tool Supply, we concur with the application of El Paso and state that Brown Tool Company has retrievable packers in use under conditions that are much more extreme than have been encountered in New Mexico, and these packers have been installed under the same approval as permanent type packers in all states except New Mexico, which to the knowledge of Brown Tools, is the only state that differentiates in the packers, and the -- we further take the position that it is an unjust burden on the retrievable packer industry to require that in order to use the retrievable packer, which the manufacturer and the operator think adequate, to require them to appear at a Commission hearing to secure that approval.

MR. VERITY: For Southern Union I would like to make this statement. In Texas, Oklahoma and Colorado they have used with universal success retrievable packers. They think they are adequate and that they would be adequate in New Mexico for dual completions, and they think that they have many advantages, particularly with regard to those situations where you may want to rework the hole or deepen it, and also recovering a packer for use in other holes. They would have no objection to the Commission reserving the right to request that in those applications wherein retrievable packers had been requested for use in a dually completed well, that it could be set down for hearing, if the Commission felt that there was a doubt about the advisability of that type of packer. But they want to join in this application and urge the Commission to allow administrative approval in those cases where the operator feels that a retrievable packer is proper for use.

Also they would have no objection to the Commission making whatever rule it feels is necessary in order to assure that ample leakage tests are made from time to time to insure no leakage between the zones.

MR. WHITE: Charles White of Santa Fe, New Mexico. I would like to read into the record a letter from Skelly Oil Company under date of September 11, 1959, addressed to El Paso Natural Gas Company.

> "Gentlemen: This is to advise that as an interested operator in the production of oil and gas in the State of New Mexico, we favor a change in Rule 11-A 2 D so as to provide that the packer used to segregate the separate producing zones of a dual completion may be a permanent type production packer or a retrievable type packer, which may be approved administratively. Yours very truly, George W. Selinger."

I would also like to read a statement on behalf of Texaco Company, Incorporated.

> "Texaco Company, Incorporated believes that an operator should be given the opportunity to select himself a permanent or a retrievable production type packer at his option, and to that extent, we concur in the application as amended."

MR. LOAR: Bill Loar, representing Sunray Mid-Continent Oil Company. Sunray had run retrievable type packers in the several states other than New Mexico, and we have found that they have been successful. Like any other well completion equipment, they must be sized and designed according to the need. We feel the operators should have this option. We have no objection, of course, if the Commission should have any doubt about the installation setting the matter for a hearing.

MR. COOPER: John Cooper appearing on behalf of Halliburton Cementing Company. Our company joins in the evidence which was presented on behalf of the manufacturers this morning, and we certainly concur with the recommendation in the application as amended by El Paso Natural Gas. One point, if the manufacturers are going to be limited, the designers and manufacturers like us to the permanent type, I feel that it might discourage the research and development which is being carried on by these companies, and which add a great deal to the advancement of the oil industry.

MR. SPERLING: Mr. Sperling, representing Magnolia Oil Company, concurs in the application of El Paso in this case.

MR. KASTLER: Bill Kastler, appearing for Gulf Oil Corporation. Gulf concurs in El Paso's recommendations that operators be permitted to use retrievable type packers with administrative approval rather than only after notice and formal hearing.

MR. BUSHNELL: H. D. Bushnell representing Amerada. Amerada is in accord with the application filed here on behalf of El Paso Natural Gas Company, and in that connection, from my observation of the testimony here offered, it is my opinion that those who are in the degree of greatest expertness have established by their testimony that the retrievable type packer is not only a satisfactory, but is apparently working well in other states, and in that connection, it is my understanding that the duties that this Commission has is making sure that there is no waste, make tion setting the matter for a hearing.

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MR. PORTER: Anyone else desire to comment on the case? The Commission will take the case under advisement, and in order to release a Commission witness, we are going to take the Southeast nomenclature case which shouldn't take more than ten minutes, Case 1758. After that we will proceed with Case 1759.

STATE OF NEW MEXICO)
:
COUNTY OF BERNALILLO)

WE, ADA DEARNLEY and JOSEPH A. TRUJILLO, Court Reporters, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission at Santa Fe, New Mexico, is a true and correct record to the best of our knowledge, skill and ability.

IN WITNESS WHEREOF we have affixed our hands and notarial seals this 30th day of September, 1959.

Ada Dearnley
Notary Public-Court Reporter

Joseph A. Trujillo
Notary Public-Court Reporter

Our Commissiones Expire:
Oct 5 1960

GOVERNOR
JOHN BURROUGHS
CHAIRMAN

State of New Mexico
Oil Conservation Commission

LAND COMMISSIONER
MURRAY E. MORGAN
MEMBER

STATE GEOLOGIST
A. L. PORTER, JR.
SECRETARY DIRECTOR

P. O. BOX 871
SANTA FE

File Packer Case File

August 21, 1959

Gentlemen:

Your attention is called to the enclosed questionnaire which the Oil Conservation Commission of New Mexico is sending to all manufacturers of oil and gas well packers.

The questionnaire is being sent out by the Commission in the hope that the information requested therein will enable us to more properly evaluate the various types of packers and their applicability to different types of completions.

Your cooperation in providing us with the desired information about the packers which you manufacture will be greatly appreciated. Please fill out and return the questionnaire by September 10, 1959, if possible.

Very truly yours,

A. L. PORTER, Jr.,
Secretary-Director

ALP/DSN/ig

OIL CONSERVATION COMMISSION OF NEW MEXICO
SANTA FE, NEW MEXICO

Instructions For Completion Of Packer Questionaire

Item 1: Basic Model Number. Show here the model number of each group, type, or family of packers which you manufacture.

Item 2: Variations of Basic Model. List here the model number of each of the different packers which you manufacture under the various groups. Do not consider different sizes of the same packer as a separate variation of the basic model unless the different sizes actually employ different mechanical design and/or setting/retrieving mechanisms.

Item 3: Type of Packer: Simply state how packer is generally described - hook-wall, tension, anchor, etc.

Item 4: This item is probably self explanatory, but may be clarified by asking, "Would this packer be recommended for zone separation in a one-packer dual completion?" If packer would be suitable under some conditions in dual completions, but unsuitable under other conditions, answer would be "Some."

Item 5: Show here the recommended maximum differential this packer should be able to sustain during the life of the well. If the differential is dependent upon other factors such as weight of tubing string, tension on tubing, etc, answer would be "Dependent."

Item 6: If temperature is a critical factor in this packer's ability to with-stand presures, give approximate maximum temperature packer can sustain. If temperature is not critical, answer would be "Non-Critical."

OIL CONSERVATION COMMISSION OF NEW MEXICO
BOX 871
SANTA FE, NEW MEXICO

PACKER QUESTIONAIRE

(1) Basic Model No.	(2) Variations of Basic Model	(3) Type of Packer	(4) Is this Packer Recommended for Permanent Zone Separation in Dual Completions	(5) Maximum Pressure Differential for which you would Recommend this Packer	(6) Maximum Temperature for which you would Recommend this Packer

OIL CONSERVATION COMMISSION
P. O. BOX 871
SANTA FE, NEW MEXICO

C O P Y

September 29, 1959

Mr. Oliver Seth
P. O. Box 828
Santa Fe, New Mexico

On behalf of your client, El Paso Natural Gas Company, we enclose one copy of Order R-1491 in Case 1755, issued by the Oil Conservation Commission on September 28, 1959. A copy of this order is being mailed to Mr. Whitworth in El Paso today.

Very truly yours,

A. L. PORTER, Jr.
Secretary-Director

ir/

Enclosure

Copy also sent to
R. Reese
Hobbs
Aztec

BEFORE THE

OIL CONSERVATION COMMISSION

STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF EL PASO NATURAL GAS COMPANY FOR AN ORDER REVISING AND AMENDING SUBSECTIONS II(d) AND V(d) OF RULE 112-A OF THE RULES AND REGULATIONS, NEW MEXICO OIL CONSERVATION COMMISSION, RELATING TO THE TYPE OF PRODUCTION PACKER REQUIRED FOR ADMINISTRATIVE APPROVAL OF MULTIPLE COMPLETIONS.	CASE NO. 1755

APPLICATION

TO THE HONORABLE COMMISSION:

Comes now El Paso Natural Gas Company, hereinafter referred to as "Applicant," and alleges and states:

I.

Applicant is a Delaware corporation with a permit to do business in the State of New Mexico;

II.

Applicant has developed and will continue to develop various lands and leases by the drilling of wells in the State of New Mexico and in many instances, multiple completions have been, and will continue to be, desirable in order to prevent waste and the unnecessary drilling of wells;

III.

At present, Rule 112-A II(d) provides that dual completions may be granted administratively without notice and hearing by the Secretary-Director of the Commission if, among other things, "The packer used to segregate the separate producing zones of the dual completion will be a permanent type production packer." Said subsection should be revised and amended so that it will hereafter read:

"The packer used to segregate the separate producing zones of the multiple completion shall be effective to prevent communication between all producing zones and may be either a permanent or a retrievable type production packer which shall be certified as adequate by the manufacturer or representative thereof as provided in Subsection V(d) of this rule."

IV.

At present, Rule 112-A V(d) is as follows:

"A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test."

This subsection should be revised and amended so that it will hereafter read:

"A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test and shall include a certification by the manufacturer of such packer or authorized representative thereof that the type of production packer to be used is adequate to satisfy the provisions of this rule with regard to the proposed completion."

V.

The granting of the relief sought in this application will prevent waste and will not violate or prejudice correlative rights, and will relieve all interested operators and the Commission of the time and expense that would otherwise result in holding unnecessary hearings;

VI.

The Commission has jurisdiction to hear and determine this cause, and said Rule 112-A II(d) and 112-A V(d) should be amended as set out above;

WHEREFORE, Applicant respectfully requests this matter be set for hearing before this Commission as prescribed by law, and that upon due notice and hearing, the Commission issue its order amending Rule 112-A as above set out to effectuate the granting of multiple completions without notice and hearing when the requirements of Rule 112-A II and 112-A V, as so amended, are satisfied, and for such other and further relief either at law or in equity to which Applicant may show itself justly entitled.

Garrett C. Whitworth
Attorney for Applicant

Case 1755

PACKER SETTING AFFIDAVIT

I, ______________________________________, being of lawful age
Name of Party Making Affidavit
and having full knowledge of the facts hereinbelow set out do state:

That I am employed by ______________________________________ in the capacity of ______________________, that on ______________, 195__,
Date
I personally supervised the setting of a ______________________________________
Make and Type of Packer
in ______________________________, ______________________________
Operator of Well Lease Name
Well No. ____________ located in the ______________________________________,
Field
______________________ County, New Mexico, at a subsurface depth of __________

feet, said depth measurement having been furnished me by ______________________

______________________________; that the purpose of setting this packer was to effect a seal in the annular space between the two strings of pipe where the packer was set so as to prevent the commingling, in the bore of this well, of fluids produced from a stratum below the packer with fluids produced from a stratum above the packer; that this packer was properly set and that it did, when set, effectively and absolutely seal off the annular space between the two strings of pipe where it was set in such manner as that it prevented any movement of fluids across the packer.

____

STATE OF NEW MEXICO ‖
COUNTY OF ______________________ ‖

Before me, the undersigned authority, on this day personally appeared ______________________________________, known to me to be the person whose name is subscribed to this instrument, who after being by me duly sworn on oath, states that he has knowledge of all the facts stated above and that the same is a true and correct statement of the facts therein recited.

Subscribed and sworn to before me on this the ______________________ day of ______________________, 195__.

____
Notary Public in and for
______________________________ County,
New Mexico

My Commission Expires ______________

Case 1755

III.

At present, Rule 112-A II(d) provides that dual completions may be granted administratively without notice and hearing by the Secretary-Director of the Commission if, among other things, "The packer used to segregate the separate producing zones of the dual completion will be a permanent type production packer." Said subsection should be revised and amended so that it will hereafter read:

> "The packer used to segregate the separate producing zones of the multiple completion shall be effective to prevent communication between all producing zones and may be either a permanent or a retrievable type production packer which shall be certified as adequate by the operator as provided in Subsection V(d) of this rule."

IV.

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> "A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test."

This subsection should be revised and amended so that it will hereafter read:

> "A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test and shall include a certification by the operator that the type of production packer to be used is adequate to satisfy the provisions of this rule with regard to the proposed completion."

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

W. P. MARSHALL, PRESIDENT

1201

SYMBOLS
DL=Day Letter
NL=Night Letter
LT=International Letter Telegram

The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

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A L PORTER, NEW MEXICO OIL CONSERVATION COMMISSION=
CAPITOL ANNEX BLDG SANTA FE NMEX=

CASE 1755 OF THE NEW MEXICO OIL CONSERVATION COMMISSION'S DOCKET FOR THE REGULAR HEARING SEPTEMBER 16 1959 IS EL PASO NATURAL GAS COMPANY'S APPLICATION TO AMEND RULE 112-A OF THE COMMISSION RULES AND REGULATIONS. WE UNDERSTAND THE PROPOSED AMENDMENT WILL PROVIDE FOR ADMINISTRATIVE APPROVAL OF DUAL COMPLETIONS UTILIZING RETRIEVABLE-TYPE PACKERS. PAN AMERICAN PETROLEUM

WESTERN UNION
TELEGRAM

CORPORATION SUPPORTS THIS APPLICATION AS WE BELIEVE
DUAL COMPLETIONS UTILIZING RETRIEVABLE=TYPE PACKER
PROVIDE AN EFFECTIVE METHOD OF SEGREGATING THE SEPARATE
PRODUCING ZONES OF A DUAL COMPLETION=
ALEX CLARKE JR PAN AMERICAN PETROLEUM CORP==

1959 SEP 14 PM 1:42
MAIN OFFICE OCC

=1755 16 1959 112=A

Brown Oil Tools, Inc.
8490 KATY ROAD • HOUSTON 24, TEXAS

September 8, 1959

DOS 3009-59

Subject: Packer Questionaire

Oil Conservation Commission of New Mexico
P. O. Box 871
Santa Fe, New Mexico

Gentlemen:

We are attaching the completed Packer Questionaire as requested in your letter of August 21, 1959. Although this is a complete listing of our packers which would conceivably be used for multiple completions in New Mexico at this time, we are constantly developing new ideas and concepts in packer materials and designs. As each tool is perfected, an addition would be necessary to keep this list current.

We trust that the information supplied is sufficient, but if you need additional data, we will be glad to furnish it.

Very truly yours,

BROWN OIL TOOLS, INC.

John B. Davis, Jr.

John B. Davis, Jr.

JBD:jac
Enclosure

ATLANTIC

THE ATLANTIC REFINING COMPANY
INCORPORATED 1870
PETROLEUM PRODUCTS
ATLANTIC BUILDING
DALLAS, TEXAS

DOMESTIC PRODUCING DEPARTMENT
PRODUCTION DIVISION
F. W. TURNER, MANAGER
V. E. STEPP, CHIEF PET. ENGR.
R. O. CHILDERS, GEN'L. DRILLING SUPT.
W. L. BOWSER, SUPT. OF NATURAL GAS
H. D. ROBINSON, SUPT. OF MATERIALS
D. W. BUCHANAN, SUPV. OF CLERICAL AND RECORDS

September 14, 1959

MAILING ADDRESS
P. O. BOX 2819
DALLAS 21, TEXAS

Mr. A. L. Porter
Secretary Director
Oil Conservation Commission
P. O. Box 871
Santa Fe, New Mexico

Dear Mr. Porter:

The Atlantic Refining Company would like to go on record as concurring with El Paso Natural Gas Company's application, as amended, to revise Subsections II(d) and V(d) of Rule 112-A of the Rules and Regulations, New Mexico Oil Conservation Commission. The application relates to the type of production packer required for administrative approval of multiple completions.

Our experience, gained through shop testing and field usage, indicates that retrievable production packers presently available from all major packer manufacturers are just as effective as permanent type drillable packers for isolating production zones at pressure differentials up to 6000 psi and at temperatures up to 300°F.

Very truly yours,

V.E. Stepp

V. E. Stepp

Brown Oil Tools, Inc.
P. O. Box 19236
Houston 24, Texas

OIL CONSERVATION COMMISSION OF NEW MEXICO
BOX 871
SANTA FE, NEW MEXICO

PACKER QUESTIONAIRE

(1) Basic Model No.	(2) Variations of Basic Model	(3) Type of Packer	(4) Is this Packer Recommended for Permanent Zone Separation in Dual Completions	(5) Maximum Pressure Differential for which you would Recommend this Packer	(6) Maximum Temperature for which you would Recommend this Packer
Brown Duo-Pak		Hookwall	Yes	Dependent	300° F
	PS-3	Hookwall	Yes	Dependent	300° F
	PS-4	Hookwall	Yes	Dependent	300° F
Brown Cam-Lok		Hookwall Tension or Weight Set	Yes	Dependent	300° F
Brown RS-1			Yes	Dependent	Over 300° F
	RS-2		Yes	In excess of 5,000 psi	Over 300° F
Brown SOS J-7		Hookwall	Yes	In excess of 5,000 psi	250° F
Brown DS-4		Anchor, Dual String	Yes	Dependent	Over 300° F
	DS-3	Anchor, Dual String w/Hyd. Hold-Down	Yes	In excess of 5,000 psi	Over 300° F
Brown DS-8	DS-8-2	Hookwall Triple String	Yes	In excess of 5,000 psi	250° F
	DS-8-3	Hookwall Triple String	Yes	In excess of 5,000 psi	250° F
Brown DS-9-2		Anchor, Dual String	Yes	Dependent	Over 300° F
	DS-9-2H	Anchor, Dual Strings w/Hyd. Hold-Down	Yes	In excess of 5,000 psi	Over 300° F

OIL CONSERVATION COMMISSION OF NEW MEXICO
BOX 871
SANTA FE, NEW MEXICO

PACKER QUESTIONAIRE

Brown Oil Tools, Inc.
P. O. Box 19236
Houston, Texas

(1) Basic Model No.	(2) Variations of Basic Model	(3) Type of Packer	(4) Is this Packer Recommended for Permanent Zone Separation in Dual Completions	(5) Maximum Pressure Differential for which you would Recommend this Packer	(6) Maximum Temperature for which you would Recommend this Packer
Brown HS-16-1		Hydraulic Set Hookwall	Yes	Unlimited	Over 300° F
Brown HS-8	HS-8-1	Hydraulic Set Hookwall	Yes	Dependent	Over 300° F
	HS-8-2 HS-8-3 HS-8-4 HS-8-5	Same as above except for multiple tbg. strings dual, triple, quadruple and Quintuple	Yes	Dependent	Over 300° F
	HS-8-1C	Hyd. Set Hookwall w/Hyd. Hold-Down	Yes	In excess of 5,000 psi	Over 300° F
	HS-8-2C HS-8-3C HS-8-4C	Same as above except for multiple tubing strings	Yes	In excess of 5,000 psi	Over 300° F
Brown Boll-Weevil		Hookwall	Yes	In excess of 5,000 psi	300° F
	BW-1	Anchor	Yes	In excess of 5,000 psi	300° F
	BW-2	Anchor	Yes	In excess of 5,000 psi	300° F
	Boll-Weevil By-Pass	Hookwall	Yes	Dependent	300° F
Brown BP-4		Hookwall	Yes	In excess of 5,000 psi	300° F
	4-A	Hookwall	Yes	In excess of 5,000 psi	300° F
Brown B-4		Hookwall	Yes	In excess of 5,000 psi	300° F

ESTABLISHED
1919

TELEPHONE
HAMILTON 1-4101

THE GUIBERSON CORPORATION

MANUFACTURERS OF OIL FIELD EQUIPMENT

P. O. BOX 1106 – 1000 FOREST AVENUE

DALLAS 21, TEXAS

September 14, 1959

State of New Mexico
Oil Conservation Commission
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.,
Secretary Director

Gentlemen:

This Corporation, a manufacturer of retrievable hookwall packers concurs with the application as amended and submitted to the State of New Mexico Oil Conservation Commission by El Paso Natural Gas Company, relating to the usage of such type packers.

Further, this is to introduce Mr. Earl W. Davis, our Assistant Sales Manager, who is qualified to testify in our behalf as to the use of retrievable hookwall packers in dually completed wells.

Very truly yours,

THE GUIBERSON CORPORATION

Executive Vice President

APS/dm

The Selection of a Multiple Completion Hook-Up

W. S. ALTHOUSE, JR.
H. H. FISHER

BAKER OIL TOOLS, INC.
LOS ANGELES, CALIF.
HOUSTON, TEX.

W. S. Althouse graduated from the California Institute of Technology in 1938 with a BS degree in mechanical engineering. He joined Baker Oil Tools, Inc. shortly after graduation and served as design engineer and chief engineer prior to assuming his present position as manager of engineering and research.

H. H. Fisher received a BS degree from Louisiana Polytechnic Institute in 1950. Following graduation he joined Baker Oil Tools as a sales and serviceman. He subsequently joined Cardwell Manufacturing Co. as a design engineer, returning to Baker after two years as a design engineer. He now serves as division mechanical engineer for the Central Div.

FEATURE ARTICLE

The Selection of a Multiple Completion Hook-Up

W. S. ALTHOUSE, JR. | BAKER OIL TOOLS, INC.
LOS ANGELES, CALIF.

H. H. FISHER | HOUSTON, TEX.
MEMBERS AIME

Abstract

The reasoning behind the inception, rate of development and successful application of current dual, triple and quadruple completions is highly economic in character. Selection of a practical multiple completion hook-up therefore must necessarily involve strong economic considerations. Type and subsequent cost of any multiple completion hook-up is directly related to number of zones to be produced and workover and artificial-lift requirements of each zone. An analysis of available subsurface equipment that makes the modern multiple completion practical in the light of design, advantages and limitations provides a base for selection of components. A systematic presentation of multiple completion hook-ups from the simplest, most inexpensive two-zone completion to the most complex four-zone completion, in order of increasing cost and flexibility provides a graphic systematic base for selection of a practical multiple completion hook-up.

Introduction

Advancement in multiple zone techniques and equipment has been so rapid in recent years that it becomes difficult even for those who specialize in this field not only to keep up with it, but to maintain an over-all perspective. Hardly a month goes by that a trade publication does not present a new dual, triple or quadruple completion method. Many of these articles not only imply widespread acceptance of the particular method but strongly suggest that previous methods are shortly doomed for obsolescence. The facts are that there are many areas, perhaps an overwhelming majority, where the complex dual, triple or quadruple completion would not be economically feasible.

Operators in these areas are confronted with the problem of selecting not only a practical multiple completion hook-up but one that is economical as well. In order to make this selection they should have as broad a view of all multiple completion techniques and equipment as possible and some sort of systematic method of evaluating each method in light of any given set of conditions. The systematic basis for this selection in our opinion involves (1) number of zones to be produced; (2) flowing, artificial-lift and workover requirements of each zone; (3) general knowledge of various types of subsurface equipment and its limitations; and (4) general knowledge of possible remedial operations that can be performed with certain fundamental hook-ups.

It is the purpose of this paper to present this information in such a manner that the selection of a practical and economical multiple completion hook-up for any given set of conditions will be within the capabilities of any operator regardless of his previous experience with this type of completion.

Brief Historical and Economic Background

Multiple completion has an interesting history. It was born in the lanquid atmosphere of the purely speculative but exceptionally attractive economic theory: two wells for the price of one. It had hardly started to grow when it was drafted as a wartime expedient to save steel or get maximum production with minimum steel. Through forced feeding it was nurtured and grew widespread, but not in other directions, with the result that through one misapplication after another it collapsed and nearly died.

For the next few years after World War II it had a chance to mature and grow naturally, though slowly, through careful application and development of downhole equipment designed specifically for multiple zone, not merely adaptations of single zone equipment. By 1953 modern dual completion in many areas had grown rapidly to the point where it was commonplace.

About three years ago the multiple completion was called upon to meet a need that was only partially stated in the "two wells for the price of one" theory behind its initial conception. Staggering development and completion costs of offshore operations made multiple completion an economic necessity. Even two wells for the approximate price of one was not enough, three and four or more if possible were required to make use of every square foot of space, to reduce total dollars invested and to get this investment back sooner with a greatly decreased payout interval.

This great need served to underwrite the high cost required for development of downhole equipment, with the result that practical equipment has been designed and perfected to permit as many as four zones to be produced, each through its own individual tubing string, through one common wellbore.

Because of the high cost of offshore operations, current equipment comes close percentage-wise to providing two, three and four wells for the approximate price of one.

Table 1[1], which serves to illustrate this, also contains some interesting information pertinent to relative cost of completion components.

Referring to Table 1, note that the well costs for the single, dual and triple are the same. Under completion costs, note that by combining perforating operations, perforating cost per zone becomes less and that there is also a slight saving in rig time. Note that more than half of the completion

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[1]References given at end of paper.

DUAL ZONE — SINGLE DRILLABLE PACKER

Tubing and Annulus Production | Parallel String Production | Pumping Parallel String Gas-Vent with Two Sets of Rods

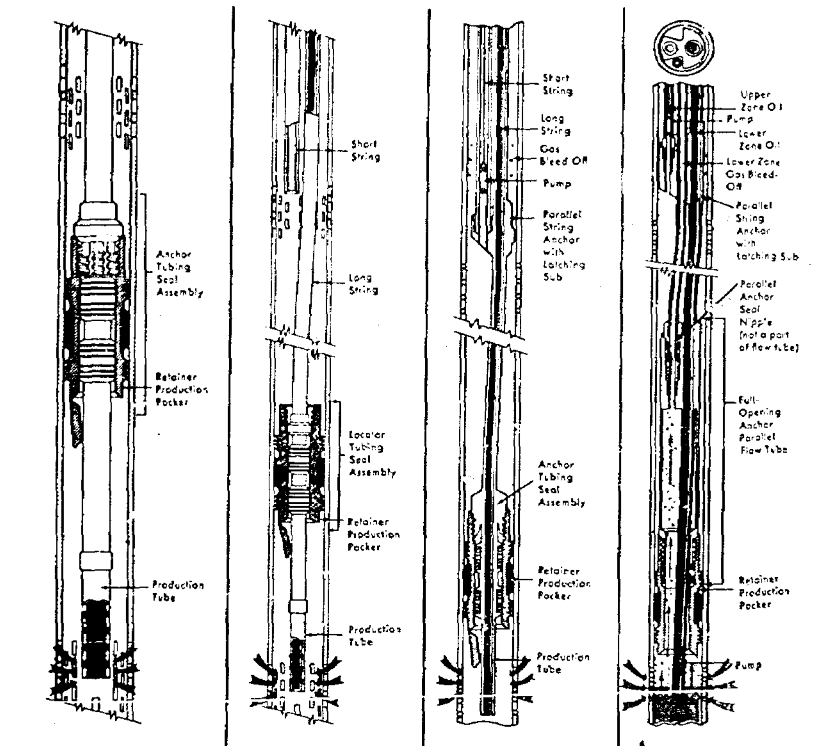

Fig. 1 Fig. 2 Fig. 3 Fig. 4

DUAL ZONE

Single Drillable Packer | Two Packer—Upper Packer Retrievable—Lower Drillable

Pumping, Parallel String—Gas Vent with Single Set of Rods | *Pumping — Tubing and Annulus Production with Single Set of Rods* | *Selective Tubing and Annulus Production*

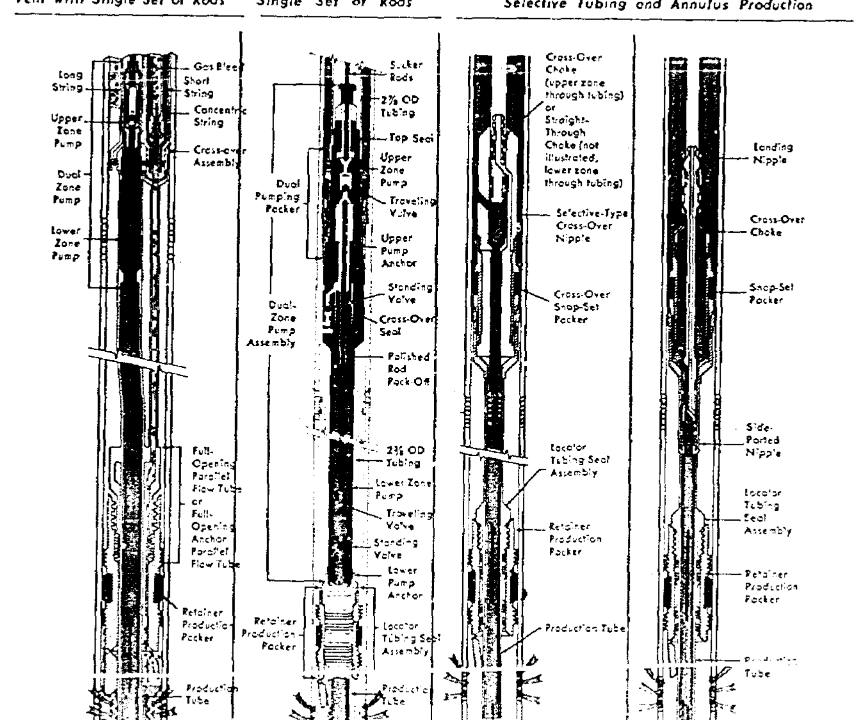

Fig. 5 Fig. 6 Fig. 7 Fig. 8

cost is contained in tubing and flowline costs. Now here is an interesting fact: *all* these costs, which total nearly 90 per cent of the completion costs, are accrued in connection with operations that require no particularly special development for multiple completion application. Note that the costs of the downhole equipment (packers, circulation valves, seating nipples) that make the multiple completion practical, *cost but a fraction of the cost of the extra string of tubing required in each case.*

Hypothetically, each zone of a tri[illegible]e can be completed at a cost of only slightly more than one-third the cost of a single-zone well, with production potential that could be three times as great and a payout time one-third as long. When related to total well costs in view of increased production, and decreased payout time, the cost of equipment that makes a multiple completion practical becomes an exceed-

Fig. 1—Shows packer set in casing with anchored production string for dual-zone production. Tubing can be released from packer by rotating to right.

Fig. 2—Hook-up with short string hanging free, permits removal of either string independently of the other regardless of sequence. Full-opening (tubing ID) long string to lower zone.

Fig. 3—Pumping, short string anchored, gas bleed-off through annulus. Permits removal of either string independently of the other; long string must be run first — short string pulled first. Full-opening (tubing ID) long string.

Fig. 4—Pumping lower zone with lower zone gas bleed-off through separate string. Upper zone flowing or pumping through separate (short) string, and gas bleed-off through annulus.

Fig. 5—Both zones pumped simultaneously with gas-bleed through concentric string for lower zone, and through annulus for upper zone. Short string and concentric bleed-off string run separately after long string is landed.

Fig. 6—Both zones pumped simultaneously; lower zone through annulus, upper zone through tubing. Does not provide for gas venting either zone.

Fig. 7—Upper zone produced through tubing, lower zone through annulus. Removal of cross-over choke and installation of straight-through choke with wire line produces lower zone through tubing, upper through annulus.

Fig. 8—Similar to Fig. 7 except choke contains integral flow tube that is retrievable. Removal of choke provides full-opening access to lower zone.

TABLE 1—BREAKDOWN OF COSTS FOR TYPICAL 10,000-FT OFFSHORE WELLS ON LOUISIANA GULF COAST

	Single Completion	Dual Completion	Triple Completion	Each Additional Alternate*
Well cost				
Drilling cost	$235,000	$235,000	$235,000	0
Mud cost	65,000	65,000	65,000	0
Casing	95,000	95,000	95,000	0
Cementing and cementing services	11,000	11,000	11,000	0
Logging services	20,000	20,000	20,000	0
Share of platform	50,000	50,000	50,000	0
Total well cost	$476,000	$476,000	$476,000	0
Completion cost				
Perforating	800	1,400	2,000	800
Drill-stem testing	1,000	2,000	3,000	1,000
Tubing	14,200	28,400	42,600	0
Packers	600	3,700	6,000	1,800
Circulation valves, seating nipples, etc.	900	2,000	3,900	900
Christmas tree	2,500	7,500	9,500	0
Flowing cost	20,000	40,000	60,000	0
Rig time	9,000	18,000	24,000	3,500
Total completion cost	$49,000	$103,000	$150,000	$8,000
	$525,000	$579,000	$626,000	$8,000

*Refers to zones produced as alternates through use of an additional packer and wire line sleeve valves or side-ported nipples.

ingly small factor. It would also follow that rather extensive and expensive workover operations could be absorbed should they be required without materially affecting the tremendous economic advantage of the multiple completion.

Economics of Subsurface Equipment

Packers, circulating valves, sealing nipples and wellhead equipment required for an offshore quadruple or triple must through necessity be approximately the same for any quadruple or triple completion regardless of its location or relative drilling and completion cost. This is true because problems of isolation, required surface communication and accessibility for workover are the same. Even so, in most instances the cost of all this equipment will nearly always be less than the cost of the extra string of tubing even in the average 5,000-ft well. It would seem therefore, that the triple and quadruple might become increasingly popular wherever two, three, four or more exploitable zones exist. Some companies have already planned to complete as many zones as possible, whenever possible.

There are, however, many areas where the complex dual, triple or quadruple will not be economically feasible. Multiple completion in these areas will more than likely be dual completions. Equipment required for these installations is considerably less complicated and consequently less expensive.

Equipment for Multiple Completions

The equipment that makes the multiple completion practical are those tools that provide: (1) required isolation of zones, (2) surface communication, (3) access for workover, (4) means of accomplishing workover through tubing, and (5) means of lifting production artificially. This group consists of the following items.

1. Packers
2. Wire line actuated sleeve valves, non-ported nipples, side-ported nipples, cross-over nipples
3. Permanent completion tools such as tubing perforating guns, retrievable tubing extensions, expendable plugs, plug cutters, etc.
4. Wire line and permanent gas-lift mandrels and valves
5. Wire line plugs and cross-over or straight-through chokes
6. Dual-zone pumping equipment
7. Wellhead equipment

Each of these components will be discussed briefly as to types, operation, advantages and limitations under applications to which they may be put in various multiple completion hook-ups.

Packers

Regardless of their individual design differences all packers used for multiple completions fall into two basic classes: permanent (drillable) and retrievable. Generally, either type can be used interchangeably or in combination throughout all multiple completion hook-ups regardless of complexity. Each has inherent advantages and disadvantages for each application. Selection of the proper packer usually involves a compromise, in that to date it has been impossible to combine desirable features of each type into one packer.

The design of multiple completion packers has become increasingly difficult in direct proportion to the number of strings of tubing required in any given completion. The basic problem is one of how to seal-off and provide passage for the required number of strings and still retain sufficient cross-sectional area in the packer wall to provide space for components such as the packing element, slips, releasing or setting mechanism, which are required to bring about a dependable pack-off. It becomes increasingly difficult to build a high performance pack-off into a continually decreasing cross section of the packer wall area. Nevertheless, packer design has apparently been adequate to date for conditions thus far encountered. Within current casing programs and available tubing, the point of diminishing returns is rapidly being reached within the concepts of current packer design.

Permanent (Drillable) Packers

Used for any multiple zone completion—as single packer; upper, intermediate and lower packers.

These packers, sometimes referred to as retainer-type packers, are run into the well and set on electric conductor cable or on tubing. When these packers are set they become for all practical purposes a permanent, though drillable part of the casing. The smooth packer bore, which contains a flapper-type back-pressure valve at its lower end, provides a sealing surface for seal units that are made up as an integral part of the tubing string. This arrangement permits the tubing to be removed from the packer bore and reinstalled whenever required.

Through use of various accessories the tubing can be anchored to the packer and subsequently released if required. The permanent packer is characterized by two complete sets of opposed slips and a packing element that is confined by expanding retaining rings that back up the expanded packing element and improve its high pressure, high temperature performance.

These packers are available with a choice of different bore sizes for a given casing ID. By utilizing the smallest bore size for the lowest packer, the next larger bore size for the intermediate packer and the largest bore size for the upper packer and the proper sealing accessories, as many as three zones or even four, can be produced each through its own individual tubing string. In many installations a permanent packer is used as the lower packer and retrievable packers for the upper packers.

The permanent packer offers two prime advantages from the standpoint of multiple completion applications: (1) the permanence and reliability of its pack-off particularly under high pressure, high temperature conditions, and (2) the flexibility provided by a removable tubing string. A third advantage, its prime disadvantage in some installations, is that it is designed to be removed by drilling out. Under many conditions where an operator might be concerned over the amount of steel in the hole, known drillability might outweigh questionable retrievability. Recent progress in the development of special packer milling tools has greatly improved the drilling-out operation.

Retrievable Packers

Tremendous progress has been made in development of special retrievable packers for multiple completions, particularly those installations requiring two or more strings of tubing. These packers are available in a variety of designs that differ principally in method of setting and releasing, packing element design, number of bores through the packer and design of the parallel heads or receptacles in which the various retrievable strings of tubing seat and seal-off. The basic types are as follows.

CONVENTIONAL SET-DOWN WITH OR WITHOUT HOLD-DOWN

Packer is set and pack-off maintained by tubing set-down weight. Hydraulic button-type hold-down actuated by pressure differentials from below packer keeps packer from being pumped up hole by pressure differential from below packer. Can be used in some single-packer, single-string dual-zone installations.

SNAP-SET PACKERS WITH OR WITHOUT HOLD-DOWN

For use in two packer single-string

Fig. 9—Shows two-packer selective dual-zone production hook-up with crossover choke installed. Flow pattern can be switched with substitution of different choke.

Fig. 10—Shows two-packer parallel string installation with each zone confined to its individual tubing string. Full opening to lower zone permits use of permanent-type completion tools.

Fig. 11—Production from each zone confined to its individual tubing string. Short string separately retrievable. Full-opening long string, retrievable packer and seals from lower packer run and retrieved together.

Fig. 12—First, second and third alternate zones to lower completion produced through sleeve valves following installation of blank-off tool or plug in non-ported nipple below. Alternate to upper completion produced through side-ported nipple.

Fig. 13—Three-packer installation (permanent packers). Production from three zones using triple string flow tube; each zone confined to an individual and isolated tubing string.

Fig. 14—Four-packer installation. Production from four zones; each zone confined to an individual and isolated tubing string.

DUAL ZONE

Upper and Lower Packers Drillable — Upper Packer Retrievable, Lower Packer Drillable

Selective Tubing and Annulus Production — Parallel String Production

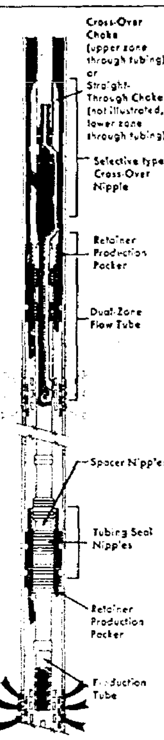

Fig. 9

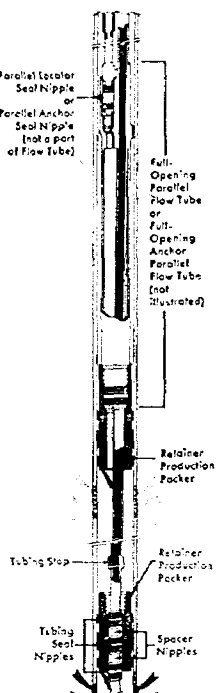

Fig. 10

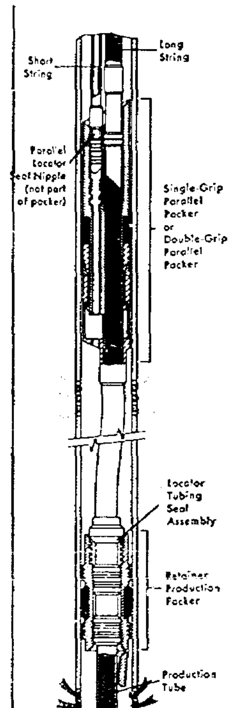

Fig. 11

PARALLEL STRING PRODUCTION

MULTIPLE (produced two at a time) Five Production Packers — TRIPLE Three Drillable Packers — QUAD Four Retrievable Packers

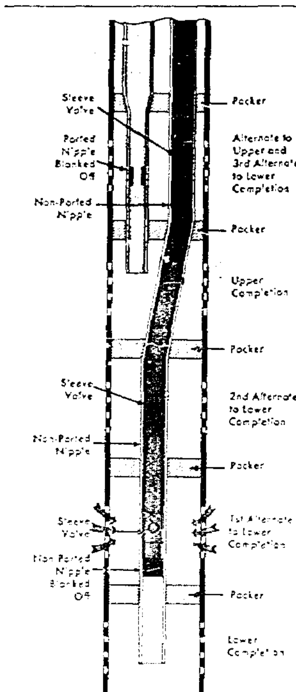

Fig. 12

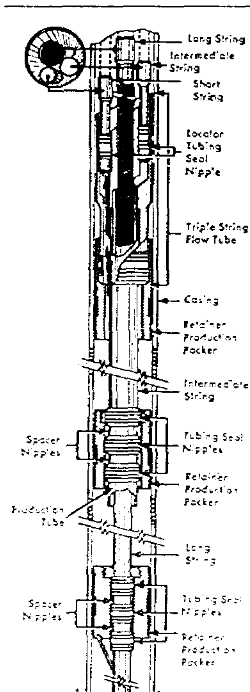

Fig. 13

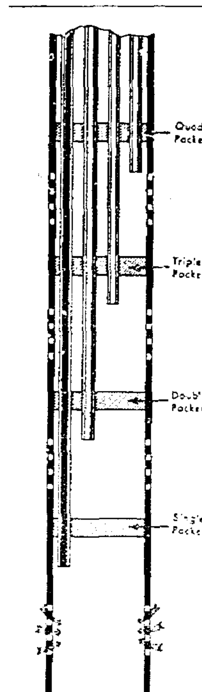

Fig. 14

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installations (involving selective cross-over) as the upper packer. Run in on tubing string until seals on tubing string seat and seal-off in bore of lower permanent packer. Set-down weight against resistance provided by lower packer sets the packer. Uses shear pin or spring-type snap-latch setting and release mechanism.

ROTATION SET PACKERS

For use in two-packer, single-string installations (involving selective cross-over) as the upper packer. Packer contains a single set of dual-direction slips and two packing elements that are expanded by cone action, set by left-hand rotation of the tubing and released by right-hand rotation.

DUAL CUP-TYPE PACKERS

Many varieties of dual cup-type packers are available, including parallel-string types. Most of these packers employ opposed cups. Some types have mechanically set slips, whereas other types contain slips that are molded into the rubber cups and are set by differential pressure. Most of these packers can be used either with a retrievable or a permanent-type lower packer.

Mechanically Set Parallel Retrievable Packers Hook-Wall Type

These packers are run in on a long string which seats and seals off in sealing bore of a lower permanent or retrievable packer. Set-down weight against resistance provided by lower packer sets packer. In one design shear pins provide control for release. The snap-latch release in another design permits the packer to be set and released as many times as required for measuring, circulating, etc. This type also available with integral button-type hydraulic hold-down. Parallel head of packers contains sealing bore for separately retrievable short string.

Hydraulic Retrievable Packers

Available with heads for one, two, three or four strings, packer is set by hydraulic pressure that is trapped in packer by closing a valve. As many as four of these packers can be run together, wellhead flanged up, fluid displaced and all packers set hydraulically through their own individual tubing strings. Packer(s) released by opening valves to release trapped pressure. Can be used for any multiple-zone application.

Advantages and Disadvantages of Retrievable Packers

The prime advantage of the retrievable packer is its retrievability. This is a desirable feature in any completion, particularly so in many multiple completions where access for truly extensive workover can only be provided by complete removal of the packer. Loss of retrievability, of course, can be a decided disadvantage.

Although it is subject to controversy, field preferences seem to indicate that the permanent packer is capable of providing a better, longer lasting pack-off particularly under exceptionally rigorous conditions of pressure and temperature than retrievable packers. One of the possible reasons for this could be that the permanent packer does not have to make any design concessions to provide for retrievability.

Wire Line Actuated Sleeve Valves and Side-ported Nipples

This equipment provides means of selectively establishing communication between the tubing string and the tubing-to-casing annulus. It can be used to circulate out mud or when it is positioned opposite any isolated zone, it can be opened to allow production of that zone through the tubing. The two different designs accomplish a similar result in a different manner. In one design the control is provided by a sleeve valve that can be opened or closed by means of a special tool run in on piano wire. The other design provides control by blanking off the ports in a special nipple by means of a small plug or choke that is run in and retrieved on piano wire.

Permanent Completion Tools

These tools include small-diameter perforating guns that can be run through the tubing, and a number of retrievable plugs, chokes and tubing extensions that are run and retrieved on wire line that permit extensive workover of zones through the tubing from perforating, cementing-off perforations, to well stimulation operations.[3]

Wire Line and Permanent Gas-Lift Mandrels and Valves

This equipment makes it possible to anticipate future gas-lift requirements by installing certain gas-lift components in the tubing string or strings at the time the well is completed. When gas lift is required, fluid is removed from the annulus and the gas-lift valves installed or actuated by wire line and the well is placed on gas lift using the annulus as a reservoir. The valves are either of the side-pocket retrievable type or of flush type of coupling OD. Both types are used interchangeably; however, in some parallel-string installations the side-pocket type is run on the long string and the flush type on the short string to facilitate installation or where rotational release of the short string is desired.

Dual-Zone Pumping Equipment

A number of pump manufacturers now provide pumping equipment that makes it possible to pump two zones simultaneously with a single set of rods. Standard pumping equipment can be adapted for pumping two zones with two sets of rods through two strings of tubing. Hydraulic pumping has also been used successfully.

Wellhead Equipment

The design of wellhead equipment has kept pace with the increased number of tubing strings being run in one wellbore. Equipment that will handle up to four strings of tubing has been developed and used successfully. Equipment is now available that will allow each string of a multiple completion to be handled selectively after all strings are landed.

Summary

From the preceding brief description of the equipment that makes a multiple completion practical, it is obvious that there is not only a variety of different basic types of equipment, but a choice of differently designed components within each category that accomplish similar results in a different manner. It is safe to say that no one manufacturer completely dominates any category. In actuality, a given hook-up may involve both drillable and retrievable packers of different manufacture, both sleeve valves and side-ported nipples of different manufacture, and possibly side-pocket and flush-type gas-lift valves also of different manufacture. Each specific component has its definite design advantages and disadvantages, the choice depends upon the particular conditions encountered in each individual well, future requirements and over-all cost extrapolated through workover, artificial lift to abandonment.

A Graphic Outline of Multiple Completion Hook-Ups

Having become generally familiar with the basic types of multiple completion tools and equipment, their advantages and limitations, the systematic selection of a practical hook-up requires general knowledge of application of this equipment. This knowledge can best be acquired by a systematic study of actual hook-ups that use this equipment. For this purpose we have arbitrarily selected 11 basic hook-ups for study. These hook-ups are arranged in sequence in accordance with the number of zones to be produced, in order of increasing completion cost, as follows:

TWO-ZONE PRODUCTION

1. One string of tubing and one packer
2. One string of tubing and two packers
3. One string of tubing and two or more packers
4. Two parallel strings of tubing and one packer
5. Two parallel strings of tubing and two packers
6. Two parallel strings; two packers; no permanent string between packers
7. Two parallel strings; two or more packers

THREE-ZONE PRODUCTION

8. Two parallel strings; two packers
9. Three parallel strings; three packers

FOUR-ZONE PRODUCTION

10. Three parallel strings; three packers
11. Four parallel strings; four packers

Each of these 11 basic hook-ups will be analyzed from the standpoint of (1) the general completion practice, which may include several variations; (2) artificial-lift possibilities, which include both pumping and gas lift; (3) advantages of the hook-up; and (4) disadvantages of the hook-up.

In all, nearly 50 hook-up drawings would be required to illustrate fully each of the basic hook-ups and their many variations. Since this would be beyond the practical limits of this or any other paper, only 14 drawings (Figs. 1 through 14) will be used to illustrate this entire section. The printed outline, however, will cover most of the possible variations.

To appreciate more fully the limitations and advantages of these hook-ups, some preliminary comment should be made regarding the hook-ups that produce one zone through the tubing and one zone through the tubing-to-casing annulus (tubing and annulus production) and hook-ups that produce each zone through its individual tubing string (parallel-string production). Each method has certain constant requirements and limitations that can be discussed generally initially, and thus avoid endless repetition in the graphic outline.

Tubing and Annulus Production

The most inexpensive multiple-zone completions fall in this category. A great number of dual-zone completions are tubing and annulus completions. The production, however, of one zone in the annulus can have many disadvantages. It is nearly impossible to run instruments in the annulus. This can be overcome by running a side-ported nipple blanking off the zone produced through tubing and opening up the zone produced through the annulus. The large area makes flow more difficult, encourages gas separation and loss of natural gas lift. Artificial lift of the zone produced in the annulus is difficult and awkward. Full pressure of the zone is on the casing, making control somewhat hazardous. The casing is also exposed to corrosive attack. Where conditions are right, however, and zones of strong flowing characteristics are present without corrosion or other complications, this method is entirely satisfactory. Some states do not allow annulus completion in all fields. For example, Louisiana will not allow annulus completion of offshore wells.

Parallel-String Production

(1) Permits each zone to be produced through an individual tubing string so that each zone will flow throughout a longer portion of the well's producing life. (2) Keeps production from the two zones isolated from each other and casing. This is most desirable from a corrosion and bursting standpoint. (3) Makes it possible to gas lift or pump either or both zones.

Not every parallel-string hook-up incorporates all these advantages.

Most operators prefer to run and pull each tubing string independently. This does not necessarily mean that either string can be removed independently of the other, but may mean that one string can be either removed or run at a time provided a certain sequence is followed. Usually the short string (string producing the upper zone) must be removed before the long string (string producing the lower zone) can be removed and vice-versa when running in. Equipment is also being developed to permit removal of either string selectively.

Planning Parallel-String Hook-Ups

Most operators prefer to have both strings full-opening (tubing ID) through the packer; however, the size of the tubing strings that are to be run within any given casing ID determines whether or not full-opening in one or both strings can be obtained. Consequently, the starting point for planning any parallel-string hook-up is the determination of the combined diameter of the long- and short-string joints desired with respect to the ID of the casing through which these strings are to be run.

This information, when compared with the theoretical casing ID less the recommended diametral clearance of 3/16 to 5/16 in., will permit selection of a practical combination of tubing strings. (Refer to Tables 2 and 3.)

Two-Zone Production

One String of Tubing and One Packer

A. Completion Practice
   1. Lower zone through tubing and upper zone through annulus (Fig. 1)

B. Artificial-Lift Possibilities
   1. Pumping
      a. Rod pump lower zone (no venting possible)
      b. Both zones pumped alternately through tubing by use of a valve positioned in tubing above packer that is opened or closed by rotating the tubing.
   2. Gas Lift
      a. Run concentric or parallel macaroni string (small diameter pipe) for hydraulic lift or single point gas injection to lift lower zone.

C. Advantages
   1. Economical
      a. By far the most widely used multiple-zone hook-up.
      b. Requires minimum investment in equipment.
      c. Simple for remedial work. Retainer-type packer, which permits removal of the tubing string and contains a flapper-type back-pressure valve, which closes to isolate lower zone when tubing is moved, permits packer to be used in place as a squeeze tool for lower zone workover. Packer can be converted to temporary bridge plug for pressuring operations required for upper zone. Retrievable packers can be removed following mudding-off of both zones permitting full-scale workovers of both zones.

D. Disadvantages
   1. Difficult to take bottom-hole pressure of upper zone. Can be done with side-ported nipple or sleeve valve.
   2. Impossible to swab or produce upper zone oil when bottom-hole pressure declines.
   3. Alternate production of zones awkward and inefficient.

One String of Tubing and Two Packers

A. Completion Practice
   1. Fixed cross-over
      a. Permits a strong lower zone to flow up annulus and weaker upper zone to flow or be pumped through tubing.
   2. Retrievable selective cross-over non-full opening. (Figs. 7 and 9).
      a. Either zone can be produced up annulus or tubing, switch

in flow accomplished by running cross-over or straight through choke on wire line. Does not provide full-opening for workover below packers.

3. Retrievable selective cross-over full opening. (Fig. 8)

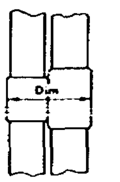
a. Permits either zone to be produced up annulus or tubing; switch in flow accomplished by running cross-

TABLE 2—COMBINED PARALLEL-STRING DIAMETERS, PARALLEL STRINGS RUN SEPARATELY

Revised 7-58

Tubing O.D. and Type Thread	1.050 E.U.	1.315 E.U.	1.315 "CS" HYDRIL	1.315 "SS" HARDY-GRIFFIN	1.660 "CS" HYDRIL	1.660 "SS" HARDY-GRIFFIN	1.660 E.U.	1.900 "CS" HYDRIL	1.900 "SS" HARDY-GRIFFIN	1.900 N.U.	1.900 E.U.	2.062 "CS" HYDRIL	2.062 "SS" HARDY-GRIFFIN	2.375 "CS" HYDRIL	2.375 "SS" HARDY-GRIFFIN	2.375 "XL" SPANG	2.375 N.U.	2.375 E.U. (2.910 Cplg. O.D.)	2.375 E.U.	2.875 "CS" HYDRIL	2.875 "SS" HARDY-GRIFFIN	2.875 "XL" SPANG	2.875 N.U.	2.875 E.U. (3.460 Cplg. O.D.)	2.875 E.U.	3.500 "CS" HYDRIL	3.500 "XL" SPANG	3.500 N.U.	3.500 E.U.
1.050 E.U.	3.320																												
1.315 E.U.	3.560	3.800																											
1.315 "CS" HYDRIL	3.212	3.452	3.104																										
1.315 "SS" HARDY-GRIFFIN	3.212	3.452	3.104	3.104																									
1.660 "CS" HYDRIL	3.543	3.783	3.435	3.435	3.766																								
1.660 "SS" HARDY-GRIFFIN	3.560	3.800	3.452	3.452	3.783	3.800																							
1.660 E.U.	3.860	4.100	3.752	3.752	4.083	4.100	4.400																						
1.900 "CS" HYDRIL	3.773	4.013	3.665	3.665	3.996	4.013	4.313	4.226																					
1.900 "SS" HARDY-GRIFFIN	3.856	4.096	3.748	3.748	4.079	4.096	4.396	4.309	4.392																				
1.900 N.U.	3.860	4.100	3.752	3.752	4.083	4.100	4.400	4.313	4.396	4.400																			
1.900 E.U.	4.160	4.400	4.052	4.052	4.383	4.400	4.700	4.613	4.696	4.700	5.000																		
2.062 "CS" HYDRIL	3.990	4.230	3.882	3.882	4.213	4.230	4.530	4.443	4.526	4.530	4.830	4.660																	
2.062 "SS" HARDY-GRIFFIN	3.990	4.230	3.882	3.882	4.213	4.230	4.530	4.443	4.526	4.530	4.830	4.660	4.660																
2.375 "CS" HYDRIL	4.360	4.600	4.252	4.252	4.583	4.600	4.900	4.813	4.896	4.900	5.200	5.030	5.030	5.400															
2.375 "SS" HARDY-GRIFFIN	4.410	4.650	4.302	4.302	4.633	4.650	4.950	4.863	4.946	4.950	5.250	5.080	5.080	5.450	5.500														
2.375 "XL" SPANG	4.660	4.900	4.552	4.552	4.583	4.900	5.200	5.113	5.196	5.200	5.500	5.330	5.330	5.702	5.750	6.000													
2.375 N.U.	4.535	4.775	4.427	4.427	4.758	4.775	5.075	4.988	5.071	5.075	5.375	5.205	5.205	5.577	5.625	5.875	5.750												
2.375 E.U. (2.910 Cplg. O.D.)	4.570	4.810	4.462	4.462	4.793	4.810	5.110	5.023	5.106	5.110	5.410	5.240	5.240	5.612	5.660	5.910	5.785	5.820											
2.375 E.U.	4.723	4.963	4.615	4.615	4.946	4.963	5.263	5.176	5.259	5.263	5.563	5.393	5.393	5.765	5.813	6.063	5.938	5.973	6.126										
2.875 "CS" HYDRIL	4.880	5.120	4.772	4.772	5.103	5.120	5.420	5.333	5.416	5.420	5.720	5.550	5.550	5.922	5.970	6.220	6.095	6.130	6.283	6.440									
2.875 "SS" HARDY-GRIFFIN	4.880	5.120	4.772	4.772	5.103	5.120	5.420	5.333	5.416	5.420	5.720	5.550	5.550	5.922	5.970	6.220	6.095	6.130	6.283	6.440	6.440								
2.875 "XL" SPANG	5.160	5.400	5.052	5.052	5.383	5.400	5.700	5.613	5.696	5.700	6.000	5.830	5.830	6.202	6.250	6.500	6.375	6.410	6.563	6.720	6.720	7.000							
2.875 N.U.	5.160	5.400	5.052	5.052	5.383	5.400	5.700	5.613	5.696	5.700	6.000	5.830	5.830	6.202	6.250	6.500	6.375	6.410	6.563	6.720	6.720	7.000	7.000						
2.875 E.U. (3.460 Cplg. O.D.)	5.120	5.360	5.012	5.012	5.343	5.360	5.660	5.573	5.656	5.660	5.960	5.790	5.790	6.162	6.210	6.460	6.335	6.370	6.523	6.680	6.680	6.960	6.960	6.920					
2.875 E.U.	5.328	5.568	5.220	5.220	5.551	5.568	5.868	5.781	5.864	5.868	6.168	5.998	5.998	6.370	6.418	6.668	6.543	6.578	6.731	6.888	6.888	7.168	7.168	7.128	7.336				
3.500 "CS" HYDRIL	5.525	5.765	5.417	5.417	5.748	5.765	6.065	5.978	6.061	6.065	6.365	6.195	6.195	6.567	6.615	6.865	6.740	6.774	6.928	7.085	7.085	7.365	7.365	7.324	7.533	7.730			
3.500 "XL" SPANG	5.910	6.150	5.802	5.802	6.133	6.150	6.450	6.363	6.446	6.450	6.750	6.580	6.580	6.952	7.000	7.250	7.125	7.160	7.313	7.470	7.470	7.750	7.750	7.710	7.918	8.114	8.500		
3.500 N.U.	5.910	6.150	5.802	5.802	6.133	6.150	6.450	6.363	6.446	6.450	6.750	6.580	6.580	6.952	7.000	7.250	7.125	7.160	7.313	7.470	7.470	7.750	7.750	7.710	7.918	8.114	8.500	8.500	
3.500 E.U.	6.160	6.400	6.052	6.052	6.383	6.400	6.700	6.613	6.696	6.700	7.000	6.830	6.830	7.202	7.250	7.500	7.375	7.410	7.563	7.720	7.720	8.000	8.000	7.960	8.168	8.364	8.750	8.750	9.000

The Dimensions listed in this Chart are the exact minimum combined O.D. as shown in the illustration. It is recommended that a diametrical clearance of 3/16" to 5/16" be subtracted from the theoretical I.D. of the casing.



It is recommended that the long string of tubing above the Flow Tube have tapered joints or beveled couplings. It is possible that the standard couplings would cause damage to the seals on the Parallel Seal Nipple or threads of Latching Sub when the short string is being run into the well.

TABLE 3—TUBING DIMENSIONAL DATA

Revised 7-58

Tubing O.D.	Type Thread	Nominal	Wt. per Ft.	I.D.	Drift Dia.	Inside Dia. Sq. in. Area	Joint I.D.	Cplg. O.D. or Joint O.D.	Special Joint O.D.
1.050	E.U.	3/4	1.20	.824	.730	.533		1.660	
1.315	E.U.	1	1.80	1.049	.955	.864		1.900	
1.315	Hydril "CS"	1	1.80	1.049	.955	.864	.970	1.552	
1.315	Hardy-Griffin "SS"	1	1.80	1.049	.955	.864	.970	1.552	
1.660	Hydril "CS"	1-1/4	2.40	1.380	1.286	1.496	1.301	1.883	
1.660	Hardy-Griffin "SS"	1-1/4	2.40	1.380	1.286	1.496	1.301	1.900	
1.660	E.U.	1-1/4	2.40	1.380	1.286	1.496		2.200	
1.900	Hydril "CS"	1-1/2	2.90	1.610	1.516	2.036	1.530	2.113	
1.900	Hardy-Griffin "SS"	1-1/2	2.90	1.610	1.516	2.036	1.531	2.156	
1.900	N.U.	1-1/2	2.75	1.610	1.516	2.036		2.200	
1.900	E.U.	1-1/2	2.90	1.610	1.516	2.036		2.500	
2.062*	Hydril "CS"	—	3.4	1.750	1.657	2.405	1.700	2.330	
2.062*	Hardy-Griffin "SS"	—	3.4	1.750	1.657	2.405	1.700	2.330	
2.375	Hydril "CS"	2	4.70	1.995	1.901	3.126	1.945	2.702	2.630
2.375	Hardy-Griffin "SS"	2	4.70	1.995	1.901	3.126	1.945	2.750	
2.375	Spang "XL"	2	4.70	1.995	1.901	3.126	1.935	3.000	
2.375	N.U.	2	4.60	1.995	1.901	3.126		2.875	
2.375	E.U.	2	4.70	1.995	1.901	3.126		3.063**	
2.375	E.U.	2	5.95	1.867	1.773	2.737		3.063**	

* Non A.P.I. Tubing
** N 80 Couplings are sometimes turned to 2.910 by the operators. This dia. is listed for reference and does not constitute a recommendation by Baker Oil Tools, Inc.

Tubing O.D.	Type Thread	Nominal	Wt. per Ft.	I.D.	Drift Dia.	Inside Dia. Sq. in. Area	Joint I.D.	Cplg. O.D. or Joint O.D.	Special Joint O.D.
2.875	Hydril "CS"	2-1/2	6.50	2.441	2.347	4.676	2.370	3.220	3.155
2.875	Hardy-Griffin "SS"	2-1/2	6.50	2.441	2.347	4.676	2.375	3.220	
2.875	Spang "XL"	2-1/2	6.50	2.441	2.347	4.676	2.381	3.500	
2.875	N.U.	2-1/2	6.40	2.441	2.347	4.676		3.500	
2.875	N.U.	2-1/2	8.60	2.259	2.165	4.008		3.500	
2.875	E.U.	2-1/2	6.50	2.441	2.347	4.676		3.668***	
2.875	E.U.	2-1/2	8.70	2.259	2.165	4.008		3.668***	
3.500	Hydril "CS"	3	9.30	2.992	2.867	7.031	2.920	3.865	3.805
3.500	Spang "XL"	3	9.30	2.992	2.867	7.031	2.907	4.250	
3.500	N.U.	3	9.20	2.992	2.867	7.031		4.250	
3.500	N.U.	3	12.70	2.750	2.625	5.940		4.250	
3.500	E.U.	3	9.30	2.992	2.867	7.031		4.500	
3.500	E.U.	3	12.95	2.750	2.625	5.940		4.500	
4.000	Hydril "CS"	3-1/2	11.00	3.476	3.351		3.395	4.343	4.315
4.000	N.U.	3-1/2	9.50	3.548	3.423			4.750	
4.000	E.U.	3-1/2	11.00	3.476	3.351			5.000	
4.500	Hydril "CS"	4	12.75	3.958	3.833		3.865	4.855	4.825
4.500	N.U.	4	12.60	3.958	3.833			5.200	
4.500	E.U.	4	12.75	3.958	3.833			5.563	

*** N 80 Couplings are sometimes turned to 3.460 by the operators. This dia. is listed for reference and does not constitute a recommendation by Baker Oil Tools, Inc.

over choke on wire line. Provides full opening through lower packer for permanent completion of lower zone.

B. Artificial-Lift Possibilities
   1. Pumping
      a. Pump either zone with remaining zone flowing up annulus.
      b. Pump one zone through tubing and one zone through annulus (Fig. 6) using dual-zone pump with single set of rods.
      c. Pump either zone hydraulically using concentric or parallel macaroni string for power oil.
   2. Gas Lift
      a. Both zones below packers can be gas lifted alternately using retrievable cross-over to open either zone to the tubing. Casing annulus above upper packer used as gas reservoir.

C. Advantages
   1. Increased flexibility, particularly in the area of artificial lift when compared to single-packer, single-string installations.

D. Disadvantages
   1. All disadvantages associated with producing one zone through the annulus.

One String of Tubing and Two or More Packers (to Permit Multiple-Zone Production Two Zones at a Time)

A. Completion Practice
   1. Packers separating two, three, four or more zones, tubing string runs through all packers and is bull plugged on bottom. Sleeve valves or side-ported nipples opposite each zone are opened and closed by wire line to produce selectively each of several zones. (Fig. 12 illustrates a parallel string hook-up; however, by considering the long string as the only tubing string—the hook-up illustrates the method referred to.)

B. Artificial Lift
   1. Same techniques used with one string and two packers apply to artificial lifting upper zone and any one of several lower zones.

C. Advantages
   1. Economical method of completing one or more marginal zones that would not normally be economically feasible to complete an individual well to these zones.

D. Disadvantages
   1. The same as those which apply to one string two packer completions (see section entitled "Tubing and Annulus Production").

Two Parallel Strings of Tubing and One Packer

A. Completion Practice
   1. Lower zone up long string; upper zone up short string.
   2. Separately retrievable short string hanging free; separately retrievable full-opening long string located, latched or tied to packer with threaded connection. Located or latched long string may be retrieved with short string in place (Fig. 2).
   3. Separately retrievable short string anchored to long string; long string located, latched or tied to packer with threaded connections (Fig. 3).

B. Artificial-Lift Possibilities
   1. Pumping (Fig. 4)
      a. Both zones pumped with two strings of rods, lower zone up long string and upper zone up short string. Upper zone gas bleed-off at casing head, lower zone gas bleed-off through macaroni string, where necessary.
      b. Both zones pumped with one string of rods using dual-zone pump (Fig. 5). Lower zone up short string; upper zone up long string. Upper zone gas bleed-off at casing head; where necessary, lower zone gas bleed-off through macaroni string concentric with short string. Gas bleed-off string separately retrievable.
      c. Pumping upper zone, gas bleed at casing head, lower zone flowing.
      d. Hydraulic pumping using concentric or parallel macaroni strings for power oil.
   2. Gas Lift
      a. Gas lift impractical.

C. Advantages
   1. Flexibility at lowest cost. Workover of either zone simple and economical. Lower zone can be permanently completed.
   2. Low cost method of converting single to successful parallel dual.

D. Disadvantages
   1. Cannot load annulus.
   2. Upper zone pressure on casing.
   3. Corrosive elements from upper zone in contact with casing.
   4. Gas lift impractical.

Two Parallel Strings of Tubing and Two Packers

A. Completion Practice
   1. Upper zone confined to separately retrievable short string that seats and seals off in head top packer (if retrievable); see Fig. 11. Lower zone confined to full-opening long string that passes through upper packer and seats and seals off in bore of lower drillable packer. Also furnished with long and short strings selectively retrievable.
   2. Upper zone confined to separately retrievable short string that seats and seals off in head of parallel-flow tube (Fig. 10). Parallel-flow tube seats and seals off in bore of upper drillable packer. Lower zone confined to full-opening long string that is connected to and extends through flow tube to seat and seal off in bore of lower drillable packer. Also furnished with long and short strings selectively retrievable.
   3. Upper zone confined to separately retrievable short string that seats and seals off in head of upper retrievable packer. Lower zone confined to full-opening long string that is connected and passes through upper packer to tie onto lower retrievable packer via threaded connections.

B. Artificial-Lift Possibilities
   1. Pumping
      a. Pump either or both zones through anchored string. Gas venting of lower zone possible if triple string flow tube or triple string packer is used.
   2. Gas Lift
      a. Gas lift both zones using casing as gas reservoir. Preplanned gas-lift installations run housings for wire line gas-lift mandrels at time tubing is run. When gas lift is required, annular fluid is removed, mandrels installed.

C. Advantages
   1. Complete isolation of each zone at all times.
   2. Can load annulus.

D. Disadvantages
   1. Difficult to vent either zone for pumping. See B-1a above.

Two Parallel Strings; Two Packers; No Permanent String Between Packers

A. Completion Practice
   1. Both long and short strings terminate in upper packer. A retrievable production tube is run through the long string to the lower packer to isolate zones for production.

B. Artificial Lift (same as for two strings—two packers)

C. Advantages

1. Either or both zones may be permanently completed.

D. Disadvantages

1. Neither zone can be vented for pumping.
2. Hook-up more complex.

Two Parallel Strings and Two or More Packers

A. Completion Practice

1. Lower packers isolate two, three, four, or more zones (Fig. 12). Long string extends through all lower packers. Sleeve valve or side-ported nipples opposite each zone isolate or open each zone to the long string.
2. A variation of this hook-up has the short string extend down through to the zone below the second packer. By this method one or more zones can be selectively opened to the long string and two zones selectively opened to the short string.

B. Artificial Lift

1. See two parallel strings and two packer installation.

C. Advantages

1. Permits the depletion of one or more marginal zones that could not be produced economically by any other method.

D. Disadvantages

1. See two parallel strings and two packer installation.

Three Zone Production

Two Parallel Strings and Two Packers

A. Completion Practice

1. Identical with two zone and two parallel string; two packer hook-up except third zone is produced in annulus above upper packer.

B. Artificial Lift

1. See two zone, two parallel string, two packer installation.

C. Comment: Could be satisfactory completion if upper zone were gas. Upper zone producing sand or excessive paraffin could complicate retrievability of lower tubing string and retrievable packers.

Three Parallel Strings and Three Packers

1. Installation using three permanent packers (Fig. 13). Lower zone produced through full-opening long string that extends through all three packers. Intermediate zone produced through annulus between long string and intermediate string and on up intermediate string. Upper zone produced through annulus between intermediate string and outer flow tube housing and up through short string. Triple string flow tube and sealing accessories for lower packers are run on long string. Two short strings for upper and intermediate zones are then run in and are stabbed into sealing bores in flow tube head.
2. Installation using three retrievable packers. Lower zone produced through full-opening long string that extends through all three packers. Intermediate zone produced through second bore of intermediate retrievable packer through intermediate string that seats in receptacle of intermediate packer. Upper zone produced through third bore of upper retrievable packer. Upper zone short string is run and seated in receptacle of upper packer.

B. Artificial Lift

Because the modern triple string hook-up is of very recent origin, little information is available regarding the application of artificial lift to this method. It would seem, however, that two zones could be pumped with two strings of rods or that any or all zones could be gas-lifted using the casing as a reservoir.

Four Zone Production

Three Parallel Strings and Three Packers

A. Completion Practice

1. Identical with three parallel string; three packer hook-up described previously except that fourth zone (upper zone) is produced in the annulus above the upper packer.

B. Comment

1. As with the two string-two packer triple completion this hook-up is feasible if the upper zone is clean gas. Production of oil into this annular space might affect the retrievability of the strings and retrievable packers used for lower zones.

Four Parallel Strings and Four Packers

Completion requires use of four hydraulic retrievable packers containing heads to accommodate one, two, three and four strings of tubing, respectively (Fig. 14). Packers for all four zones are made up successively on long string with connecting strings stabbed into proper packer bores in sequence. Christmas tree installed, packers set in sequence from top down circulating around unset packers to unload successive zones. Because this is a relatively recent completion, other than its initial success, little is known of its future requirements from the standpoint of workover and artificial lift.[6]

Conclusion

It is obvious that there are innumerable ways to make multiple-zone completions, only a few of which can be discussed at any great length in a paper. Even though the systematic approach for the selection of a practical multiple completion hook-up, as presented in this paper, is followed, conditions may be such that none of the basic arrangements appear to be completely satisfactory. In such instances it is well to remember that manufacturers of multiple completion equipment more than likely have a number of solutions to completion problems of which even their own field men are not aware. It is suggested therefore, that whenever a seemingly unsolvable completion problem exists, that the individual manufacturers be contacted directly for their suggestions before attempting to design equipment for a specific "problem" installation.

References

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2. Miller, E. B., Jr.: "A Survey of Dual Completions", *Drill. and Prod. Prac.*, API (1947) 74.
3. Huber, T. A. and Tausch, G. H.: "Permanent-Type Well Completions", *Trans.* AIME (1953) 198, 11.
4. Tausch, G. H. and Kennedy, J. W.: "Permanent-Type Dual Completions", *Drill. and Prod. Prac.*, API (1956) 208.
5. Ray, J. H. and Rowley, K. G.: "Multiple Completions Save Money Off-Shore", *World Oil* (1958) 146, No. 7.
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7. Bennett, E. O.: "Multiple Zone Completions", *Drill and Prod Prac.* API (1942) 9.
8. Huber, T. A., Tausch, G. H. and Dublin, J. R. III: "A Simplified Cementing Technique for Recompletion Operations", *Trans.* AIME (1954) 201, 1.
9. Kastrop, J. E.: "World Oil's Special Report on Permanent-Type Well Completion", *World Oil* (1954) 138, No. 11.

★★★

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 1755
Order No. R-1491

APPLICATION OF EL PASO NATURAL
GAS COMPANY FOR AN AMENDMENT OF
RULE 112-A OF THE COMMISSION
RULES AND REGULATIONS TO PROVIDE
FOR ADMINISTRATIVE APPROVAL OF
DUAL COMPLETIONS UTILIZING RE-
TRIEVABLE-TYPE PACKERS

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on September 16, 1959, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 28th day of September, 1959, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, El Paso Natural Gas Company, proposes that Rule 112-A II (d) of the Commission's Rules and Regulations be amended to read as follows:

> The packer used to segregate the separate zones of the multiple completion shall be effective to prevent communication between all producing zones and may be either a permanent or a retrievable-type production packer which shall be certified as adequate by the operator.

(3) That in many instances a retrievable-type production packer is adequate to effect permanent zone separation and provision should be made in the Commission Rules for administrative approval of dual completions utilizing such packers.

(4) That the proposed amendment of Rule 112-A II (d) of the Commission Rules and Regulations will neither cause waste nor impair correlative rights.

IT IS THEREFORE ORDERED:

That Rule 112-A II (d) of the Commission Rules and Regulations be and the same is hereby amended to read as follows:

> The packer used to segregate the separate zones of the dual completion shall be a production-type packer and shall effectively prevent communication between all producing zones.

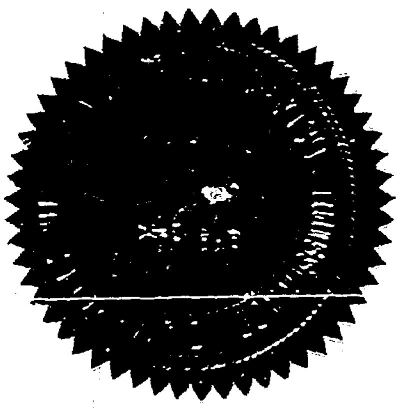
DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary



lcr/

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
El Paso EXHIBIT No. 1
CASE 1755

PACKER SETTING AFFIDAVIT

I, ______________________________, being of lawful age
Name of Party Making Affidavit
and having full knowledge of the facts hereinbelow set out do state:

That I am employed by ______________________________ in the capacity of ______________________________, that on ______________ (Date), 195__, I personally supervised the setting of a ______________________________ (Make and Type of Packer) in ______________________________ (Operator of Well), ______________________________ (Lease Name) Well No. ______________ located in the ______________________________ (Field), ______________________________ County, New Mexico, at a subsurface depth of ______________ feet, said depth measurement having been furnished me by ______________________________; that the purpose of setting this packer was to effect a seal in the annular space between the two strings of pipe where the packer was set so as to prevent the commingling, in the bore of this well, of fluids produced from a stratum below the packer with fluids produced from a stratum above the packer; that this packer was properly set and that it did, when set, effectively and absolutely seal off the annular space between the two strings of pipe where it was set in such manner as that it prevented any movement of fluids across the packer.

____

STATE OF NEW MEXICO)(
COUNTY OF ______________)(

Before me, the undersigned authority, on this day personally appeared ______________________________, known to me to be the person whose name is subscribed to this instrument, who after being by me duly sworn on oath, states that he has knowledge of all the facts stated above and that the same is a true and correct statement of the facts therein recited.

Subscribed and sworn to before me on this the ______________ day of ______________, 195__.

____
Notary Public in and for
______________________________ County,
New Mexico

My Commission Expires ______________

1755

EL PASO NATURAL GAS COMPANY

Memorandum

To: Mr. L. D. Galloway Date: September 14, 1959

From: Gas-Production Engineering Place: Farmington, New Mexico

A record of Dual Completions in the San Juan Basin is as follows:

EPNG Only

148	Duals Completed
17	Drilled and Not First Delivered
13	Drilling
23	To be Drilled by 12/31/59 (est.)
201	

Other Operators

74	Duals Tied In
2	Triple Completions
76	

277	Total

H. L. Kendrick
Gas Engineer

HLK/nb

EL PASO NATURAL GAS COMPANY

Memorandum

To: Mr. L. D. Galloway — Date: September 14, 1959

From: Gas-Production Engineering — Place: Farmington, New Mexico

Listed below are the multiple completions producing one zone or all zones on the dates shown.

	EPNG	PNW
February 28, 1959	158	60

Total = 218

	EPNG	PNW
August 31, 1959	192	63

Total = 255

H. L. Kendrick
Gas Engineer

HLK/nb

No. 32-59

DOCKET: REGULAR HEARING SEPTEMBER 16, 1959

Oil Conservation Commission 9 a.m., Mabry Hall, State Capitol, Santa Fe, New Mexico.

ALLOWABLE: (1) Consideration of the oil allowable for October, 1959.

(2) (Show Cause Hearing) In the matter of the hearing called by the Oil Conservation Commission to require El Paso Natural Gas Products Company to appear and present testimony as to whether it prorated oil purchases in any county in Northwest New Mexico during July, 1959, without notifying the Commission, and if so whether such prorationing was on a ratable basis.

(3) Consideration of the allowable production of gas for October, 1959, from six prorated pools in Lea County, New Mexico, also consideration of the allowable production of gas from seven prorated pools in San Juan, Rio Arriba and Sandoval Counties, New Mexico.

CONTINUED CASE

CASE 1600: In the matter of the application of M. A. Romero and Robert Critchfield concerning the operation of gas prorationing in the Blanco Mesaverde Gas Pool in Rio Arriba and San Juan Counties, New Mexico, as well as from the Choza Mesa-Pictured Cliffs Gas Pool in Rio Arriba County, New Mexico.

NEW CASES

CASE 1755: Application of El Paso Natural Gas Company for an amendment of Rule 112-A of the Commission Rules and Regulations. Applicant, in the above-styled cause, seeks an amendment of Rule 112-A of the Commission Rules and Regulations to provide for administrative approval of dual completions utilizing retrievable-type packers.

CASE 1756: Application of Union Oil Company of California for an order promulgating special rules and regulations for the Tatum-Wolfcamp Pool in Lea County, New Mexico. Applicant, in the above-styled cause, seeks an order promulgating special rules and regulations for the Tatum-Wolfcamp Pool in Lea County, New Mexico, to provide for 80-acre proration units.

CASE 1757: Application of J. C. Williamson for an order establishing 80-acre proration units in an undesignated Devonian pool in Chaves County, New Mexico. Applicant, in the above-styled cause, seeks an order establishing 80-acre proration units in an undesignated Devonian pool in Chaves County, New Mexico. The discovery well is located 660 feet from the North and East lines of Section 1, Township 12 South, Range 28 East.

CASE 1758: Southeastern New Mexico nomenclature case calling for an order creating and extending existing pools in Eddy and Lea Counties, New Mexico.

(a) Create a new oil pool for Pennsylvanian production, designated as the Baish-Pennsylvanian Pool and described as:

TOWNSHIP 17 SOUTH, RANGE 32 EAST, NMPM
Section 21: SE/4

(b) Create a new oil pool for Brushy Canyon production, designated as the Cotton Draw-Brushy Canyon Pool and described as:

TOWNSHIP 24 SOUTH, RANGE 31 EAST, NMPM
Section 24: SE/4

(c) Create a new oil pool for Devonian production, designated as the King Camp-Devonian Pool and described as:

TOWNSHIP 14 SOUTH, RANGE 29 EAST, NMPM
Section 27: NE/4

(d) Create a new gas pool for Tubb production, designated as the Weir-Tubb Gas Pool and described as:

TOWNSHIP 20 SOUTH, RANGE 37 EAST, NMPM
Section 15: SE/4

(e) Extend the Bishop Canyon Pool to include therein:

TOWNSHIP 18 SOUTH, RANGE 38 EAST, NMPM
Section 9: NE/4

(f) Extend the Four Lakes-Devonian Gas Pool to include therein:

TOWNSHIP 12 SOUTH, RANGE 34 EAST, NMPM
Section 2: SE/4

(g) Extend the Jalmat Gas Pool to include therein:

TOWNSHIP 25 SOUTH, RANGE 36 EAST, NMPM
Section 23: SE/4

TOWNSHIP 26 SOUTH, RANGE 36 EAST, NMPM
Section 12: NE/4

(h) Extend the Justis Drinkard Pool to include therein:

TOWNSHIP 25 SOUTH, RANGE 37 EAST, NMPM
Section 13: NW/4

(i) Extend the Little Lucky Lake-Devonian Pool to include therein:

TOWNSHIP 15 SOUTH, RANGE 30 EAST, NMPM
Section 29: SE/4

(j) Extend the Maljamar Pool to include therein:

TOWNSHIP 17 SOUTH, RANGE 33 EAST, NMPM
Section 16: NW/4

(k) Extend the Roberts Pool to include therein:

TOWNSHIP 17 SOUTH, RANGE 32 EAST, NMPM
Section 12: SE/4

(l) Extend the Robinson Pool to include therein:

TOWNSHIP 17 SOUTH, RANGE 31 EAST, NMPM
Section 11: NE/4 NW/4

(m) Extend the Skaggs Pool to include therein:

TOWNSHIP 20 SOUTH, RANGE 38 EAST, NMPM
Section 20: NW/4

(n) Extend the Teas Pool to include therein:

TOWNSHIP 20 SOUTH, RANGE 33 EAST, NMPM
Section 23: NW/4

(o) Extend the Wilson Pool to include therein:

TOWNSNIP 21 SOUTH, RANGE 35 EAST, NMPM
Section 29: NW/4

CASE 1759: Northwestern New Mexico nomenclature case for an order extending existing pools in San Juan and Rio Arriba Counties, New Mexico.

(a) Abolish the Chimney Rock-Gallup Oil Pool for the purpose of joining two pools producing from a common source of supply, to be known as the Horseshoe-Gallup Oil Pool.

(b) Extend the Blanco-Pictured Cliffs Pool to include therein:

TOWNSHIP 29 NORTH, RANGE 9 WEST, NMPM,
Section 16: S/2

(c) Extend the South Blanco-Pictured Cliffs Pool to include therein:

TOWNSHIP 25 NORTH, RQNGE 3 WEST, NMPM,
Section 22: E/2
Section 26: N/2

TOWNSHIP 26 NORTH, RANGE 4 WEST, NMPM,
Section 19: NW/4

(d) Extend the Tapacito-Pictured Cliffs Pool to include therein:

TOWNSHIP 25 NORTH, RANGE 3 WEST, NMPM
Section 14: E/2

TOWNSHIP 26 NORTH, RANGE 4 WEST, NMPM,
Section 25: E/2

TOWNSHIP 27 NORTH, RANGE 5 WEST, NMPM,
Section 15: W/2
Section 16: All
Section 17: E/2
Section 20: E/2
Section 21: All
Section 22: All
Section 23: All
Section 26: NW/4

(1)

Extend the

TOWNSHIP
Section

Extend

TOWNSHIP
Section

Extend

TOWNSHIP
Section

Northwestern
pools in

(a) Abolish
two pools producing from
Horseshoe-Gallup Oil Pool

Extend the

TOWNSHIP 29 NORTH, RANGE
Section S/2

TOWNSHIP

(e) Extend the Otero-Chacra Pool to include therein:

TOWNSHIP 25 NORTH, RANGE 5 WEST, NMPM
Section 19: NE/4
Section 20: N/2 & SE/4

(f) Extend the Blanco-Mesaverde Pool to include therein:

TOWNSHIP 27 NORTH, RANGE 6 WEST, NMPM
Section 33: All

(g) Extend the Angels Peak-Gallup Oil Pool to include therein:

TOWNSHIP 27 NORTH, RANGE 10 WEST, NMPM,
Section 28: S/2 NW/4

(h) Extend the Horseshoe-Gallup Oil Pool to include therein:

TOWNSHIP 30 NORTH, RANGE 16 WEST, NMPM,
Section 6: SE/4 NE/4
Section 8: NE/4 NE/4
Section 9: NW/4 NW/4
Section 13: S/2 SW/4

TOWNSHIP 31 NORTH, RANGE 16 WEST, NMPM,
Section 27: SW/4 SW/4

TOWNSHIP 31 NORTH, RANGE 17 WEST, NMPM,
Section 3: SW/4 SW/4
Section 4: All
Section 5: NE/4, E/2 SE/4, & NW/4 SE/4
Section 9: NE/4, N/2 NW/4, SE/4 NW/4, & N/2 SE/4
Section 10: W/2, SE/4, & S/2 NE/4
Section 11: SW/4
Section 13: SE/4 SW/4
Section 14: N/2 & SE/4
Section 23: E/2 NE/4
Section 25: SE/4 SE/4

TOWNSHIP 32 NORTH, RANGE 17 WEST, NMPM,
Section 33: SW/4 SW/4

(i) Extend the Otero-Gallup Oil Pool to include therein:

TOWNSHIP 24 NORTH, RANGE 5 WEST, NMPM,
Section 5: SW/4
Section 8: NW/4 NW/4

(j) Extend the Verde-Gallup Oil Pool to include therein:

TOWNSHIP 31 NORTH, RANGE 14 WEST, NMPM,
Section 21: SW/4 & SW/4 SE/4

(k) Extend the Angels Peak-Dakota Pool to include therein:

TOWNSHIP 28 NORTH, RANGE 10 WEST, NMPM
Section 31: All

Docket No. 32-59

(1) Extend the West Kutz-Dakota Pool to include therein:

TOWNSHIP 27 NORTH, RANGE 12 WEST, NMPM,
Section 18: N/2

ig/

Dept Reg.

MAIN OFFICE OCC

1959 JUL 24 PM 3 : 05

BEFORE THE

OIL CONSERVATION COMMISSION

STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF EL PASO NATURAL GAS COMPANY FOR AN ORDER REVISING AND AMENDING SUBSECTIONS II(d) AND V(d) OF RULE 112-A OF THE RULES AND REGULATIONS, NEW MEXICO OIL CONSERVATION COMMISSION, RELATING TO THE TYPE OF PRODUCTION PACKER REQUIRED FOR ADMINISTRATIVE APPROVAL OF MULTIPLE COMPLETIONS.	CASE NO. 1755

A P P L I C A T I O N

TO THE HONORABLE COMMISSION:

Comes now El Paso Natural Gas Company, hereinafter referred to as "Applicant," and alleges and states:

I.

Applicant is a Delaware corporation with a permit to do business in the State of New Mexico;

II.

Applicant has developed and will continue to develop various lands and leases by the drilling of wells in the State of New Mexico and in many instances, multiple completions have been, and will continue to be, desirable in order to prevent waste and the unnecessary drilling of wells;

III.

At present, Rule 112-A II(d) provides that dual completions may be granted administratively without notice and hearing by the Secretary-Director of the Commission if, among other things, "The packer used to segregate the separate producing zones of the dual completion will be a permanent type production packer." Said subsection should be revised and amended so that it will hereafter read:

"The packer used to segregate the separate producing

Docket mailed 7-24-59

zones of the multiple completion shall be effective to prevent communication between all producing zones and may be either a permanent or a retrievable type production packer which shall be certified as adequate by the manufacturer or representative thereof as provided in Subsection V(d) of this rule."

IV.

At present, Rule 112-A V(d) is as follows:

"A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test."

This subsection should be revised and amended so that it will hereafter read:

"A packer setting affidavit shall accompany the report of the initial segregation test and packer leakage test and shall include a certification by the manufacturer of such packer or authorized representative thereof that the type of production packer to be used is adequate to satisfy the provisions of this rule with regard to the proposed completion."

V.

The granting of the relief sought in this application will prevent waste and will not violate or prejudice correlative rights, and will relieve all interested operators and the Commission of the time and expense that would otherwise result in holding unnecessary hearings;

VI.

The Commission has jurisdiction to hear and determine this cause, and said Rule 112-A II(d) and 112-A V(d) should be amended as set out above;

WHEREFORE, Applicant respectfully requests this matter be set for hearing before this Commission as prescribed by law, and that upon due notice and hearing, the Commission issue its order amending Rule 112-A as above set out to effectuate the granting of multiple completions without notice and hearing when the requirements of Rule 112-A II and 112-A V, as so amended, are satisfied, and for such other and further relief either at law or in equity to which Applicant may show itself justly entitled.

Garrett C. Whitworth
Attorney for Applicant

SETH, MONTGOMERY, FEDERICI & ANDREWS

By: [signature]
Attorneys for Applicant

Case 1756

Pertinent Data
Tatum (Wolfcamp) Field
Lea County, New Mexico

Discovery: Union et al #1-6 Duncan "A", September 26, 1957

Average producing depth	10,320
Average porosity	6.7%
Average permeability	6 md.
Connate water saturation	22.0%
Gas cap	None
Oil-Water contact	Indefinite
Gravity of oil	43° API
Solution Gas-Oil Ratio	1200 cf/B
Bubble point (correlation)	3000 psig.
Formation volume factor (correlation)	1.69
Reservoir fluid viscosity	0.4 cp.
Original reservoir pressure @ -6300'	3904 psig.
Predominant Drive	Water
Average pay thickness	19'
Oil-in-place per acre-ft., STB	240 B/AF
Cumulative oil production to 8/31/59	156,794 bbls.
Current water production	Less than 1%
Number of producing wells	1 flowing 2 pumping
Total wells drilled to date	4

6

Exh 6-A

CORE ANALYSIS REPORT

FOR

UNION OIL COMPANY OF CALIFORNIA

DUNCAN NO. 1-6 WELL

WILDCAT

LEA COUNTY, NEW MEXICO

LOCATION: SEC. 6-T13S-R36E

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

October 11, 1957

REPLY TO
P. O. BOX 36
MIDLAND, TEXAS

Union Oil Company of California
Box 6738
Roswell, New Mexico

Attention: Mr. D. A. Dunn

Subject: Core Analysis
Duncan No. 1-6 Well
Wildcat
Lea County, New Mexico
Location: Sec. 6-T13S-R36E

Gentlemen:

Diamond coring equipment and water base mud were used to core several intervals between 10,290 and 14,393 feet in the Duncan No. 1-6. Samples were selected by an engineer of Core Laboratories, Inc. at the direction of a representative of Union Oil Company of California. These samples were quick-frozen at the well site and analyzed in the Hobbs laboratory. The samples on which two permeability measurements are shown were analyzed by whole-core analysis procedures. The remaining samples were analyzed by conventional procedures. Results of the analysis are presented in this report.

Formation analyzed from 10,290 to 10,322 feet is essentially impermeable and nonproductive.

Wolfcamp formation analyzed from 10,325 to 10,356 feet exhibited residual fluid saturations indicative of oil production where the formation was permeable. In the interval, there are 9.3 feet of formation considered to be permeable and oil productive. The average permeability is 6.5 millidarcys, and the productive capacity is 60 millidarcy-feet, and an economic completion will be dependent upon a successful formation treatment. The average porosity in the interval is 8.2 per cent.

Estimates of recoverable oil have been prepared using the observed core analysis data in conjunction with estimated reservoir fluid characteristics considered applicable. These estimates are presented on the core summary and calculated recoverable oil page of the report, and are subject to the conditions set forth in the body of and in the footnotes to the summary page.

Intervals analyzed between 10, 370 and 12, 803 feet were analyzed for permeability and porosity only.

Devonian formation analyzed at intervals between 14, 077 and 14, 283 feet is considered to be virtually nonproductive due to the low porosity and the low permeability.

Formation analyzed between 14, 353.4 and 14, 387.3 feet is interpreted to be primarily water productive where the formation is permeable.

We sincerely appreciate this opportunity to be of service to you.

Very truly yours,

Core Laboratories, Inc.

R S Bynum Jr (P)

R. S. Bynum, Jr.,
District Manager

RSB:PE:ds

Form F-11B

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS, TEXAS

Page 1 of 1 File WP-3-799 WC & FC
Well Duncan No. 1-6

CORE SUMMARY AND CALCULATED RECOVERABLE OIL

FORMATION NAME AND DEPTH INTERVAL: Wolfcamp 10,325.0-10,356.0

FEET OF CORE RECOVERED FROM ABOVE INTERVAL	29.0	AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE		29.9
FEET OF CORE INCLUDED IN AVERAGES	9.3	AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	(c)	29.9
AVERAGE PERMEABILITY: MILLIDARCYS Max.: / 90°.:	6.5 / 6.5	OIL GRAVITY: °API	(e)	42
PRODUCTIVE CAPACITY: MILLIDARCY-FEET Max.: / 90°.:	60 / 60	ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	(e)	1500
AVERAGE POROSITY: PER CENT	8.2	ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	(e)	1.90
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE	7.8	CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT		235

Calculated maximum solution gas drive recovery is 43 barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is 185 barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

FORMATION NAME AND DEPTH INTERVAL:

FEET OF CORE RECOVERED FROM ABOVE INTERVAL		AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE	
FEET OF CORE INCLUDED IN AVERAGES		AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	
AVERAGE PERMEABILITY: MILLIDARCYS		OIL GRAVITY: °API	
PRODUCTIVE CAPACITY: MILLIDARCY-FEET		ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	
AVERAGE POROSITY: PER CENT		ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE		CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT	

Calculated maximum solution gas drive recovery is barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

(c) Calculated (e) Estimated (m) Measured (*) Refer to attached letter.

These recovery estimates represent theoretical maximum values for solution gas and water drive. They assume that production is started at original reservoir pressure; i.e., no account is taken of production to date or of prior drainage to other areas. The effects of factors tending to reduce actual ultimate recovery, such as economic limits on oil production rates, gas-oil ratios, or water-oil ratios, have not been taken into account. Neither have factors been considered which may result in actual recovery intermediate between solution gas and complete water drive recoveries, such as gas cap expansion, gravity drainage, or partial water drive. Detailed predictions of ultimate oil recovery to specific abandonment conditions may be made in an engineering study in which consideration is given to overall reservoir characteristics and economic factors

Distribution of Final Reports

2 Copies	Union Oil Company of California Box 6738 Roswell, New Mexico Attention: Mr. D. A. Dunn
2 Copies	Union Oil Company of California Union Oil Building Midland, Texas Attention: Mr. J. S. McNulty
4 Copies	Union Oil Company of California Union Oil Building Midland, Texas Attention: Geological Department
2 Copies	Skelly Oil Company Box 993 Midland, Texas Attention: Mr. L. G. Ditzell
6 Copies	Sinclair Oil & Gas Company Box 809 Roswell, New Mexico Attention: Mr. H. A. Merrill
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Distribution of Final Reports (Continued)

1 Copy	Leonard Oil Company Box 708 Roswell, New Mexico Attention: Mr. Joe Leonard
2 Copies	Delta Gulf Drilling Company Box 866 Odessa, Texas

Ex 6-B

CORE ANALYSIS REPORT

FOR

UNION OIL COMPANY OF CALIFORNIA

ATWOOD BRADLEY NO. 1-5 WELL

LEA COUNTY, NEW MEXICO

LOCATION: SEC. 5-T13S-R36E

CORE

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

December 13, 1957

REPLY TO
P. O. BOX 36
MIDLAND, TEXAS

Union Oil Company of California
Box 6738
Roswell, New Mexico

Attention: Mr. D. A. Dunn

Subject: Core Analysis
Atwood Bradley No. 1-5 Well
Lea County, New Mexico
Location: Sec. 5-T13S-R36E

Gentlemen:

Diamond coring equipment and water base mud were used to core the intervals, 10,274 to 10,296 and 10,305 to 10,410 feet, in the Atwood Bradley No. 1-5. Samples of recovered formation were selected for analysis as directed by representatives of Union Oil Company of California. These samples were quick-frozen to preserve fluid content, and were transported to the Hobbs laboratory for analysis. Samples shown on the accompanying Completion Coregraph having only one permeability value assigned were analyzed by conventional procedures, and samples having two or more permeability values assigned were analyzed by whole-core procedures using long segments of full-diameter core. Complete analysis results are presented in this report.

Wolfcamp formation analyzed from 10,335 to 10,341 feet is characterized by extremely low permeability and porosity and is considered to be essentially nonproductive.

From 10,341 to 10,347 feet, Wolfcamp formation is characterized by favorable residual fluid saturations, and is considered to be capable of oil production from points where permeability equals or exceeds 0.1 millidarcy. The average permeability of the 5.3 permeable feet in this interval is 2.1 millidarcys, and the total observed natural productive capacity is 11 millidarcy-feet, which is entirely inadequate to support satisfactory rates of oil production unless favorable response is obtained to treatment. The average measured porosity of this interval is 6.3 per cent, and the empirically calculated connate water saturation averages 29.0 per cent of pore space.

Cumulative production to be obtained from the Wolfcamp formation, 10,341 to 10,347 feet, will be restricted because of the limited thickness and low productive capacity. However, to aid in evaluating this interval, estimates of recoverable oil have been calculated using the observed core analysis data in conjunction with estimated reservoir fluid characteristics considered applicable. These estimates are presented on page one of the report and are subject to the conditions set forth in the body of and in the footnotes to the summary page.

Formation analyzed from 10,347 to 10,349 feet is considered to be essentially nonproductive by virtue of very low permeability and porosity.

Analyzed portions of the Wolfcamp formation in the extended interval, 10,361.0 to 10,391.5 feet exhibit unfavorable residual fluid saturations and are interpreted to be predominantly water productive where permeable.

We sincerely appreciate this opportunity to be of service and trust that this report will prove useful in making a preliminary evaluation of the Wolfcamp formation analyzed from the Atwood Bradley No. 1-5.

Very truly yours,

Core Laboratories, Inc.

R S Bynum Jr

R. S. Bynum, Jr.,
District Manager

RSB:JDJ:sw
2 cc. - Addressee
2 cc. - Mr. J. S. McNulty
Union Oil Company of California
Midland, Texas
4 cc. - Union Oil Company of California
Midland, Texas

Form F-11B

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS, TEXAS

 File WP-3-954 WC & FC

Well Atwood Bradley No. 1-5

CORE SUMMARY AND CALCULATED RECOVERABLE OIL

FORMATION NAME AND DEPTH INTERVAL: Wolfcamp 10,341.0-10,347.0

FEET OF CORE RECOVERED FROM ABOVE INTERVAL		6.0	AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE		29.0
FEET OF CORE INCLUDED IN AVERAGES		5.3	AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	(c)	29.0
AVERAGE PERMEABILITY: MILLIDARCYS	Max.:	2.1	OIL GRAVITY: °API	(e)	43
	90°:	1.6			
PRODUCTIVE CAPACITY: MILLIDARCY-FEET	Max.:	11	ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	(e)	1500
	90°:	8.5			
AVERAGE POROSITY: PER CENT		6.3	ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	(e)	1.90
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE		8.0	CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT		183

Calculated maximum solution gas drive recovery is 33 barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is 144 barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

FORMATION NAME AND DEPTH INTERVAL:

FEET OF CORE RECOVERED FROM ABOVE INTERVAL		AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE	
FEET OF CORE INCLUDED IN AVERAGES		AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	
AVERAGE PERMEABILITY: MILLIDARCYS		OIL GRAVITY: °API	
PRODUCTIVE CAPACITY: MILLIDARCY-FEET		ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	
AVERAGE POROSITY: PER CENT		ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE		CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT	

Calculated maximum solution gas drive recovery is barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

(c) Calculated (e) Estimated (m) Measured (*) Refer to attached letter.

These recovery estimates represent theoretical maximum values for solution gas and water drive. They assume that production is started at original reservoir pressure; i.e., no account is taken of production to date or of prior drainage to other areas. The effects of factors tending to reduce actual ultimate recovery, such as economic limits on oil production rates, gas-oil ratios, or water-oil ratios, have not been taken into account. Neither have factors been considered which may result in actual recovery intermediate between solution gas and complete water drive recoveries, such as gas cap expansion, gravity drainage, or partial water drive. Detailed predictions of ultimate oil recovery to specific abandonment conditions may be made in an engineering study in which consideration is given to overall reservoir characteristics and economic factors.

Ex 6-C

CORE ANALYSIS REPORT

FOR

UNION OIL COMPANY OF CALIFORNIA

DUNCAN "B" NO. 1-6 WELL

SOUTH TATUM WOLFCAMP FIELD

LEA COUNTY, NEW MEXICO

LOCATION: SEC. 6-T13S-R36E

CORE LAB

PETROLEUM RESERVOIR ENGINEERING

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

February 18, 1958

REPLY TO
P. O. BOX 36
MIDLAND, TEXAS

Union Oil Company of California
Box 6738
Roswell, New Mexico

Attention: Mr. D. A. Dunn

Subject: Core Analysis
Duncan "B" No. 1-6 Well
South Tatum Wolfcamp Field
Lea County, New Mexico
Location: Sec. 6-T13S-R36E

Gentlemen:

Diamond coring equipment and water base mud were used to core the intervals, 10,263 to 10,366 and 10,410 to 10,468 feet, in the Duncan "B" No. 1-6. Engineers of Core Laboratories, Inc. selected samples of recovered formation for analysis as directed by representatives of Union Oil Company of California. These samples were quick-frozen to preserve fluid content and were transported to the Hobbs laboratory where analysis was made by whole-core procedures using long segments of full-diameter core. Complete analysis results are presented in this report.

Wolfcamp formation at permeable points of analysis between the depths of 10,263 and 10,442 feet is characterized by residual fluid saturations which are considered to be favorable to oil production. The average permeability of the 13.9 permeable feet analyzed in this over-all 135-foot interval is 8.8 millidarcys, and the total observed natural productive capacity is 122 millidarcy-feet, indicating that a formation treatment will probably be necessary in order to establish sustained satisfactory rates of flow. The average measured porosity is 6.8 per cent, and the average calculated connate water saturation is 35.4 per cent of pore space.

Union Oil Company of California
Duncan "B" No. 1-6 Well

Because of the limited number of productive feet analyzed in the interval, 10,263 to 10,442 feet, the cumulative production to be obtained will probably be somewhat restricted. To aid in the evaluation of this zone, however, estimates of recoverable oil have been calculated using the observed core analysis data in conjunction with estimated reservoir fluid characteristics which are considered to be applicable to this horizon. These estimates are presented on page one of this report and are subject to the conditions set forth in the body of and in the footnotes to the summary page.

We sincerely appreciate this opportunity to be of service and trust that this report will prove useful in making a preliminary evaluation of the Wolfcamp formation analyzed from the Duncan "B" No. 1-6.

Very truly yours,

Core Laboratories, Inc.

R S Bynum Jr

R. S. Bynum, Jr.,
District Manager

RSB:JDJ:sw

Form F-11B

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

 File WP-3-1001 WC
Well Duncan "B" No. 1-6

CORE SUMMARY AND CALCULATED RECOVERABLE OIL

FORMATION NAME AND DEPTH INTERVAL: Wolfcamp 10,263.0-10,442.0

FEET OF CORE RECOVERED FROM ABOVE INTERVAL	135.0	AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE		35.4
FEET OF CORE INCLUDED IN AVERAGES	13.9	AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	(c)	35.4
AVERAGE PERMEABILITY: MILLIDARCYS Max.:	8.8	OIL GRAVITY: °API	(e)	43
90°:	4.1	ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	(e)	1500
PRODUCTIVE CAPACITY: MILLIDARCY-FEET Max.:	122	ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	(e)	1.90
90°:	57	CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT		180
AVERAGE POROSITY: PER CENT	6.8			
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE	10.3			

Calculated maximum solution gas drive recovery is 33 barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is 125 barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. *(Please refer to footnotes for further discussion of recovery estimates.)*

FORMATION NAME AND DEPTH INTERVAL:

FEET OF CORE RECOVERED FROM ABOVE INTERVAL		AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE	
FEET OF CORE INCLUDED IN AVERAGES		AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	
AVERAGE PERMEABILITY: MILLIDARCYS		OIL GRAVITY: °API	
PRODUCTIVE CAPACITY: MILLIDARCY-FEET		ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	
AVERAGE POROSITY: PER CENT		ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE		CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT	

Calculated maximum solution gas drive recovery is barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. *(Please refer to footnotes for further discussion of recovery estimates.)*

(c) Calculated (e) Estimated (m) Measured (*) Refer to attached letter.

These recovery estimates represent theoretical maximum values for solution gas and water drive. They assume that production is started at original reservoir pressure; i.e., no account is taken of production to date or of prior drainage to other areas. The effects of factors tending to reduce actual ultimate recovery, such as economic limits on oil production rates, gas-oil ratios, or water-oil ratios, have not been taken into account. Neither have factors been considered which may result in actual recovery intermediate between solution gas and complete water drive recoveries, such as gas cap expansion, gravity drainage, or partial water drive. Detailed predictions of ultimate oil recovery to specific abandonment conditions may be made in an engineering study in which consideration is given to overall reservoir characteristics and economic factors.

Distribution of Final Reports

2 Copies	Union Oil Company of California Box 6738 Roswell, New Mexico Attention: Mr. D. A. Dunn
2 Copies	Union Oil Company of California Union Oil Building Midland, Texas Attention: Mr. J. S. McNulty
4 Copies	Union Oil Company of California Union Oil Building Midland, Texas Attention: Geological Department
1 Copy	Delta Drilling Company Box 866 Odessa, Texas Attention: Mr. C. H. Roberts
1 Copy	Delta Drilling Company Box 2012 Tyler, Texas

Ex 6-D

CORE ANALYSIS REPORT

FOR

UNION OIL COMPANY OF CALIFORNIA

ANDERSON NO. 1-7 WELL

TATUM WOLFCAMP FIELD

LEA COUNTY, NEW MEXICO

LOCATION: SEC. 7-T13S-R36E

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

May 5, 1958

REPLY TO
P. O. BOX 36
MIDLAND, TEXAS

Union Oil Company of California
Box 6738
Roswell, New Mexico

Attention: Mr. D. A. Dunn

Subject: Core Analysis
Anderson No. 1-7 Well
Tatum Wolfcamp Field
Lea County, New Mexico
Location: Sec. 7-T13S-R36E

Gentlemen:

Wolfcamp formation was cored in the subject well between 10,250 and 10,476 feet using diamond coring equipment and water base mud. Samples were selected from the interval, 10,303 to 10,361 feet, by an engineer of Core Laboratories, Inc. as directed by a representative of Union Oil Company of California. Remaining samples were selected for analysis by a representative of the operator and all samples were quick-frozen to preserve fluid content. The analysis was performed at the Hobbs laboratory by whole-core procedures using long segments of full-diameter core and complete results are given in this report.

Analyzed portions of Wolfcamp formation from 10,263.0 to 10,357.5 feet exhibit favorable residual fluid saturations and are considered to be capable of oil production where permeability equals or exceeds 0.1 millidarcy. The 23.0 permeable feet analyzed in this interval have an average permeability of 7.7 millidarcys and a total observed natural productive capacity of 176 millidarcy-feet, indicating that a formation treatment may be necessary in order to establish satisfactory rates of flow. The average measured porosity is 6.2 per cent and the average calculated connate water saturation is 29.6 per cent of pore space.

To aid the evaluation of the Wolfcamp formation interval, 10,263.0 to

10,357.5 feet, estimates of recoverable oil have been calculated using the observed core analysis data in conjunction with estimated reservoir fluid characteristics considered applicable. These estimates are presented on page one of this report and are subject to the conditions set forth in the body of and in the footnotes to the summary page.

From 10,418 to 10,437 feet, Wolfcamp formation is characterized by somewhat higher total water saturations than the previously discussed interval and is interpreted to be predominantly water productive.

We sincerely appreciate this opportunity to be of service. We hope that this report will assist the preliminary evaluation of the Wolfcamp formation analyzed from the Anderson No. 1-7.

Very truly yours,

Core Laboratories, Inc.

R. S. Bynum, Jr.,
District Manager

RSB:JDJ:dw

Form F-11B

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

 File WP-3-1059 WC
Well Anderson No. 1-7

CORE SUMMARY AND CALCULATED RECOVERABLE OIL

FORMATION NAME AND DEPTH INTERVAL: Wolfcamp 10,263.0-10,357.5

FEET OF CORE RECOVERED FROM ABOVE INTERVAL	94.5	AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE	29.6
FEET OF CORE INCLUDED IN AVERAGES	23.0	AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE (c)	29.6
AVERAGE PERMEABILITY: MILLIDARCYS Max.: / 90°.:	7.7 / 5.6	OIL GRAVITY: °API (e)	38
PRODUCTIVE CAPACITY: MILLIDARCY-FEET Max.: / 90°.:	176 / 129	ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL (e)	1500
AVERAGE POROSITY: PER CENT	6.2	ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL (e)	1.90
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE	6.5	CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT	178

Calculated maximum solution gas drive recovery is 33 barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is 147 barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

FORMATION NAME AND DEPTH INTERVAL:

FEET OF CORE RECOVERED FROM ABOVE INTERVAL		AVERAGE TOTAL WATER SATURATION: PER CENT OF PORE SPACE	
FEET OF CORE INCLUDED IN AVERAGES		AVERAGE CONNATE WATER SATURATION: PER CENT OF PORE SPACE	
AVERAGE PERMEABILITY: MILLIDARCYS		OIL GRAVITY: °API	
PRODUCTIVE CAPACITY: MILLIDARCY-FEET		ORIGINAL SOLUTION GAS-OIL RATIO: CUBIC FEET PER BARREL	
AVERAGE POROSITY: PER CENT		ORIGINAL FORMATION VOLUME FACTOR: BARRELS SATURATED OIL PER BARREL STOCK-TANK OIL	
AVERAGE RESIDUAL OIL SATURATION: PER CENT OF PORE SPACE		CALCULATED ORIGINAL STOCK-TANK OIL IN PLACE: BARRELS PER ACRE-FOOT	

Calculated maximum solution gas drive recovery is barrels per acre-foot, assuming production could be continued until reservoir pressure declined to zero psig. Calculated maximum water drive recovery is barrels per acre-foot, assuming full maintenance of original reservoir pressure, 100% areal and vertical coverage, and continuation of production to 100% water cut. (*Please refer to footnotes for further discussion of recovery estimates.*)

(c) Calculated (e) Estimated (m) Measured (*) Refer to attached letter.

These recovery estimates represent theoretical maximum values for solution gas and water drive. They assume that production is started at original reservoir pressure; i.e., no account is taken of production to date or of prior drainage to other areas. The effects of factors tending to reduce actual ultimate recovery, such as economic limits on oil production rates, gas-oil ratios, or water-oil ratios, have not been taken into account. Neither have factors been considered which may result in actual recovery intermediate between solution gas and complete water drive recoveries, such as gas cap expansion, gravity drainage, or partial water drive. Detailed predictions of ultimate oil recovery to specific abandonment conditions may be made in an engineering study in which consideration is given to overall reservoir characteristics and economic factors.

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4 Copies	Union Oil Company of California Union Oil Building Midland, Texas Attention: Geological Department
6 Copies	The Ohio Oil Company Box 617 Roswell, New Mexico
1 Copy	Magnolia Petroleum Company Box 672 Roswell, New Mexico
5 Copies	Sinclair Oil & Gas Company Box 809 Roswell, New Mexico
1 Copy	Leonard Oil Company Box 708 Roswell, New Mexico
1 Copy	Delta Drilling Company Box 2012 Tyler, Texas
1 Copy	Delta Drilling Company Box 806 Odessa, Texas

Oil Production
Tatum (Wolfcamp) Field

	Anderson #1 bopm	Duncan "A" #1-6 bopm	Duncan "B" #1-6 bopm	Monthly Field Production	Cumulative Field Production
1957					
October		1,043		1,043	1,043
November		2,378		2,378	3,421
December		5,148		5,148	8,569
Total		8,569		8,569	
1958					
January		4,416		4,416	12,985
February		4,582	276	4,858	17,843
March		5,141	1,449	6,590	24,433
April		4,937	4,286	9,223	33,656
May		4,296	4,785	9,081	42,737
June	729	4,444	4,652	9,825	52,562
July	856	3,975	4,891	9,722	62,284
August	816	4,019	4,990	9,825	72,109
September	757	3,335	4,458	8,550	80,659
October	515	2,317	4,773	7,605	88,264
November	875	4,088	4,481	9,444	97,708
December	537	2,894	4,733	8,164	105,872
Total	5,085	48,444	43,774	97,303	
1959					
January	509	2,979	4,707	8,195	114,067
February	474	467	3,962	4,903	118,970
March	372	1,063	5,002	6,437	125,407
April	253	1,309	4,898	6,460	131,867
May	419	1,498	4,916	6,833	138,700
June	247	1,485	4,632	6,364	145,064
Total 6 mo.	2,274	8,801	28,117	39,192	
July	297	1,232	4,424	5,953	151,071
August	364	1,429	3,984	5,777	156,794
Cumulative Oil as of 8/31/59	8,020	68,475	80,299	156,794	

E-7

Summary of 24-hour Well Tests
Tatum (Wolfcamp) Field

Well	Date	TP (psig)	Choke	SPM	Length of Stroke (in)	Oil bopd.	% Cut	GOR
W. D. Anderson #1	7-25-58	0-180	16/64	-	-	50	0	1281
	2-9-59			8	85	34	0	1450
	7-24-59			6½	38	8	4	2290
R. W. Duncan #1-6	11-14-57	910	1/4			345	0	1235
	2-7-59	-	-	9	90	152	-	1100
	4-26-59			8½	120	61	.8	1260
R. W. Duncan "B" #1-6	4-4-58	830	14/64			254	1	1213
	2-7-59	680	17/64			157	-	1298
	7/23-59	680	1/4			171	-	1690
	9-14-59	630	14/64			178		1410

Summary of Bottom Hole
Pressure Tests, @ datum of -6300'
Tatum (Wolfcamp) Field

Date	UCC et al #1 Anderson		UCC et al #1-A Duncan		UCC et al #1-B Duncan	
	BHP	hrs. S.I.	BHP	hrs. S.I.	BHP	hrs. S.I.
10-19-57	Initial field pressure		3904	91		
2-25-58					3684	102
3-17-58			2659	70		
10-27-58	1601	73	1982	74		
7-27-59	445	70	2119	70	2752	72
9-11-59					2740	108

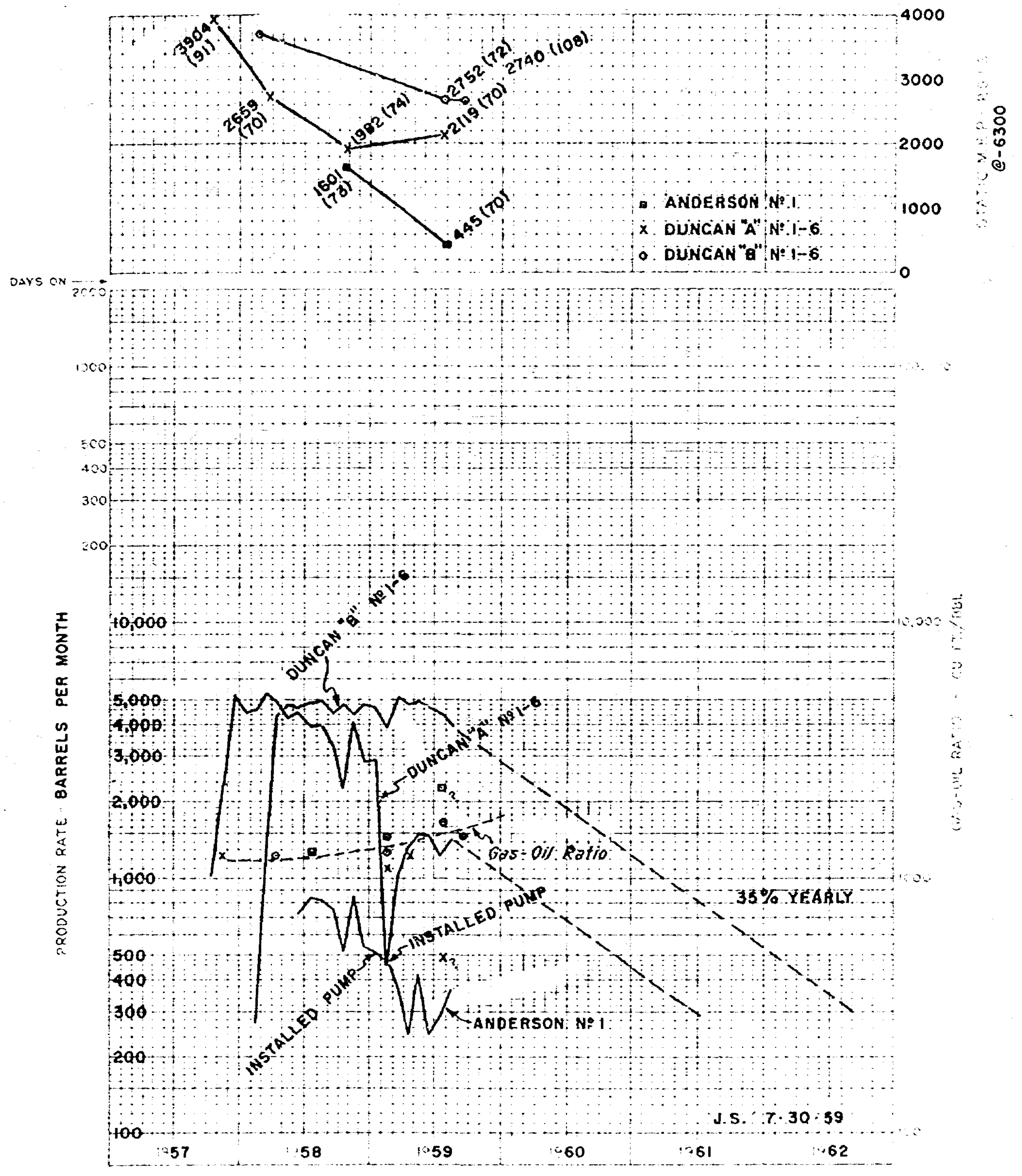
PERFS.

FIELD **TATUM**

ZONE **WOLFCAMP**

LEASE

WELL NO.



FORM 293

Ex 9

VOLUMETRIC RECOVERABLE OIL RESERVES TATUM (WOLFCAMP) FIELD LEA COUNTY, NEW MEXICO

Oil-in-Place/ acre-ft. =

$$= \frac{7758 \text{ Bbl/acre-ft.} \times \text{Porosity} \times (1\text{-Water saturation})}{\text{Formation Volume Factor}}$$

$$= \frac{(7758)\ (.067)\ (1-.22)}{1.69}$$

= 240 Bbl/acre-ft.

Extimated Recovery factor = 45%

Recoverable Oil/acre-ft. = 240 x .45
= 108 Bbl/acre-feet

Estimated Productive Acre - Feet in Field
= Productive Surface Acres x Average pay thickness
= 1040 x 19 Feet = 19,760 acre-feet

Estimated Recoverable Oil
= Recovery/acre-feet x acre-feet
= (108) (19,760)
= 2,140,000 bbl.

11

Recoverable Reserve Estimate
Production Decline Method

Combined Estimate of the Ultimate Recovery for Duncan "A" 1-6) Duncan "B" 1-6)	313,000 bbls.
Acres dedicated	160 acres
Average pay thickness	19 Feet
Estimate Recovery per Acre Foot.	103 bbls.

40-ACRE SPACING VS. 80-ACRE SPACING

Area Reasonably Expected to be Productive				1,040 acres
Wells Required with 40 Acre Spacing				26 wells
Wells Required with 80 Acre Spacing				13 wells
Investment @ $180,000 Per Well				
For 40 Acre Spacing (26 Wells)			$4,680,000	
For 80 Acre Spacing (13 Wells)			$2,340,000	
Ultimate Reserves				
Oil			2,140,000	
Gas (no gas connection)				
W.I. Net Operating Income Per Gross Bbl. of Oil Produced Including Income From Gas Produced with Oil				
Value				
Bbl. of oil (43° API)		$3.01		
MCF Gas (No gas connection)		-		
		$3.01		
Costs				
Severance & Advalorum Taxes	$0.18			
Royalty	.60			
Trucking to Pipeline	.26			
Lifting Costs	.26			
		$1.30		
Net Operating income per gross bbl.		$1.71		
W.I. Total Net Operating Income				
2,140,000 bbls. x $1.71/bbl.			$3,660,000	
Net Economic Loss for 40-Acre Spacing				
Net Economic Loss per well	($39,200)		($1,020,000)	
Net Profit for 80-Acre Spacing			$1,320,000	
Net Profit per well	($101,500)			

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:

CASE 1756

TRANSCRIPT OF HEARING

SEPTEMBER 16, 1959

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
SEPTEMBER 16, 1959

IN THE MATTER OF:

CASE 1756 Application of Union Oil Company of California for an order promulgating special rules and regulations for the Tatum-Wolfcamp Pool in Lea County: New Mexico. Applicant, in the above-styled cause: seeks an order promulgating special rules and regulations for the Tatum-Wolfcamp Pool in Lea County, New Mexico, to provide for 80-acre proration units.

BEFORE:

Gov. John Burroughs
A. L. Porter
Murray Morgan

TRANSCRIPT OF PROCEEDINGS

MR. PORTER: The meeting will come to order, please. The Commission will consider Case 1756.

MR. PAYNE: Case 1756. Application of Union Oil Company of California for an order promulgating special rules and regulations for the Tatum-Wolfcamp Pool in Lea County, New Mexico.

MR. COOLEY: May it please the Commission, William J. Cooley, appearing for Union Oil of California.

MR. PORTER: Any other appearances to be made in this case?

MR. ERREBO: If it please the Commission, Burns Errebo, Modrall, Seymour, Sperling, Roehl & Harris, appearing on behalf of the Magnolia Petroleum Company. We will have a statement later on.

MR. PORTER: No testimony?

MR. ERREBO: No.

MR. PORTER: Any other appearances?

MR. COOLEY: As the advertisement in this case would indicate, we have made application herein for 80 acres in the Tatum-Wolfcamp Pool in Lea County, New Mexico. In support of that application, we will present three witnesses, a geological witness, an engineering witness, and landman. The first witness will be Mr. David Dunn. However, to save time, I would like to have all witnesses sworn in at the same time.

(Witnesses sworn)

DAVID A. DUNN,

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

DIRECT EXAMINATION

BY MR. COOLEY:

Q State your full name, please.

A David Arthur Dunn.

Q Where do you reside, Mr. Dunn?

A Roswell, New Mexico.

Q And by whom are you employed?

A Union Oil Company of California.

Q And how are you employed, Mr. Dunn?

A I'm employed as District Geologist for Southeastern New Mexico district.

Q Mr. Dunn, do you have any degrees of higher education?

A Yes, sir. I was graduated from the Texas Technological College in 1936 with a degree of Bachelor of Science in science and majored in geology.

Q Would you briefly tell the Commission what your experience has been since the time of your graduation?

A In 1936 I was employed by the Gulf Oil Corporation, Roswell, New Mexico as a geologist. Remained with them in that capacity in Roswell until 1938 when I went out as a consultant in Lubbock, Texas doing work in Southern New Mexico and West Texas. In 1941 I entered the Air Force where I served until 1946 as a photo officer. 1946 I was employed with Phillips Petroleum Company in Midland, Texas as a geologist. Remained with them until 1952. In this capacity, I was in charge of core hole, pool analysis and subsurface studies. In 1952 I was employed by the Union Oil Company as District Geologist in Roswell, and have remained in that capacity since.

Q In your position as District Geologist in Southeastern New Mexico for your employer, Union Oil Company of California, does it fall within the purview of your duties to study the geology of the actual Wolfcamp area in Lea County, New Mexico?

A It does.

Q Mr. Dunn, have you prepared a structure map of the

Tatum-Wolfcamp pay zone in the pool area?

A I have.

Q Mr. Dunn, I hand you what has been marked and identified as Union Oil Company's Exhibit No. 1, and ask you to explain to the Commission what is shown thereon.

A Mr. Cooley, if I may, I will explain on the large copy of this map that the small copy is a photo reproduction from.

Q Proceed.

A This map is a structure contour map drawn on the top of the Tatum-Wolfcamp pay, utilizing a 50-foot structural contour interval. The heavy lines are designated with a subsea datum. The total amount of relief shown on the map by the datum on the contours from a minus 6300 to a minus 6400. The area covered by the map is the area immediately surrounding the Tatum-Wolfcamp Field. It covers acreage located in four Townships, Township 12 South, Township 13 South, Ranges 35 and 36 East. The pool boundary of the Tatum-Wolfcamp Field as designated by the Oil Commission is shown in orange outlined on the map. The three producing wells in the Tatum-Wolfcamp Field are designated with solid circles. One dry hole adjacent to the Field, drilled by Union, is designated by the appropriate dry hole symbol. The only other well control on the area is the Skelly West Tatum unit located in Section 26. The red arrow points to a proposed location within the pool boundary. The scale of the map and the appropriate symbols of such structure map are shown.

Q What are the vertical red lines shown contained in the pool?.

A The red lines designated here as AA,A Prime, BB,B Prime indicate Sections that will be presented in evidence in this case.

Q Mr. Dunn, what control did you have available in the preparation of this structure map?

A There were two types of control available in the preparation of the map, seismic and subsurface control. The seismic control, of course, was the basis on which prospect was first oriented. The subsurface control developed as the wells were drilled. Each has modified the others throughout the history of the drilling in the immediate area. This is a subsurface map but the dips are controlled to a large degree by the seismic information which has been improved upon as we have gotten additional subsurface information.

Q What are the particular wells in the immediate pool area for which you have used as control?

A The Union No. 1 "B" Duncan 6, Union's "B" 1 "A" Duncan 6, Union No. 1-7 Anderson, the Union No. 1, Atwood and Bradley. In addition to these wells, this control, we have the Skelly West Tatum Unit which is approximately two miles northwest and beyond the limits of the map. The Sinclair No. 1 Anderson which is approximately four miles north of the pool area.

Q Mr. Dunn, I can understand how you can use the four wells in the immediate area as control for this structure map, but isn't it somewhat far removed to be using the Sinclair and Skelly wells, being respectively five miles and two miles from the area?

A Generally speaking, in many cases, control that far away is not very reliable. However, in the case of the Wolfcamp, correlations are very accurate and continue over extremely long distances. Actually, in drilling the Duncan 1 "A" 6, which was the discovery well and the first well drilled in the pool area, we had correlated the well to such a degree that we were able to core the entire pay section with the exception of a small stringer in the lower part of the Wolfcamp without waiting to encounter it, based on core analysis made from the Skelly West Tatum Unit.

Q Did you find it to a high degre in the Sinclair and Skelly wells in this pool?

A Yes, it was extremely remarkable.

Q Mr. Dunn, will you please tell the Commission what you feel to be the productive limits, that is, the area which contains some oil, as shown on this, in the Wolfcamp formation, as shown on this structure map as Exhibit No. 1?

A In the drilling of the Union's No. 1 No. 5 Atwood Bradley, we found water as will be explained later at minus 6350. I have every reason to believe that oil will be contained within the area out to the minus 6350 contour as shown on this map.

Q What do you feel to be the commercial productive limits of the Tatum-Wolfcamp Pool, Mr. Dunn?

A On the basis of the performance of the wells and the information we've obtained from cores and electric logs, I feel that the commercial limits of the field will be the area contained between the minus 6300 contour in the area of the map.

Q Now, approximately how many acres are contained within that contour?

A Approximately a thousand and forty acres.

Q And how many 80-acre well locations does that represent?

A That represents thirteen 80-acre well locations, three of which have been drilled, ten of which remain to be drilled.

Q Now, Mr. Dunn, you don't mean to say by your testimony that all of these ten undrilled locations will eventually be drilled on the basis of the information you know have, do you?

A No, Mr. Cooley, I can't make that statement at this time. Our information at the present time which we consider very reliable, indicates the certain area that should be commercially productive. At the present time I have recommended to my company the drilling of one location shown here as the proposed location. The information --

Q What is the location?

A The information gained from this well can confirm the picture and lead to an orderly development. Now, the area might be slightly reduced; on the other hand, it might be enlarged by the drilling of these wells. On the basis of the present information, it appears that a thousand and forty acres is within the commercial limits of the pool area.

Q Would you tell the Commission what the location of the proposed well is which you have recommended?

A The location of the proposed well is 1980 feet from the East line and 660 feet from the North line of Section 6, Township 13 South, Range 26 East.

Q Mr. Dunn, have you prepared a cross section of the productive wells in the Tatum-Wolfcamp Pool?

A I have.

Q Is the cross section which is posed on the board as Exhibit No. 2 the cross section to which you refer?

A It is.

Q Referring to the cross section, please, Mr. Dunn, tell the Commission what this cross section purports to show.

A This cross section is prepared from electric log -- detailed electric log and core information. The large scale electric logs of the three producing wells, the Union No. 1-6 Duncan "B," the Union No. 1-6 Duncan "A," the Union No. 1-7 Anderson are all shown in a proper line of correlation based on structure. The blue line through here is a minus 6,000 subsea datum. The blue line through here is a minus 6,500 subsea datum. On this cross section in green we have shown lines of correlation. In order to save space, we started with the formation marker in the Wolfcamp which is the top of the Burson, extended the section up to take in that portion of the Wolfcamp up slightly above the Burson to show correlation. The grey line shows correlation in the Burson formation of the Wolfcamp. We also have the formation marker at the top of the Pennsylvanian as we described it, labeled the top of the Cisco which is the formation of the Pennsylvanian. For the sake of clarity and because our Exhibit No. 1 is contoured on the top of the pay section, we have shown on this section in a green line a correlation line at the top of the Wolfcamp pay, also shown on the section, using colors to graphically illustrate it is the pay sections as encountered in the Tatum-Wolfcamp Field, with the solid red indicating continuous good porosity. The dashed red in this case indicates broken porosity in the continuous zone from the top of the pay into the good porous section. The cores have been plotted in the center of the electric log with the shows encountered in the cores shown by blocked solid lines to the right of the core. The discrepancy between where the red line crosses the cored section and the electric log section is brought on by difference in depth measurements after running the electric log. For the sake of correlation of core analysis data, it was felt it was better to use the actual cored depth that was used when it was cored so that there could be no misunderstanding or discrepancy. However, these cores can be moved and adjusted exactly with the electric logs. The correlation with the shales, the correlation of the pay section here is similar again, and the correlation of pay section is very clear and very continuous in all cases.

Q Moving from well to well, Mr. Dunn, what degree of correlation do you find between the wells with regard to each individual pay stringer?

A Moving from the Duncan "B" south to the Anderson and the Duncan 1-6 "B," we have a broken zone of porosity shown. In our core interval through here is a very minor thin streak of pay and they show the same way on the electric log, and we have approximately -- I might mention, Mr. Cooley, that each of the small lines represent two feet on this log, which I had neglected to mention before. So we have approximately six feet of good porosity broken only by one slight six-inch tight zone. This line of continuous porosity is definitely correlatable to the Union No. 1-6 Duncan "A," where again approximately six feet of continuous pay section with very minor type breaks are noted. Again, the broken streaks of pay on the log are noted here. In this case the offset is approximately seven feet, or there was a depth correction of seven feet that would have been applied had we corrected the core to the log measure. This same zone correlates exceptionally well in the Union No. 1 Anderson as a solid zone of six feet of permeability and porosity with thin broken pay streaks above, which again was indicated by the core. In this case again, approximately a six-foot error in depth correction was used or was necessary to tie the log and the core together. Each of the zones here are a maximum of three and a half feet in thickness.

Q Now, is that the middle zone to which you refer?

A We will call -- for the sake of description -- we will call this the middle zone of the Wolfcamp pay. This is a one solid line unit with only two zones, actually two zones of pay encountered in it, and all of the wells in the area. This zone again is continuous and it rests directly on a thin shale break that is very clear-cut and is present in all wells. The thickness remains constant throughout the line of the section and is definitely correlatable. The lower Wolfcamp pay is only producing from one well. It is shown and correlated, however, from the 1-6 Duncan as a two and a half foot pay zone overlying a shale -- again a streak shale, and it can be correlated as the zone of porosity and permeability from the electric log on the No. 1 "A" Duncan above the same shale body, and it can be correlated on the Union No. 1 Anderson again above the same shale break. In the case of the 1-7 Anderson and the 1 "B" Duncan we have coes, and in the 1 "A" Duncan we do not have cores.

Q Do both of the cores that we are taking through this area show the zone to be productive of oil?

A They do.

Q Would you tell the Commission in what order the three wells shown on Exhibit No. 2 were drilled and why this lower zone is perforated only in one well?

A The Duncan 1 "A" 6 was the discovery well, the first well drilled, and on this section, the No. 1 -- Anderson -- and the No. 1-6 Duncan is a second well drilled, and the 1-7 Anderson is the third well drilled. In the 1 Duncan this zone was not recognized at the time of completion as a possible productive zone.

Q This is the lower zone to which you refer?

A The lower zone was not recognized definitely as a possible producing zone. It was noted as having a show inasmuch as the analysis from the electric log did indicate that it might be potential pay. However, such a thin zone did not seem to warrant testing. That would be expressive and possibly complicate the completion of the well at that time. After drilling the 1-6 Duncan and we will have to continue to the next --

Q That's the 1-6 Duncan "A?"

A That's right, 1-6 Duncan "A." In order of sequence of wells in this section, the 1 Duncan "B" was the next well -- deep well drilled, and this time we cored to evaluate the section, and from the evaluation of it we found definitely that the core indicated that zone should be productive. It was somewhat doubtful from the electric log analysis, so this zone was perforated,individually treated with 500 gallons of mud acid, after which treatment it flowed 27.5 barrels of oil in one hour on a quarter inch choke.

Q Why was the lower zone not perforated in the last well drilled?

A On the No. 1-7 Anderson, again the zone was cored. The core indicated that the well should be productive, have a productive capacity. The electric log indicates that it should have a productive capacity. However, we have had apparently excellent pay zones appearing in the upper Wolfcamp. In addition, this well, being structurally higher, it was felt from the electric log analysis that this zone should be productive that is shown here. These three zones were perforated together, and in this case this zone was found to contain water. In an attempt to complete the well -- I might point out that here we have all of the various treatments that we have conducted on this well on attempting to complete it. They were perforated, these three zones.

Q Now, the three perforations to which you have just referred, the two upper ones were productive of oil, and the lower being productive of water?

A Yes, and in the course of attempting to shut the water off from here, which should have been easy, we squeezed the zone individually, and found that we had communication behind the pipe. We made three separate attempts to shut the water off from this zone. After the three attempts and over a period of over a month of working on the well, we finally managed to shut the water off behind the pipe even though we had not been able to shut it off in perforations. We set a bridge plug, plugging the well back to ten thousand three twenty-four, and had we attempted to drill out the plug and perforate this zone as we had originally intended from the core analysis, we might have run the pay zone that we finally brought in on the well. We decided it was not economically feasible to perforate a two-foot zone at the risk of destroying this thin pay section which had finally been completed, even though it has been completed as a relatively poor well.

Q You say "relatively poor well." The permeability seems to be constant there, and the question arises in my mind, why is it a poor well, mechanical failure?

A Mr. Cooley, as I pointed out, we squeezed it with a hundred sacks. We made three other squeeze jobs with a hundred sacks each. That cement could not be kept out of the pay section. We do not know the degree that the cement damaged the pay section. We have every right to assume damage. We had many difficulties in this narrow zone from the water zone. We had communication behind it. Had we followed with a strong acid treatment, that might have corrected the damage done by the cement; we would have simple acidized,backed into the water and would have been back at it all over again. It is my opinion that this well was definitely damaged in completion due to mechanical difficulties beyond our control.

Q Now, on Exhibit No. 1, Mr. Dunn, you show a dry hole to the immediate east of the field. Have you prepared a cross section which also includes that well?

A Yes, sir, I have. Cross section B, BB Prime.

Q Is the cross section to which you refer the same cross section that is shown here on the Exhibit Board as Exhibit No. 3?

A It is.

Q Would you please explain to the Commission what the significance of this Exhibit is?

A This Exhibit is drawn on the same matter as Exhibit

No. 2, utilizing the electric log and the cores, and showing the same logs used as the center well of Exhibit No. 2, the Union No. 1-6 Duncan "A." And it extends -- this is called an east-west cross section -- extends more northeast than east, extends northeast to the Union No. 1 Atwood 1-5, Atwood Bradley. The same lines of correlation are shown, the top of the Burson, the top of the pay. The top of the Cisco is not shown because the No. 1 Atwood and Bradley was not carried to a depth sufficient to reach the Cisco. It did not penetrate to a point sufficient to reach this zone. Now, I might point out that the No. 1-5 Atwood Bradley was the second well drilled after the 1-6 Duncan, and this zone had not been evaluated at that time. We did not know what its potential would be; it was still in the suspect column.

Q The dry hole was the second well in the pool, then?

A That is correct. We did not carry it to that depth because the well was running slightly low to the No. 1-6.

Q From --

A From the cores, we considered this zone doubtful.

Q Which zone is that to which you refer?

A The middle zone, the middle pay of the Wolfcamp. However, the electric log indicated that it could and should be productive, and we perforated the two zones, the same two zones we had successfully perfora ,d here. We had very little reason for perforating those zones since this middle zone was only five feet low to the zone in the No. 1 Duncan, which was producing prolifically.

However, after treating the well with acid -- and again we have the data -- after treating the zone with acid, we found that this zone, the lower zone, was water productive, definitely water productive. Five hundred gallons mud acid treatment. We swabbed thirty-seven barrels of salty water in six hours. We squeezed off this zone and attempted to complete from the upper perforations. After having squeezed the perforations, reperforated, treated, we tried a disel squeeze job and again had to use acid, we had the well flowing, well, we had the well flowing briefly at one time, and we had it at a point where we were swabbing a hundred barrels of oil in forty-eight hours. We reacidized in order to try to make it a commercial well with 1295 percent sulphur water. We had spent a considerable period of time and money, and it was decided that this could not be made into a profitable well because of the near proximity to water of the pay zone. It would be impossible to complete this zone and shut the water off and make a well from the completion that would be commercial. However, the presence of oil in this zone is definitely proved by our test as well as by the cores and the electric logs.

Q And again you do find a continuity in the upper zone?

A A definite continuity in both zones, the only difference being that here we have water as indicated by blue in the middle zone, where we have oil as indicated by red in the middle zone on the 1-6 Duncan. The zone is continuous. It simply contains water in this zone in the Atwood Bradley.

Q Mr. Dunn, does the encounter of water in the Atwood Bradley Well give you any indication, from a geological standpoint only, the type of drive that this pool might have?

A Yes. It is a definite indication that it has water or should have a water drive.

Q Mr. Dunn, have you made studies of the Bough Pool approximately fifteen miles to the north of this area?

A I have.

Q Are you familiar with the type of drive contained in that pool?

A Yes, I am. It has a definite water drive or had a definite water drive. It is practically -- completely depleted at the present time.

Q Have you attempted to construct a cross section showing the correlation of the Bough zone, the Bough pay zone all the way down to the Tatum-Wolfcamp pay zones?

A I have.

Q Is the Exhibit here on the board marked as Exhibit No. 4 the Exhibit which you have prepared a cross section to which you have just referred?

A It is.

Q Will you please explain to the Commission the significance of this Exhibit?

A This is a Wolfcamp correlation section from the Bough Field which is located in Township 19 South, Range 35 East, south to the Tatum-Wolfcamp Field which is located in Township 13 South, Range 36 East. The insert map on this section shows the line of section and the well controlled used along this line. This point No. 6 is the point in the Bough Field where the section starts. The next point of control is the Phillips No. 1. Cross the next point of control is the Mid-Continent Dirkin zone. The next point of control, No. 3, is the Tennessee Gas No. 1 Gulf State. The next point of control is the Sinclair No. 1 Anderson, which I have mentioned previously. This we used as a control when we drilled the well, and it ties to our discovery well, the last control on the section, the Union No. 1-6 Duncan "A." On this we have shown the top of the Waco or Wolfcamp formation in correlation inasmuch as generally this zone is indicated by a change from the overlying Abo dolmite to a white crystal line limestone. This zone is not a perfect correlation marker. However, it is widely used in the industry and is a point of correlation that is carried and is frequently used in subsurface work. As I mentioned previously, the top of the Burson, the unit of the Wolfcamp, is a much better correlation marker, and we have drawn a correlation marker on the top of the first one,which is almost a perfect point of correlation. Over the larger part of Northeast New Mexico,along this line of section,it can be considered actually as a perfect zone. Each individual unit with its accompanying shales and limestone have a remarkable uniformity of thickness porosity and general overall characteristics that can be traced over this entire distance of over twenty miles north and south into the Tatum-Wolfcamp Pool. Again we have used the top of the Tatum-Wolfcamp pay zone as a line to show the correlation is continuous from the Bough Field to the Tatum-Wolfcamp Field. This Tatum-Wolfcamp pay zone, the top of the pay zone corresponds with the top of the Bough zone in the Bough Field. In the Bough Field locally, they use the term Bough A, Bough B, Bough C and Bough D. The Tatum-Wolfcamp pay is representative of the Bough A, that is the upper pay. The lower pay as I have shown in the other section correlates with the Bough C, which is the main producer in the Bough Field.

Q Mr. Dunn, did you in your analysis of the intervening wells between the Tatum-Wolfcamp Pool and the Bough Pool encounter any anomolous from a geological standpoint that would indicate any different geology from the Tatum-Wolfcamp Pool from the Bough Pool?

A None whatsoever. There is a difference in the porosity and permeability, a slight differenco in porosity and permeability through the line of section, but there is no difference in the characteristics of the formation,and its overall characteristics. A conclusion I might draw from it is that both fields would have to be structural; there is no evidence whatsoever of stratographic characterization of oil.

Q Mr. Dunn, if we assume that there is a water drive as the active drive mechanism in the Bough Pool, can you draw any geological conclusions, and again I stress geological conclusions only as to what type of water drive you might expect to -- what type of drive you might expect to encounter in the Tatum-Wolfcamp Pool?

A The drive in the Tatum-Wolfcamp Pool should be a water drive. Again the continuity in the zone is obvious to the extent, from north to south, of the water drive in the Bough, which is structurally higher. A water drive should be effective in the Tatum-Wolfcamp Field.

Q Did you observe, Mr. Dunn, anything in the geological analysis that you made of the Tatum-Wolfcamp Pool that would give any indication whatsoever that one well would not be able to drain 80 acres in that Pool?

A None whatever.

Q Did you observe any indicia that might lead you to believe that it would drain 80 acres in that Pool?

A Yes, definitely, the pay zones are continuous, the zones of permeability and porosity being interconnected, as far as we can connect any point in geology. There is no reason why the zones should not be continuous, and as such, capable of producing over extremely wide areas, and with a water drive and a confined pay zone, it should definitely produce at least 80 acres and possibly more.

MR. COOLEY: Thank you, Mr. Dunn.

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

CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. Dunn, after you were able to look at some logs on these various wells in this pool, did it materially change the seismic picture that you had of this formation before you started drilling?

A Not materially. It definitely changed it as frequently happens, Mr. Nutter. We found, of course, we were attempting to drill our discovery well at the optimum position. Now, you must remember one thing, and that is that the Duncan 1-A was drilled as a Devonian test, and the location was selected on the basis of its structural position from seismic work on the Devonian, not on the Wolfcamp. So, from our seismic work this did not appear to be the highest possible point on the Wolfcamp, a point that is frequently encountered. We have made some minor changes in our seismic interpretation brought on by corrections after we obtained a velocity survey from the Duncan No. 1 - A. Since that time we have been able to tie our well systematically.

Q Hasn't the tendency been to adjust the seismic pictures to decrease the size of the structure or enlarge it?

A It has been a tendency, actually, in zone, to enlarge it.

Q So you may have a larger and flatter structure than you originally anticipated?

A That is correct.

Q Well, now, we have two wells on these two cross sections that have made substantial quantities of water. I guess the

Atwood Bradley made so much water you plugged and abandoned it, and the Anderson No. 1-7 made so much water you plugged it off. Are those two zones comparable zones that made the water?

A May I refer to the Exhibit so that I can be sure I have your question correct? I'll get the small scale of the large scale copy. Your question, as I understand it, is that is the water zone from the 1-7 Anderson the same as the water zone from the No. 1 Atwood and Bradley.

Q Yes, sir, that lower water zone?

A No, it is not. Now, there is a continuous water zone that is present in the Atwood and Bradley that is the same water zone that was encountered in the No. 1 Anderson, but that is not the zone that was perforated. May we refer back to the large section. Frist, let me correlate a little more clearly, Mr. Nutter, the zones here. This is in the No. 1 Atwood and Bradley. This zone and the No. 1 Duncan which we are calling the middle pay zone of the Wolfcamp correlate definitely with the zone here which is permeable, porous and contains water; it was the zone that was perforated. We tried to squeeze off the water, it caused our difficulty, and we were unable to complete the well.

Q Why do you think --

A Now, this zone down slightly below this middle zone here which shows porosity and permeability carried considerable water in the core and indicates from the electric log on the No. 1 Duncan, that zone is present here, and was cored and also carried water, was porous and permeable in the No. 1 Atwood and Bradley. It was clearly water; we made no attempt to perforate. That is the zone that we perforated that caused our difficulty and from which we obtained water in the No, 1 Anderson. It is this zone here. This zone was structurally high at this point, and we felt that it could contain oil, where this same zone definitely contained water here. I have made no attempt to show how these zones of porosity and permeability carry definitely across from well to well unless they contain oil, but they all do, the water zones and the oil zones, the shale zones. The continuity is perfect.

Q Now, have you picked water-oil contact for this pool as being at minus 6350?

A The only statement I could make about a water-oil contact in an extremely thin zone is where we have definitely encountered it. Again, for purposes of illustration, this upper and middle is one gross unit. The water -- the entire porous element in the No. 1 Atwood and Bradley contains water, the lowest --

Q Now, would that include the red shading on that Atwood Bradley?

A No, only the blue shading. Since this is tight -- since this zone is tight above that zone of porosity, I cannot say that there is not water in it. However, with this zone containing oil in the gross zone and we see no shale break that will separate what we are calling the middle Wolfcamp from the upper Wolfcamp pay, it must be considered a gross limestone zone, and any section in here that carried water, we would not expect to find until we passed the seal to find oil below it, so we can assume that we had oil down to a minus 6350 in the No. 1 Duncan, as shown here. And we can assume that we have only water below minus 6350 from a correlation point in the Atwood and Bradley, which is as clear-cut a case of identifying in an extremely thin bed an oil-water contact that I've encountered.

Q Now, is the blue line on the Atwood Bradley Well on your Exhibit No. 3, is that 6350?

A The top of that is 6350.

Q I see. Now, why --

A The bottom of this, Mr. Nutter, is also minus 6350.

Q Why is the red section in the Atwood Bradley Well not productive of oil?

A The red section here?

Q Yes, sir.

A It would be productive of oil, Mr. Nutter. I have testified that we actually produced oil from it. We could not make a commercial producer from it because of the mechanical difficulties. We had gone as far as we could go in attempting to complete that as a commercial producer in the proximity of the zone. We have a maximum tight zone here between us and water of two, four, six, eight, ten, twelve, fourteen feet. And that fourteen feet was not sufficient after we had perforated. Had we been aware that this was a water zone, we would have probably been able to complete the well satisfactorily if we got a good cement job. It is all the same danger, always adherent, in completions of this type of pay.

Q Is the permeability less in that red section of the Atwood Bradley than it is in the other well?

A Let me check that, sir. I didn't consider it any less from visual analysis. In the No. 1-6 Duncan, in that zone, the maximum permeability was -- by analysis -- was twelve milladarcies, and I have no -- the engineering witness will later give averages, and I would prefer to wait for that. In this zone we had a maximum permeability of five milladarcies. However, the averages, Mr. Nutter, would be very close to the same. We didn't have as high a maximum permeability, but we had close. The zone looked comparably definitely.

Q You didn't feel that the failure of the Atwood Bradley No. 1 could be attributed to poor permeability?

A No. It can be attributed to low pay section and mechanical difficulties.

MR. NUTTER: I see. Thank you.

MR. PORTER: Mr. Utz.

QUESTIONS BY MR. UTZ:

Q Mr. Dunn, if you have a water table at 6350, then wouldn't it be reasonable to assume that you have oil out to that point, the 6350 contour?

A I testified to that, sir.

Q Well, you testified that you only had a balance of 80 acres, I believe it was, that was commercial?

A No, sir. I testified that there was only a thousand and forty-eight acres that I considered to be commercially productive. I also testified that production would extend -- that the oil limits would extend, in my opinion, to a minus 6350 and be included in this line, but the limit of commercial production, as I defined it, was included within the minus 6300 contour.

Q Well, if you could have completed without mechanical difficulty, your Atwood Bradley 1-5, you think it would have made a productive well?

A It would have made a productive well, sir, and it would have had a definite salvage value, but it would not, in my opinion, represent the type of a well that I would recommend we drill to 10,300 feet to obtain. I would certainly want to produce it for all the salvage since we had already drilled a well that we could get.

Q Then, between the 6300 and 6350 contour, you don't feel it is commercial or productive?

A No, sir. Now, the additional information brought on by future development indicates that zones of permeability and porosity can be developed here, and I have no reason to assume that they will be.

MR. UTZ: That's all I have.

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

Mr. Cooley, before he is excused, do you desire to offer the Exhibits?

MR. COOLEY: I was going to offer all of them at the end.

Mr. Stanley, will you take the stand?

WILLIS M. STANLEY,

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

DIRECT EXAMINATION

BY MR. COOLEY:

Q State your full name, please.

A Willis M. Stanley.

Q Where do you reside, Mr. Stanley?

A In Roswell, New Mexico.

Q And by whom are you employed?

A By the Union Oil Company of California.

Q And in what capacity are you employed by the Union Oil Company of California?

A As a district landman.

Q As district landman for Union Oil Company of California, does it fall within the purview of your duties to take care of the landman activities in the Tatum-Wolfcamp Pool in Lea County, New Mexico?

A It does, sir.

Q Are you familiar with the ownership of the land within the Tatum-Wolfcamp Pool as defined by the Commission?

A I am.

Q Have you prepared an Exhibit, Mr. Stanley, which would portray this ownership graphically?

A I have, Mr. Cooley.

Q Is this Exhibit, which is posted here on the wall as Exhibit No. 5, the Exhibit to which you refer?

A It is.

Q Would you please come up here and explain this Exhibit as to what the different colors mean?

A This is a lease and royalty ownership plat designed to show a common ownership of royalty and of lease under each particular tract. The orange, the part in 35, is one ownership. It refers to royalty only. The green is royalty. All the colors are royalty. The notes on it are lease ownership.

Q Now, Mr. Stanley, referring to the orange diagram on Exhibit No. 1, which shows the pool limits, would you tell the Commission whether there is available within the Tatum-Wolfcamp field an additional forty acres of identical ownership which could be dedicated to each of the three producing wells in that pool at the present time?

A There is, definitely. This E/2 of 6 and the NE of 7 here compare with the pool outline as designated by the Conservation Commission. This entire S/2 is owned by one royalty owner;

the SE of 6, and the yellow is one royalty owner, and NE of 6 is a separate royalty owner.

Q Then, Mr. Stanley, would it be possible to dedicate an 80-acre tract running either east-west or north-south to each of the three producing wells in the present pool limits with out changing the distribution of royalty or working interest income in any degree whatever?

A It would be.

MR. COOLEY: Thank you. That's all.

MR. PORTER: Any questions of Mr. Stanley? The witness may be excused.

(Witness excused)

JACK SCHRINKEL,

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

DIRECT EXAMINATION

BY MR. COOLEY:

Q Will the witness state his full name, please?

A Jack Schrinkel.

Q And where do you reside, Mr. Schrinkel?

A Midland, Texas.

Q By whom are you employed?

A Union Oil Company of California.

Q In what capacities are you employed?

A Reservoir engineer for West Texas Division.

Q Do you hold any degrees of higher education, Mr. Schrinkel?

A Yes, sir. Bachelor of Science in petroleum engineering from the University of Texas, 1950.

Q Are you a registered professional engineer in the State of Texas?

A Yes, sir. I have been a registered professional engineer in the State of Texas for four years.

Q Would you please state to the Commission what your experience has been since the date of your graduation?

A From March, 1950 to March, 1951 I was employed by the Pure Oil Company in an engineering capacity. From March, 1951 to October, 1953 I was employed by the Standolin Oil & Gas Company as an engineer in Andrews and Midland, Texas. Since that time I have been employed by the Union Oil Company of California.

Q And in what capacity did you say you were employed, Mr. Schrinkel?

A As a reservoir engineer for the West Texas-New Mexico Division.

Q And does this West Texas - New Mexico Division for which you are the reservoir engineer include the Tatum-Wolfcamp Pool in Lea County, New Mexico?

A Yes, it does.

Q And in the course of your work for Union Oil Company, has it been your duty to prepare certain studies with regard to this pool?

A It has.

Q Would you tell the Commission,first,the number of wells that have been drilled in the immediate pool area, Mr. Schrinkel?

A To date, there have been four wells drilled in the Tatum-Wolfcamp Field, one of which is now flowing, two which are pumping, and one which is a dry hole.

Q Were all or any of these wells cored at the time they were drilled, Mr. Schrinkel?

A A portion of the pay section has been cored in each of the four wells.

Q Have you had an opportunity to study these cores?

A Yes, sir, I have.

Q And have you made a tabulation of data shown by these cores together with certain other data available to you and placed it in a tabular form?

A Yes, sir, I have.

Q I hand you, Mr. Schrinkel, what has been identified as Union Oil Company's Exhibit No. 6, and ask you if this is the tabulation to which you referred?

A It is.

Q Would you go through this tabulation and explain to the Commission the significance of the data shown thereon?

A Exhibit 6 consists of pertinent information in a tabular form on the Tatum-Wolfcamp Field. The discovery well and date was the Union Oil Company, et al No. 1-6 Duncan "A," which was completed September 26, 1957. The average producing depth of this field is 10,320 feet. The weighted average porosity is 6.7 percent. The weighted average permeability is six milladarcies. The connate water saturation is 22 percent. There is no gas-oil contact.

Q No gas-oil contact?

A No, sir.

Q You mean gas cap?

A There is no gas cap, I'm sorry. No gas-oil contact, no gas contact. The oil-water contact is indefinite because of the thin pays. And the possibility of separate oil-water contacts for each of the porous zones which have previously been brought out, the gravity of the oil is 43 degrees API. The solution gas-oil ratio is 1200 cubic feet per barrel. The bubble point from correlation charts is 3,000 PSIG. The formation volume factor, also from correlation charts, is 1.69. The reservoir fluid viscosity is 0.4 centipoise. The original reservoir pressure at datum of minus 6350 was 3904 PSIG. The predominant drive is believed to be water. The average pay thickness is nineteen feet. The oil in place per acre foot in stock tank barrels is 240 barrels per acre foot. And the cumulative oil production through August 31, 1959 is 156,794 barrels. The current water production is less than 1 percent.

Q Mr. Schrinkel, I note that you have indicated the predominant drive in the Tatum-Wolfcamp Pool to be a water drive.

On what factors have you based this conclusion?

A Well, there are several reasons. The first reason is that it correlates very well geologically with the Bough Pool. The second reason is that we have obtained water production in the Atwood Bradley and also in the well to the south here, the Anderson -- No. 1 Anderson. Also, there has been no increase in -- no significant increase in the gas-oil ratio of the pool, and most significantly is the character of the pressure plotted versus cumulative production.

Q What significance do you see in this pressure plotted against cumulative production?

A It gives as an indication that it is flatteningwhich is characteristic of water drive fields.

Q Your apparent estimated recovery is going to be greater than it would be if it were solely a solution gas drive?

A Yes, it will.

Q Mr. Schrinkel, I hand you four core analyses which have been marked respectively as Exhibit 6-A, 6-B, 6-C and 6-D. Are these the cores from which the tabulations identified as Exhibit 6 were made?

A Yes, sir, they are.

Q Mr. Schrinkel, have you had an opportunity to study the production history of the Tatum-Wolfcamp Pool?

A Yes, sir, I have.

Q And have you prepared a tabulation of the production history of that pool?

A Yes, sir.

Q I hand you Exhibit No. 7, and ask you if this is the tabulation to which you refer?

A It is. Exhibit No. 7 sets out the monthly production of each of the producing wells in the Tatum-Wolfcamp Field since their completion, and also lists the cumulative field production and the monthly field production. You'll note that Anderson No. 1 in August produced 364 barrels for a cumulative production as of August 31st, 1959 of 8020 barrels. Duncan "A" No. 1-6 in August of this year produced 1,429 barrels for a cumulative production to the end of the same period of 68,475 barrels. The Duncan "B" No. 1-6 in August of this year produced 3,984 barrels for a cumulative production of 80,299 barrels. The cumulative production from these three wells as of August 31st, 1959 was 156,794 barrels.

Q Looking at this tabulation of oil production from the Tatum-Wolfcamp Pool, Mr. Schrinkel, which of the three producing wells is the best well?

A Well, it's evident when examining this Exhibit that Duncan "B" No. 1-6 has a cumulative -- has a cumulative production higher than the sum of the other two wells, and is also producing roughly three times the sum of the other two wells.

Q Now, is there any explanation for the extremely low production of the Anderson No. 1 Well, the 80,299 barrels?

A Yes, sir, there is.

Q What is that explanation, sir?

A Well, as Mr. Dunn has previously brought out, there was considerably difficulty encountered in attempting to complete this well, and we feel that poor performance of this well is due to that completion difficulty that we had, and that it is not representative of the field as a whole.

Q Of the three wells -- the three producing wells shown on this, which of the three do you feel is the most representative?

A Well, I feel that the Duncan "A" No. 1-6 and the Duncan "B" No. 1-6 represent most nearly what we might expect and/or representative of this field.

Q Mr. Schrinkel, have you tabluated the various well tests that have been taken in the Tatum-Wolfcamp Pool since the date of discovery of this pool?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 8, and ask you if this is the tabulation to which you refer?

A Yes, it is.

Q Would you please explain to the Commission what the significance of this Exhibit is?

A At the top of Exhibit No. 8 is a summary of the twenty-four hour well tests which have been obtained on each of the wells in the Tatum-Wolfcamp Field. You'll notice that starting at the top the production tests for the Anderson No. 1 and the R.W.Duncan No. 1-6 and the Duncan "B" 1-6 had been tabulated showing their tubing pressures, or if they are pumping, their strokes per minute, length of stroke and the oil production percent, water and gas-oil ratio at each of these periods. The bottom portion of Exhibit 8 consists of a summary of the bottom hole pressure tests which have been taken at a datum of minus 6300 feet for these same wells in the Tatum-Wolfcamp Field.

Q How many of the three producing wells, Mr. Schrinkel, are presently on artificial lift?

A Two of the wells are now on artifical lift, the Duncan "A" 1-6 and the Anderson No. 1.

Q Mr. Schrinkel, have you prepared a graphic illustration of the various pressure tests that have been taken on the producing wells in the Tatum-Wolfcamp Pool together with the production history of these wells?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 9, and ask you if that is the graphic illustration to which you refer?

A It is.

Q Will you please explain the significance of this Exhibit?

A Exhibit 9 sets out the bottom hole pressure history by well and the production history by well of each of the wells in the Tatum-Wolfcamp Field. Starting at the top, you'll note that the pressuresfor the Anderson No. 1 are denoted by the squares. The bottom hole pressures for the Duncan "A" No. 1-6 are denoted by the

"X", and the Duncan -- and the bottom hole pressures for the Duncan "B" No. 1-6 are denoted by the circles. In slant lettering to the left of each pressure point well to the left and in some instances to the right are the actual measured bottom hole pressures, and the number in the parenthesis indicates the number of hours each well was shut-in prior to obtaining pressure. At the bottom of the graph is the monthly oil production for each well plotted on a semi-log rhythmic scale, to which sets out the monthly production from each well, and also enables us to make some estimate of the future trend of production.

Q Now, have you also plotted the gas-oil ratios on this graphic illustration?

A Yes, sir, I have. The gas-oil ratios are -- the average field gas-oil ratio is the dotted line which appears in the lower one-third of the graph, in this maze of points, you see, using the same symbols as appear at the top of the graph, each -- the gas-oil ratio for each well can be obtained from that.

Q Have you also indicated the point at which artificial lift equipment was installed on the two wells which are now using artificial lift?

A Yes, sir, I have. Those are set out -- you'll notice that the -- this is rather hard to read, but the Anderson No. 1 pumping equipment was installed in January of 1959, and that pumping equipment was installed on the Duncan "A" No. 1-6 in February of 1959.

Q I note in the lower portion of Exhibit No. 9 that you have a dotted extrapolation of the production of the two better wells, that being the Duncan "B" No. 1 and the Duncan "A" No. 1. Would you please explain how you arrived at that particular extrapolation of production?

A Well, the dotted lines represent my interpretation of what the future producing rate of these two wells will be. You'll notice that on the upper curve for the Duncan "B" No. 1-6, that for the last six months period the production has been declining from this well at approximately the same rate as the extension of this dotted line. Based on this information, I felt that the decline of the Duncan "A" No. 1-6, or the lower dashed line, would follow the same trend as the stronger producer.

Q Now, did you have any other aid in establishing the slope of this decline?

A Yes. I examined the production history of the Bough Pool to the north. The Bough Pool in 1957 produced 326,322 barrels. In 1958 this production had declined to 224,650, for a decline of 101,672 barrels compared with the previous period, or a decline of 35 percent yearly.

Q Do you feel that the producing characteristics of the Bough Pool and the Tatum-Wolfcamp Pool are sufficiently similar as to use the decline in the Bough Pool as an aid to estimating the ultimate recovery from the wells in the Tatum-Wolfcamp Pool?

A I certainly do.

Q Upon what similiarities have you found to exist?

A Well, the -- of course, the indicated decline rate here was from the Duncan "B" 1-6 which checks within engineering accuracy the decline of the Bough Pool that has been observed in the past. Also, in my opinion, there was strong evidence that both of these fields are water drive fields which are connected through a common aquifer in the Wolfcamp. Other characteristics are that the Bough Pool also has thin porous streaks in the Wolfcamp formation, and the similiarity in my opinion, is very great.

Q What is the estimated ultimate recovery for the Duncan "B" No. 1 well, as shown by your Exhibit No. 9?

A Mr. Cooley, I don't have that right here in front of me. I combined the two in my estimate, actually. That was the Duncan "B" 1-6?

Q Yes.

A From an extrapolation of the decline curve on this Exhibit, my estimate of the ultimate recovery for the Duncan "B" No. 1-6 is 206,000 barrels. Using the same method, my estimated recovery from the Duncan "A" No. 1-6 is an ultimate recovery of 107,000 barrels, which is a total of 313,000 barrels for these two wells.

Q Now, is that based upon a 300 pound abandonment pressure?

A No. That is based on a 300 barrel per month abandonment pressure. And the reason for selecting that particular abandonment pressure is the fact that I felt like the economic limit would be 300 barrels per month per well, due to the fact that it is anticipated that we will have to pump large volumes of water along with the oil in the future, and, therefore, we would have a high economic limit.

Q Your lifting cost at the depth which you are now dealing, averaging 10,300 feet, would be as great at that late life of the pool?

A That's true.

Q Mr. Schrinkel, have you attempted to construct a pressure production decline curve for the Tatum-Wolfcamp Pool?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 10, and ask you if this is the decline curve to which you refer?

A It is, yes, sir.

Q Would you please explain what is shown on this Exhibit?

A Exhibit No. 10 is a plot of bottom hole pressure and gas-oil ratio tests versus the field cumulative oil production. Immediately under the legend is again the symbols used to designate the various wells, the square for the Union Oil Company, et al's No. 1 Anderson, the "X" for the Union Oil Company, et al's No. 1 "A" Duncan, and the circle for the Union Oil Company, et al's No. 1 "B" Duncan. Near the top of the graph is a red dashed line which indicates the initial field pressure of 3,904 PSIG as measured in the discovery well, the Duncan "A" No. 1-6 on October 19, 1957 before any production had been obtained from the pool. This is the initial field pressure, approximately three-fourths of an inch on this well. Well, I might clarify that a little bit. This black declining line here represents my interpretation of what the true reservoir pressure in the Tatum-Wolfcamp Field is. This point, approximately three-quarters of an inch down the line, represents the initial field -- the initial pressure as measured in the Duncan "B" 1-6 before any production had been obtained from this well. And you'll note that the pressure in this well was 300 -- I mean 3,684 pounds per square inch after a shut-in time of one hundred two hours, and represents a drawdown of 220 pounds from the initial field pressure of 3,904 PSIG. Now, the other points which appear underneath this black line are measured pressures and their corresponding shut-in times for the Atwood Bradley No. 1 and the Duncan "A" No. 1-6.

Q Is that the Anderson instead of the Atwood Bradley?

A I beg your pardon. It is the Anderson. The Atwood Bradley is a dry hole, therefore, it has no pressure. The reason that -- now, these points, in my opinion, are not representative of what the true field pressure was at the particular time that they were taken. Now, the reason for that, in the case of the Anderson No. 1,is the fact that we had this completion difficulty, which we have previously referred to, and it is simply due to the fact that we had destroyed the capacity of the well so much in our completion procedure or remedial procedures that, in my opinion, the pressures were not building up to the true pressure at the end of that time. Now, the pressures denoted by the "X" which are those obtained on the Union Oil Company's No. 1 "A" Duncan, or the subsequent pressures after the initial field pressure also fall below this line which I believe to be representative. On this bottom hole pressure obtained September 27, 1959, on the Duncan "B" No. 1, which is in the center of Exhibit 10, with a pressure of 1982 pounds, on that particular point we had a pressure buildup curve. In other words, we measured the pressure. We had a continuous recording of the bottom hole pressure in this well and we found that at the end of 74 hours the pressure in this particular well was still building up at the rate of approximately 30 PSIG. So we don't feel like that pressure is representative. And, although, on this subsequent pressure, in the same well of 2119, we had not been producing the well as hard, if you'll look back at the previous Exhibit, and we feel like it is a little bit closer to what the true formation pressure is. Now, on going back to the Duncan "B" 1-6, on July 27, 1959 -- 27th, 1959 -- we obtained a bottom home pressure at the end of a 72-hour shut-in period of 2,752 PSIG.

Q Is this the point that is shown along your decline curve as being the next to the last point?

A Yes, it is, Mr. Cooley. Now, on September the 11th, 1959 we obtained a pressure in this same well, the Duncan "B" 1, of 2,740 PSIG at the end of the shut-in time of 108 hours, This point also was at the end of a pressure buildup test, and although the pressure was not completely built up, it had gained only 8 pounds in a 24-hour period and within the limits of accuracy on the equipment itself, reaching very near the stabilized bottom hole pressure, so that is the reason that we chose this line as we did.

Q Then, to recapitulate the pressure decline as you have shown on Exhibit No. 10, is a point drawn between the initial field pressure in the "A" 1 Well, the initial pressure in the "B" 1 Well, and two subsequent pressures at later dates on the "B" 1 Well?

A That is correct.

Q Does this pressure curve as you have constructed it, also conform to the estimated recoveries which you have, which you believed you were going to get from these two wells?

A No, sir, it does not. In a water drive field it is impossible to forecast the ultimate recovery from a simple extrapolation of the pressure decline curve.

Q The replacement of the produced oil with the incoming water tends to hold the pressure up, does it not?

A That is correct.

Q Have you also shown on Exhibit No. 10 the GOR history of the Tatum-Wolfcamp Pool?

A Yes, sir, I have. The significance of the --

Q How is that portrayed, first?

A Well, the gas-oil ratio history is portrayed by the green line near the bottom of the graph, and is, the legend for this graph or the scale for this graph, appears at the right of Exhibit 10. The significance of this curve is that the initial gas-oil ratios in each of the wells were with the limits of accuracy of measurements very very or practically identical and have not increased any significant amount.

Q Mr. Schrinkel, in a pool of the comparatively smallness of the one with which we are dealing here, also taking into consideration the thickness of the pay, would this gas-oil ratio performance be characteristic of the pool if it had a solution gas drive solely rather than a water drive?

A No, sir. Considering the small amount of oil in place, I would say that we would have a much more rapid gas-oil ratio increase if it was producing on a gas drive.

Q The pressure in all of the wells that are now producing in the Tatum-Wolfcamp Pool are all below the bubble point, are they not?

A Yes, sir, that is correct.

Q Mr. Schrinkel, from the pressure performance that is portrayed here on Exhibit No. 10, can you draw any conclusions as to the ability of the production from one well to affect the pressure in other areas of the pool, or in plainer words, the degree of communication in the Tatum-Wolfcamp Pool?

A Well, the fact that the initial pressure in the Duncan

"B" 1-6 was 220 pounds lower than the initial reservoir pressure of 3904, after a cumulative production of only approximately 17,000 barrels, in my opinion, definitely indicates that there is communication between these two zones which are some 3300 feet apart.

Q You say these three wells are some 3300 feet apart?

A Yes, sir.

Q Was the initial pressure on the No. 1 "B" Well taken over a longer period of time and thus given a greater opportunity to build up than was the initial pressure for the pool?

A Yes, sir, it was. That is correct.

Q Now, in comparing the permeabilities found in the three producing wells in the Tatum-Wolfcamp pool, which of the three wells has the worse permeability?

A Well, our core analysis data indicates that the discovery well, the Duncan "A" 1-6, had the poorest permeability from the information that we have.

Q And that's from the core analysis?

A From the core analysis data, it indicates that it has much poorer capacity than the Duncan "B" 1.

Q But dispite this fact, in a relatively short period of time with the very comparatively small amount of oil production, the pressure was drawn down to a considerable degree before the drilling of the "B" 1 Well, is that correct?

A Yes, sir, that is correct.

Q Can there be any other engineering explanation for this draw down on the Duncan "B" 1 other than the conclusion which we have reached, being that there must be communication between the Duncan "A" 1 and the Duncan "B" 1?

A Well, in my opinion, there could be no other explanation, in this particular case.

Q In this particular case?

A Yes, sir.

Q There could be other explanations in different types of pools where there were anomalous conditions occurring throughout the pool, could there not?

A Yes, sir, that's correct, or we could have equipment difficulties if qualified people were not obtaining these tests, which was not the case in this particular instance.

Q Do you feel that both of these pressures are definitely accurate?

A Yes, sir, I do.

Q That is, within the degree of error of the machinery used?

A Yes, sir.

Q From the core analyses which have been made available to you on the four wells in the Tatum-Wolfcamp Pool area, have you been able to construct a volumetric estimate of the amount of oil that can be recovered from this entire pool?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 11, and ask you if that is the calculation on the volumetric basis to which you refer?

A It is.

Q Will you please go through in some detail and explain to the Commission the significance of this calculation?

A The volumetric recoverable oil reserves for the Tatum-Wolfcamp Field have been calculated by the standard volume method. The oil in place for each acre foot is equal to the constant 7,758 barrels per acre foot, times the average porosity, times 1 minus the connate water saturation, all of which is divided by the formation volume factor. This works out to be the constant 7,758 multiplied by the porosity of 6.7 percent.

Q Where was this porosity obtained again, sir?

A This porosity value is the weighted average porosity from the core analysis data.

Q And as you proceed through the reserves estimate, please inform the Commission the source of all of your other variables.

A The connate water saturation of 22 percent was calculated from the electric logs obtained in the field, and the formation volume factor of 1.69 was obtained from Standolin's correlation charts, using the initial gas-oil ratio of 1200 cubic feet per barrel and other information. All of this works out to indicate that we have in the Tatum-Wolfcamp Field 240 barrels of stock tank oil in place originally per acre foot. Now, based on analogy with the Bough Field and the ranges of recoveries which can be reasonably expected from a water drive field, I estimated the recovery factor for this field to be 45 percent of the oil which was originally in place.

Q Mr. Schrinkel, what is the recovery factor in the Bough Pool?

A I believe that fifty percent was, in that range, the range of recovery that myself and others have previously arrived at.

Q Now, you have said that there are strong similiarities between the Bough Pool and the Tatum-Wolfcamp Pool. Why is it that you have not used a 50 percent recovery factor rather than the 45 percent which you select?

A Well, it's a matter of judgment, in my opinion. I felt like this field was maybe not quite the quality of the Bough Pool, which we have used for analogy, and it's strictly based on experience and looking at the information is what I believe it is reasonable to recover.

Q And I take it, from the comparison of all the known factors in both pools, it is your opinion that the recoveries will be somewhat but slightly less than, in the Tatum-Wolfcamp Pool, than they would be in the Bough Pool?

A Yes, sir, that's correct.

Q Will you proceed, then, with your estimate?

A Well, as has been previously testified to, it is believed that the productive area of the field will be 1,040 surface acres. Using the average pay thickness of 19 feet, gives us a volume or the estimated volume of the South Tatum-Wolfcamp Field of 19,760 acre feet.

Q Now, where did you obtain the average pay thickness of 19 feet, Mr. Schrinkel?

A From the core analysis and electric log information.

Q Proceed.

A Then, to estimate the recoverable oil in the Tatum-Wolfcamp Field, we take the recovery in the -- recovery per acre feet, which was 108 barrels per acre feet and multiply this times our estimate or volume of the field, or 19,760 acre feet and arrive at the recoverable oil for the South Tatum or for the Tatum-Wolfcamp Field to be 2,140,000 barrels.

Q Now, this calculation is, of course, necessarily based on the assumption of the exact correctness of the estimate that Mr. Dunn made, that there would be 1,040 productive surface acres?

A That's true.

Q And if that figure varied, this would necessarily vary?

A That's very true.

Q In order to check the accuracy of your volumetric calculation of recoverable oil in the Tatum-Wolfcamp Pool, have you attempted to make a production decline estimate, using the production decline method of calculation, rather than the volumetric calculation?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 12, and ask you if this is the calculation to which you refer?

A It is.

Q Would you explain this Exhibit to the Commission, please?

A Exhibit 12 is a recoverable reserve estimate by the production decline method for the Duncan "A" No. 1-6 and the Duncan "B" No. 1-6. The total estimated ultimate recovery for these two wells is 313,000 barrels, which was obtained from the production versus versus time decline in Exhibit No. 9. If we further dedicate 160 acres to these two wells and use the average pay thickness of 19 feet, we get an estimate recovery per acre foot for these two wells of 103 barrels per acre foot.

Q Thank you, Mr. Schrinkel. Mr. Schrinkel, as reservoir engineer for your company, does it also fall within the purview of your duties to attempt to determine with the greatest degree of accuracy possible the development from an economic standpoint of any particular prospect that your company might drill?

A It certainly does.

Q Have you attempted to evaluate from an economic standpoint the possible prospect of drilling the Tatum-Wolfcamp Pool on 40-acre space as compared with the drilling of the same pool on 80-acre spacing?

A Yes, sir, I have.

Q I hand you what has been marked as Exhibit No. 13, and ask you if this is the calculation to which you refer?

A It is.

Q Will you please proceed to explain what is shown thereon?

A Exhibit 13 is an economic comparison of 40-acre spacing versus 80-acre spacing for this field. Using information that has been previously developed, the area which we reasonably expect to be productive is a thousand and forty acres. If it is required to drill this well on 40-acre spacing, we will -- it will be necessary to drill twenty-six wells. If the field is developed on 80-acre spacing, it will be necessary to drill only thirteen wells. Now, before we get to the investment cost here, the actual well cost on the development to date on this field is as follows: The Union Oil Company et al No. 1 Anderson cost $242,499 to drill. The Union Oil Company et al No. 1 Atwood Bradley cost $197,317 to drill. The Union Oil Company et al No. 1-6 Duncan "A," the discovery well, cost $429,365 to drill. The Union Oil Company et all No. 1-6 Duncan "B," the most recent well, cost $187,078 to drill, for a total investment of the field of $1,056,259 to date. Now, these figures do not include geophysical and land costs which would make the investment in the field even greater. These figures were obtained from our accounting records, Mr. Cooley.

Q Now, Mr. Schrinkel, isn't there in those figures you have just read one more or less inherent error in charging the entire expense of the discovery well to the Tatum-Wolfcamp Pool?

A That is correct. The discovery well was a Devonian test, and that is why the well cost is so much out of line with the others. Although --

Q Disregarding that well, then, the other three wells cost in the neighborhood of $200,000 apiece to drill?

A That is correct, Mr. Cooley.

Q Well, I note on Exhibit No. 13 you have used a figure of $180,000 per well for the future wells that are to be drilled in this pool?

A That is correct. We believe on the fact that as we gain experience in the field that we can drill the wells for that sum. I mean, making use of the knowledge that we obtained in the drilling of the other wells.

Q As development wells, you wouldn't expect to core quite as much as you would on the earlier discovery wells?

A Well, that is possibly true.

Q Then proceeding with the estimated cost of $180,000 for each additional development well, will you continue with your analysis?

A Yes. For 80-acre spacing or twenty-six wells, it would require an investment of $4,680,000.

Q I believe for 80-acre spacing, Mr. --

A I'm sorry. For 40-acre spacing and twenty-six wells it would require an investment of $4,680,000 for 80-acre spacing or thirteen wells, it would require an investment of $2,340,000. The estimated ultimate oil reserves, as have been previously calculated for this producing area, are 2,140,000 barrels, and we have assigned no gas reserves to this particular field because of the lack of gas -- of a gas connection, and the gas volumes are not large enough tojustify the installation of any gathering system in this field.

Q Now, is the 2,140,000 barrels, the volumetric calculation that you made earlier --

A Yes, sir.

Q -- rather than the production decline method --

A That is correct.

Q -- and it was slightly the higher of the two, was it not?

A Yes, sir, that is correct.

Q Then, would you proceed to tell us what operating income you would expect to receive on the basis of this production?

A Well, we are receiving three dollars and one cent for this oil and no value assigned to any gas production, so the gross revenue is three dollars and one cent per barrel. Under costs, we have severance and ad valorem taxes at eighteen cents per barrel. Royalty is sixty cents per barrel, trucking to the pipeline is twenty-six cents per barrel, and the lifting cost is very conservatively estimated at twenty-six cents per barrel. We feel like over the life of this property, if we have to or when we start lifting these -- artifically lifting these large volumes of water, the twenty-six cents per barrel is going to be a pretty optimistic lifting cost, and those figures total up to be $1.30 per barrel, which leaves as net operating income for gross barrels of $1.71. Now, if we apply this net operating income for gross barrel of $1.71 to the total estimated recoverable oil of 2,140,000 barrels, we get a net operating revenue of 3,660,000 barrels.

Q Dollars?

A I'm sorry, dollars. Get a net operating revenue of $3,660,000. If we subtract the investment of $4,680,000 for development on 40-acre spacing from this revenue, we incur a loss of $1,020,000, or a loss of $39,200 per well. Going further, if we develop this field on 80-acre spacing, we will show a profit of $1,320,000, or a profit of $101,500 per well on an investment of $2,340,000.

Q In light of the conclusions that you have reached as a result of your economic study as a reservoir engineer for Union Oil Company responsible for recommendations for future activity in this pool, could you recommend to your management that this pool be developed on 40-acre spacing?

A I could not. I would definitely recommend that Union Oil Company do no additional development on this field if 40-acre spacing were the pattern.

Q Do you feel that any company could economically enter into this pool and develop on 40-acre spacing?

A No, sir, I certainly don't.

Q What would be the result, then, Mr. Schrinkel, if you were to stay on 40-acre spacing on this pool?

A Well, I think it is obvious that development would cease.

Q Mr. Schrinkel, in light of all of the knowledge and data which has been made available to you, as a result of your study in the Tatum-Wolfcamp Pool, I would like to have your opinion as to whether or not you feel that one well can efficiently and economically drain and develop 80 acres in the Tatum-Wolfcamp Pool?

A Well, in my opinion, the information that we presented here today indicates to me that one well will drain at least 80 acres. Now, the reasons for these are: first, the difference in the initial pressures before production between the Duncan "A" 1-6, which was the discovery well, and the subsequent pressure after production of approximately 17,000 barrels in the Duncan "B" 1-6 before any production. This indicates that we have communication or interference over a distance of at least 3300 feet. And, secondly, the production performance of these wells indicates to me that they will produce far in excess of the actual recoverable oil in place under a 40-acre tract as determined from core analysis. And third, the correlation of an active, or the idea that we have an active water drive in the field coupled with these pay sections which are isolated by limestone barriers, indicates to me that we will get very high flushing efficiency over long distances, which is characteristic of a frontal drive displacement, what we call a frontal or more nearly could be described as a loose fitting piston, pushing this oil to these wells.

Q Well, in view of these factors, Mr. Schrinkel, do you feel that development of this pool on 80-acre spacing as compared with the development on 80-acre spacing would result in any significant quantity of oil?

A I do not.

Q You feel that the ultimate recovery of the pool on 80-acre spacing would be just as great as it would be on 40-acre spacing for all practical purposes?

A Yes, sir, I do.

MR. COOLEY: No further questions.

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

CROSS EXAMINATION

BY MR. PAYNE:

Q Mr. Schrinkel, I believe you testified that the casinghead gas was being vented at the present time, is that correct?

A That is correct.

Q How much casinghead gas do these wells make, is it substantial?

A Well, our current gas-oil ratio -- if you'll note, the Exhibit is approximately 1500 cubic feet per barrel, so we can multiply that volume by our August production. I'd say this is approximately 7,000 MCF per month, which is not a significant quality.

Q So in all probability, there wouldn't be any connection, then?

A That is true.

Q This proposed location, is this a drilling well or just staked or just proposed?

A I believe that we have applied for the location. I don't know.

Q Do you propose to drill this well no matter what spacing the Commission establishes, whether 40 or 80?

A Yes, sir, that's true.

Q Now, why are you going to do that when you are going to lose $39,000? You don't have an offset obligation, do you?

A No, sir. We might feel that we might be able to drain even larger areas than 80-acre spacing.

Q In other words, while you don't believe in developing this field up on 40, the fact that you drill at 40, you still feel that that particular well will drain more than 40?

A Yes, sir, I certainly do.

Q Now, did you take any bona fide interference test?

A No, sir, we have not. We have not taken conventional type interference test. Now, the drawdown of this initial pressure on the Duncan "B" 1 is an interference test. You get more conclusive test than you do the conventional where you flow one and try to --

Q You feel that shutting in one well and flowing the other one wouldn't give you any additional valuable data on drainage radius?

A Well, it would be very helpful. We would see that, the pressure decline in the shut-in well while we produce the other one.

Q Now, I believe you testified that this pressure indicates -- this pressure drawdown indicates that one well, your 1 "A" is affecting your 1 "B" and vice versa?

A Yes, sir.

Q Now, the fact that it is affecting is not the same, is it, as saying that the one well can drain efficiently all the intervening acreage between the two?

A Well, that's a rather difficult question to answer with the type of geology we have, where we have these thin pay sections isolated between these limestone stringers or isolated between impervious limestones; we get what we call a frontal advance type displacement. In other words, the water, wherever it may be out here, is pushing the oil into the areas of lower pressure, and a characteristic of that type producing mechanism is that it is very efficient. In other words, as we get out from the wells, this front tends to become a circle,in a case like this, where we have no permeability barriers in the area.

Q Well, now, is this an edge water drive you are talking about?

A Well, it's -- a frontal advance type displacement is not -- It can be an edge water drive or it can be a circular drive. In this case it's similar to a displacement mechanism. In other words, if we had a, oh, let's say a pipe and our fist was about the same size of this pipe, and filled with water, and we pushed it in there, we would get a pretty effective displacement. If you translate this to a plane where you have this pistonlike force on the edge of the field, you get what's known as frontal advance, which has characteristically very effective flushing efficiency. In my opinion, this field would be much blacker than it is if we weren't getting highly efficient recovery. It may be even greater.

MR. PAYNE: Thank you.

QUESTIONS BY MR. NUTTER:

Q Mr. Schrinkel, we've heard quite a little bit about the Bough Pool today; you compared it on several occasions. How does this porosity of 6.7 compare with the porosity in the Bough?

A Well, Mr. Nutter, we had some work done by our Roswell geologic -- our Roswell geologic office, which they sent to our Midland office a good number of core analyses, which they were able to obtain in the Bough Pool, and as I recall, the average porosity values in this field ranged from three to a high of thirteen percent. Now, I believe that's right, and it's more or less of a matter of how you want to weigh those porosities to obtain what you think is the average field porosity. My own particular interpretation of this data was that the porosity was somewhere between five to eight percent, and that's about as close as I could tell you what I think it might be.

Q Didn't you say that this 6.7 percent porosity was derived from the logs?

A That was derived primarily from core analysis data, adjusting the intervals for electric logs. You take a zone of this meager porosity, it is very difficult to make accurate electric log calculations when you start getting down in the lower porosity ranges. These represent the core porosity permeabilities.

Q These are core porosities?

A Yes, sir.

Q What was the range of those porosities?

A Well, we'll have to look at those Exhibits.

Q I will withdraw that question, sir. We've got that here, the core analysis. I hadn't looked at those.

A Yes, sir.

Q Now, on this Exhibit No. 9, Mr. Schrinkel, you have extrapolated the decline for your Duncan "B" Well No. 1-6 --

A Yes, sir.

Q -- based on the production for the last five or six months, I believe, primarily, is that correct?

A That is true. The Duncan "B" 1-6, yes, sir.

Q How long has it been since that well was capable of making the top allowable,for the pool, I should say?

A Well, I don't know, Mr. Nutter. I would assume that that occurred in May of 1959.

Q Since May it hasn't been able to make top allowable?

A Yes, sir. This is -- each of these leases are one-well leases.

Q So since May this represents the capacity of the well to produce?

A Yes, sir.

Q Now, is that -- on one of the Exhibits I notice tubing pressure, Exhibit No. 8 for the Duncan 1-6. Is that the flowing tubing pressure there, that 630 pounds, or is that shut-in pressure?

A That's flowing pressure. Now, I might qualify that point, that that flowing test was the day after we obtained this most recent bottom hole pressure for this hearing. In other words, the well had a built-up pressure, and this represents a flush test.

Q Well, now, this -- in other words, this well is -- it made 178 barrels on the test?

A Yes, sir, which is certainly capable of making the allowable based on this test, but like I say, this test was obtained the day after we had had the well shut-in for a hundred and eight hours.

Q So there had been a buildup of fluids in the vicinity of the well bore?

A Yes, sir.

Q What is the normal flowing pressure for the well?

A Well, I really don't know other than what information we have here. I understood from our foreman in telephone conversations that the flowing tubing pressure was in the order of about 420 pounds before this period -- before this shut-in period. In fact, I believe that I have that.

Q Isn't that rather unusual, Mr. Schrinkel, for a well to have such a high flowing pressure and still not be able to make the allowable?

A Well, not necessarily. All these things are a matter of degree. The only way I can answer that question is that we have a field over in West Central Texas there that some of the wells have flowing pressures of 75 and 100 pounds per square inch, and yet they'll only make 3 and 4 barrels of oil per day. I mean it is a function of permeability of the formation and how effective the completion is, or the PI to get back to its function of how great the PI is and what the gas-oil ratio is.

Q And do you think there is a possibility that these allowables in this pool may not be too high?

A No, sir, I don't think that from the way our bottom hole pressure has tended to level out that they are.

Q Well, now, there is only one well that has had bottom hole pressure level out?

A That's true, but in any field -- in any field, in fact, I would say that in the West Texas-New Mexico area, that probably 75 percent of the wells don't build up in the end of a three-day shut-in period, regardless of how they may be weighted and interpreted, and so forth, it is probably likely that less than 75 percent of the wells, except in formation, like the Devonian.

Q The virgin pressure of the pool was 349 pounds, and at the end of 17 barrels' production, the second well was brought in for 3684?

A Yes, sir.

Q And you mentioned that that drawdown from the virgin pressure in the second well was probably due to communication between wells?

A Yes, sir. I think that's the only interpretation I could make from the facts.

Q Well, now, do you think that this failure of all of these various points on Exhibit 10 to fall on the black decline line represents a lack of communication in the rest of the pool?

A No, sir, I don't. These pressure buildups are relatively thin -- I mean, we go from extremely tight fields to fields that are like turning on a water faucet. East Caprock Field, for instance, they build up almost immediately. And the buildup time is a function of several factors; the oil viscosity, and the compressibility of the oil, and the porosity that we have existing, and permeability of the formation, it is proportional to the permeability.

Q Is there any possibility that the buildup time on the initial pressure of the Duncan of 172 hours, was sufficient?

A Like I stated in my testimony, Mr. Nutter, there was an

80-pound pressure increase in the 24 -- comparing it with the pressure obtained in the previous 24-hour period. Now, the accuracy of this equipment is in the order of one-tenth of 1 percent or one part in a thousand. So, we are getting down near the range of where if we had the arrow working against us both ways we are just about built up, you see.

Q Now, on your Exhibits 11 and 13, you assume a productive area of 1040 acres. Now, Mr. Dunn testified that he thought there was oil production all the way up to that minus 6350 line, although it may not be of sufficient quantities to justify drilling a well out there. Do you think some of this oil may come out with this frontal advance piston movement that you were discussing a while ago?

A Yes, I think so.

Q You haven't taken that into consideration in your economics, have you?

A No, sir. These economics are based on our best interpretation of data,as is anything.

Q That area outside that 6300 foot line is probably twice as big as the area inside the 6300 foot line, isn't it?

A Well, I would say it increased the size of the area 25, 30 percent. Just looking at the map here. Geology, as well as engineering, is an interpretative science.

Q There are wells inside that can be produced from that inside, that 1040 acres, is that right?

A There is a possibility. If it is out there, there is a possibility that we will produce a portion of it.

MR. PAYNE: That just shows they are draining 80 acres, doesn't it, Mr. Schrinkel?

A Well, I suppose. I didn't quite understand.

Q Well, some of this oil, if it should move in would help the Commission's picture of wells?

A We certainly hope so.

Q You stated also, Mr. Schrinkel, that you didn't have any gas connection in the field and that you were only venting or flaring about 7,000 MCF per month. Now, that's with the three existing wells?

A Yes, sir.

Q As time goes on and more wells are drilled, there will probably be more gas produced?

A That's true.

Q How far is it to the nearest gas gathering facility?

A I'm not too familiar with the area,to be truthful. Actually, I think Mr. Dunn here might. Do you know?

MR. DUNN: I believe that it is within ten miles of the El Paso -- I think it is within four miles of the pool area, the El Paso high pressure line. That would require high compression to inject gas into that system.

A The nearest gasoline plant that I know of, I am not familiar with the plants at all, is the Denton or I believe Townsend has a plant.

Q Now, this 7,000 MCF per month from the three existing wells amounts to $700 a month, does it not?

A That's true, yes, sir.

MR. NUTTER: I believe that's all. Thank you.

REDIRECT EXAMINATION

BY MR. PAYNE:

Q Mr. Schrinkel, are any of these wells capable of producing top unit allowable?

A Well, the only one that could be would be the Duncan "B" 1-6, that would have any possibilities, and as Mr. Nutter has asked me about, I believe that we recently had a restricted allowable on it.

Q So that generally speaking, at least if your application is granted, it wouldn't have any effect on the allowable?

A No. If we had a larger allowable from the three wells that we have here, we are capable of producing.--

Q I mean the wells are not capable of producing the allowable now, so even if you had an 80-acre allowable, it wouldn't change the production?

A Not on these three wells. In the event that the well to the north had a greater capacity to produce, we certainly could produce an increased allowable.

MR. PAYNE: Thank you. That's all.

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

You may be excused.

REDIRECT EXAMINATION

BY MR. COOLEY:

Q Mr. Payne seemed concerned that you were willing to go ahead regardless of the outcome of this case, and drill on the location as shown up there as a proposed location. I ask you, Mr. Schrinkel, is that what you might call an 80-acre location, regardless of what the spacing is at the pool at the present time?

A Yes.

Q And would you recommend to the management drilling any inside location or any 40-acre location?

A I previously made that recommendation.

Q That you would or would not?

A Would not recommend 40-acre development.

Q Also some question concerning interference tests. I believe you testified that two -- that three producing wells at the present time are now on pumping units. It would be impossible to conduct an interference test between those two wells, would it not?

A Well, we could pull the rods and conduct an interference test if it were required.

Q What would such a test cost?

A Well, as far as dollar expenditure, I would say that an interference test between the Duncan "A" 1 and the Duncan "A" 1-6 would cost in the neighborhood of $1500, not counting the loss of production.

Q What would the loss of production amount to?

A Well, the -- if we saw fit to put the pressure bomb in the Duncan "A" 1-6, which is currently producing approximately 1400 barrels per month, that would be a net operating loss of 1400 barrels a month times a dollar and seventeen cents a barrel times the amount of time it would be necessary for us to show interference, which may be a few days or it may be a couple of weeks, to get this drawdown.

Q It would be a considerably expensive venture to try to run pressure interference tests in the pool in the three existing wells?

A Yes, it would.

Q Now, the inquiry was made as to whether this was an edge drive, and you said it was a frontal type of drive. It definitely is not a bottom water drive, is it?

A No, it is not. I think if we keep the geologic Exhibits in mind, that we see it is impossible for us to see a bottom water drive.

Q Mr. Nutter inquired if possibly the allowables might not be too high in this pool. Is there any possibility of hurting a well where there is no bottom water? In other words, where is there no possibility of coning?

A In my mind, there is no coning problem at all in this field.

Q If there is no coning problem, are these type of wells very sensitive?

A No, sir.

Q Now, the economic picture that you portrayed in Exhibit No. 12 was based on the calculated oil in place under an 80-acre tract, was it not?

A Yes, sir. Did you mean Exhibit 12?

Q Well, Exhibit No. 12. What I'm getting at is the calculations; comparison between 40-acre spacing and 80-acre spacing was based on oil in place in the pool based on the information that we now have?

A Yes, sir.

Q And if by some fortuitous event we should recover more oil through either a 40-acre well or an 80-acre well, it would of necessity have to come from somewhere outside the 80-acre tract on which it was drilled, would it not?

A Yes, sir. That would indicate drainage of even larger areas than 80 acres.

Q And do you not expect that there will be some of this oil in the area that is not commercially productive to drill that will be recovered through the wider acreage pattern?

A Yes, sir, we will recover some of that oil.

Q And to whatever extent the additional recovery is in excess of 80 acres,we will just be that much better off,won't we?

A Yes, sir.

Q Mr. Nutter calculated for you that the 7,000 MCF of gas that we are now producing to be seven hundred dollars at ten cents an MCF. It isn't worth anything unless you have a market, is that right?

A That's true. Unless we have pipeline connections and are able to sell, it has no present or future value.

Q Until somebody sees fit to construct a gathering system in this pool, this gas is for all practical purposes worthless?

A That's true.

MR. COOLEY: No further questions.

QUESTIONS BY MR. PORTER:

Q Has any attempt been made to make a gas connection?

A We are selling it to one of our mineral owners there for irrigation gas, so it is not completely going to waste.

Q Run irrigation engine?

A Yes, sir, but to my knowledge, from what I know about the gas industry, I believe that a person would be extremely reluctant to construct a gathering system into this field from the probable gas reserve that he has unless he was near --

Q Considering expansion of the area now, a gas line, it is not entirely improbable to expect a gas connection at some time in the future?

A If the field drilled out this way, if we are currently producing 7,000 MCF per month and we had roughly eight times that amount of wells, it would make us produce about six or seven million a day.

Q It would be more attractive?

A Yes, sir.

MR. PAYNE: Did you list in your economic calculation the volume of the sale of this gas to the land owners?

A I believe he has the right to take that in time, and he is being charged nothing whatsoever. He is just -- we are making use of something that would otherwise be wasted.

Q (By Mr. Porter) Wouldn't your royalty payments, then, be less than the sixty cents?

A Well, unfortunately he has a 20 percent royalty on our properties, so he is getting his fair share.

Q In other words, this is a royalty owners gas?

A Royalty owner is using his other gas.

MR. NUTTER: Mr. Schrinkel, in response to a question by Mr. Cooley, you said that in an edge water drive field, you don't have any coning problem. There can exist such a thing as a fingering problem in an edge water drive, can't there?

A That's very true, Mr. Nutter, but as we have -- if we have a large periphery or a large -- oh, how shall I say it -- circumference to this area, our oil withdrawals from the total area are not so large, we don't have a series of fingering problems as if the water was moving in very fast. In other words, if we had a well of over five acres and we are just taking every drop we could out of this area, we would be more likely to have a fingering problem at the edge of the field.

Q Now, you also mentioned that if you had some oil moving into this 1040-acre from outside of the area, that that would indicate communication and drainage of a larger radius than an 80-acre location has, but would that be any indication necessarily of the efficiency with which a well was draining a larger area?

A Would you state that question again, please?

Q Well, in response to a question on redirect by Mr. Cooley, you said that if the oil was coming in from outside of that 1040-acre area that that would indicate that the wells were draining a larger area than the location radius. Would that be any indication of the efficiency with which that well was draining a larger radius?

A Well, I don't know whether I can answer that directly. I can answer it in this fasion, that the thing that we are always driving for in any oil field is a minimum residual oil saturation when we get through. In other words, we hope that in a water drive field that nearly all of the oil will be displaced by water, and that in a solution gas drive field that we will end up with a very high gas saturation in the porous or the rock, indicating that we have most all of the oil out. And it really, fortunately, I say fortunately in this particular Wolfcamp area or the field, that it appears to me that considering the low porosity and the thin pay sections, that we have a very fortunate producing mechanism in our favor, where we are more or less getting this pistonlike effect. And so if we conceive this thing as one big low porosity thin disc with water on the edge of the thing, it boils down to a fact of how fast can we take the oil out of the center of it before we have any serious fingering problem. As you pointed out there, instead of -- well, it really doesn't matter from the standpoint of efficiency whether you take all that oil out of one well in the center of this disc. If you had the capacity to produce it or if you had a number of wells, you would still, as water encroached, you would have more or less the same residual oil saturation.

Q I see.

A I hope that makes it clear.

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

(Witness excused)

MR. COOLEY: This concludes our case, Mr. Commissioner. I have closing remarks if there are no other witnesses.

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

MR. COOLEY: May it please the Commission, we feel that the presentation of the evidence that we brought forward to you today, considering the geology of the pool, the thin pay zones, and the -- in light of the water drive that we are certain exists here, that we have an extraordinary flushing action that will assure the recovery of substantially an equal quantity of oil regardless of the spacing pattern, whether it be 40 or 80. In light of the economics that have been presented, regardless of what little additional oil might be obtained from this periphery, certainly this can't be claimed to be a very rosey economic picture. And we feel very definitely that development of this pool on 40-

acre spacing is just too great a risk from an economic standpoint. Thank you.

MR. PORTER: Anyone else have any statements to make in this case? Mr. Errebo.

MR. ERREBO: If it please the Commission, Magnolia Petroleum Company is the owner of leasehold interests in two of the wells in this pool and recommends the adoption of 80-acre spacing.

MR. PORTER: Anyone else have any comments?

MR. PAYNE: Mr. Commissioner, we received a communication from Sinclair Oil & Gas Company who urges that Union's application in this case be granted.

MR. PORTER: Nothing further, case will be taken under advisement and take up next Case 1757.

MR. PAYNE: Off the record.

(Discussion off the record.)

MR. COOLEY: Let the record show that I move the introduction of all Exhibits, 1 through 12.

MR. PORTER: Let the record show that the Exhibits were admitted.

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this, the 2nd day of October, 1959, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Joseph A. Trujillo
NOTARY PUBLIC

My Commission Expires:
October 5, 1960