Vol. 1

BEFORE THE OIL AND GAS CONSERVATION COMMISSION

OF THE STATE OF COLORADO

IN THE MATTER OF THE INVESTIGATION TO TAKE MEASURES TO PREVENT WASTE OF OIL AND GAS IN THE RANGELY FIELD IN THE STATE OF COLORADO

CAUSE NO. 2

Ord # 2-4

PURSUANT TO NOTICE the above-entitled matter came duly on for re-hearing upon the application of The Union Pacific Railroad Company and The Texas Company at 1280 Sherman Street, Denver, Colorado, at the hour of 11:00 o'clock a. m., Tuesday, April 15th, 1952.

BEFORE:

MR. WARWICK DOWNING, Chairman

MR. JOHN E. CRONIN, Secretary.

MR. H. C. BRETSCHNEIDER, Vice-Chairman

MR. RUSSELL H. VOLK, Vice-Chairman

MR. CLARK F. BARB, Member.

MR. J. J. ZORICHAK, Director

MISS ANNABEL HOGSETT, Assistant Secretary.

A P P E A R A N C E S

THE ATTORNEY GENERAL OF COLORADO FOR THE OIL AND GAS CONSERVATION COMMISSION, by Mr. Ralph Sargent, Jr., and
Mr. Wilbur Rocchio, Assistant Attorneys General.

THE CALIFORNIA CO., by Mr. E. N. Dunlap, Denver,
Mr. Woolen H. Walshe, New Orleans,
Mr. A. L. Vitter, New Orleans,
Mr. Wm. H. Ashly, Jr., New Orleans,
Mr. J. L. Wany, New Orleans,
Mr. Robe rt W.Sullivan, Denver.

THE BAY PETROLEUM CORP., by Mr. Mark J. Mourne, Denver.

THE BRITISH-AMERICAN OILPRODUCING CO., by
Mr. W. T. Hudson, Denver.

McLAUGHLIN INTERESTS, by Mr. Jean S. Dreitenstein, Denver,
and Mr. S. W. McLaughlin, Rangely.

PHILLIPS PETROLEUM CO., By Mr. H. H. Kaveler, Bartlesville,
Mr. Claude Peavy, Denver,
Mr. Fred Kurgis, Denver.

SINCLAIR OIL & GAS CO., by Mr. John P. Akolt, Denver.
Mr. Geo. D. Almen, Tulsa.

THE SHARPLES OIL CORP., By Mr. Edward G. Knowles, Denver,
Mr. J. Clayton Carpenter, Denver,
Mr. John W. Stayton, Austin,
Mr. Samuel Butler, Jr., Denver,
Mr. Max S. Loy, Denver,
Mr. R. J. Corbett, Denver.

STANOLIND OIL & GAS CO., By Mr. S. B. Richards, Casper,
Mr. R. B. Laughlin, Casper,
Mr. D. H. Falkingham, Rangely,
Mr. Geo. B. Jenkinson, Tulsa,
Mr. Stanley H. Stoker, Tulsa,
Mr. P. P. Manion, Jr., Tulsa.

THE SKELLY OIL CO., by Mr. George W. Selinger, Tulsa,
Mr. C. J. Nalte, Sterling.

THE TEXAS COMPANY,by Mr. Walter E. Will, Denver,
Mr. Tom T. Freeman, Denver,
Mr. T..O. H. Mattson, Denver.

THE UNION PACIFIC RAILROAD COMPANY, by Mr. Lee S. Osborne, L.A.
Mr. Read Winterburn, L. A.
Mr. D. O. Churchill, L. A.
Mr. W. C. Carpenter, Denver,
Mr. E. G. Knowles, Denver.

UNITED STATES GEOLOGICAL SURVEY, by Mr. G. G. Frazier, Denver,
Mr. R. D. Ferguson, Casper.

and others.

I N D E X

Exhibits

FOR TEXAS-UNION PACIFIC		Received
1		284
2		284
3		284
4	Study of Dakota for Storage to be marked and filed later.	

Witnesses

CHAIRMAN DOWNING: We are ready to proceed with the Rangely matter at this time. We have a number of issues in the Rangely matter to consider at this time, one is the re-hearing in regard to the rules on the application of the Texas Company and the Union Pacific Railroad Company and the matter of the injecting wells for conservation in the entire field.

Before proceeding it might be well to get your ideas as to how you wish to proceed. I believe both matters should be considered together.

MR. KNOWLES: Perhaps we assumed too much a week ago. We thought the normal course of events was to dispose of this matter regarding the former order of the Commission. We have been granted the re-hearing and we assumed that we should go ahead with that because it seems natural that it perhaps not be disposed of but perhaps the matter relating to that that before testimony in general on plans that were submitted, and we have prepared our testimony along that line and would like to submit it in that fashion. We do think, however, that the entire record should be considered and we would like and assume really again that the testimony taken at the two hearing in November, on the 14th and on the 29th, should be considered as part of the record in this case and that the two matters should be consolidated for hearing, both the matter of the plans and our contentions with regard to rule 3.

CHAIRMAN DOWNING: Are there any further preliminary remarks at this time? If there is no objection it will

be now ordered that all of the evidence and what ever has been filed in connection with the two previous hearings are made a part of this record, and that we now consolidate the two matters, that is, re-hearing and the other matter which we might call the general matter or all other matters. Is there any objection to that procedure? (No response.)

I might state further -- it will probably help -- that the Commission members have had some conferences and we are of the opinion that there were some errors in our order No. 2-1 of which you complain. It might be advantageous to revoke or to grant your petition in respect to the former order. And in that event it will not be necessary to go into any great detail as to your evidence.

We should like to have you present your case briefly more as a guide to the future so that we don't make the same errors again.

I might say that it is our intention to grant your petition and set aside that order.

MR. KNOWLES: We then would like to go ahead with some testimony which we think will be of assistance to the Commission in the consideration of the problem generally and particularly when you come to consider the plans that have been offered.

CHAIRMAN DOWNING: That is what we would like to have, something that would be a sort of guide for the future. Anything you have will be welcome.

MR. SARGENT: Mr. Knowles, I think it might be well for the Texas Company and the Union Pacific Railroad Company to proceed with the evidence they have to show the effect of the Commission's rule 3 on them.

MR. KNOWLES: Yes, we intend to bring that out. That is what we think is the foundation for any procedure that you adopt from here on.

CHAIRMAN DOWNING: All right, you proceed with such evidence as you want to present in regard to the petition for re-hearing and also with respect to whether your proposal should take its place, what order we should make to prevent the waste of oil and gas.

MR. KNOWLES: We have some concrete suggestions along that line, if there is any need for an order at all of that character.

CHAIRMAN DOWNING: We would like to hear it fully.

MR. KNOWLES: Our proposal primarily is -- and other companies join us in the thought -- that that particular rule is probably not necessary; we are going to state the circumstances though in our testimony and you will be the judges of that.

CHAIRMAN DOWNING: You may proceed with both phases and present your testimony. You may ask for any other testimony from any of the other parties in interest.

MR. WALSHE: (California Company) Before the

testimony is introduced, the California Company would like to make a general statement as to the position it takes in connection with these hearings and I think it might be helpful for the Commission possibly for the other companies to make general statements before the testimony is presented. We would like to make our general statement at this time.

CHAIRMAN DOWNING: You are suggesting that each company make a sort of an opening statement?

MR. WALSHE: Yes, sir.

CHAIRMAN DOWNING: So that the Commission will know better what it is all about?

MR. WALSHE: Yes, sir.

CHAIRMAN DOWNING: Very well, we will proceed in that manner.

MR. SARGENT: We should take all the appearances before proceeding further.

MR. KNOWLES: I don't believe that is necessary. The appearances have already been made.

MR. SARGENT: Are there any people who have not appeared heretofore in Cause No. 2 that wish to enter their appearances?

CHAIRMAN DOWNING: This is a new notice.

MR. KNOWLES: I don't think it is necessary. You don't mean that we need to repeat the appearances that we made on paper?

CHAIRMAN DOWNING: Is there anyone here who wasn't here at our previous meetings?

MR. JENKINSON: Stanolind Oil and Gas Company has one additional appearance -- George B. Jenkinson.

MR. STAYTON: J. W. Stayton for the Sharples Oil Corporation and Dr. Byron Boatright is also making an appearance here for Sharples. He wasn't here at any of the other hearings.

MR. STOKER: Stanolind has another one. Stanley H. Stoker.

CHAIRMAN DOWNING: Perhaps at this time we should introduce our proofs of notice. This is the second hearing.

MR. ZORICHAK: Notices of hearing were published in a paper of wide circulation in Denver for both the rehearing, application by the Union Pacific Railroad Company and the Texas Company, and also for the hearing that was to have taken place for the purpose of presenting plans for injecting gas into the Weber formation. The publication date in the Denver paper was March 29th. And the publication date in the Meeker Herald was April 3rd. We haven't received proof of publication from the Meeker Herald but I called them yesterday by long distance telephone and they told me that it was published on April 3rd and that proof of publication was being mailed.

MR. SARGENT: Chairman Downing, I think the record should show that those proofs of publication should be considered a part of the record and that proof of publication

from the Meeker Herald should be allowed to be made as a late filing for this record.

CHAIRMAN DOWNING: It is so ordered. This notice, as you remember, covers the Commission's order adopting such measures as it deems necessary and appropriate to prevent waste of oil and gas in the said Rangely Field as in the judgment of the Commission the facts might justify. I call your attention to the fact that it is an all-embracing hearing.

Is there anything else that you wish to suggest, Mr. Attorney General, before we proceed with the opening statements?

MR. SARGENT: I believe there is nothing else.

MR. KNOWLES: I have a very brief opening statement. I assume that is all you want?

CHAIRMAN DOWNING: Yes.

MR. KNOWLES: There is one question that I would like to ask. Should all the witnesses be entered in here? It isn't necessary to enter the appearances of the witnesses that we have?

CHAIRMAN DOWNING: No.

MR. SARGENT: Just counsel.

MR. KNOWLES: There is no need for any legal argument in connection with the granting of the application since it has been granted.

But, very briefly, in that application which we filed, we took the position that the operation of the Rangely Field is vitally and adversely affected by the findings and the rule in that order.

We will offer testimony relating particularly to the findings in No. 6, 7, 8 and 9, and with respect to rule 3 and in part rule 4.

Our witnesses will, in their testimony, point out the things that perhaps should be corrected in those. The part in 4 is minor.

You have to bear in mind in this matter the important limitations in the Act which prevents the commission from restricting production of any pool or well to an amount less than such pool or well can produce without waste in accordance with sound engineering practice. That, of course, is something that is quoted very generally. It has to be quoted very generally but will be quoted very frequently, because that is the limitation on the Commission's power.

Our evidence will show that compliance with rule 3 by the Texas Company and the Union Pacific Railroad has resulted in substantial loss and damage. And the prospect faces us of further irreparable damage if curtailment of our oil production is not removed.

It is the sincere desire of the Texas-Union Pacific that the Commission issue herein an order that will avoid an

attack in court because such an attack might not only upset the order but might be an attack on the Act itself and none of the parties, we think, desires to have the Act declared invalid.

After we have presented our objections to the present rule 3, that being now swept out of the way, but at the same time it furnishes the point around which we make our case.

We will submit suggestions, as I said before, on rule 3 and a small change in rule 4.

In this proceeding the Union Pacific and the Texas Company are acting jointly.

The first witness who has something fundamental to give us happens to be a witness from the Texas Company. And therefore I would like at this time to refer to Mr. Walter Will for a few remarks on our case and also then he will start out with the first witness after statements by the other companies have been made.

MR. WILL: Mr. Chairman and Members of the Commission. The Texas Company and the Union Pacific Railroad Company each own producing properties in the Rangely Field and pursuant to an agreement between the two companies, the Texas Company is the operator of the joint property. We join with Union Pacific in this application in some instances in order to have the order clarified. But particularly we joined with them because we think that the order and particularly rule 3 should be set aside and re-considered. You

seem to have already granted that.

The Texas Company, as the operator of the properties, continually makes studies of the reservoir conditions in order that the company may operate these properties as efficiently as possible. One of these studies which was actually commenced before any hearings were had in this cause, has recently been completed. Mr. Darell Pierson, petroleum engineer, for the Texas Company, will present the results of his study. I understand that before putting him on other companies desire to make some statement and I believe you have granted that request.

After those companies have made their statements to you we will then continue by putting Mr. Pierson on.

CHAIRMAN DOWNING: Just what do you contend? Do you contend, briefly, that the previous order, with the limitations invoked as to so many feet in a day and so many feet in comparison to oil, that is what you object to in the previous order, is it not? Or is there some other things?

MR. WILL: Well, we object to the establishment of this gas-oil ratio in the limitations of 150,000 cubic feet per day for any well in the field. We intend to bring out in here why we object to that, how it doesn't tend to conserve the natural resources out there. That is our contention.

CHAIRMAN DOWNING: Do you believe or do you not believe that there is waste of oil and gas out there?

MR. WILL: No, we don't acknowledge that.

CHAIRMAN DOWNING: What is your position?

MR. WILL: We do not believe that the Rangely Field is being wastefully produced.

It is further our contention that it sets out in there by putting this gas back into the Weber it will definitely damage the reservoir, particularly if these indiscriminate places that the order provides are used.

MR. STAYTON: Mr. Chairman, inmaking a short statement for the Sharples Oil Corporation, I wish to state that our position will be substantially the same as the Texas-Union Pacific. We will contend, and will offer evidence in support of the position, that no gas-oil ratio limit is justified and that the 150,000 cubic feet per day limit is not justified and not necessary to prevent waste in the field. We will also offer testimony, we believe, that will show that the injection of this gas into the Weber formation will cause rather than prevent waste.

If it is satisfactory to the Commission, since our position is substantially the same as these gentlemen, we would like to follow them in the proceedings with the evidence.

MR. WALSHE: (California Company) As I understand it, this is a consolidated hearing not only to consider the plans that have been submitted to the Commission but also to consider the re-hearing on order 2-1.

In response to order 2-1 there has been submitted

to this Commission some six different plans. Those plans were submitted in order to prevent waste. And the Commission I think called for plans concerning the gas injection program at Rangely. The first plan was the plan of the California Company for a field-wide unitization using as a basis of participation a five-year forecast of production.

The second plan was an alternate plan of the California Company calling for the establishment of three separate units in the field using the same forecast as the basis of production.

The third plan was the plan submitted by the Texas Company and the Union Pacific Railroad Company which provided for field-wide unitization using as a basis of participation a revised five-year forecast of production.

The fourth plan was a proposal in the form of a letter submitted by the Sharples Oil Corporation which provided for field-wide unitization and proposed that the only fair and equitable basis for unitization would be to determine participating percentages from actual production history over a stated period of time.

The fifth proposal was in the form of a letter from the Phillip's Petroleum Company in which field-wide unitization was favored on the following basis:

That the percentage of participation as between properties be determined on the basis of a formula giving equal weight to the following factors:

(1) Sand Thickness;
(2) Productive capacity of individual wells determined by actual production tests not to exceed 150 barrels per well per day.

The sixth plan or proposal was in the form of a letter from the Stanolind Oil and Gas Company in which it favored field-wide unitization and proposed that a compromise formula be developed in which participation would be based upon oil in place, bottom hole pressure and current producing rates or some combination of these factors.

Now, the plan of the California Company for field-wide unitization was rejected by a majority of the operators in the field at a meeting held here in Denver January 24th. We reported this fact to the Commission in a letter dated February 7th, I think it was.

The plan of the Texas Company appears to be a firm proposal to unitize on the basis of percentage-participation factor as set forth in a table, I think, on page three of their plan. If this is a firm proposal it is rejected by the California Company.

We stated in our letter to the Commission that the fundamental problem at Rangely has been and is the establishment of a fair and equitable formula to allocate the oil and gas to the various tracts and leases in the field. We do not think this plan of the Texas Company is fair and equitable and we are prepared today to put on testimony to that effect.

The Texas-U.P. plan calls for a succession of unit operators. The California Company is opposed to that. We feel that the agreements should provide safeguards as to the operations by a unit operation, by a unit operator. And the agreement should also provide for the removal for cause of an operator. None of the agreements in which we are a party has it ever proofed satisfactory for each operator to operate his own property or to have a succession of unit operators. For these reasons we are rejecting the plan of the Texas and Union Pacific Railroad.

As I say, we will be in a position to offer testimony as opposed to their so-called revised forecast of production.

In regard to field-wide unitization, the operators have been trying for the last five years to get together on a fair and equitable basis of participation. And from a review of the various plans that have been submitted to this Commission we don't feel that we are any closer today on field-wide unitization than we were five years ago. And it is the considered opinion of the California Company that field-wide unitization at Rangely today is not possible.

As an alternative to field-wide unitization and in an attempt to accomplish the things that this Commission is trying to accomplish at Rangely, we have suggested the formation of three separate units in the field, each sufficiently large so that all of the gas produced from each unit can be

returned to that unit without materially affecting the correlative rights of people in that unit. We think this plan will accomplish the purpose this Commission is trying to accomplish. We believe that will put it on a fair and equitable basis in Rangely. We believe that it will conserve the gas. We believe that it will increase recovery and we are prepared today to put on testimony to that three-unit plan with the help of this Commission and with the help of the U. S. G. S. it will accomplish these things at Rangely.

Now, in the interrim -- because it is going to take time to determine whether or not there is going to be a sufficient number of operators and a sufficient number of royalty owners to approve those plans -- in so far as the west unit is concerned, I might say that the majority of the operating parties have already agreed for a tentative plan for that west unit.

I understand a majority of the operators in the east unit have agreed upon a plan for the east unit.

As for the central unit, I know of no plan that has been adopted. That unit is the unit in which the Texas and the Union Pacific Railroad own a majority of the acreage.

So, as I say, in the interrim we are asking this Commission on the re-hearing of order 2-1 to clarify that order so as to put in a gas-oil ratio for all wells in the Rangely Field.

To reiterate, at the last hearing a well producing with a gas-oil ratio of less than a thousand to one is not committing waste and their production should not be restricted. However, those wells that are producing with a gas-oil ration in excess of a thousand to one should be restricted in their gas production to 150,000 cubic feet per day of gas unless the operator returns that gas to the Weber formation. We are asking that that order be clarified so that it will stand up in court and give us a chance to work out our three-unit plan with the rest of the operating parties and the royalty owners in the field.

CHAIRMAN DOWNING: Your position then, as I gather, is that there is waste in the production of oil and gas in the field.

MR. WALSHE: (California Co.) I think there gas-oil wells in high production and waste is imminent unless something is done on the high gas-oil wells.

CHAIRMAN DOWNING: Does anyon else have a short statement they would like to make ar this time?

MR. STOKER: Stanolind proposes, and is prepared to offer, some additional evidence today supplementing the evidence taken at the previous hearings supporting supporting some rule restricting gas-oil ratios along the line of the present rule or some gas oil ratio restriction. And we will also have some comment to makealong the other matter to be considered today, that of unitization, which, at the

proper time will be handled by Mr. Jenkinson.

CHAIRMAN DOWNING: Are there any other statements at this time? If anybody at any time during the proceedings would like tomake a statement they will be granted the privilege upon application.

Mr. Walshe, you referred to an offer of the Texas Company. Is that in this document that I hold?

MR. WALSHE: That is correct. I think it is.

CHAIRMAN DOWNING: About how much time do you gentlemen believe you will need?

MR. KNOWLES: I think we will be able to complete our testimony -- between the Texas and the Union Pacific -- in about two hours, maybe less, depending upon cross examination.

CHAIRMAN DOWNING: How about you, Mr. Walshe?

MR. WALSHE: I would estimate it would take us about two hours to put on our testimony.

CHAIRMAN DOWNING: We do not want to curtail you, of course, but the members of the Commission, as you know, are serving without compensation, and we do not like to devote any more time wastefully. We are opposed to waste, not only in the production of gas but in the time element. You may proceed.

MR. KNOWLES: Before calling Mr. Pierson to the stand I think we should have all of the exhibits of the Texas-Union Pacific marked for identification.

(Whereupon, Texas-U.P. Exhibits No. 1, 2 and 3 were marked for identification.)

CHAIRMAN DOWNING: I want to amplify the remarks that I made about the re-hearing. We are inclined to think there was error in our previous order. Therefore, we thought we should make that known to you. It might save some of your time.

The purpose of this hearing is to reconsider the first order and also to consider fully all questions raised as to the waste of oil and gas in the Rangely Field.

MR. KNOWLES: Call Mr. Pierson.

D. S. PIERSON

called as a witness for the Texas-Union Pacific Railroad Company, being first duly sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath testified as follows:

DIRECT EXAMINATION

BY MR. WILL:

CHAIRMAN DOWNING: Let me state that when this witness finishes, anyone who cares to may make such examination as they desire.

MR. WILL: As I explained, Mr. Pierson is an engineer for the Texas Company and he has made a study of the reservoir with particular reference to the expansion of the gas cap.

CHAIRMAN DOWNING: Let us all agree that any witness produced here are competnet and qualified as experts unless

objection is made.

MR. WILL: We will certainly agree to that. Mr. Pierson's analysis will be presented by him to you in narrative form and for your convenience we will submit to each of you a copy of his statement and to anyone else.

CHAIRMAN DOWNING: Proceed.

Q. (By Mr. Will) State your name, please.

A. D. S. Pierson.

Q. By whom are you employed?

A. Texas Company.

Q. And where are you employed at the present time?

A. In the Rangely Field.

Q. In what capacity?

A. Senior field engineer.

Q. Have you prepared your testimony to be given in this case, Cause No. 2, in the form of a statement?

A. Yes, I have.

Q. Will you please read that statement to the Commission?

A. (Reading) Texas-Union Pacific Exhibit No. 1 is basically a structure map of the Weber reservoir in the Rangely Field, which I will refer to in discussing the results of my study of the Weber gascap expansion. This study was initiated during the fall of 1951 because our engineers in the field needed to know the areal and vertical extent of the gas-cap in order to plan individual well work-over procedures most

effectively. It consisted primarily of an analysis of produced gas-cap ratio trends in relation to the various factors which have an effect upon gas-oil ratios.

The orange line which you see on the map outlines an area, principally on the crest and on the southwest flank of the structure, within which lost circulation occurred in numerous wells during drilling operations. This area was originally reported and outlined by the Rangely Engineering Committee in their bottom hole pressure survey report of April, 1950.

You will note that certain areas on the map are shown in colors -- yellow, brown, and red. The yellow and red areas around the two gas injection wells, which are located above the orange line, are not included in my references to colored areas, inasmuch as the gas injection project is not a part of my discussion. All but three of the total number of wells located within the colored areas are either presently producing with gas-oil ratios of 1000 to 1 or greater or have previously produced at such ratios. I describe these colored areas as high ratio areas and the wells within those areas as high ratio wells. These terms are used merely as a matter of convenience to distinguish between those ratios which are greater than 1000 and those which are less than 1000. The brown coloring delineates the high ratio area in March, 1950; and the yellow and brown together delineate the high ratio area in October, 1951, which was the latest month

for which data were available at the time the study was made. In preparing the map, gas-oil ratios for individual wells were obtained from themonthly production tabulations of the Rangely Engineering Committee.

A number of wells within the colored areas were producing at ratios less than 1000 to 1 as of October, 1951. However, all but three of these wells had previously produced at ratios of 1000 to 1 or greater, but had had corrective work performed on them to lower their ratios prior to October, 1951. High gas-oil ratio wells, with casing set above the gas-oil contact at minus 330 feet subsea elevation, were not included in the colored areas except where the surrounding wells, with casing set below minus 330 feet, had also developed high ratios. These wells were not included because their producing intervals were open to the original gas-cap and therefore their high ratios could not be attributed to migration of gas-cap gas.

It is quite possible that there are wells within the colored areas which are not actually producing gas-cap gas. In localized areas certain zones within the Weber could be depleted to the point where the relative permeability to gas is sufficient to allow production of gas released from solution in the reservoir, in which case gas-oil ratios as high as 1000 to 1 would not be attributable to gas-cap gas. However, comparisons of cumulative withdrawals from several

structurally similar tracts situated within and outside the present high ratio areas show that in percentage of oil in place, cumulative production has been no greater within the high ratio area than outside. Furthermore, the reservoir pressure in the high ratio tracts is fully as great as it is in the tracts having lower ratios. Therefore, the only reasonable conclusion is that the excess gas produced from wells in the high ratio areas comes from the original gas-cap.

Nearly all the wells which were drilled in and near the gas-cap were completed with casing set well below minus 330 feet subsea, the elevation of the original gas-oil contact.

Furthermore, the interbedded shales and impermeable sand stringers which are common to the Weber sand would normally prevent any extensive vertical migration of oil or gas. Despite these conditions a large number of wells have developed high gas-oil ratios during the past three years. Referring to the map you can readily see that the high ratio area has developed generally on the southwest flank of the structure and in the vicinity of the major fault bisecting the field. As early as March, 1950, the 24 wells shown in brown had reached gas-oil ratios exceeding 1000 to 1, even though their producing intervals are all below the original gas-oil contact. Seven of these wells on the southwest flank had casing set 74 feet to 142 feet below

the gas-oil contact. On the north side of the structure some thirty wells with casing set from 0 to 70 feet below the gas-oil contact had not developed high ratios as late as October, 1951, indicating that no uniform expansion of the gas-cap has occurred. The only reasonable way to account for the early high ratio wells on the southwest flank is by vertical Downward movement of gas-cap gas to the producing intervals of those wells. In view of the absence of vertical permeability in the reservoir rock such vertical movement could have occurred only through fractures.

Furthermore, you will note from the map that the high gas-oil ratio area is developing in a pattern quite similar to the lost circulation area of the Mancos shale, which is also shown. It is possible that the forces which caused the fracturing in the Mancos shale have also caused fracturing in the Weber sandstone. This is substantiated through an examination made of records on Texas-Union Pacific wells situated within the lost circulation area of the Mancos shale. The investigation revealed that fracturing was present in 65% of those wells whose records were examined. Furthermore, the only Texas-Union Pacific wells in which lost circulation has been recorded while penetrating the Weber sandstone are located within that lost circulation area.

From the foregoing I have concluded that the high gas-oil ratio area has developed in the irregular manner

shown on Exhibit No. 1 and described above because of fractures in the Weber reservoir which permit vertical and lateral movement of gas-cap gas into well bores due to pressure differentials which exist under operating conditions. In moving through these fractures the gas must be by-passing the bulk of the oil which is contained in the pores of the sandstone; therefore, it cannot be an efficient oil-expulsive force.

The fact that cementing casing well below the original gas-oil contact has not prevented migration of gas-cap gas into the oil zone suggests that a general program of setting packers to exclude such gas would be equally ineffective. In addition, the setting of packers in the affected wells would exclude large sections of productive oil sand and thereby prevent the recovery of the reserves present in these zones. Attempts to control thismigration by shutting in wells within the area affected by the expansion would not only prevent the recovery of most of the reserves in that area, which amount to approximately 63 million barrels of oil, but would also result in accelerating the extension of the limits of the areas affected by gas-cap gas beyond present boundaries, thus involving additional otherwise recoverable reserves.

MR. WILL: That is all.

CHAIRMAN DOWNING: Thank you. That is a very nice presentation.

MR. ZORICHAK: May I ask the witness a question?

CHAIRMAN DOWNING: Yes. If anyone else wishes to ask this witness any questions they may do so.

Q. (By Mr. Zorichak) Mr. Pierson, how long has it been since the last well that was exposed to the gas-cap into the lower pays had corrective work done on it?

A. I think it was done within the past few months, that the last well was corrected.

Q. In other words, the gas-cap in the original gas-cap area had free access to the lower pays through that well on which corrective work has been done only recently. Is that right?

A. That is correct.

Q. Do you suppose there have also been several other wells in the gas-cap area on which packers have been set and successful shutoff attained? Is that right?

A. There have been successful shutoffs, yes, sir.

Q. But up until recently, when the last well was repaired, there has been continuous intercommunication and access from the gas-cap to the lower pays through open bores. Is that right?

A. Yes. However, I think that those wells were shut in at least a part of the time. They don't happen to be Texas-Union Pacific wells.

Q. 132 I have in mind particularly on which recently a corrective job has been done.

A. The casing on that well, I am sure, is cemented below minus 330 feet.

Q. Nevertheless, it was producing gas-cap gas. Is that right?

A. The indications were that there was gas-cap gas coming into the well through fractures.

Q. Now with the packer job on that well the gas-cap gas is excluded successfully?

A. It was a successful shutoff to date.

Q. Then, if that job had been performed, say, years ago, there wouldn't have been the opportunity for the gas-cap gas to intermingle with the lower pays. Is that right?

A. That is correct.

Q. Then, wouldn't it be a fair statement to say that this gas which has spread in various directions could have been caused caused by those several uncorrected wells which created access from the gas-cap to the lower pays?

A. Yes, that is substantially my contention, that it has expanded through fractures in the wells in the colored areas on the map.

Q. Is it also not a fact that one of the operators who has done extensive packer work has had fairly good success in reducing gas-oil ratios?

A. I believe they have on the wells where the work-overs have been performed. However, I believe they have

experienced some indication that the gas is merely being pushed to the other wells.

Q. But continuous observation and continuous corrective work might facilitate control of mygrant gas. Is that right?

A. I think that ultimately is the only control that would definitely halt that expansion, would be to shut the wells in. Because, as you get enough packers set in all of the wells, you have the same condition that you had before the expansion started to occur. You had pipes set through the gas-cap and it hasn't been successful in confining it at all. Therefore, I think when you attempt to set these packers you have the same condition and you have got the packers all in then the gas -- then you can start re-setting your packers, and ultimately you have to shut your wells in, I believe.

Q. Of course, the most ideal setup would be complete unitization and where wells with extremely high gas-oil ratios are closed in and production taken from such wells with a desirable gas-oil ratio but as long as we don't have unitization, don't you think it would be in the interest of conservation to continue the corrective work with packers to reduce high gas-oil ratios?

A. I do not. Because I think that the oil that you are placing behind those packers is far more valuable than the gas that you are attempting to conserve.

Q. Isn't that gas we conserve a source of potential

energy for driving oil to other wells?

A. There is a possibility that it can be so used advantage ously if the field is unitized.

Q. That is very desirable, I admit.

A. I agree.

MR. ZORICHAK: That is all.

CHAIRMAN DOWNING: Does the U.S.G.S. have any questions.

MR. FERGUSON: No.

CROSS EXAMINATION

BY MR. STAYTON:

Q. Mr. Pierson, this gas-cap gas that has been produced from these wells within the yellow and brown area, has at least performed the useful purpose, has it not, during production of pushing the oil ahead of it into the well bores?

A. I think it has done little good in that respect due to the fact that it is passing through fractures and in passing through fractures I don't believe it is an efficient oil expulsion force.

Q. If you should inject gas into the gas-cap area in large volumes and these fractures are present you would just aggravate this condition that you talk about? Is that correct?

A. That is my contention.

Q. Now, let us say that you inject gas through input wells outside of the gas-cap area and should encounter

some fracturing in that particular well, would you then expect channeling of that gas that you put into that in-put well?

A. I certainly would.

MR. STAYTON: That is all.

BY MR. McLAUGHLIN:

Q. Mr. Pierson, is it true that there are a number of wells that have been shot in the gas-cap area?

A. It is true.

Q. Is it feasible to set packers in those wells?

A. I believe it is. I would also like to point out that in shooting wells behind -- within the gas-cap area we are being very conservative in keeping the top of our shots well down the hole. And we are even more careful as a result of this study.

Q. Is that true of the wells that were shot early in the development?

A. There might have been some shots close to the gas-oil contact but I think the caliber of the runs show that you still might get a successful shutoff in a packer well.

MR. MCLAUGHLIN: That is all.

CHAIRMAN DOWNING: If there are no more questions of this witness, call your next witness.

(The witness withdrew.)

MR. KNOWLES: We have two suggestions for order number 3 and 4. We are going to hand them to you. While we are getting that distributed I might call attention to the fact that Mr. Winterburn has been sworn and re-sworn. He doesn't really need it again. He prepared this written statement.

READ WINTERBURN

a witness called by the Union Pacific Railroad Company, having been previously sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath testified as follows:

DIRECT EXAMINATION

BY MR. KNOWLES:

Q. Mr. Winterburn, you have a statement before you. Will you read it to the Commission?

A. Yes. (Reading) The Texas-Union Pacific considers rule 3 of the Commission's order number 2-1 --

MR. KNOLWES: Just a minute! For the benefit of those who were not present at the previous meetings, Mr. Winterburn is chief petroleum engineer for the Union Pacific Railroad Company.

A. (Continuing) -- objectionable for the following reasons:

1. It requires the shutting in of certain wells completely.

2. It reduces the efficiency of operations.

3. It is, in effect, a proration order rather than an order for the prevention of waste.

4. It subjects Texas-Union Pacific properties to drainage losses.

5. It has forced Texas-Union Pacific to curtail their production of oil, thereby causing them financial damage.

6. It requires that all excess gas be injected into the Weber formation, notwithstanding that such injection is completely impractical under competitive conditions and may damage ultimate recovery of oil.

7, Paragraph "e" relating to wells producing free gas from the gas-cap area is ambiguous. This provision should be revised tomake clear that it applies only to wells having the initial gas-cap open in the producing interval.

With respect to our first objection: Should the provision requiring the shutting in of all wells having a ratio in excess of 1,000 cubic feet of gas per barrel of produced oil be enforced it would result in the shutting in of 82 wells in the field. In my opinion, such a procedure would prevent the recovery of a large quantity of oil which would normally be produced by the wells shut in, because only a portion of the oil denied these shut-in wells could be recovered by other wells in the field. In addition to the

loss of this oil there would be a loss of the liquid petroleum products which are derived from the gas produced with the oil. The portion of this oil which would be recovered by competitors' wells would represent drainage losses.

Concerning our second and third objections; namely, that the rule reduces efficiency of operations and is, in effect, a proration order: Limiting the gas production from each well to 150,000 cubic feet per day has the effect of prorating oil production from wells regardless of their efficiency. Also, such limitation creates adverse drainage conditions in cases where it results in curtailing the rate of oil production on one property while permitting production at higher rates on adjoining properties. A low gas-oil ratio well will produce efficiently regardless of the rate at which it produces. Thus the imposition of an arbitrary gas production limit on such a well could have no connection with the prevention of waste. Under rule 3 a well with a 600 cubic foot per barrel ratio would be limited to 250 barrels of oil per day despite the fact that it might be capable of producing twice that amount of oil with the same efficient ratio.

The enforcement of rule 3 would, under certain conditions, actually result in reduced over-all efficiency as measured by the amount of gas used in producing a barrel of oil. One example which illustrates how efficiency would be reduced thereby is the case of two wells producing from a

common reservoir, one of which wells has a gas-oil ratio of 500 cubic feet per barrel and the other a gas-oil ratio of 2,500 cubic feet per barrel. The application of rule 3 would permit an oil production of only 300 barrels per day from the low ratio well and of 60 barrels per day from the high-ratio well, or a total from the two wells of 360 barrels per day, with an average gas-oil ratio of 833 cubic feet per barrel. However, if rule 3 were modified to permit unrestricted production from low-ratio wells the low-ratio well could then be produced at its assumed capacity of 600 barrels per day and the high-ratio well would remain restricted to 60 barrels per day. The two wells together would produce 660 barrels, with an average gas-oil ratio of 682 cubic feet per barrel. This example, showing how more oil can be obtained with a lower gas-oil ratio under a modification of rule 3, clearly shows that the application of rule 3 results in proration of oil production from low-ratio wells and causes a decrease in over-all operating efficiency.

Another example of how the application of this rule would result in decreased efficiency is found in the fact that by restricting production of the more prolific areas, where pressures are already higher than those in areas where smaller producers are located, the undesirable pressure differentials already existing between various parts of the reservoir would be increased. In addition, the injection of

gas into these high pressure areas would further accentuate the pressure differentials.

Turning now to our fourth and fifth objections to rule 3, dealing with the adverse effect which the rule has had on the Texas-Union Pacific properties: The Texas-Union Pacific companies complied with rule 3 and operated under it during the first three months of 1952. This resulted in damage and financial loss by forcing them to curtail the amount of oil produced from their properties to less than their normal market outlet. The original tender for the month of January, 1952, was 13,430 barrels per day for the Texas-Union Pacific properties, and definite commitments were made for the delivery of that amount of oil. However, the application of rule 3 made it necessary to reduce the rate of oil production from the Texas-Union Pacific properties, and as a consequence they produced, during the first three months of this year, 110,000 barrels less than their normal market outlet as indicated by their tender for January. This curtailment in production resulted in a decrease in oil revenue of $280,000.00. Furthermore, operators on adjoining properties were able to produce certain portions of their properties at higher rates, and as a result Texas-Union Pacific lands were subjected to adverse drainage and permanent loss of a portion of the curtailed production.

Concerning the sixth objection, which is directed against the requirement of the rule that excess gas be in-

jected into the Weber zone: Unless an operator curtails his oil production, rule 3 as now written forces him to inject excess gas into the Weber zone regardless of whether the reservoir conditions on his property are favorable for such injection and even though the injection of gas into the reservoir beneath his property may actually cause him damage.

It has been brought out in the plan of operation submitted for the Commission by Texas-Union Pacific, as well as in my testimony before the Commission November 29, 1951, that the low average permeability of the sand, lenticularity of the permeable lenses, and the presence of fracturing in the Weber zone render it highly improbable that any benefit to ultimate recovery will result from gas injection and that the possibility actually exists that ultimate recovery will be adversely affected thereby. Such loss will result because of the very thick producing section of the Weber and the wide variation in permeabilities and because of the presence of fracturing, which would be conducive to by-passing and blow-through of the gas from the injection well to the producing wells. This would result in only a small portion of the more permeable parts of the Weber being affected by gas injection and would prevent the production of all oil from all those portions not actually swept by the injected gas. It is probable that the only way in which much of the oil from tight lenses and layers will reach the wells is by

entering more permeable channels and passing to the wells through them. If gas injection results in depletion of only these permeable channels and develops high gas saturations in these channels before the oil is depleted from the tighter portions of the reservoir, most of the oil in these tighter portions may never be recovered because the high gas saturations in the permeable channels will reduce the oil permeability to such an extent that the passage of the oil through these channels to the well will be prevented.

Mr. Pierson's study of the expansion of the initial free gas-cap indicates that the gas has moved both laterally and vertically through fractures. The affected area coincides with areas of fracturing in the Weber sandstone which have been delineated by occurrence of lost ciruclation, presence of known faults, pressure behavior, and water encroachment.

The area of fracturing covers most of the original gas-cap area in the central portion of the field and a considerable portion of the original gas-cap area in the west block proposed as a separate unit by the California Company in their alternate three-unit plan. This situation makes it probable that attempts to inject all the gas at the top of the structure would be accompanied by much more pronounced by-passing than has occurred in the experimental injection wells being used by the Texas-Union Pacific and California companies, both of which are located well outside the area

of pronounced fracturing.

The latest available production data shows that the eight wells in the first line of offsets surrounding injection well UP 57-21 are producing about 662 barrels of oil per day with a weighted average gas-oil ratio of 1,347 cubic feet per barrel, which represents more than a four-fold increase over the ratio at which ratio these wells were producing prior to the beginning of injection about fifteen months ago. Also, a substantial increase in gas-oil ratio has taken place in three second-line offset wells during the same period. These wells are UP 15-28 whose ratio has increased from 594 to 1200; UP 31-21, from 400 to 1622; and and UP 64-22, from 290 to 915. This performance indicates continual by-passing of the injected gas.

Five of the direct offsets to the California Company's injection well have shown abnormal increases in gas-oil ratios. The average ratio of these five wells has increased from 209 cubic feet per barrel immediately prior to injection to 1,014 in February, 1952.

The average ratio of the eight direct offsets has increased from about 200 cubic feet per barrel to 695 cubic feet per barrel during the same period.

I might say that increase from209 to 1,014 is not included in that yellow area but it is a fourfold increase.

43-28, directly south of 28 is in excess of 1,000

now but it is impossible to determine which way the gas is moving.

Although the present average gas-oil ratio of the first-line offset wells surrounding the Texas-Union Pacific injection well is much higher than the average ratio of the wells offsetting The California Company's injection well, the percentage increase in each case since injection started is nearly the same. In other words, the Texas-Union Pacific wells have shown about a 300% increase, whereas The California Company wells have shown about a 250% increase in their gas-oil ratios. Our estimates indicate that during the month of February, 1952, about 28,000 Mcf. of by-passed gas was produced by first and second line wells surrounding the Texas-Union Pacific injection well, or about 85% of the injected gas. During the same month about 29,000 Mcf. of by-passed gas was produced by wells surrounding the California Company's injection well, or about 86% of the injected gas.

The results of the study of gas-cap expansion, as well as the performance of the experimental gas injection wells, strengthen our contention that the Weber zone reservoir as a whole is not adapted to pressure maintenance by gas injection; and it is still our opinion that the only effective means of recovering the available oil will be to reduce the reservoir pressure prior to attempting any means of secondary recovery, and that probably the most efficient

secondary recovery method will be water flooding applied at the proper stage of pressure depletion. Even though it should be found that certain portions of the reservoir would respond satisfactorily to gas injection it would be impossible, unless the field were completely unitized, to inject gas into those portions without causing damage to operators in the remaining portions of the field.

Since full-scale injection of gas into the Weber is undesirable, the only other means by which the gas now being flared can be conserved for future sale or other use is through its storage in some other formation, or in some nearby gas field.

As to our seventh objection, with respect to paragraph "e" of rule 3: This paragraph requires that all wells producing free gas from the gas-cap area be shut in or corrective work performed to exclude such free gas. The language used is ambiguous. If it is intended to apply only to wells having the initial gas-cap open to production in the producing zone it should be revised to so state. Thisis the interpretation which we have placed on the paragraph, and we assume that it conforms with the Commission's intentions. However, if the paragraph is interpreted to apply to any well to which free gas from the gas-cap has migrated, it would require shutting in many wells which have only oil sand open to production. This in turn would prevent the recovery of

a large part of the normal future production of these wells, which amounts to about 63 million barrels.

Furthermore, if these wells were shut in, migration of the free gas into other wells not yet affected would be accelerated, and the number of wells required to be shut in would be rapidly multiplied. Inasmuch as the free gas has channeled into the oil-bearing portion of the Weber, performance of corrective work by setting packers to exclude gascap gas from producing wells would have the same effect as shutting in wells, in that it would be necessary to place normally productive oil sands behind the packers in order to exclude the gascap gas. Again after such exclusion the movement into as yet unaffected portions of the oil zone would be accelerated.

From the foregoing it can be seen that application of this portion of rule 3 under the second possible interpretation mentione dwoud cause reductions in ultimate recovery of oil in amounts far greater than the estimated theoretical increases to be derived from pressure maintenance, and thus would actually result in waste.

The foregoing, in general, explains our objections to the Commission's rule 3. Texas and Union Pacific have prepared a substitute rule 3 which we believe will alleviate the objectionable features of the Commission's rule, and which we recommend be adopted. Our proposed rule is set out in full in our Exhibit No. 4, now No. 2.

Our suggested rule 3 provides that the permitted gas-oil ratio for each well shall be established quarterly and shall be twice the average field-wide ratio for the field for the three-month period ending sixty days prior to the beginning of the quarter. It also provides that wells producing above these permitted ratios shall be restricted to 150 times the permitted ratio. Wells producing below their permitted ratio will be unrestricted.

The suggested rule 3 also contains a revised paragraph "e" which is so worded that its prohibition against production of gas-cap gas applies only to wells whose producing intervals extend into the initial gas-cap.

It was brought out in testimony by Mr. Vitter, of The California Company, and by Mr. Kaveler, of Phillips Petroleum, in the hearing before this Commission November 14, 1951, that a depletion type reservoir such as the Weber zone at Rangely it is normal for the produced gas-oil ratios of the field to increase as the field is depleted and that the permitted ratios should be increased from time to time to permit normal operation of the field. At the time ofthis previous testimony the suggested permitted gas-oil ratio of 1,000 cubic feet per barrel of oil was approximately twice the average field-wide gas-oil ratio. Our suggested rule provides in effect that the permitted gas-oil ratio retain this relation ship to the field-wide ratio and automatically

results in the necessary adjustments each quarter without requiring hearings to be held and revisions to be made in the rule.

While our suggested changes in rule 3 will eliminate many of the objectionable features of the present rule, nevertheless it must be realized that the Weber reservoir at Rangely is operating as a depletion type reservoir, without gravity segregation or water drive. Under these conditions there is always a natural increase in gas-oil ratio during production, due to increasing relative permeability to gas, and it is not possible to produce such wells without experiencing such increase. Thus it can be seen that what will be an excessive ratio for one well might be a perfectly normal ratio for a well in a more advanced stage of depletion. For this reason it is my opinion that a large portion of the oil remaining to be recovered can only be produced by continuing to produce each well, even though the ratio of many of the wells may exceed whatever arbitrary limit is imposed. The true efficient ratio for individual wells will vary widely, depending on structural position, character of the reservoir surrounding the well, cumulative production from the well, and other factors. It is quite likely that we will eventually find that any attempt to impose arbitrary gas limitations will interfere with the recovery of available reserves. Nevertheless, we are agreeable to the application

at this time of our suggested gas rule. Of course, the whole plan of operation should be reviewed and proper rules formulated when unitization of the field is accomplished.

We also have a change to suggest in rule 4 of the Commission's order No. 2-1 to provide for the testing of each well by the operator at least once every month, in addition to the witnessed test required in the present rule to be performed every six months. Texas-Union Pacific Exhibit No. 5, now No. 3, contains our proposed rule 4 in full. The change which we suggest is based upon the fact that there is naturally considerable variation in the gas-oil ratios as determined by individual tests, and in order to judge whether the semi-annual test is truly representative, the examination of a number of tests performed at frequent intervals is required. One test each month is the minimum requirement for intelligent operation of producing wells.

MR. KNOWLES: Is there anything further you would like to add to your statement?

A. No, there is one thing that might be of interest, and that is the method of calculating the excess gas, the amount of circulated gas being produced. That was done by determining what the normal ratio of these areas would be without injection. And to do that, a line of wells were selected from the same structural position here (indicating on map) in ratio of that line computed and another line in here

and a third one out there. We determined the ratio of this area (first), between these two lines it was used and the other between this central line and the easterly line used here. That resulted in a normal -- computed normal ratio here of 294 which is a little less than 50% greater than it was 15 months ago when injection and computation started, and here 60 or 40% greater than the time injection was started. Since these increases obtained in this way are so much greater or at least equal to the increase in the field as a whole, we consider the computations of the by-passed gas in this manner to be conservative.

Q. (By Mr. Churchill) I believe you stated that rule 3, suggested by Texas-Union Pacific, provides that wells producing with a ratio greater than the permitted ratio shall be restricted to 150 times the permitted ratio?

A. Yes.

Q. While your proposed rule is set out in full, nevertheless, for the record, in connedtion with your testimony, does not that suggested rule permit those wells exceeding the permitted ratio to produce more than a daily gas limit of 150 times the permitted ratio under certain circumstances?

A. That's right. In my remarks I failed to mention the feature that permitted such wells to produce in excess of this permitted amount providing the excess is injected

into the Weber zone or into a suitable storage reservoir. Also, when an input well is used for injection, the rule would permit the 150-times-the-permitted-ratio to be transferred from this well to the producing wells.

CHAIRMAN DOWNING: Are there any more questions?

CROSS EXAMINATION

BY MR. RICHARDS: Stanolind.

Q. I notice in your statement, Mr. Winterburn, that you say that the 150,000 cubic feet limitation on every well in the field creates adverse drainage conditions. In the case where it curtails the production of oil of the one producer, permitting a higher rate of production on an adjoining property, did you object to that adverse drainage condition? and do you propose a rule whereby the low gas-oil ratio well will be allowed to produce 6,000 barrels a day and you do not object to that adverse drainage condition?

A. No, that is normal production of the field as a depletion type reservoir and there is no intention in any of those rules to deal with adverse drainage but where a rule actually causes adverse drainage without preventing waste it is certainly not applicable.

CHAIRMAN DOWNING: Are there any more questions?

BY MR. ZORICHAK)

Q. Mr. Winterburn, this map does not indicate the wells in which packers have been set to correct gas-oil ratios here in this area, on the southeast of 28, wells 13, 11 and

57 have packers and the gas naturally is available to the upper pays. Do you suppose that all of this yellow area, above, is due to the injection rather than intercommunication evenwith the gas cap here?

A. Well, I stated that 43-28, that red line there indicates the wells that have developed a thousand ratio after October -- that is, they hit a thousand ratio in February of this year -- 43-28 is in question for that reason. But aside from that one well there is no question in my mind that the rest of it came from the injection well.

Q. Yes. The more recent map drawn on high gas-oil ratios show this oil area is intercommunicating now?

A. Yes, that may have occurred in February if you take it through 43.

Q. Yes.

A. But anything that happened before that was independent, I am sure.

Q; If we should permit this field to produce under natural depletion methods with the natural drop in reservoir pressure, wouldn't you have practically the same conditions of gas caps and gas areas by the evolution of gas from the oil in the reservoir with even lower pressures and with resulting lower pressures in the reservoir whereas if the gas is re-injected into the Weber your pressures would be maintained and instead of the gas in the gas caps being gassive

solution it would be injected gas and the injected gas would have kept the gas in solution in the oil in place?

A. That's right. And the injected gas would have also prevented the oil from reaching the producing wells if the prossure was maintained. That is the main objection to injection. You inject and your system affected by injection probably constitutes 5%, or something of that order, of your permeable reservoir which will produce oil. You maintain pressures in that 5% and prevent the rest of it from reaching the wells.

Q. But isn't it a fact that the oil is produced by virtue of differential pressures?

A. That's right.

Q. Then if we permit this reservoir to drop in pressure as time goes on we have less and less potential energy to drive the oil. Isn't that right?

A. You can't produce the oil without using energy.

Q. Then if we should re-inject gas we would partly maintain pressure in the Weber reservoir, wouldn't we?

A. Yes.

Q. We would?

A. In part of the Weber reservoir.

Q. Then wouldn't it be possible by control and packer use to take advantage of such energy as is supplied by injected gas and ultimately produce more oil?

A. Well, it has been our conclusion from the date that was developed so far and produced in the field that I think the difference we may have in there in speaking of energy is that we consider even though you might conserve this energy and have this pressure confined in a small part of the reservoir that there is no way under the reservoir conditions here that you can effectively use that energy in that -- that additional energy -- in building up the energy by expelling oil from the sand. If you can't expell the oil from the sand you are wasting your time and you may cause a lot of damage.

Q. There might be some difference of opinion on that, some think that we can't say absolutely. That will be all. Thank you.

REDIRECT EXAMINATION

BY MR. STAYTON: SHARPLES:

Q. Mr. Winterburn, in order that I may understand your testimony, I take it that you believe if gas is put back into the Weber well or zone we will assume, for the sake of my question, put back into the gas-cap area, that that gas is going to find or at least for the most part will find its way to the well bores through the permeable section. Is that right?

A. Permeable section or fractures.

Q. Or fractures. And that when gas saturation in that fracture or section reaches a certain point it no longer will

permit the production of oil through it. Is that correct?

A. It will greatly impede the movement of oil through it.

Q. And through thatprocess, in your opinion, there will be more oil left in the reservoir than would have been left if you hadn't tried the injection process in the first place. Is that correct?

A. That is my opinion.

Q. Now, in a solution gas drive field of this type, is it your opinion as an engineer that in order to prevent underground physical waste -- I am talking about underground physical waste now -- that you realy need any gas-oil ratio limit at all provided you have done the proper corrective work in your well and not produced them into the open from the gas-cap?

A. I think any uniform arbitrary limit is just -- it is not able to determine any limit that would be applicable because the conditions are so widely variable that in order to get the oil out you are going to have to produce that thing as a depletion type and not exceed the natural expansion of the fluids in movement toward the wells.

Q. In other words, if you are going to produce a field as a depletion type reservoir, this gas solution drive field provides depletion through primary methods -- secondary recovery methods being out -- it is your opinion

that the only way you can get the oil out is to get the gas and gas-oil ratios are going to increase and really, in so far as the preservation of underground reservoir energy is concerned, you don't think there is any need for any gas-oil ratio?

A. That's right.

Q. (By Chairman Downing) What do you think can be done or ought to be done in there to increase ultimate recovery from the field?

A. I think the field should be produced through its normal primary stage to a relatively low stage of pressure depletion and in the meantime all the available information should be gathered relative to water flooding and preparations made for that. And make investigations and all preliminary work and even some pilot injection during the primary stage. Then when the proper time comes to institute a water flooding project, if everything you have done in investigating it up to that time is favorable. I think there are many favorable factors here for water flooding.

Q. By this normal process, as I gather, you would expect to recover about 20%, is that right, of the entire oil in the reservoir?

A. Yes, something on that order.

Q. Do you think that is about the maximum that can be recovered?

A. No, I think you can get a very large increase in water flooding after that.

A. Except by water flooding?

A. That's right.

CHAIRMAN DOWNING: Are thereany other questions?

Q. (By Mr. Stayton, Sharples) Isn't it a fact, Mr. Winterburn that there are oil fields that you can not put a secondary recovery project in until you reach a water flooding stage?

A. I think so.

Q. And this is one of them, in your opinion, is that right?

A. Yes.

Q. (By Mr. Zorichak) Mr. Winterburn, wouldn't we encounter the same obstacles in water flooding that we would be encountering in gas injection?

A. That would limit to some extent the amount that you would recover as it would still be channeling of water and certain portions of the reservoir would be by-passed. But by careful control and I think it would probably be necessary to conduct a divers drive or five-spot all over the field, injection wells, and maybe restricting the intervals in which the water is injected, but you could affect a large enough percentage of the reservoir volume there to make very substantial increases in the ultimate recovery.

Q. Wouldn't also a water drive program be considerably more expensive than a pressure maintenance program with gas?

A. Well, that is hard to answer. Of course, when you speak of the cost of a pressure maintenance program of gas, starting now, it isn't too great. But for the amount of by-passing that has occurred both in the initial gas-cap migration and in the injection wells, there is no doubt at all that full scale injection there would be accompanied by extremely rapid increases in the field ratio. And I would anticipate that before you got very far in your pressure maintenance program with gas you would have such tremendous quantities of gas to compress that you would back off.

Q. (By Mr. Sargent) Mr. Winterburn, I have a couple of questions. Are you familiar with the facts in the record as to the amount of gas that is being flared daily at Rangely?

A. Approximately.

Q. Am I not right that there is between 17 and 20 Mcf. of gas being flared daily?

A. Yes.

Q. Now, is it the position of the U. P. that that does or does not constitute waste?

A. That is a legal opinion. That doesn't require a technical answer.

Q. What is the position of the Union Pacific on that problem?

A. Well, under the Act, as I understand it, and this

can be amended by the attorneys, the burning and blowing of a reasonable amount of gas produced with the oil does not constitute waste. And, since the Rangely field is not being wastefully produced, I don't think it could be said to be waste.

Q. Then, following on further, as I under stand your proposed order, am I not correct that you propose that the Commission set a gas-oil ratio of a thousand to one? Is that correct?

A. Well, around eleven hundred; twice the field ratio.

Q. As to the gas wells produced with a gas-oil ratio of less than that, your suggestion is that there wouldn't be any limitation then on the amount of production of gas. Is that right?

A. Yes.

Q. Now, as to the gas wells that produce with a ratio in excess of that, your suggestion is that there be a limitation of 150 times the ratio. Is that right?

A. Yes.

Q. Well, now, Mr. Walshe, in his opening statement, suggested so far as the California Company is concerned that the Commission limit the production of wells with a gas-oil ratio in excess of a thousand cubic feet per barrel of oil to 150,000 cubic feet of gas.

A. Yes.

Q. Per day?

A. Yes.

Q. What would be the effect of such an order as that on the Union Pacific?

A. We haven't computed the exact factor or attempted to estimate it. But it would be much more acceptable to us. We could operate in a much more normal manner under such a rule than we can under the rule that has just been in effect.

Q. To what extent does your proposal differ from the California Company's?

A. Well, as far as the ratios are concerned, it differs in that instead of a thousand cubic feet per barrel we would set the permitted ratio at twice the field ratio which would be closer to a 1200 cubic feet per barrel. Then it differs in the amount of credit allowed for gas stored in storage reservoirs rather than being injected into the Weber zone.

Q. And your limitation would be 150 times the permitted ratio rather than 150,000 cubic feet?

A. Yes.

Q. Per day?

A. That's correct?

MR. SARGENT: That is all. Thank you.

Q. (By Mr. Churchill) Your proposed rule would also make the permitted ratio self-adjusting, would it not?

A. Yes, it would automatically change the field ratio

and make the adjustment to normal operation automatic rather than requiring frequent hearings to be held to change that.

Q. In what direction would the adjustment probably be made, in your opinion?

A. Upward or downward. The field ratio will continue to change as long as it continues to produce.

CHAIRMAN DOWNING: Are there any more questions? It is now twenty minutes after twelve. I assume you all want to finish today. I would like to ask how long do you want to argue the case?

MR. CHURCHILL: You understand we have some additional witnesses?

CHAIRMAN DOWNING: Yes. I was just trying to figure out the time.

MR. SARGENT: Chairman Downing, might it now not be well to suggest that the interested parties be given an opportunity to file written briefs if they desire? That will eliminate the necessity of argument here.

CHAIRMAN DOWNING: If they desire, of course. Mr. Knowles, would something like that be desirable?

MR. KNOWLES. Yes, if the other people would like to do that. If we are pressed for time we could probably eliminate any argument this afternoon at all and present a memorandum within some future stated time.

CHAIRMAN DOWNING: Let's come back then at 2:00 or 1:45 o'clock this p. m.

(Whereupon, at 12:20 o'clock the hearing was recessed until 1:45 o'clock this afternoon.)

The hearing convened at 1:45 o'clock p. m., Tuesday, April 15th, 1952, pursuant to recess.

CHAIRMAN DOWNING: The hearing will come to order. You may call your next witness.

MR. KNOWLES: We didn't attempt to apply to the California Company in regard to this matter of unitization but we certainly want it well understood that the Union Pacific and Texas Companies are doing their best in cooperating in the matter of unitization and it is important that we have Mr. Lee S. Osborne who will state authoritatively as a witness for the Union Pacific their position.

CHAIRMAN DOWNING: On this qestion of unitization, it just occurs to me that after all the only thing that stands in the way of unitization is a determination of an appraisal, isn't it? In other words, here are people who have a divided ownership or that they want it into an undivided ownership and that is not only an appraisal but it is an appraisal of one property compared with the other. You fellows can't agree. But there are appraisers, men like Joe Collins and his firm. Why don't you get together and employ a firm of that type to make this appraisal for you. I don't know who is going to win or lose. I have confidence in their fairness and I think you have. I throw that out as a suggestion to you. I see no excues for not going it.

MR. KNOWLES: It is hard to get a meeting of the minds.

CHAIRMAN DOWNING: Business transactions come up almost every day in which the question of value appears. And that is the last thing we fight about, because there is always an appraiser. If we don't know we get an appraiser. And sometimes when we think we do know we have a dispute and we get an appraiser and generally the appraisers know more about it than we do and if you get a good one he is fair. Why can't you fellows join in selecting one or three appraisers. That is all that stands in the way of it, isn't it?

MR. KNOWLES: I think that is one of the questions that Mr. Osborne will perhaps give you some type of an answer on.

MR. OSBORNE: Do you wish an answer at this time or wait until I finish?

CHAIRMAN DOWNING: If you want to. I make that suggestion to you.

MR. KNOWLES: He may answer that at the end of his testimony which we want to get from him.

So that you all know who he is, he is president of the Union Pacific Railroad Company.

LEE S. OSBORNE

called as a witness in behalf of the Union Pacific Railroad Company, having been previously sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath stated as follows:

DIRECT EXAMINATION

BY MR. KNOWLES:

Q. Mr. Osborne, you have had considerable experience in the oil development business, have you not?

A. As assistant to the vice president in charge of oil development, yes, I have.

Q. Are you a technical man yourself?

A. Yes, I am a technical man.

Q. What has been your experience as a geologist?

A. I was employed 15 years as Shell Petroleum Company's petroleum engineer and manager.

CHAIRMAN DOWNING: There is no question as to his ability.

MR. KNOWLES: I wanted to let everyone know that if he gives an opinion here he isn't just pulling it out of thin air.

Q. (By Mr. Knowles) Mr. Osborne, you have reduced your testimony to a statement, have you not?

A. Yes.

Q. Will you read it?

A. Yes, I will.

MR. KNOWLES: We have no copies of this to distribute. Proceed, will you?

A. In response to the order of this Commission, Union Pacific Railroad Company and the Texas Company jointly submitted their plans for measures necessary to prevent waste

of oil and gas including a plan for injection of residual gas into formations in the Rangely Field and to bring about maximum ultimate recovery.

In that submission, we also stated the difference between the parties which so far prevented agreement upon a common plan. Copies of our plan were sent to the other Rangely operators and I will not take the time to repeat our complete proposal.

However, it included certain matters that I would like to discuss briefly at this time. Almost from the beginning of the development at Rangely there has been more gas produced than has been used in the operation of the field or than could be disposed of through local sales. And the possible use of this gas for injection into the Weber formation as a means of increasing ultimate recovery has been considered.

In considering full scale injection, it has always been assumed that such only will be carried out under unit operation. However, it was also recognized that because of Weber reservoir conditions full scale injection into the Weber would be unwise without first determining whether the reservoir was suitable for such a program.

With this in mind an experimental pilot gas injection project was instituted by the California Company and Texas and Union Pacific and is still in progress. As Mr.

Winterburn pointed out, the result of the pilot gas injection program became more and more discouraging and while we plan to continue it a little longer we now have small hope that the final result will encourage any expansion of the experiment. It is possible that under unit operation through the careful selection of zonal intervals into which gas would be introduced and proper selection of withdrawal wells some benefit might be realized throu the injection of gas into the Weber at the proper stage of completion. Unfortunately wishful thinking rather than sound reasoning seems to have progressed to the point where not the results of gas injection into the Weber are considered in terms of proven benefit rather than possible benefit. This wishful thinking has completely overshadowed all other considerations so that the effect of full scale injection of gas into the Weber might actually be detrimental to all manners of recovery is wholly ignored or blindly pushed aside.

Certainly any requirement for injection of all excess gas into the Weber formation at this time without unit operation would result in an indiscriminate, ill--planned, uncontrolled project and without due consideration of its effect on various properties as well as all ultimate production from the field as a whole.

We appreciate the problem of flaring at Rangely and are most willing to cooperate in its elimination. However,

we will most vigorously oppose being stampeded into a full scale Weber injection -- Weber zone injection program at this time. In the meantime, inorder to eliminate the flaring of excess gas I point out that we have always advocated the storing of the excess gas and have suggested the Dakota as being a suitable reservoir. However, the nearby gas fields of Piceance Creek or Douglas Creek or the recently discovered Johnson might be equally suitable for storage.

We strongly advocate and alwyas have strongly advocated unitization of the Rangely Field as a single unit. And we assure this commission we will give every effort to expediting unitization; not only because of secondary recovery features but for the general benefits that are inherent in unit operation. We consider the formation of a single field-wide unit as necessary before any secondary recovery program can be initiated. We are opposed to any multiple unitization which in itself will continue the very evils sought to be avoided by unitization. Under a multiple unit plan the separate units would necessarily be operating competitively and there would be no basic change in the situation which now exists.

It is most difficult if not virtually impossible to divide the Rangely Field into units where all would be equally affected by secondary recovery operations conducted individually by each unit and where each unit could maintain

a share of production in keeping with its reserves.

It has been suggested that the formation of three units would be a temporary measure with the three units eventually being combined into a single group. At the present time, any attempt to combine the three units into a single unit, we would be again faced with fixing participating interest. This problem would then be much harder to solve because of the fact of interim operations involving gas injection into the Weber and attending problems resulting from gas production limitation would have distorted the values of the area compared with present true values.

It is certain that the operation of the Rangely Field on multiple unit basis would have the effect of penalizing one unit in relation to other units and thereafter the opportunity of the penalized unit to secure its fair position in the single unit would be non-existant.

Early in the life of the Rangely Field, when consideration was first being given to the use of the excess gas for injection into the Weber, it was recognized and said the program would require unitization and many meetings have been held by Rangely operators in arriving at mutually agreeable permanent basis for all involved. Originally an attempt was made to establish a permanent basis on a number of considerations such as involve oil in place, volume of oil, which might be recovered, respective land holdings of each operator and many others. However, because of the many

factors involved in each consideration and the different weights placed upon the values of each factor by each operator, all efforts failed in attempting to arrive at a common agreement.

The California Company has submitted a plan for a single field-wide unit and in this plan they have come forth with a new proposal for determining percentages of participation. We are in full accord with the basic principles of their proposal.

They propose "fixed participating percentages be established for each of the properties for each of the four years 1952 to 1955 inclusive; that these percentages shall be that ratio which the estimated future yearly production from each property bears to the estimated future yearly total field production for each of these four years. And that the ratio so determined for the four years shall constitute the fixed percentages for the property for the remainder of the life of the unit.

Their plan as proposed included some features to which we had strong objection, and these were outlined in our submission to the Commission on February 9, 1952. Nevertheless, we so strongly advocate unitization that we are fully confident the features to which we took exception can be reconciled if the percentages can be agreed upon.

I believe you are all aware of the difference be-

tween the percentages set forth by the California Company and the percentages as calculated by Texas-Union Pacific. I shall not go into the technical aspect of these calculations. However, briefly, the percentages proposed by the California Company were based upon forecasts of production calculated by a group of engineers of four of the Rangely operators in December of 1950 at which time certain assumptions were made regarding the productivity of the Texas-Union Pacific wells. We considered these assumptions to be erroneous but our objections were disregarded. We thereupon prepared our own forecasts for the operators and they were shortly thereafter advised as to our position.

In 1951 the productive capacity of each Texas-U. P. well was accurately determined by tests and the results proved the assumption used in December of 1950 were incorrect. Our actual production in 1951 also proved that those assumptions were in error. In January of this year we again made a forecast of production for the five principal operators in the field. And in making this forecast, we used the same basic principles and methods followed by the engineers in December of 1950 and which is proposed by the California Company. The only change which we made was the substitution of the correct productive capacity figures for Texas-U. P. properties. We recommended that others use the corrected, up-to-date data in estimating the future production

from all properties. But to no avail. Notwithstanding, such information prooved the forecast proposed for use by the California Company was erroneous. And certainly self evident. Texas-U. P. can not be expected to submit to an erroneous forecast merely because that forecast has been made.

Despite the difference in percentages as proposed by the California Company and the Texas-U. P., all operators at Rangely agree that unitization is advisable and we are ready at any time to further negotiate for arrival at percentage participation figures that will be agreeable to all.

We recognize, and I am sure the other operators recognize that if such attempts are to be successful, the thing must be realistic and we must all be prepared to make reasonable concessions.

Q. Do you have any other remarks that you wish to make at this time? If not we will submit him to examination unless you have an answer to make to the Chariman's question.

A. I thought possibly that would answer Mr. Downing's question. But if it doesn't I will explain further.

CHAIRMAN DOWNING: It doesn't. Will you agree with the others if they will agree to appoint an appraiser? I will suggest Mr. Collier Naughton to determine the relative percentages of the several interests.

A. We would submit to arbitration only as an extreme

last resort and I don't think we have reached that spot yet.

Q. (By Chairman Downing) Aren't we pretty clost to the last resort now?

A. I may be optimistic about it but I don't think so.

Q1 You have hopes now of unitization?

A. I think now, as I said, if everyone of us takes a realistic viewpoint of it and is willing to make reasonable concessions that we could get together. And we would be very happy to try to do that at any time.

Q. Might I ask you, as far as I understand you, you have contended for 21%? Now, I know that you are not going to make very much of a concession, but is that inflexible? or are you willing to make concessions?

A. It is not inflexible. As I stated in the last sentence, we are willing to make reasonable concessions and I think that when you consider ours is set forth as 20% or 21%, the California Company is 56%. If the California Company willmake 1/2 tims as much of a concession as we make, we'll get together.

Q. 2 1/2 times. Well, let'ssee. The difference is 18% and 21%?

A. Theirs is 50 and ours is 21; about 2 1/2 times as much interest in the field as we have.

MR. KNOWLES: If you have no further questions along this line we will submit him for cross examination?

CHAIRMAN DOWNING: I want to ask one or two.

(The Honorable Dan Thornton, governor of the State of Colorado, entered the hearing at this point and examination of the witness was recessed.)

CHAIRMAN DOWNING: I believe the Governor needs no introduction to this audience. I doubt if the oil industry realizes the extent to which it is indebted to Governor Thornton for our oil and gas conservation law.

I feel certain that if he hadn't been an ardent enthusiast of conservation and hadn't known a very great deal about the oil business and hadn't presented this in the proper frame to the legislature, we wouldn't have any law at all. I take this opportunity to give him the thanks he deserves for a very substantial part he played in the passage of the law we have..

I might say further, Governor, that we are here engaged in probably the most important job we will have. As you know, we have the Rangely Field under consideration at this time and are in the midst of the hearing. Just as you came in we heard one of the participants give us a very splendid talk about the possibilities of unitization. That means a compromise and getting together. They can accomplish a great many things through unitization that we could not accomplish through any orders that we may make.

I noticed recently that a high executive -- really

a higher executive than governor -- made an order that not only told the industry what to do but took over their whole darn business. Now, maybe you might have to do something like that and get these fellows together and bump their heads and if we do we will call on you.

Governor, will you say a few words, please?

(Applause)

GOVERNOR THORNTON: Mr. Downing, you certainly do me undue credit. I know there is far more intelligence on a subject than I have and that I accord to you gentlemen here in the room.

Mr. Downing, I think I am a very good friend in that I don't agree with the "super gentleman" when it comes to taking over an industry. Some people do not respect individual limits and personal rights.

I think that we here in Colorado today are at the beginning of a greater era with plans on one thing and another that will insure a great industry for this State. I for one have always believedthat instead of deterring the individual or the company that is trying to develop, you should aid them if possible. I still believe this State of ours is one of the greatest places in the world from the standpoint of its natural resources.

It would seem the job of we people, not only who live in Colorado but those who invest their money here,

should be in a long term plan as to how we can return most to the people who are directly in the oil business. That calls for thinking. It calls for the conservation of our natural resources. And it calls for a plan to enable us to get the most oil out of the ground over a period of years. It is just plain good business to me. And I know that you gentlemen being good business men think in those terms.

I believe Colorado has a great potential in the oil industry. I believe we have a great potential as far as the development of untold resources that perhaps we only suspect at this time, and we shall do nothing, of course, to hold back that development. That development means a very great deal not only to the oil people of the state but to the people and the economy of Colorado for generations to come.

In the formation of our conservation plans we should be ever conscious of one thing; be guided as to how we can benefit most and how we can employ conservation to the point where the state and the people who engage in that business will in the end extract the most oil from the ground to the greatest benefit of all concerned.

We should not deplete these resources in a dangerous manner. We want some well thought-out plan whereby we will benefit more from the final result.

I am sold on Colorado. I can stand here and tell you many things about this great and wonderful state. And

the more I am over the state the more I am sold on it. I firmly believe that in any industry, whether it be oil, agriculture or steel, you get more by letting the people themselves develop it than you do by governmental direction. I believe that government in business should only be there to act as a referee or to look out for the interests of future generations and not to take over what the individual should develop for himself. That is the way I look at it. I think that the state government is something that should be set up to insure a fair sort of operation, not only for the present but for the future. The state government should not be instrumental in tearing down a business. It should weld people together in their thinking and to sell them on the idea rather than give them laws or legislation. It is my firm conviction that when you get a group of Americans, particularly men in the oil industry, men who have an interest in the development, that you can arrive at a fair answer. I believe the state should not be put in the position of dictating except in the extreme. I feel that way not only about the oil industry but any industry. We have a great potential.

I am going to Phoenix, Arizona, to speak of the oil resources of this great state and what we can do to develop it and what we can do to assure a future for that type of industry. I have often said that I do not believe in taxing

an industry out of business. I believe that through facts developed as the case is, that each industry, each individual pay his fair share of that tax. I certainly do not believe, however, that we should pick on one industry or one individual. I do not believe in that sort of class legislation. I think if facts and figures show that the oil industry should be taxed -- and the oil people are fair enough to understand that -- however, before we do anything of such radical nature, I still believe that certain facts and figures and certain information pertinent to their case should be developed and presented to those who act in the capacity of passing those laws so they will know what they are doing. I have not found the oil industry to shirk its responsibility. Neither have I found that other people in the state, when they have facts and figures, shirk their responsibilities.

I, in the final analysis, believe that if we do anything as far as passing legislation that hinders any industry it must be built absolutely on facts and not on emotionalism. I want to see this state developed. I don't want to see any hindrances set up to that detriment. And I think one of the great industries that can be developed is the production of oil and gas and the by-products that go with it. I want to see that development be very successful because if we can broaden this tax basis here in Colorado by industrial development of our natural resources, by bringing

more people in here then we can broaden also the tax burden, and in that manner it will be less per person. And I think that the security and prosperity of Colorado rests on the development of its natural resources in an orderly manner, and certainly not be preventing certain industries their right to develop as they should by intervention by state or federal governments. I think we have a great responsibility here. I only hope that I can join with you as a part of the directing force to insure that development. I want to see it done orderly and I want to see it done in a business like fashion. I want to see the same principles of fairness exist in regard to this industry as I do any other industry.

I want to see this state developed on a businesslike basis. I like to see taxes down when it is possible. I also like to see the people of the State have the things they need. But let's remember when we think of taxes, whether it is in regard to your industry or mine, that after all we are a state of 1,400,000 people and I think our great responsibility is to bring more people and more industry and to develop the resources we have here and we can have those things without bankrupting the taxpayer to get it.

I predict a tremendously rosy future for the oil industry. Your reserves are great in Colorado, not only from pools underground but we do have the great potential of oil shale.

I have often called this state the great energy storehouse because of the fact that in oil and gas we have a tremendous amount of energy.

We have about 90% of this country's domestic supply of uranium out on the Colorado Plateau.

One of the largest coal reserves in the nation is in our state. And we have many other energy producing resources.

My idea is to see that they are developed, to see that they are not wasted, to see that future generations have a chance to participate in those resources. But it should be done along the American line, under the direction of private business without the interference of government or without restrictions that the government imposes which at times kills that development. I believe that the American way is to develop and not to restrict or prevent development. On that basis I join with you in trying to help build a real industry and insure a great business that you can participate in. (Applause.)

CHAIRMAN DOWNING: Thank you, Governor Thornton. Does anyone have any questions of the witness, Mr. Osborne?

Q. (By Chairman Downing) Let me ask you, Mr. Osborne, if this field were unitized by private agreement, what benefit do you think would follow? Can you measure it in dollars and cents?

A. Yes. I think that you could. It is a little bit

difficult to place an actual value because even though you found the gas injection in the secondary recovery method was not feasible. Still the field could be produced in a more efficient engineering manner than it is now. And if you did that, of course, you would realize additional benefits.

Q. Well, it has been suggested here that under present and past and ultimate recovery might be 20% or would probably be 20% of the oil and gas in the ground. This amounts to about 350 million barrels. Do you think by unitization that that recovery might be doubled?

A. I presume when you say "unitization" that you have in mind the ability to gas-inject and that sort of thing?

Q. I mean complete unitization.

A. I would say under no circumstances would production be doubled.

Q. How much do you think it would increase?

A. Well, if you had ideal reservoir conditions --- I don't mean ideal, but reasonably good reservoir conditions -- you might increase your production maybe in the neighborhood of 10%

Q. Do you mean we might increase it from 350 million to 385 million barrels?

A. Something like that.

Q. Are you familiar with the report made by the Engineering Committe of the operators, I think, in 1950?

A. Yes.

Q. Where they gave it as their opinion that by gas injection something like 250 million barrels might be added to ultimate recovery?

A. No, I disagree with that statement. They said by unitization to mor efficient operations you should recover an additional 20 million and by gas injection you might increase it 30 million making a total of 50 million. That 50 million was not attributed to gas injection solely.

Q. If that was correct it didn't include recovery by water drive or any secondary methods?

A. No, it didn't.

Q. Don't you think by secondary methods you could greatly increase recovery?

A. I think that the experimental work we have conducted in the field now indicates that gas injection is not going to improve our ultimate recovery and possibly water flooding will increase it some, I say maybe 10%. I don't know.

Q. I thought from the way that you urged unitization that you thought by unitization the ultimate recovery might be increased to a very large extent?

A. No, I didn't. We prefer to see a field operated as a unit. As you know, now the Union Pacific Railroad almost invariably insists on unit operation. Our lands are thrown

into units as a general thing because we thing that unit operation of a field is the proper way to operate it. You can operate it regardless of lease lines. You can take oil out of this well and out of that well without worrying about who you are going to hurt. And when you can do that you can improve the efficiency of production and you will realize more oil, I do believe, eventually.

Q. (CHAIRMAN DOWNING:) And, of course, if you had unitization it would not only be ultimate recovery by known methods but when scientific methods are developed they get rogether and do not stop with the present, they look to the future?

A. That's right.

Q. You very strongly favor unitization?

A. Yes, we do.

Q. Again, how far will you go to bring it about?

A. Well, I made a suggestion. But I think that any meeting of the Rangely operators should be conducted, let's say, in privacy. I don't think there should be anybody else here.

Q. You didn't take very kindly to my suggestion that a man like Mr. Collier be selected as an appraiser or arbitrator.

A. I have the greatest respect for him but I have also the greatest respect for our own engineers. And, as I said,

I do not think we would care to submit to arbitration except as a last resort and I do not feel that we have reached that point.

CHAIRMAN DOWNING: All right. That is all. Are there any other questions of this witness? If not, call your next witness.

(The witness withdrew.)

MR. WILL: Mr. Chairman, as I explained to you, the Texas Company is the operator of the Texas-Union Pacific joint property.

Mr. Tom T. Freeman is present and might care to make a few remarks on this subject right here of unitization.

MR. FREEMAN: (Texas Co.) Governor Thornton and Mr. Chairman, I do not qualify as an expert witness so do not take my remarks to indicate that. I merely want to make one general statement emphasizing what Mr. Osborne has said on behalf of both the Union Pacific and the Texas Company. Since I happen to be here I thought it might not be amiss for me to say directly for the Texas Company that we also share the definite opinion of the Union Pacific that the field should be unti zed on a field-wide basis and that we are perfectly willing at any time on any level from the highest to the lowest to further sit down and consider the matter of trying to arrive at equities whichis obviously the first big hurdle to get over in getting unitization. I just

want to make that general statement. Thank you very much.

CHAIRMAN DOWNING: Does anyone want to ask Mr. Freeman any questions? If not, call your next witness.

MR. KNOWLES: Call Mr. Graydon Oliver, proceeding with our general line of testimony, it is not out of line with any discussion of unitization

GRAYDON OLIVER

called as a witness for the Union Pacific Railroad Company, having been previously sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath testified as follows:

DIRECT EXAMINATION

BY MR. KNOWLES:

Q. Mr. Oliver, will you state your name, please?

A. My name is Graydon Oliver.

Q. Will you state where you live and what your busniess is?

A. My residence is Los Angeles, California. I am a consulting petroleum engineer I maintain offices is Los Angeles and field offices in Ventura, California.

Q. Will you state very briefly your education and experience? Since he is not one of our local people I thought perhaps the Commission would like to have him state his qualifications as an expert.

CHAIRMAN DOWNING: Whatever you wish.

A. I am a graduate of the University of California at Berkely in the class of 1917, having received my degree of B.S. in engineering.

Immediately subsequent to my graduation from the University I entered the United States Army; I was in the science and research thereof under Colonel Robert A Milliken who later was president of the California Institute of Technology.

I entered the California petroleum industry in 1919 and have been active not only in California but in such states as Arkansas, Louisiana, Texas, Montana, Wyoming, Colorado, Utah and probably others.

My experience covers natural gas, natural gasoline manufacturing, extraction, transportation of natural gas, natural gasoline and crude oil, refining of crude oil, trea ment of crude oil and distillates, gasoline plant design and construction, drilling and operation of natural gas wells, drilling and operation of oil wells, technology of oil production and development, sub-surface engineering, research and core analysis and laboratory control of drilling operations, evaluation of physical properties incidental to refining, transportation and production of natural gas, natural gasoline and crude oil valuations, surface and subsurface oil and natural gas and special problem work in connection with petroleum technology and development, tax valua-

tion problems and so forth.

My specialized experience includes being instructor at the University of California Extension Center in utilization of liquid petroleum gas and natural gas engineering. For a short time I was technical editor of the Petroleum World and also in the same capacity for the California Oil Well.

I am a member of the American Petroleum Association, Petroleum Geologists and American Petroleum Institute, member of the California Natural Gasoline Association, member of American Petroleum and California Engineers and a member of American Society of Civil Engineers.

I have done special work in connection with the Rangely reservoir which started as early as 1940. I have continued to make studies of the field from time to time and when I was employed by the Union Pacific Railroad Company to use those various studies and their reports and I will attempt to give you my impartial opinion.

Q. Have you prepared a written statement?

A. I have sir.

Q. Will you read that?

A. Yes. (Reading) Studies which I have made of the Rangely reservoir have led me to a conclusion of opinion that any attempt toward pressure maintenance of the reservoir sands without complete unitization of the entire reservoir

are inadvisable. In the absence of complete unitization it is far preferable to continue operations as they are being conducted at the present time rather than attempt an indiscriminate, piece-meal, or multiple gas injection operation. Indiscriminate injection could conceivably do irreparable damage. Any pressure maintenance program requires extremely careful planning in order to obtain the maximum recoverable oil in the reservoir. Experience has shown that when gas is available as an injection medium it should be used for gas-cap repressuring in order to obtain the maximum efficient unitization. This can only be done under a complete unitization program. Gas-cap repressuring augments normal processes that function within a reservoir, whereas indiscriminate gas injection can only be classified as an inefficient secondary recovery operation.

The Rangely Weber reservoir is being efficiently operated at the present time under independent and competitive production programs. No secondary recovery programs are, in my opinion, desirable or warranted at this time. I believe that rather than attempt indiscriminate gas injection, reservoir pressures should be reduced by normal competitive production practices to the proper stage of depletion, at which time water flooding can be undertaken. Water flooding is recognized as being a very efficient and effective method of secondary recovery, under favorable conditions.

The full application of this Commission's rule 3, which limits the gas-oil ratios of producing wells, establishes a gas production limit on individual wells and allows credit for gas injected into the Weber formation, reflects a desire on the part of the Commissionto inaugurate a pressure maintenance program at a time when they are probably not fully cognizant of the damaging effects that indiscriminate gas-injection operations might ultimately have on the reservoir as a whole. Uniform movement of gas through the formation, such as that resulting from gas-cap injection under favorable reservoir conditions is beneficial and reasonably efficient. This contemplates a planned program. Indiscriminate gas injection, by its very character, is unplanned and in a hetrogeneous formation can seriously harm the reservoir by blocking off large portions of the formation and preventing drainage thereof.

The Rangely Weber reservoir has been both drilled and subsequently operated in a most efficient manner. Mr. J. J. Zorichak, in his opening statement before this Commission on November 14, 1951, claimed that waste is presently occurring in the Rangely field because a number of wells have been producing oil with gas-oil ratios exceeding 1,000 cubic feet per barrel, inferring that such ratios were inefficient and constituted underground waste. In this conclusion I do not concur. Gas-oil ratios are very definitely

related to the ratios of formation permeabilities relative to oil and to gas, to the reservoir viscosities of the gas and oil, and to the degree to which the formation is oil-saturated. Variations in the produced gas-oil ratios will vary with these several parameters.

Generally, the gas-oil ratios in any particular well will tend to increase as the formation saturations decrease through production processes. Consequently, each and every well will have its individual gas-oil ratio, resultant from efficiently draining the formation surrounding the well bore and efficiently utilizing the reservoir energy incidental thereto. These gas-oil ratios will undoubtedly vary widely, depending upon many factors; yet each well will be making the most efficient usage of the reservoir energy and not wasting any portion thereof. For this reason, I do not believe any arbitrary value for gas-oil ratios can be established on a field-wide basis; rather, this becomes an individual well problem, subject to frequent change as reservoir conditions change.

The Rangely Weber formation is a heterogeneous assemblage of sediments, tightly compacted and variably cemented. The formation generally has a predominantly low permeability to fluid flow, but within the section are encountered occasional thin streaks or lenses whose permeabilities are relatively high. There appears to be no definite

lateral continuity to these more permeable streaks throughout the drilled area of the field, and such continuity as does exist is highly localized and restricted to rather definite areas of influence. These more permeable streaks or lenses are encountered in the well bore at intervals. After the well has been placed on production, the fluid entry into the well from the entire formation is in direct relationship to the permeabilities of the formation. Consequently, the majority of the total fluid entry into the well bore occurs at points where the highest values of formation permeabilities are encountered. These more permeable streaks or lenses extend radially from the well bore over rather large areas. Under such reservoir conditions the only possible manner by which the forty-acre parcel upon which the well is located can be effectively drained is by the movement of the reservoir fluid out of and away from the low permeability portions into the higher permeability streaks, which in turn act as conduits for the delivery of the reservoir fluid to the well bore.

Oil and gas contained in those formations of low permeability which immediately overlie and underlie the more permeable streaks or lenses are drained vertically into the more permeable streaks, which then act as conduits to the well bore.

Oil and gas in any formation can only move or mi-

grate from one location to another by the existence of a differential pressure. Oil and gas move from the formation surrounding a well bore into the well bore because the pressure within the well bore is less than the pressure behind the fluid in the formation. In the Rangely Weber reservoir, for any given differential pressure between the oil and gas in the formation and the well bore, the primary controlling factor governing the fluid movement is the permeability of the formation.

With these fundamental concepts in mind, the performance pattern for the fluid movement within the Weber reservoir will consist generally of a vertical migration of the reservoir fluid from those portions of the formation having low permeabilities, which constitute the major portion of the reservoir rocks, into those relatively few more permeable conduits, and thence through these conduits radially toward the well bore. These more permeable conduits are fed vertically by the overlying and underlying low-permeability formations. Once these conduits or channels have been established they become an adjunct of the well and are necessarily a controlling factor in the productivity of the well.

In any secondary recovery operation, of which pressure maintenance is but one type, it is obvious that if the maximum recovery of oil is to be obtained from any for-

mation oil must be displaced from all the pores to a maximum degree. Whenever the displacing fluid, such as injected gas, enters some of the pores but not all of them by-passing occurs. The simple term, by-passing, encompasses a very complex phenomena. Some forms of by-passing are largely transient, dynamic phenomena which can be controlled by judicious control of the rates of injection, the proper selection of injection wells, and the proper control of the over-all reservoir fluid production. While many of the effects of by-passing are considered transient, nevertheless, if they are long continued they will result in the isolation, effected by the permanent by-passing, of large portions of the formation containing oil which would otherwise be recoverable.

In gas injection processes it is to be remembered that gas is soluble in the oil. There is no wetting action of the formation based upon the interfacial relations such as we experience in water flooding. Furthermore, due to the expansibility of gas, the gas in any gas-injection process always tends to travel through those channels in the formation which contain the least amount of oil, these being the channels from which the oil has been more completely removed during primary recovery operations. The oil saturation within these channels is further decreased by the gas injection process, thereby increasing the effective permeability of the channel to the gas, and decreasing the effective

permeability of the channel to the oil. Gas passes through the channel with greater ease, and oil witn increasingly greater difficulty, so that as a result the gas-oil ratios increase excessively and become difficult to control.

It is recognized that water drive, when properly operated under favorable reservoir conditions, is probably the most efficient form of secondary recovery, as a water drive can displace as much as 70% of the original oil in place. In my opinion, it will ultimately befound necessary to institute water drive operations in order to obtain the maximum recovery from the reservoir. Certain benefits can be obtained in some fields by means of a gas-cap drive, but in both water drive and gas-cap expansion unitization is essential in order to have the proper control of withdrawals. Unitization permits the taking of the oil from selected areas of the reservoir, which is necessary for the successful operation of a secondary recovery project. Gas injection without unitization must be classified as indiscriminate. Therefore, the requirement of this Commissionunder rule 3 which provides for the return to the formation of all gas produced in excess of 150 thousand cubic feet of gas per day, without consideration as to what portions of the structure this gas is injected into, and without regard to any unified plan of operation, and without regard to the effects that such injection will have on the reservoir, must be

definitely classified as indiscriminate injection.

According to the records, The California Company has proposed a plan for dividing the Rangely Weber reservoir into three segments, each to be operated under some form of unit plan, separate and distinct from the others, and which provides for gas injection into these three segments separately and without consideration to each other. This type of operation must also be classified as indiscriminate gas injection.

By-passing is one of the undesirable features that is experienced in indiscriminate gas injection. By-passing can and does occur under unified plans of pressure maintenance, even though such plans are properly conceived and efficiently carried out. Such by-passing, however, at these times is generally transient and can be largely controlled so that no permanent damage is done to the formation. By-passing in its initial stages is now being encountered in the Rangely Weber reservoir. Mr. Read Winterburn, of the Union Pacific Railroad, has described the results of the injection experiments which have been carried on by the Texas-Union Pacific companies.

This project was originally conceived for the purpose of ascertaining the receptiveness of the formation to gas injection, and to permit the study of the effect of such injection when applied to the Weber reservoir. This injection

project has been in operation for approximately fifteen months, and substantial quantities of gas have been injected into the formation. The eight offset wells to the injection well, UP 57-21, have shown that over a period of time a very definite increase in the average gas-oil ratio, it being approximately four times greater after fifteen months of injection than it was when injection was started. Furthermore, substantial increases have been noted in the gas-oil ratios of three of the second line of offset wells. These increases in the gas-oil ratios indicate that the injected gas has not gone into solution in the oil, but has migrated from the injection well to the first line of offset wells, and now is making its appearance in the second line of offset wells. Due to the relatively short period of time in which this injected gas has made its appearance in the first and second line of offset wells, it is clearly indicated that migration is taking place through the more permeable channels which have opened up between the injection well and the offset wells, the gas by-passing virtually all the oil in those formations of lower permeability, both underlying and overlying these permeable channels. If gas injection is continued, the oil so by-passed may be permanently lost.

Studies of the Rangely Weber reservoir indicate considerable vertical fracturing, particularly on the top

and on the southwest flank of the structure. In all probability, other fracture zones exist within the structure, which have not as yet been delineated but which will reveal themselves as the reservoir is depleted. Mr. D. S. Pierson, of the Texas Company, has recently completed a comprehensive study relative to the expansion of the gas-cap, and the effects thereof. Mr. Pierson's study reveals that there has been very little general expansion of the gas-cap but that there has been expansion through considerable portions of the fracture zones. These fracture zones establish addition-permeable channels within the reservoir, in addition to those heretofore mentioned. These channels are additional conduits in which by-passing can occur if gas injection is conducted. Mr. Pierson's analysis of the reservoir conditions supplies additional evidence that gas expansion is taking place through these fracture zones, which further minimizes the possible beneficial effects that might be obtained through gas injection into the gas-cap under a unitization program. If attempts are made to inject gas into the gas-cap, the injected gas will soon migrate throughout each fracture zone, as well as through those higher permeable conduits, and the great volume of oil contained in the low permeability formations will be by-passed. The beneficial effects of any pressure maintenance system in a heterogeneous reservoir of this type are quite dubious, as, even under the most ideal

conditions, probably not more than a 10% increase in overall recovery could be anticipated. Under the conditions as they are now found it is highly doubtful if any beneficial effects could be obtained by any form of a pressure maintenance program. Even at the present time the expansion of the gas from the gas-cap is following zones of fracturing, and this condition will become aggravated and become increasingly apparent as the reservoir is depleted.

Indiscriminate gas injection, as I have previously stated, is a poor form of secondary recovery operation, even under the most ideal conditions. In depletion type fields, where the expansion of the gas released from solution in the oil is the primary source of energy, the ultimate recovery approximates only 15% to 25% of the oil in place. In reservoirs where the permeability is sufficiently high and wherein an active water drive is absent, additional recovery may be obtained through gravity drainage, but, otherwise, in order to obtain any additional quantities of oil, secondary recovery operations must be resorted to. Any form of indiscriminate gas injection operation will be costly and inefficient. It is my opinion that eventually secondary recovery in the form of a water drive will be both desirable and necessary. Therefore, in the interests of efficiency and economy, it would be advisable to consider only one type of secondary recovery operation, which, I believe, should be

some type of water drive.

At the present time approximately eighteen million cubic feet of gas per day is being flared in the Rangely field. There exists but a very limited market for this gas. On account of its low B.t.u. value the gas does not meet the minimum requirements for sale to domestic consumers in the territory where a large demand exists. The gas can only be utilized by industrial consumers, or by public utility companies who can blend the gas with gas from other sources having higher B.t.u. values. Even though a market were found, and a pipe line were built into the field to convey the gas to points of consumption, it would be desirable to have some form of a balancing reservoir in which the gas could be stored for temporary periods. Consumption of natural gas by domestic consumers fluctuates with weather conditions. During the summer months the demand is low and during the winter months the demand is high. The Dakota formation appears to be an ideal reservoir for the storage of the gas pending consumption. In the event the pipe line requirements, particularly during summer months, were less than the gas produced from the reservoir, the excess gas could be stored in the Dakota formation and re-delivered during the periods of peak demand. Such procedures are commonly followed in other parts of the country. There appear to be no insurmountable difficulties surrounding the utilization of the Dakota formation as a storage reservoir, and I believe

that the formation could be efficiently used for such a purpose. In order to do this, however, some sort of a unit agreement would have to be negotiated. Inasmuch as there is no substantial market for the major portion of the gas at the present time, and no pipe lines connecting the field to major centers of consumption, such facilities will all have to be provided, and this will take time. In the meantime, however, the Dakota formation could be readied as a gas storage reservoir, and injection of the gas now being flared could be commenced within a reasonably short period of time. The presence of additional gas reserves stored in the Dakota formation would be attractive to the pipe line companies, and would undoubtedly accelerate the development of a market for the gas that is now being flared.

I have attempted in this statement to cover the salient features of reservoir performance that will undoubtedly occur under the full application of rule 3 of the Commission's Order 2-1. With full consideration given to the inherent natural characteristics of the Rangely Weber reservoir, I do not believe that an arbitrary gas-oil ratio can be established on a field-wide basis. Each well is an individual problem. Any well will most efficiently utilize the available reservoir energy only when a gas-oil ratio for it is established on an individual basis and under actual operating conditions. Furthermore, any gas-oil ratio so established should be subject to frequent change as reservoir

operating conditions change.

The establishment of an arbitrary volume of gas to be produced by any one well is not only, in effect, a proration order but limits the operator in making the most efficient use of his reasonable proportion of the reservoir energy. That portion of the rule which allows credit only for such gas as in injected into the Weber formation presumes the establishment of a program of indiscriminate injection, which not only is hazardous but also could do irreparable damage to the reservoir as a whole. As I stated earlier, there appear to be no insurmountable difficulties surrounding the injection into the Dakota formation of all gas now being flared. Such a program could be materially assisted if this Commission would grant credit for gas injected into the Dakota, and it would be a definitely constructive conservation program. All these features could reasonably be accomplished under unitization, but not without it. I am not of the opinion that unitization is absolutely essential at this time, yet I do believe that many of the problems could be more readily resolved under unitization, and for this reason only I advocate that steps toward unitization be taken. It is believe that under unitizati on the maximum benefits in the form of recoverable oil will accrue to all.

CHAIRMAN DOWNING: Does the U. S. G. S. wish to

ask any questions of this witness? Does anyone else?

MEMBER BRETSCHNEIDER: Mr. Knowles, did you have the witness to describe the Dakota sand as a suitable reservoir for the storage of gas?

MR. KNOWLES: That was covered quite fully in the hearing of November 29th and that is the reason we didn't go into that today. I believe Mr. Winterburn could, very quickly, summarize that for you becauseit would be a little repetition of his testimony.

MEMBER BRETSCHNEIDER: I probably wasn't at the meeting of November 29th. But I understood the Dakota reservoir is not a very suitable storage for gas.

MR. WINTERBURN: Well, our investigation of it indicated that it would be perfectly satisfactory, based mostly on the fact that Rangely was a reservoir in which gas had accumulated and therefore must have been a closed reservoir.

MEMBER BRETSCHNEIDER: It is largely full of water now, isn't it?

MR. WINTERBURN: Where there is gas in it there is water and the wells that produce gas are large producers indicating high permeability. And we thought that if sufficient quantities were injected to raise the pressures higher than one wanted to in the present available storage area the volume could be increased by removing water from the Dakota as we introduced it.

MR. ZORICHAK: Has any estimate been made as to the volume of gas that can be stored in the Dakota formation?

MR. WINTERBURN: No. We thought that by an expansion of the present area of accumulation which would probably be both through driving the water back and because it is compressible -- probably more so than water because it must have had some gas in the solution -- and further in expanding it by taking water out through water-removal wells, we would have an ample reservoir.

COMMISSIONER BRETSCHNEIDER: I believe Mr. Oliver stated that before any plan like that could be undertaken you would have to unitize the Dakota area. Would there be much difficulty in unitizing the Dakota storage reservoir area?

MR. WINTERBURN: I don't see why, if there was an effort at cooperation in doing it. Because there is nothing there now that is being produced. There is no value involved. As a matter of fact, it would increase the value of the property for everyone concerned.

MR. SARGENT: Along that same line, Mr. Chairman, the Texas Company has suggested the availability of other gas fields as a possible place of storage. What are those gas fields and what studies have been made?

MR. OLIVER: I personally haven't made any studies of those. I think possibly Mr. Osborne referred to Douglas Creek and another in the vicinity. I personally have made

no study of those fields but I believe Mr. Winterburn knows something of them or Mr. Osborne.

MR. SARGENT: I will direct my question to Mr. Winterburn. What other specific gas fields are there and what studies have been made along that line?

MR. WINTERBURN: We haven't made specific studies of other fields. We know they are there, and gas storage in a gas producing field is nothing new. I can't foresee any particular difficulty except the limitation of its size and permeability.

COMMISSIONER BRETSCHNEIDER: Do you have in mind the Douglas Creek field and the Piceance field?

MR. WINTERBURN: Thos are possibilities.

COMMISSIONER BRETSCHNEIDER: And the White River field, too?

MR. WINTERBURN: Well, there is another field southwest of Rangely, I am not sure what the official name of it is, the Johnson discovery. We mentioned some of them that we knew existed. There is not a great deal of production being taken out of those fields now as there is no market. In fact, if the gas in Rangely is ever marketed, which I think it will be, that large steady of supply of gas that you will have along with the oil there will require some storing reservoirs in order to adjust the deliveries to the market demand which fluctuates with the weather.

COMMISSIONER BRETSCHNEIDER: But you haven't made any studies as to the practicability?

MR. WINTERBURN: We just considered that as an additional problem very recently.

CHAIRMAN DOWNING: Are there any more questions? If not, Mr. Oliver is excused. Thank you.

(The witness withdrew.)

COMMISSIONER VOLK: I would like to ask Mr. Winterburn a question. Have you made any study of the possibility of liquefying gas at Rangely?

MR. WINTERBURN: No.

COMMISSIONER VOLK: Would it be feasible? or have you given it any thought at all?

MR. WINTERBURN: I haven't thought about it. I don't have an opinion off hand.

MR. OLIVER: I don't think it would be possible to liquefy the gas. I don't see how it would be feasible.

CHAIRMAN DOWNING: Are there any further questions?

MR. KNOWLES: If theCommission please, we would like at this time to offer exhibits 1, 2 and 3; 1 being the map and the others being those suggested orders.

CHAIRMAN DOWNING: There being no objection, those exhibits are received into evidence.

(Whereupon, Union Pacific Exhibits No. 1, 2 and 3" for identification were received into evidence.)

MR. KNOWLES: At the present that is all that the Texas-Union Pacific has to offer. I would like to introduce to the Commission a gentleman already identified, Mr. Stayton, who appears for Sharples Oil Company, as do Mr. Carpenter and myself. So we will ask him to take over now.

MR. STAYTON: Gentlemen, I would like to offer the testimony here of Doctor Boatright. I will qualify him briefly as he has never appeared in one of your hearings.

CHAIRMAN DOWNING: We will accept his qualifications.

BYRON B. BOATRIGHT

was called as a witness for Sharples Oil Corporation, being first duly sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath stated as follows:

DIRECT EXAMINATION

BY MR. STAYTON:

Q. Your name is Byron B. Boatright?

A. That is correct.

Q. Where is your home?

A. Austin, Texas.

Q. What is your profession?

A. Comsultant analyst, gas engineer.

Q. What education have you had to qualify you to testify in this hearing?

A. I graduated from the Colorado School of Mines and

I received a degree in mining engineering in 1922 with a degree of doctor of philosophy in 1936 from the University of Colorado.

Q. How many years of experience have you had in the oil business?

A. Approximately 30 years.

Q. Briefly tell us what that experience consisted of.

A. Well, it consisted of a year and a half as roustabout in Wyoming and about two years as tool dresser in Wyoming; a year and a half or two years with the Bureau of Mines, ending up as engineer in charge of the State of Colorado for oil and gas leasing division of the U. S. G. S.; two years as district engineer in Montana with the Texas Oil Company, Borger and West Texas, and different places, engineering department, and professor of petroleum production at the Colorado School of Mines. The balance of that time has been mostly spent in cnnsulting work in various states west of the Mississippi, in Canada and Mexico.

Q. During that time you have represented a great many large and small companies and also individuals, have you not?

A. That's correct.

Q. As a matter of fact, have you represented some of the companies involved in this hearing?

A. Most of them at one time or another.

Q. What has been the scope, briefly, of your consulting

work?

A. It has covered oil well drilling and completion and testing wells. I have worked on secondary recovery operations, evaluations, gasoline plant operation, pipe line operations.

Q. What states have you practiced in?

A. Practically all of them west of the Mississippi and in Canada and Mexico.

Q. Besides your consulting work, have you had any position with any gas companies or oil companies?

A. Yes, I was vice president and chief engineer of the Republic Gas Company a year and a year and a half or two years as scout, vice president and production superintendent for Ebaugh Company and Continental Drilling Company in Austin, Texas.

Q. Have you published articles on oil and gas?

A. Yes, I have.

Q. Now, Doctor Boatright, have you made a study of the Rangely field?

A. Yes, I have.

Q. To assist you in the study, what information did you have?

A. I had all the information of the files of the Sharples Oil Company and the reports of the Engineering Committee, numerous publications in connection with the Rangely Field, supplemented by studies of technical problems involved

as explained by numerous scientific and technical publications.

Q. You had all the information that Sharples could give you, did you not?

A. That's correct.

Q. Briefly, what is the geology of the field -- to show you are familiar with it?

A. It covers in all about 25,000 acres in Rio Blanco County, Colorado. The productive section covers about 7500 feet in thickness. The average porosity is between 12 and 13 percent and with very low and erratic permeabilities ranging from zero to 500 millidarcies. The central portion is fractured with a water contact at a depth of minus 1150 and gas-oil contact at about minus 330.

Q. Right there, what is the average permeability, Doctor? You gave us the range.

A. The average permeability would be in the neighborhood of 15 millidarcies, something of that sort.

Q. What about carbonated water?

A. It averages about 22%. It undoubtedly varies between wide limits depending upon permeability. However, I didn't have a great deal of information on the carbonated water content.

Q. How much solution gas is there?

A. It varies with position on structure, but it ranges from 200 to a maximum of 450 cubic feet per barrel of oil.

Q. What is the bubble point?

A. The bubble point in the top part of this portion of the structure is about 320 lbs. and 1700 lbs on the lower portion, gravity of oil ranges from 33 to 36 API.

Q. What about the bottom hole pressure?

A. The reported bottom hole pressure is about 3750 per square inch and at the present time averages around 1500.

Q. What was theoriginal gas-oil ratio?

A. The produced gas-oil ratio, I believe, was about 3300 cubic feet per barrel.

Q. What is it now?

A. Somewhere around 600.

Q. What is the average productive section?

A. Approximately 700 feet.

Q. As to that productive section, is that the total section?

A. That is the total section. The actual productive section averages about 120 feet.

Q. What about water production in the field today?

A. There is some water produced. There have been about a total of something like 700 or 800 thousand barrels of water total. I believe that engineering reportshows that there are about 50 or 60 wells with water.

Q. Does that indicate effective water drive?

A. Not in my opinion at this time.

Q. What about the gas-cap?

A. The original gas-cap covered about 2200 acres and has expanded now to something like 4400 acres. It only represents a very small portion of the reservoir, probably in the neighborhood of 1% or 2%.

Q. What, in your opinion, Doctor, based upon your studies, is the type of drive that you have in this field and they way you are going to have to operate it, assuming that you are going to have to make a one-unit operation?

A. I think it is a typical solution gas drive reservoir and will have to be produced as such, in my opinion. But that primary source of energy, ov course, will be supplemented as time goes on and a pressure drop by drainage. There may be a small effect of water encroachment, although present indications do not justify an assumption that it is ever going to be effective to any great degree. A small amount of gas in the gas-cap can be disregarded from the over-all reservoir standpoint because it is a small volume that it occupies.

Q. In a field of this type, Doctor, what is going to be the behavior of the gas-oil ratios?

A. They are going to continue to go up until they reach a maximum at which time they will gradually reduce.

The gas-oil ratio in an individual well at any time in its particular life is going to be a function of its productivity over the particular period of its productive life.

And every well in the field is going to go through that same cycle. They will produce first at low gas-oil ratios which approaches the solution ratio at that particular point on structure. After the bubble point is reached the gas-oil ratios will start to increase. Those will increase until such a time as the reservoir pressure and the solution differential reaches the minimum difference at which time the figures will decrease to the depletion of that particular well. Every individual well in the field is going to have that history.

And the mere fact that wells in the field at the present time have different gas-oil ratios merely indicates that the different wells are in different stages of their productive life at this time.

Q. All right, now, you have noticed, I assume, in reading the record of the two prior hearings that some concern has been expressed about these gas-oil ratios?

A. In this type of production they can be expected and they will continue to increase as the field goes along until some maximum point is reached at which time the gas-oil ratio average will start to drop.

Q. As an engineer and based upon your study of this field and considering the type of drive that you have in the field there, is there anything you can do about gas-oil ratios?

A. There is not a thing you can do about it. If you are

going to produce oil you are going to have to produce the gas and any artificial control on the gas is not going to result in any great ultimate recovery; they are simply going to result in upsetting the correlative rights of the various individuals involved.

Q. Purely from a theoretical standpoint, if you want to have a man on each well and watch the production each day, might you do something about production in producing at a more efficient rate?

A. I think there are undoubtedly a number of wells in the Rangely field that accurately gage gas-oil ratios at different rates of flow or in which accurate gas-oil ratios at different rates of flow would indicate that they have a maximum efficient rate. That is due probably to gas-cap gas breaking into the wells. In general, in that type of well, I think you will find that the higher the rate of oil production the lower the gas-oil ratio will be. However, those type of tests I do not believe would be feasible in this field for several reasons. In the first place, the value of requiring tests of that sort, unless they are supervised, is very questionable. In the second place, if the tests are to be supervised it would require a large number of personnel in an official capacity. And there is this point to consider: That the gas that is produced by the gas-oil ratio wells, even though the gas comes from the gas-cap,

has, under Colorado law, served to drive oil ahead of it regardless of how much, providing the casing was set below the gas-oil gas ratio contact.

Now, I think, undoubtedly in any well in which the casing has been set in the gas-cap and not below the oil-gas contact, that the excessive gas-oil ratios, in wells of that sort, it should be curtailed.

Q. You make a distinction between gas-cap gas that is produced after it has driven oil ahead of it through one of these fractures or gas-cap gas that is produced in open hole through the gas-cap?

A. That is correct. Gas-cap gas, under the Colorado law, which is produced into the open air without lifting oil is definitely waste and that sort of waste should be stopped because it serves no useful purpose and, of course, may not be detrimental to the reservoir as a whole but may be. But it certainly serves no useful purpose and is definitely waste under the Colorado statute. If, however, that gas-cap gas breaks through an oil stand and gets into the well bore that, in my opinion, is not waste under the Colorado statute.

As far as using packers to combat that condition, progressively as a well-life goes, it is my opinion that it is economically unfeasible to do so, even though it could be accomplished practicably. And, where there may be a case where it can be done, depending upon the actual conditions

in the well bores of a particular well, I think, the adoption of any such field-wide plan would be unrealistic and could not be done economically.

Q. All right, then, Doctor, I believe we can sum up your testimony that, considering the nature of drive you have in this field all you can do about gas-oil ratios in your opinion -- and that is impractical -- would be just to have a man on each well producing each one at the maximum efficiency. Is that correct?

A. That would be the only thing you could do and that would only result in conservation of the gas-cap gas and not in solution gas.

Q. Would any gas-oil ratio limit, whether it is a thousand cubic feet per barrel or two thousand or any other number of cubic feet per barrel, result in prevention of underground waste, in your opinion?

A. It will not.

Q. Will it increase the ultimate recovery of oil from the reservoir?

A. No.

Q. Why?

A. Because it is simply a gas type drive reservoir and in order to produce the oil you must produce the gas and to produce the oil you are going to have to produce with gradually increasing gas-oil ratios and the gas-oil ratio of a particular well at a particular time is a function of that

well's current plac e in the productive life of that well. And every well in the field is going to go through that same process. The mere fact that you have certain wells with high gas-oil ratios now and others with low gas-oil ratios merely show the wells with low ratios are in a different period of their productive life than the other wells.

Q. All right, let's assume that you establish a gas-oil ratio limit. Let's just assume a thousand cubic feet per barrel. That will catch some wells now, will it not?

A. That is correct.

Q. Three years from now such a ratio limits will probably catch a large number of wells in the field?

A. Undoubtedly.

Q. And in order to produce at that time what would happen would be an increase in gas-oil ratio limits. Is that correct?

A. That is correct. In the interim the fellow that has been penalized originally would be penalized right straight through and gradually the other fellow's would be penalized as their wells reach the same stage of their productive life.

Q. In other words, the effect of that gas-oil ratio limit is to penalize a man now for what somebody else's well is going to do in the future, every one of them, isn't it?

A. In fact it is penalizing because his well is in that particular productive stage of its life and every well is

going to have to go through that stage sooner or later.

Q. Now, Doctor, are you familiar with a book calld "Petroleum Oil Well Spacing?"

A. Yes, I am.

Q. By whom was that book published?

A. The book is also entitled "Joint Progress Report on Reservoir Efficiency and Well Spacing" and was put out by the Committees on Reservoir Development and Operation of the Standard Oil Company of New Jersey and Affiliated Companies and of the Humble Oil & Refining Company.

Q. Does that work have a chapter on the solution gas drive reservoirs?

A. Yes, it does. And I would like to read from it because it states in very clear language what I have just finished discussing.

Q. Don't read the whole chapter, but read parts of it that you feel are particular pertinent and let anybody else read whatever they want.

A. The part entitled "Recovery Mechanisms: Section "A", Dissolved Gas Drive. Mechanism: -- In dissolved gas drive the oil is expelled from the sand solely by expansion of the gas released from solution in the oil, no extraneous source of energy or displacement medium being available. To visualize the governing features of dissolved gas drive, assume that a cubic foot of reservoir sand, with its contained

oil and dissolved gas under virgin conditions, represents a miniature reservoir, with no free gas cap and no water drive available, and with oil and gas flow in the sand restricted to the horizontal. When a well penetrates this reservoir the low pressure point created allows the reservoir fluids to expand, driving oil and gas into the well. Pressure in the reservoir declines because of the fluid withdrawal and gas evolves from solution to occupy the space vacated by the withdrawals. As the oil and gas withdrawals continue, further pressure decline takes place and more and more free gas is formed. Gas flow increases and oil flow is impeded by rising gas saturation. This is a direct result of the saturation-permeability relationship and leads to gas depletion when oil recovery is still relatively low."

The second heading is "Conditions required: -- The major requirements necessary to make a dissolved gas drive operation unavoidable, or nearly so, may be listed as follows:

"First, Flat structure, usually with substantial stratification or low vertical permeability, obviating the possibility of appreciable gravitational segregation of gas released from solution."

MR. STAYTON: Let me interrupt, Doctor, do we have that in this field?

A. We have an erratic permeability but do not have a low flat structure.

Of course, here, I think we are going to get a good deal of gravity drainage but because of the erratic permeability very little gas segregation.

"(B) Absence of a free gas cap or of a water body which could move into the oil reservoir."

It is true here that we do have slight movement but it is negligible.

" (C). High rate of production, substantially exceeding the ability of any water present to advance into the reservoirs, or the ability of a free gas cap, if present, to expand efficiently"-- which covers the situation we have in this reservoir.

Going on, "The two fundamental atrributes of this recovery mechanism are first the horizontal flow of oil and gas, which provides no opportunity for the vertical segregation of the two fluids, and (2) the lack of extraneous source of energy or displacement medium, such as a free gas cap, or edge or bottom water capable of moving into the reservoir and displacing the oil and gas. Even where a structure is not flat, the horizontal type of flow may be brought about by low vertical permeability or by high flowing pressure differentials occasioned by high producing rates and tight sand".

"Behavior Characteristics" is the title of the title of the next section. "The dissolved gas drive mechanism is characterized by continually increasing gas saturation in

the sand as depletion proceeds. Broadly speaking, the effect of gas saturation on oil production rates is such that when the gas saturation approaches 10% of the pore volume, gas flow -- hence gas-oil rations -- increase rapidly, and when gas saturation reaches approximately 20% to 30%, the flow of oil becomes negligible. In the course of this trend, the gas-oil ratio, as measured at the surface, rises to a peak and then declines rapidly as available gas becomes exhausted and the reservoir pressure approaches zero. Thus, oil recovery by purely dissolved gas drive is inherently limited to a low percentage of the original oil in place.

"Fundamentally, the gas-oil ratio and the reservoir pressure in this mechanism are solely dependent on the degree of depletion of the reservoir and hence may be related directly to the oil recovery. The exact behavior of gas-oil ratio and pressure during the depletion period will depend on the nature of the sand and fluids but is not dependent on operating practices or completion methods; assuming, of course, that one of the more efficient mechanisms cannot become operative.."

Q. All right, Doctor Boatright, summarizing that. Is that to the same effect as your previous testimony, namely, that you can't, by gas--oil ratio limits, increase the ultimate recovery of oil from this field?

A. That's correct. This is simply read to possibly more clearly put it before the Commission.

Q. Now, I want to direct your attention to the feature of the order that was in effect until this rehearing was granted that placed a daily gas limit of 156 thousand cubic feet per well, in your opinion, would a rule or order of that kind increase the ultimate recovery of oil from this reservoir?

A. None whatever.

Q. Why wouldn't it?

A. Because this is a solution gas drive reservoir, and arbitrarily restricting a well that happens to be in a certain period of its productive life simply puts off the time at which it will do its producing and it is not going to change the gas-oil ratio though at the time they allow it to produce. Some extraneous things come in and upset correlative rights which will happen in the event those wells are closed in and others allowed to produce.

Q. Correlatively, if you put in some such oil limit as that, you might have migration that you would not have otherwise?

A. Migration you are going to have of gas over property lines, and oil.

Q. Is there a gasoline plant in this field?

A. I understand there is, with a capacity of about 30 million cubic feet per day.

Q. Did you understand that all the gas or practically

all of the gas is going to the plant?

A. I believe the testimony this morning indicated 18 to 20 million feet -- or about 30 million feet going into the plant with the residue of about 18 million feet going out and being flared.

Q. In your opinion, is there any way this flaring could be avoided?

A. There is no way -- yes, there are several ways in which flaring can be avoided. It can be avoided by re-compressing the gas and placing it in a subsurface reservoir. It can be avoided by shutting down the field completely. It can be avoided by getting a pipe line connection and selling the gas to market.

Q. Now assume you don't have this pipe line connection. Would it be advisable to have reservoirs available where you might put this gas?

A. Previous testimony has indicated that there are several reservoirs available. There is the Weber reservoir itself. There is the Dakota reservoir above it. I believe there is the Morrison reservoir above that. There are several other fields which may possibly be adapted to gas storage.

Q. In so far as you have been able to gather the information about the Dakota reservoir, do you see any reason why it wouldn't take the gas and why it couldn't be stored there?

A. None whatever. And I have read the objections given in the previous testimony here by numerous witnesses.

Q. What about the Weber? What about putting this gas back in the Weber?

A. There is no question the gas could be put back in the Weber but it is my opinion that if that is done it is more apt to cause a loss in ultimate recovery than an increase in ultimate recovery. It is my feeling that the injection of gas, even under unit plan, in the Rangely field is more apt to cause a loss in ultimate recovery over what would be obtained by natural depletion.

Q. Why?

A. Because of the fact that the gas is inevitably going to follow the more permeable channels. And, although the permeable channels are the principal drainage mediums for getting the oil out of the reservoir, particularly under 40-acre spacing, and if that gas is allowed to force the oil out of the permeable streaks and run the gas saturation up, at the time the gas saturation of those permeable streaks reaches a figure between 20% and possibly 30% or 35% relative permeability, oil is going to be zero or very close to that. That means that that particular permeable streak has ceased to be a conduit for the accumulation of oil to the well bore from the less permeable sand in the reservoir, both above and below that permeable streak.

Q. Have you hear and read the testimony about these two pilot injection wells?

A. Yes, and their action is just --

CHAIRMAN DOWNING: I believe we might shorten this up if you will let the witness testify to what he knows and not merely confirm what other witnesses have said.

MR. STAYTON: I merely wanted to ask him, Mr. Chairman, if that confirms his opinion.

A. It does.

Q. (By Mr. Stayton) Is that confirmation of your opinion about the behavior of injected gas?

A. Yes.

Q. That testimony is based upon unitization of the reservoir?

A. That is correct.

Q. What if you do not unitize and start putting gas back in the Weber later where any operator may desire to put it back, what is going to be the effect of that?

A. The situation is merely going to aggravated.

Q. What about correlative rights and cross-lease drainage under those circumstances?

A. There are certainly going to be correlative rights violated if any such rule or order or any such program as that is allowed.

Q. What would the natural tendency of an operator be

as to putting his injection well if he is uncontrolled and wanted to drop his neighbor, where is he going to put it?

A. He is very apt to put it against a lease line.

Q. Then what, Doctor, is your recommendation in so far as the problem that faces the Commission is concerned?

A. At this time I think that the field should be allowed to produce under its natural mechanism. At some future time, after the reservoir pressures have declined, I think they are even starting now, pilot tests on water flooding should be started. I think that if the present experiments on gas injection are taken that they should be watched very closely and stopped as soon as they have satisfied themselves that it is going to be detrimental rather than beneficial.

Q. Do you see any reason where this is going on why you can't utilize the Dakota reservoir?

A. None whatever.

Q. Just from a practical standpoint, do you see any more difficulty in unitizing the Dakota than unitizing the Weber?

A. It would be, in my opinion, twice as simple to unitize the Dakota than the Weber. In the first place there are no present values involved in the Dakota so far as is known, and it would be very easy to measure the gas that went into the Dakota and that would automatically set their share without any trace -- they would eliminate the human

element almost entirely.

Q. Is there anything you would care to add to your testimony, Doctor, that we haven't covered?

A. I think not. I believe that covers myopinion on the subject.

BY MR. ZORICHAK:

Q. Doctor Boartright, why is the pressure maintained above the bubble point in a field like East Texas and other pressure-maintenance fields?

A. Mr. Zorichak, I think that the bubble point in a field in East Texas, which is a water drive field, has very high permeabilities and porosities and entirely different conditions than you have here and in the first place it isn't the same type structure and a very active water drive with an enormous amount of water behind it. I think any attempt to correlate those conditions with these is just "spinning your wheels," to put it crudely.

Q. Let's take a field that doesn't have a tremendous active water drive, yet the efforts are still made to maintain pressures above the bubble point.

A. That is true. And if the reservoir conditions in the field are feasible then it is tried. If you will analyze the various pressure maintenance efforts that have been made throughout the United States and reported in various Bureau of Mines publications and others, you will find that a very

small percentage of them can be proved to have been beneficial. It depends upon the reservoir characteristics and the characteristics of the gas and the oil and whether or not the field is unitized and whether the gas is put back. And in my opinion, with the experience I have had with that sort of thing, this field is not suited to it.

Q. Doctor Boatright, in your analysis of the Rangely field bottom hole pressure maps, have you observed that the pressure gradient extends from the west to the east?

A. Yes, I have.

Q. That the highest pressures have been reported on the west and southwest edge of the field?

A. That's correct.

Q. And also that one or two wells have already gone completely to water and one abandoned?

A. Yes, I knew that.

Q. And that several others are producing water in the range of 80%, more or less?

A. (Nods affirmatively.)

Q. How do you explain that gradient of pressure from the west to the east?

A. Well, it may be explained in a number of ways. I don't think there is conclusive evidence that it is an active water drive. It may be that those wells in that portion of the field have better permeability and porosity than the rest and therefore are capable of draining more efficiently

a greater portion of the reservoir that is open into the hole. There may be a pressure effect of some sort or other on the water column due to the reservoir itself, such as you have in Borger where you have pressure exerted at certain points on the water and the wells act just the same. We have a number of cases in West Texas where that is true, where you don't have an active water drive in the ordinary sense, an unlimited supply of water with hydrostatic heads, but you have the equivalent effect by pressure exerted by that pressure reservoir or possibly another reservoir difference. You mentioned East Texas and that happens to be a very good example.

The Hawkins Field that is located in East Texas very definitely shows an influence of East Texas withdrawals from pressures in that Hawkins Field. Some other fields can be included. I don't think the mere fact that you have that small amount of water produced, which I believe was estimated at something like 700 thousand barrels, represents anything like an effective water drive.

Ordinarily, when we discuss an effective water drive, we are thinking in terms of water equivalent, number of barrels of water coming in when compared with the number of barrels of oil taken out. And if you limited your withdrawals in this field so that even assuming the water would still come in you would certainly have your allowables reduced to a diminishing point because only 700 thousand barrels

were produced all together. I think that is an estimate, however.

Q. The total amount that has been produced to the end of February was one million barrels.

Q. That is true. I think my figure was dated during the hearings.

Q. However, the fact still remains that the pressure on the west side of the field, I believe, now is still on the order of only about 500 and some pounds?

A. In the neighborhood of 2200.

Q. -- below the initial pressure. Whereas, on the east side of the field the pressures at some instances are way below a thousand. In other words, there is a gradient from one side of the field to the other. Now, while that may not be 100% water drive, there might be, don't you think, a limited water drive?

A. I think undoubtedly you have possibly a limited water drive effect just as you have a very limited gas-cap effect.

Q. Yes.

A. But I don't think, from the overall standpoint, that either one of those mechanisms are going to be appreciably controlled in the field unless artificially augmented.

Q. Doctor Boatright, you made the statement to the

effect that packer work is not very effective or would not be very effective. Are you familiar with the packer work that was done in the Hobbs Field?

A. I am.

Q. Isn't it a fact that due to that corrective work with packers, the gas-cap gas has been excluded from a portion of the field?

A. I think that is undoubtedly true, but you are talking about two entirely different types of field. You can not take any production mechanism or production method and because it works one field say that it will work in another. In my opinion, in the first place you have a lot of shot holes you are going to have a lot of trouble setting packers. Furthermore, in packer setting in a field of this type it is only a temporary expedient and when you set a packer and get a shot and shut off the gas because of your numerous streaks of vertical layers inevitably you are going to shut off some layers you will never get oil out of. So the small saving you can possibly get in this field, in my opinion, by using packers is very probably going to be offset in ultimate loss in oil recovery even if it is successful.

Another point that is very important is the cost of setting those packers in a field of this type. And that can run into a lot of money. I don't believe that it is

economically feasible to enter any packer rule in this field. I think it would be economically unsound. In addition to that, I doubt very much whether it proves successful except for a very limited period of time unless you might possibly find a few isolated areas where it would work.

Q. There may be a difference of opinion on that?

A. I wouldn't be surprised. There seems to be quite a few differences of opinion developed in these various cases.

BY COMMISSIONER BARB:

Q. Doctor Boatright, a bit ago, early in your testimony, when you were discussing the placing of a man on each well to control it, for example, then shortly after that you made a statement regarding gas-cap going into a well. I understood you to say something like that, that the gas-oil ratio of a well in which the gas-cap gas cuts down the gas-oil ratio would be less if the well was produced at a high rate?

A. That seems to be true in a number of instances. I wouldn't be surprised if you wouldn't find that to be true here. You will find my studies have indicated there are a number of wells here which, at low rates of flow have a high ratio and a low ratio at high rates of flow. That is in supoort of that statement.

Q. I wanted to be sure I understood you. Thank you.

BY MR. SARGENT:

Q. Doctor Boatright, is it your opinion -- I didn't

follow it exactly from your testimony -- that flaring of the residue gas constituted waste or it doe not constitute waste?

A. In my opinion, residue gas that is being flared under your Colorado statute is not waste. It has been used to lift oil and under your Colorado statute that is not waste. Obviously the gas is going into the air and is not being used at the present time and you can eliminate that in the various ways that I suggested. But any opinion, under your Colorado statute, that because of the fact that that gas has been used in lifting oil that it is not or can not be called waste under your statute. It is true that in a sense it is being wasted in that it is not being used but that serves in the first place and not subsequently.

CHAIRMAN DOWNING: Are there any more questions of this witness? Thank you very much.

(The witness withdrew.)

MR. KNOWLES: Since that question has been raised by the Commission, I would like to call on Mr. Osborne for a statement in that regard. Mr. Osborne, would you care to make a statement regarding the suitability of the Dakota and other nearby fields for storage of that gas?

MR. OSBORNE: Regarding the Dakota as a suitable storage for the gas, we have made a study of the Dakota, at least enough to satisfy ourselves that the Dakota would

be a satisfactory storage reservoir . And I will make the commitment to furnish to the Commission copies of a complete study of the Dakota showing complete results of our study and I think that will convince you that it is a satisfactory reservoir for storage. I will do that as soon as we can.

CHAIRMAN DOWNING: I am sure we will be glad to receive it.

MR. WALSHE: (California) May I also ask that it be an economic study as to putting the gas in the Dakota?

MR. OSBORNE: Yes.

MR. KNOWLES: Thatis all that we have, unless Mr. Will has something.

MR. SARGENT: Mr. Osborne, will that be filed as a late exhibit?

MR. OSBORNE: Because of the time angle, I am not sure we will be able to get that in in time. We will try to have it in in two weeks.

MR. SARGENT: Mr. Chairman, you should be certain there is no objection to that being considered a part of this record.

CHAIRMAN DOWNING: We will be glad to file that.

MR. KNOWLES: We will call that Exhibit 4.

CHAIRMAN DOWNING: If you don't get it in soon, we may decide the case before you get it in.

MR. WALSHE: I would like to see a copy of that. In answer to that, we don't think it is economically feasible.

CHAIRMAN DOWNING: I assume that when we have finished here today both sides may wish to file some additional proof. We would be glad to hear it. We don't want to foreclose any proper evidence.

Who is going to take charge for the other side? Perhaps I should ask it this way. Is there any further evidence to be introduced at this hearing?

MR. WALSHE: (California Co.) It might be good if we have in the record a statement from the Phillips Petroleum Company. They have made no statement today.

MR. KURGIS: (Phillips Petroleum Co.) We yield to the California Company.

MR. WALSHE: We have but one witness, Mr. Vitter. We would like to divide our testimony into three parts. The first evidence will be to the plan submitted by the Texas-Union Pacific in regard to field-wide unitization.

The second we would like to put on testimony in support of our alternate plan of three units.

Third, we would like to offer our suggestions as to amendments in connection with the order 2-1 and possibly answer some of the testimony that has been put on here today.

I would like to make the California Company's position completely clear in so far as field-wide unitization is concerned. Everybody here says it is a fine thing and

certain figures have been quoted here to the effect that The California Company should give in maybe two and a half times and soforth.

There have been numerous studies, as you know, made on Rangely. And unfortunately we have gotten into a position where we are trading from the top rather than going back to fundamentals. I don't thinkwe can sit down and say the Texas Company can take 21% or 19% and I don't think The California Company can sit down and say we will take 50% or 52%, because if we negotiate percentages we have to sit down and negotiate an allocation of those percentages to every tract in the field. We have tried it and it can not be done.

If we trade with Texas-Union Pacific then I know Sharples will want to trade and I think Phillips will try to trade with the California Company. And we are not going to subsidize that entire field.

CHAIRMAN DOWNING: You haven't been able to agree?

MR. WALSHE: We haven't been able to agree on the values upon each and every tract in the field.

CHAIRMAN DOWNING: Wouldn't we all be satisified if we agreed upon an impartial appraiser?

MR. WALSHE: It all depends upon what appraiser you get and what field rules you have to appraise by.

CHAIRMAN DOWNING: Couldn't we leave that all up to the appraiser. When I select an appraiser I say, "That is

your job."

MR. WALSHE: I don't think an appraiser would take it on that basis. He would want to know what basis he is going to take it on, whether one millidarcy, three millidarcies or five millidarcies, and unless you give him certain ground rules to go by I don't think he would be willing to take it and I don't think anyone of us would be willing to abide by it unless we agreed upon the field rules.

CHAIRMAN DOWNING: If you agreed on one you wouldn't need the other.

MR. WALSHE: One ties in with the other.

CHAIRMAN DOWNING: Present whatever you wish. It seems evident to me that we will not be able to conclude the hearing today. We want all the evidence in. We will stay with you until midnight or until we get it all in.

There may be additional information you will want to file. I assume that will be satisfactory. If we proceed at this rate we will not have much time for oral argument.

MR. WALSHE: Do you wish to go over until tomorrow or would you prefer to finish today?

CHAIRMAN DOWNING: We would like to close it today if we can. We want a full hearing. If we do not get through, perhaps you can cover it in a brief or supplemental statement.

MR. WALSHE: We will be glad to do that. We can

file briefs, although I would like it understood what type briefs we are going to file, whether or not it is merely on the authority of this Commission or whether or not we are going to re-hash all of the evidence that has been presented and file a factual brief. We will be glad to file briefs.

MR. SARGENT: Mr. Downing; it might be possible to continue the hearing for twenty or thirty days, if the Commission sees fit, after the completion of the evidence for the purpose of filing additional briefs. I feel that those briefs should be directed to the legal question and not to re-ahash the facts.

MR. WALSHE: I agree.

MR. SARGENT: That is simply my suggestion, Mr. Downing. As you know, we must enter our order within 30 days after the Commission takes the matter under advisement. If we are going to allow 30 days to file the brief that wouldn't give us much time to consider the briefs. It was my thought to continue the hearing for 30 days or whatever time you agree upon and possibly the additional evidence they might want to go in and my suggestion is that those briefs go to the legal argument, as to what the powers of the Commission are in this situation.

CHAIRMAN DOWNING: I believe we have a pretty good idea as to what the facts are, particularly with the assistance of Mr. Zorichak and the members of the Commission.

MR. SARGENT: I believe we will have upon completion of this hearing.

CHAIRMAN DOWNING: Yes. What I am interested in is, as you say, what are our powers and secondly how can we best accomplish our purpose. What ought our orders to cover? if we make any orders what ought we to do to bring about the desired result?

MR. STAYTON: Speaking on behalf of the Sharples company, I would like to second the motion of the Attorney General. We would like to file a brief in that manner and it would enable us to do it. We would be perfectly happy to do that.

CHAIRMAN DOWNING: This is the most important job we will have and it is pretty tough and we want all the information we can get and then we know why we make a mistake.

MR. WALSHE: Mr. Chairman, in regard to the factual data, we have some evidence we would like to be heard and Stanolind has two or three witnesses to be heard and they would like the opportunity to be heard and we would like not to submit factual data in briefs. Even if it takes tomorrow and the next day, we would be glad to stay. We would like to be heard. It is an important matter.

CHAIRMAN DOWNING: We will give you all the time necessary. We would be glad to go on this afternoon until

6:00 o'clock and meet again at 7:30 this evening. We want to expedite this all we can.

MR. WALSHE: All right, sir. Call Mr. A. L. Vitter.

(The balance of the hearing appears in Volume II)

Vol. 2

BEFORE THE OIL AND GAS CONSERVATION COMMISSION

OF THE STATE OF COLORADO

OP# 2-4

IN THE MATTER OF THE INVESTIGATION TO TAKE MEASURES TO PREVENT WASTE OF OIL AND GAS IN THE RANGELY FIELD IN THE STATE OF COLORADO

CAUSE NO. 2

PURSUANT TO NOTICE the above-entitled matter came duly on for re-hearing upon the application of The Union Pacific Railroad Company and The Texas Company at 1280 Sherman Street, Denver, Colorado, at the hour of 11:00 o'clock a. m., Tuesday, April 15th, 1952.

BEFORE:

MR. WARWICK DOWNING, Chairman

MR. JOHN E. CRONIN, Secretary.

MR. H. C. BRETSCHNEIDER, Vice-Chairman

MR. RUSSELL H. VOLK, Vice-Chairman

MR. CLARK F. BARB, Member.

MR. J. J. ZORICHAK, Director

MISS ANNABEL HOGSETT, Assistant Secretary.

A P P E A R A N C E S

THE ATTORNEY GENERAL OF COLORADO FOR THE OIL AND GAS CONSERVATION COMMISSION, by Mr. Ralph Sargent, Jr., and Mr. Wilbur Rocchio, Assistant Attorneys General.

THE CALIFORNIA CO., by Mr. E. N. Dunlap, Denver,
Mr. Woolen H. Walshe, New Orleans,
Mr. A. L. Vitter, New Orleans,
Mr. Wm. H. Ashly, Jr., New Orleans,
Mr. J. L. Wany, New Orleans,
Mr. Robe rt W.Sullivan, Denver.

THE BAY PETROLEUM CORP., by Mr. Mark J. Mourne, Denver.

THE BRITISH-AMERICAN OILPRODUCING CO., by Mr. W. T. Hudson, Denver.

McLAUGHLIN INTERESTS, by Mr. Jean S. Breitenstein, Denver, and Mr. S. W. McLaughlin, Rangely.

PHILLIPS PETROLEUM CO., By Mr. H. H. Kaveler, Bartlesville,
Mr. Claude Peavy, Denver,
Mr. Fred Kurgis, Denver.

SINCLAIR OIL & GAS CO., by Mr. John P. Akolt, Denver.
Mr. Geo. D. Almen, Tulsa.

THE SHARPLES OIL CORP., By Mr. Edward G. Knowles, Denver,
Mr. J. Clayton Carpenter, Denver,
Mr. John W. Stayton, Austin,
Mr. Samuel Butler, Jr., Denver,
Mr. Max S. Loy, Denver,
Mr. R. J. Corbett, Denver.

STANOLIND OIL & GAS CO., By Mr. S. B. Richards, Casper,
Mr. R. B. Laughlin, Casper,
Mr. D. H. Falkingham, Rangely,
Mr. Geo. B. Jenkinson, Tulsa,
Mr. Stanley H. Stoker, Tulsa,
Mr. P. P. Manion, Jr., Tulsa.

THE SKELLY OIL CO., by Mr. George W. Selinger, Tulsa,
Mr. C. J. Nalte, Sterling.

THE TEXAS COMPANY,by Mr. Walter E. Will, Denver,
Mr. Tom T. Freeman, Denver,
Mr. T..O. H. Mattson, Denver.

THE UNION PACIFIC RAILROAD COMPANY, by Mr. Lee S. Osborne, L.A.
Mr. Read Winterburn, L. A.
Mr. D. O. Churchill, L. A.
Mr. W. C. Carpenter, Denver,
Mr. E. G. Knowles, Denver.

UNITED STATES GEOLOGICAL SURVEY, by Mr. G. G. Frazier, Denver,
Mr. R. D. Ferguson, Casper.

and others.

I N D E X

Witnesses

E X H I B I T S

A. L. VITTER

called as a witness for The California Company, being first duly sworn to state the truth, the whole truth and nothing but the truth, upon his corporal oath testified as follows:

DIRECT EXAMINATION

BY MR. WALSHE:

Q. You are Mr. A. L. Vitter?

A. That's right.

Q. By whom are you employed?

A. By the California Company as assistant chief engineer.

Q. I believe that you have heretofore testified before this Commission in their behest as an engineer. We would like his qualifications to be recognized.

CHAIRMAN DOWNING: There being no objection, he is recognized as an expert.

Q. (By Mr. Walshe) Mr. Vitter, we would like to take up first the plan of the Texas-Union Pacific that has been submitted by the Texas and Union Pacific already. It is divided into several parts. I will briefly run through those various parts and give you an opportunity to comment on those features that you feel need comment. The first is in connection with field-wide unitization. They have made the statement that only field-wide unitization willwork and that field-wide unitization is necessary for a full-scale

injection program. Will you please comment on that?

A. On this point, I certainly disagree that field-wide unitization is a necessity for the injection of gas in the Rangely Field. I think that field-wide unitization is advisable but, failing that, the best alternate is a program along the lines that we have proposed, namely, that of three-unit plan in which gas injection would be possible in each of the three units.

This plan contemplates that production from each of the three units would be injected back into the same unit in the formation from which it was produced, such as the Weber.

Each of these three units would be roughly seven thousand acres or more each. And this is indeed larger than many oil fields.

I feel that that well-planned program and not a haphazard, indiscriminate injection plan could be carried out. There are numerous instances in this country of gas injection not under a field-wide unitization. In Texas and in North Carolina fields are carrying through a gas injection program in which gas is injected into each governmental section. There are many others that I can't recall off hand. But it is indeed feasible and is a good alternate field-wide unitization. We feel that it will accomplish the major portion of the benefits of a field-wide unitization.

I might point out the manner in which the three-unit

plan was inspired.

MR. WALSHE: In connection with the witness' testimony we have some seven exhibits.

(Whereupon, documents were marked California Co. Exhibits 1, 2, 3, 4, 5, 6, and 7 for identification.)

A. I would like to point out the crux of the Rangely problem, if it hasn't already been understood,. In the field as a whole you could consider, as an analogy, that you are trying to divide or unitize a bunch of apples, oranges and lemons. In other words, all the problems in Rangely are not the same kind of fruit. And when you try to agree on some basis of unitization you have to agree upon the relative merits of an apple, orange, and lemon in order to consolidate the whole into an undivided interest. This has been our major difficulty in the past five years, trying to solve that problem. And it inspires the three units to circumvent that problem, because we can divide the field up into three parts in which all the apples are in one place and all the oranges are in another and all the lemons in still another. Therefore we completely avoid that problem.

To bring my point out clearer, exhibit number 1 shows the history and production forecast by operating interests in the Rangely field from 1946 up to date on actual production and a forecast based upon the much-quoted December 1950 Committee forecast. You can see the interest of the

California operated properties are steadily increasing and fall about in line with the forecast. Phillips are decreasing some and Sharples property show a slight decrease and Stanolind properties have been decreasing. Texas properties have been going up and have now started to come down.

When you break the field up into these three portions and plot this same information you notice that all the lines are more or less horizontal so that the equities or proportions of the production that we have to date is pretty much representative of what we are going to have in the future. Therefore we have narrowed the gaps substantially of our differences.

It was with that thought in mind that we have offered it as an alternate plan -- the three-unit plan. We will go into that in a little bit more detail later.

I would like now to get back to the discussion of the Texas-Union Pacific program. The Texas-U.P., in commenting on the forecast of December 1950 of the Engineering Committee stated that the Committee considered the rate of production prior to 1951 to represent the productive capacity of the Texas-U. P. leases. This observation of Texas-U.P. is entirely incorrect as the Committe only considered the capacity of a lease to determine by its production when the lease production was less than normal average production for a proficient lease. And the term "proficient lease"

meaning an amount of oil to supply the current market demand. Even in such cases the Committee recognized that it may be possible to perform remedial work on the well, such as shooting and oil squeezing to increase the productive capacity and made reasonable estimates as to the effectiveness of such remedial work.

The Committe also approached the matter of capacity from the studies of such subsurface data and core data and data on all types of wells. This correlation is shown in figure eleven ofthe Committee's report and in so doing determined what capacity could be theoretically expected from each lease in the field. If the current capacity of a field was less than this theoretical capacity and some remedial work remained to be done, shooting or oil squeezing, then the Committee forecast such work could be done with certain effectiveness. This was done on a uniform basis throughout the field and there was no discrimination among leases -- those of Texas-U.P. and others in the field.

In order to demonstrate the merits of the forecast, the table shown below shows the average batteries of the Union Pacific lease for the forecast 1951 and '52 made by the Committee. U.P. Battery No. 20 in February 1952 produced 227 barrels per day per well, whereas the Engineering Committee forecast that it would be 230 barrels per day per well in 1951 and also in 1952; an agreement within three barrels per day.

Battery 21 "A", containing nine wells produced, in February 1952, 189 barrels per day per well whereas the Committee forecast that in '51 it would produce 141 barrels per day per well and in '52 174 per day per well.

So, in interpolating between those two you have a slight difference but a reasonable agreement between the two, an agreement between the forecazt and the actual production.

Battery 21"B" of the Union Pacific lease in February of '52 produced 44 barrels per day per well. The Committee predicted 48 barrels per day per well and respectively for '51 and '52 which shows very good agreement.

Batteries 27 and 34, which are now consolidated into battery 27, produced in February '52, 167 barrels per day per well compared to 175 and 144 respectively for '51 and '52; again an agreement.

Battery 28, containing 10 wells produced 173 barrels per day per well compared to a forecast of 167 and 130 respectively fore the years '51 and '52. And in this case the forecast was a little bit low.

Battery 29 actually produced in February '52, 192 barrels per day per well as compared with the forecast of 167. In this case the forecast was a little bit low.

Battery 32 "A" produced actually 71 barrels per day in February of '52 compared with the forecast of 128 and 102 respectively for '51 and '52. Here the forecast was high.

Battery 32-B, actual production was 78 barrels per day compared with a forecast of 120 and 95 respectively for '51 and '52. Again the forecast was a little high.

The overall lease total the actual production in February was 140 barrels per day per well compared with 146 and 132 forecast respectively for '51 and '52; almost right on the nose.

It may be seen that for most leases, actual production compares very well with the Committee's forecast and that minor variations between actual production and forecast on individual batteries are as much in one direction as in the other and on the overall lease basis cancel out.

It will be observed that the average well production on the Union Pacific lease for February of '52 was 150 barrels per day whereas the Committee forecast a figure of 146 barrels per day for '51 and 132 barrels per day for '52. A figure which is half way between these two compares remarkably well.

It may be argued by some that the February '52 production is not representative of capacity. However, it is noteworthy that the Texas-U.P. production dropped several hundred barrels per day, almost as much as a thousand barrels per day for the first two months of 1952 below their porduction during the latter part of '51.

It is obvious that in the competitive situation

that exists at Rangely that Texas-U. P. would not allow this loss of production if they could possibly do anything about it. One must therefore conclude that the February 1952 production is indeed the productive capacity.

The Texas-U. P. has made their forecast of productive capacity without any regard whatsoever for conservation measures which this Board undoubtedly will take. We plainly admit that the Engineering Committee did make certain assumptions which were consistent with good conservation practices. Texas-U.P., in their forecast of production rate, have in no way restricted the production from high gas-oil ratio wells. The Committee, on the other hand, assumed in December, 1950, that it was reasonable and proper to expect a gas-oil ratio control in the near future which would penalize wells having a gas-oil ratio in excess of one thousand cubic feet per barrel. As it turned out, this was a reasonable assumption to make, and therefore the Texas-U. P. forecast must be modified by such considerations as well as the many other unsound bases they used to determine their forecast as will be related below. Texas-U. P. Stated that the California Company now refuses to use information they obtained in early 1951 on their leases in order tomake another forecast to take the place of the December, 1950, Committee's forecast. Perhaps some of you know and perhaps some of you do not know that the inspiration for the 1950 C ommittee meeting was almost 100% that of the Texas Com-

pany, inasmuch as they felt that such a five-year forecast would clear the air on the matter of field-wide unitization. The Committee's forecast has in no way changed the mind of Texas-U.P. on the matter of Rangely Unitization, and it is with this experience in mind that the California Company has discouraged continued Engineering Committee meetings.

I might point out that the Texas Company and the Union Pacific has representatives on this Committee andparticipated in the activities of the Committee. There was a representative of each there all the time and more from time to time.

So it is with this experience in mind that this attempt can not solve the problem that we have discussed.

We will show the so-called forecast made by the Texas-U.P. is unsound and that the forecast made by the December, 1950 Committee is sound.

Q. Mr. Vitter, do you feel that the Engineering Committee could arrive at an unbiased forecast today?

A. I do not believe that it would be possible today under the circumstances. The Engineering Committees have tried to contribute to a solution of this problem and judging by our experiences in the past they have not been able to bring the meetings of mind amongst the various people.

Q. And it is your opinion that that revised forecast of Texas-U.P. is not a just and equitable participation for

the field?

A. Yes, because the forecast is based upon unsound methods.

In regard to the plan of operation which Texas-U. P. proposes, the steps which they suggest pending unitization are, for the most part, a fruitless waste of time. Evidently the Texas and the Union Pacific intend to ignore the experiences of many other operators, not only the operators in the Rangely field but the many other gas injection and water flooding operations that have been extremely successful through the country and say that gas injection must be proven at Rangely. Well, fortunately I am going to take the same basic information which the Texas-U. P. has presented this morning as regards the pilot gas injection program and to show that it is indeed performing very well.

When I was before this Commission last November, I was quite reserved in making any comment on the performance as of that date. But since that time, with the additional performance data that we have, I now feel confident and can conclusively show to you that the performance has been exceptionally good and I shall do that a little later in the testimony.

Texas-U.P. recommends that an operator should receive credit for gas injection into the Dakota formation, whereas most of the other operators have recommended that they receive credit only when injected into the Weber, the

formation from which it was originally produced.. At the previous hearings before this Commission, The California Company and others have related why gas injection into the Dakota is neither feasible nor desirable because of the hazard, low recovery, the poor economics, and the complete disregard for the very much good gas injection can do in the Weber reservoir. It is very doubtful if half of the gas injected into the Dakota would be recovered if indeed the gas did not escape and become hazardous to the producing Weber wells.

Furthermore, this is just a plain storage program and is concerned only with conservation of the gas. The recovery of additional Weber oil is a far greater consideration for which the other operators at Rangely are justifiably concerned as well as all other interested parties at Rangely.

Texas-U. P. also suggests the initiation of laboratory investigations with respect to water injection in the Weber fornation. We certainly do not object to that but feel that it in no way should interfere with some constructive action at Rangely at this time.

Texas-U. P. recommends certain steps to be taken following unitization, which in effect is to inject gas both in the Weber and the Dakota and determine which is the proper program to follow. In order to follow this program, it will be appreciated that the Rangely Weber reservoir is

continually being depleted and that one may find himself closing the barn door after the horse is stolen, if one followed this recommendation.

Texas-U. P. recommends the drilling of experimental five-spot wells to determine whether present spacing will result in maximum ultimate recovery of oil. At the November hearing, we presented testimony on the interference at newly drilled 40-acre five-spot locations in an area originally developed on 80 acres. In all cases it was demonstrated that these infill locations were at the same pressure as the original 80acre locations and that therefore this area was drained by the 80-acre spaced wells prior to infill drilling of the 40-acre wells.

We also showed that a spacing of wells less than 40 acres would lead to economic waste inasmuch as many millions of dollars could be expended in drilling more wells with nothing in return except to get the oil out faster.

Texas-U. P.'s plan of indecision on the matter of gas injection is further complicated by their indecision on water injection into the Weber formation.

Water injection into the Weber formation certainly ought to be considered, but it is much more attractive to consider it at a later stage in the life of the Rangely Field from both an economic and a conservation point of view, and it is the recommendation of The California Com-

pany that gas injection be started as soon as feasible and that at a later stage in the life of the field, water injection be attempted at least on a pilot program basis.

In Appendix (A), Texas-U. P. iterate their conclusion that a single field-wide unit is a necessary prerequisite for performing any secondary operation at Rangely. The California Company and most of the other operators disagree with Texas-U. P. and consider a three-unit plan for the field as feasible and the best alternate to a field-wide unitization.

Texas-U. P. further comments that the three-unit plan would not basically change the situation which now exists. I have related to you earlier in the testimony the great problem which the three-unit plan circumvents as demonstrated in Exhibits 1, 2, 3 and 4. We shall show in another part of this hearing the testimony of the pilot-gas injection program and that the injected gas as a matter of fact has shown a movement north on the flank of the structure rather than the crest of the structure. The reason why the gas has moved north onthe flank of the structureis not per se but because the pressure gradient causes a flood of fluid in the reservoir in the direction down structure toward the flank. In other words, the effect of the pressure gradient causing a flow of fluids in the reservoir far outweighs any effects of gravitational segmentation, and therefore

any fear of gas moving upon the structure is ill founded by both theoretical considerations and actual observations of the gas injection program.

I believe that the Commission will recall that certain other parties have indicated that injection in the Weber of gas would result in the gas zooming up to the top part of the structure and gas flooding out those leases in that area. I shall show by the actual performance of the pilot program that this is not what happens. In fact, the movement is in the opposite direction.

Texas-U. P. says that the determination of various participating interests in the three units offer the same difficulties as the determination of participating interests in a single unit. I have demonstrated by Exhibits 1, 2, 3 and 4 that as a matter of fact it was to solve this problem that the three-unit plan was inspired.

Q. In that connection, Mr. Vitter, you would be merely putting three leases together rather than, say, 105 leases in the field if we can form one unit some place down the line?

A. That's right. The enormalities we face in the formation of a field-wide unit somewhere down the line because in effect, as you say, you have then only the problem of unitizing three leases rather than 105 because at such time as a field-wide unit is formed the interests within

each of the three units are undivided and you have only the problem of determining equities between those three leases or unit of leases.

Furthermore, the three-unit plan will allow a constructive conservation program during the interim years prior to the consolidation into a field-wide unit and will allow a additional performance data in the three different areas of the field which will materially aid in the determination of the true values and decrease the gap which now exists as to the true equities between the three parts. In other words, the cards will be on the table for sure at that time.

Furthermore, in Appendix (B), Texas-U. P. says that the December, 1950 Engineering Committee meeting computed a reduced capacity for properties high on the structure. They further comment that this was not done uniformly and they further comment that it should not have been done at all.

As mentioned before, the attitude of the Texas Company and the Union Pacific will completely disregard some control of high gas-oil ratio wells and is diametrically opposite from the attitude which the Engineering Committee adopted in setting forth the basis for estimating future production rates.

As to the Texas-U.P. comments regarding reduction in capacity due to high gas-oil ration being not applied uniformly, it can only be said that the report of the Com-

mittee will not bear this out and will, in fact, show that it was done quite uniformly.

The Texas-U. P. criticizes the Committee for not using the theoretical capacity for the Texas-U. P. properties. The Committee did not use the theoretical capacity because they were not capable, clearly, of producing this amount of oil.

As related above, the Committee did recognize that some correction of this should be made and accordingly made proper allowance therefore.

Texas-U. P. also contends that their representatives at the December, 1950, meeting were told how to forecast the future production from their leases. They infer that their representatives did not have any part in arriving at a joint method of approach to the problem. Such was not the case and, although the Committee had differences from time to time, they, in every instance worked out methods which were agreeable to all. Texas-U.P. may not agree with the Engineering Committee but all of the members of the Engineering Committee agreed on the methods and calculations jointly made by them as being sound and reasonable. Texas-U.P. contends that their representatives agreed to the method only to proceed with the calculations and get finished inasmuch as the results did not bind anyone. The only objection which the Texas-U.P. representatives made was that they felt

they should be allowed to forecast production capacity higher than the theoretical capacity by means of forecasting effects of remedial work. If the capacity can be increased indefinitely by shooting a well over and over, it is obvious that one can arrive at almost any capacity. And it is for this reason that the Committee acted as it did, as being unrealistic, that is, the approach would be unrealistic.

In another part of this hearing, we shall present testimony relative to Tables 1 and 2 of Texas-U.P. plan of February 9, 1952. It will show that the methods which they have used to determine the productive capacity of the wells on the Texas-U.P. property completely unsound, and they have greatly magnified the productive capacity of this lease.

Again in Appendix (B) they admit that they have not used a factor anticipating the limitation of gas production and state their reason for not doing so is that such a factor does not reflect the true productivity of the lease.

Again, we felt, or the Committee felt, some sort of gas-oil ratio control could be anticipated as being reasonable and proper and that it was indeed a factor in the future production at Rangely and would, as a matter of fact, influence the amount of oil which each operator would produce under competitive operation.

I would now like to present some information on the performance of the pilot program.

(Whereupon, documents were marked as California Co. Exhibits No. 5, 6, and 7 for identification.)

(Continuing) I would like to point out that three or four witnesses for the Texas Company and Sharples originally have testified about the Weber reservoir and how there is a great difference in permeabilities distribution in the Weber reservoir and they have said that in one broad step gas injection will not work. Exhibit 5 shows the cross section of several wells in the pilot program injection area and we chose a particular section which said section could be correlated with several of the wells in general as several of the other witnesses have testified. You find it impossible to correlate for very long distances across the field in any particular sand section. And that is a very fortunate circumstance because then it keeps the gas from just zipping through that section because it does not extend for a very great distance before it must slow down and the other gas that was previously going very slowly, when it comes to a permeable section.

When you look at that carefully and try to find a sand section that is present and corelatable across several locations such as is shown in Exhibit 5 and plot on there the permeability, as I have indicated on the core analysis, you will find the picture something like this:

This has been colored to indicate the permeable range.

The red represents the very permeable section. In P55 shown on the left in section 20, the red is the permeable section. Naturally the gas will go into that section of the well bore. But then you notice when you get to the next well, P46, some of that red section is still present but some of it has turned to blue which is less permeable, meaning between 5 and 1 millidarcies, and some of it is even less permeable, less than one milidarcy in that portion. And by the time you get to the third well there is even less red connected all the way through and by the time you get to the fourth well there isn't any of the red connecting all the way through. So that nature has provided a sort of natural correction within the sand itself to straighten out this gas as it sweeps through and keeps it from channeling.

This can be demonstrated in another way, if, perhaps, this colored picture doesn't bring it out to you. Below there you see a permeability profile. In other words, that shows the permeability which is proportional to the horizontal distance plotted at the proper depth and you can see that the sand is indeed heterogeneous, that is, non-uniform. And that it has all these terrible properties that other witnesses have described to you. But when you cover this permeability profile with the next one you find it is still ragged looking but better than it was before, and the next one it is improving all the time and you go to the fourth

one and it is remarkably uniform.

At the previous hearing on Rangely, I have related to you that in several of our injection programs -- and we have four gas injection programs operating injecting some 250 million cubic feet a day -- they have been rather alarmed at first when you get to the first row of wells, because of the situation I have described to you. To be sure, the gas gets there a little prematurely and if you don't have a little confidence you will tend to be scared off and say it wouldn't work. But if you do have a little confidence and wait around until the gast gets to the second row of wells it is a lot better and by the time it gets to the third and fourth row of wells it is working better than you have anticipated.

Last fall I found myself in the position of this first and second row of wells business. And it is indeed difficult to convince a skeptic when you are in this stage of injection. But when you go further, the effects of it are immediately clear.

I am going to emphasize that the gas-oil ratio information upon which these exhibits, No. 6, is prepared, is exactly the same information which formed the basis of this exhibit on the wall, Exhibit No. 1 of the Texas-U.P. and several others.

Several witnesses have testified that the gas-oil

ratio has gone up on offset wells as if this was not to be anticipated and it was indeed a terrible thing. One would indeed be surprised if the gas-oil ratio didn't go up. In fact, that is the natural course of events and is exactly what you should anticipate.

Now, if it goes up alarmingly fast, then you might get cautious about it. I don't think any testimony to the effect that gas-oil ratio has increased three times on the wells around the injection wells or four times on two offsets or anything such as that is in any way pertinent to the gas injection program. In order to evaluate that gas injection program, you must first understand how it is supposed to work and then, as a matter of fact, see if it does work that way.

Exhibit No. 5 shows the area around the two injection wells which indicates the area which has been invaded by injected gas as of the end of February 1952.

These maps were drawn by observing the gas-oil ratio in all the wells in the area and enclosing the area which had wells of one thousand gas-oil ratio or less. The basis for the thousand gas-oil ratio is this: Theoretically, if you had a homogeneous sand, which we do not have at Rangely, but in order to explain that basis I must go back to a simple case, then the gas would go through perfectly uniformly. Then all of a sudden the ratio would start increasing. As a

matter of fact, it would increase from the solution ratio of some three hundred cubic feet per barrel up to twenty-five hundred cubic feet per barrel, just like that, for a homogeneous sand. Rangely is not a homogeneous sand and therefore because some sections are a little bit more permeable than others, gas gets through those sections first and so the rise in ratio is gradual. So a reasonable criterion is a thousand ratio as being some place between the 300 and 2500.

Now, if you put a limit on that area and find out what area has been invaded by gas you know how much gas you put into the sand it is very easy to compute the effectiveness of gas as a flushing medium for the recovery of oil in the Rangely field. Exhibit 7 shows that very simple calculation. It shows the P65 area and the Texas-U.P. 51-27 area.

The first shows the accumulated amount of gas which has been injected into those two wells as of the end of February, '52, amounting to approximately 600 million cubic feet of gas each. The average reservoir pressure in those two areas were 1700 and 1550 per square inch respectively. The reservoir temperature was 076 degrees Fharenheit, permeability .9, porosity-feet 16 in the case of California 65 and 21, in the section with U.P. wells.

Now, you will recall that that porosity-feet is a product of the feet of effective sand multiplied by the po-

rosity. The area within the gas front turns out to be 105 and 262 acres respectively.

The assumed coverage we found would be 50%.

The Rangely sand would work only half as good as a homogeneous sand -- an ideal sand. And in so doing we assumed only half the sand section is swept. And I will show you later how that compares with actual performance.

We computed the reservoir volumes by knowing how gas is compressed under given conditions of pressure and temperature and found out how much space it takes in the reservoir and finally we arrived at the amount of pore space saturated with gas and it turns out to be 15.6% in the California area and 11.2% in the U. P. Area.

I have said, in order to evaluate a gas injection plan you must start out by analyzing how it should theoretically behave. And if you do that and calculate these displacement volumes, you find out that the break-through is based on relative permeability measurements that we have and all the various committees have used in these last five years. You find that the gas saturation, when the gas first breaks through, should be 15.55%, which is in perfect agreement with California P65 and a little bit high compared to 6UP.

Now, let me point out that this gas injection pilot program is operating under rather severe handicaps. We know for instance that the gas is only going into the top half.

Now, we have not been able to clean out the bottom part of the hole or compress the liquid level so as to inject gas into it because we have not had sufficient pressure to do so, mostly, and therefore we know that we are only injecting so much gas.

CHAIRMAN DOWNING: I believe we will take a short recess.

(Whereupon, a short recess was had.)

CHAIRMAN DOWNING: The hearing will come to order. You may proceed.

Q. (By Mr. Walshe) Mr. Vitter, I believe you were discussing the pilot injection program and the possible handicaps that we are operating under in that plan.

A. To sum up the performance of the pilot injection program, we have analyzed the performance to date and have found out that in spite of the fact that we are injecting into only half of the vertical hole -- which situation we know we can correct -- indeed, the program is working out just about as was to be expected and that the theoretical analysis indicates that we will ultimately recover some 10% to 12% additional oil by such a gas injection program. Therefore, it is our conclusion that gas injection should certainly not be ruled out at this time. In fact, it offers a great deal of promise in materially increasing the recovery of oil at Rangely.

Q. Does that complete your testimony on the pilot injection plan, Mr. Vitter?

A. Yes, except to point out that this has been a well-planned program -- well planned by all the parties involved, namely the California, Texas and Union Pacific and that, in spite of the Texas-U.P!s sour analysis of its performance to date, I think that the evidence very plainly indicates that it is doing well and is encouraging and that a gas injection program of this type could be worked out in a three-unit program and it certainly can not be called an indiscriminate program. It would certainly be under the jurisdiction of the proper regulatory bodies to see that it went according to some well conceived plan and that it would not cause by-passing of oil and a waste of oil. In fact, it would cause an increase in recovery of oil.

BY CHAIRMAN DOWNING:

Q. Do I understand there is an east unit and a west unit in this formation?

A. Yes.

Q. But supposing the third unit doesn't unitize. How would that affect your testimony?

A. Well, we think there will have to be some similar type of operation in the central portion of the field in order to protect the various units from drainage. In other owrds, the three units can go along on a similar type of program and can protect each other from drainage and protect the correlative interests of all parties concerned. But if

one or two of the units go along on such a gas injection program and the other portion of the field is allowed to produce at high gas-oil ratios and not re-inject it, this will act to the detriment of the other two units. So the three-unit plan very definitely requires the cooperation of all and the supervision of the Colorado Oil and Gas Conservation Commission and the U. S. G. S. And I don't think any of the parties involved in the east and west units could hope to go very far without the cooperation of the central unit.

BY MR. ZORICHAK:

Q. Mr. Vitter, isn't the pilot program now in effect already located in the central unit?

A. Well, one well, the Texas-U.P. well, is and the California Company well is just on the east edge of the west unit.

BY CHAIRMAN DOWNING: I didn't quite get your testimony as to the two units being formed and the third was not unitized. What would that failure to unitize do to the plans of the other two units?

A. Would you say that over, Mr. Downing?

Q. If you only had the two units and the remaining portion didn't unitize, then what should we do?

A. I think that it will require some type of gas injection program in the remainder of the field in order that the west unit and the east unit can proceed and put in effect

a good gas injection program. Because otherwise all the money and efforts spent in injecting this gas back into the Weber would go to no avail if it could be blown to the air in the other portion of the field.

Q. (From the floor) Mr. Vitter, wouldn't it also be a fact that the injection of gas in the east and west units would be a benefit to the central portion rather than a detriment to the central unit?

A. Yes.

BY CHAIRMAN DOWNING:

Q. In other words, the Commission in that case would have to pass some regulation or order that would coordinate the activity of the three portions, if it could?

A. I believe that is correct. It would have to provide some similar type of operation involving the injection of gas and require that it be followed in the remaining portion of the field.

BY MR. WALSHE:

Q. You don't expect any immediate migration of gas in the immediate -- up to the gas cap, Mr. Vitter. Will you explain why, just generally, the gas is going to the flank rather than coming up structure into the gas cap?

A. Yes. As I mentioned, there has been some fear expressed that this injected gas is just going to run right up to the top of the structure and affect the correlative

rights of those parties owning leases up there. I think you can see from Exhibit No. 6 the position of the injection wells shown by the deep red areas, related areas, as related to the presnet location of the injected gas. You will see, as a matter of fact, that the gas has gone preferentially north and east. Now, the reason this happens is because there are lower pressures north and east and the gas has naturally moved in the direction of the lower pressures; which brings out the point that that is the controlling factor in pressure differentials, and gravity segregation is a minor consideration, which is exactly what one would expect in this low permeability formation.

BY MR. WALSHE:

Q. Mr.Vitter, I think if that completes your testimony on pilot injection we will review briefly some of the testimony that has been introduced at this hearing this morning. First is the statement of Mr. D. S. Pierson concerning fracturing in the field. Will you please comment on that?

A. Exhibit No. 1 indicates the location of high gas-oil ratios as of today. It has been interpreted that the location of these high gas-oil ratios are associated almost entirely with the fracturing that exists in the field.

Q. That is the Texas Company Exhibit No. 1, Mr. Vitter?

A. That is correct. I do not deny that there is fracturing in the field and that it has certain effects but I think

the predominant behavior of the field has been controlled by the original location of the gas-cap area. Wells in the gas-cap area are the ones that have gone up on rations above one thousand. But this has been secondarily distorted by fracturing over in the soutwest edge of the field. So I think that one should not be hasty in saying that this frattur-ing is a very insurmountable obstacle that we have in the Rangely field and that we can't do anything about it. We certainly can't remove the fractures. But I don't think it is anything to be alarmed about as far as the gas injection program is concerned. We certainly should be watchful of it and take certain precautions in injecting gas in certain areas but I don't think that is anything to be alarmed about.

I would expect that a full-scale gas injection on either the field-wide or the three-unit plan would go along very well and similar to the pilot program performance to date.

I think the pink outline on figure one of the Texas exhibit is based on fractures up in the upper formation and not necessarily in the Weber. However, there is som similar-ity between fracturing in the upper formation of the Weber but I don't think the fracturing in the Weber is nearly as extensive as the Texas Exhibit No. 1 would indicate.

Also, one must realize in interpreting such infor-mation as Exhibit one of the Texas Company that there are

additional complications which have not been mentiond, and that is the release of solution gas -- gas in solution. We know that the reservoir pressure at Rangely has dropped down to an average pressure of some 1500 lbs. per square inch. And we know, as a matter of fact, that certain areas of the field have gone down to a sufficiently low pressure that solution gas has been released and is starting to flow to the well bores. For instance, up in the upper parts of the reservoir one should expect that with a reservoir pressure of 1700 lbs. per square inch that the gas-oil ratio should reach one thousand cubic feet per barrel, even if there never was any gas-cap in Rangely.

So I am pointing out that some of these effects up here are simply due to decrease in pressure and not necessarily a situation which one could not overcome, such as fracturing. I think it is much too early to say that fracturing will preclude any sort of gas injection program.

I think that is all I have to say on that, except Mr. Pierson indicated setting of packers, which we have done on some 20 or 25 wells, hasn't done any good. We feel that we have spent over a hundred thousand dollars in doing this; approximately five thousand per well. We feel that we have accomplished a lot of good. We have prevented the flaring of gas in the production of two or three billion cubic feet. That is a very valuable source of energy in the production

of oil at Rangely and in so conserving that we have made possible an additional amount of recoverable oil.

Another witness has commented that the setting of these packers is not economically feasible. Well, we have been doing this for some two or three years now and it looks like if it wasn't we would have found out at least by now whether it wasn't a worthwhile thing. We started this two or three years ago and we are continuing to do so and intend to continue.

With regard to Mr. Winterburn's comments, I hardly know where to begin. Perhaps it would be well to stick to the seven reasons he has listed as to why Rule 3 is objectionable. He stated that it reduces the efficiency of the operation. And in illustration of this, quotes an example to demonstrate his point. However, I think that as a practical matter; the application of Rule 3 as a gas limit for all wells is not nearly as serious as indicated. I will remind the Commission that the California Company has not recommended and does not now recommend that gas limit on all wells in the field. We have indicated that we think that a gas-oil ratio is a measure of waste. We have recommended that wells with a gas-oil ratio in excess of one thousand be restricted in their production to an amount comparable to the reservoir average of wells which are producing non-wastefully.

BY MR. DOWNING:

Q. Do you approve our present No. 3 of our present rules or do you think it should be amended?

A. I think the present rule is ambiguous and should be clarified.

Q. Will you submit to us your recommendations on the rules?

A. We will do that, which will be pretty much as I have described in regard to gas-oil ratio control.

Mr. Winterburn says that such control subjects the Texas-U.P. properties to drainage loss. Well, if you want to talk about drainage loss you will probably have to get into the question of the correlative rights of what are the rights of each of the parties involved. And the natural thing to say is that one has a right to take equal withdrawals from the reservoir. And it is with this thought in mind that our recommendation of a thousand cubic feet of gas as the gas-oil ratio limit was founded for such wells. We have steadfastly avoided the matter of proration bynot recommending any control on those wells which are producing at a gas-oil ratio of less than one thousand. But we still feel the wells with high gas-oil ratios should be restricted because they are producing wastefully and should be restricted to a reservoir withdrawal comparable to a well which is not producing wastefully and that is the theory upon which our

thousand gas-oil ratio limit is based.

Mr. Winterburn says here that the order requires that all excess gas be injected into the Weber formation. Notwithstanding that such injection is completely impractical under competitive conditions and may damage ultimate recovery of oil. Number one, the order does not require it. Number 2, such injection is very practical and will increase the ultimate recovery of oil as I have tried to describe previously.

BY MR. WALSHE:

Q. In that connection, Mr. Vitter, we don't believe any credit should be given for gas put in the Dakota or some place else because that would encourage unequal withdrawals from the reservoir and in turnaffect the drainage. that Mr. Winterburn is talking about. Is that correct?

A. That is very true. In other words, we are much more concerned about the conservation of oil than we are about the conservation of gas. The gas has a value but the value of thatgas in recovering additional oil is far greater than it is for anything else. It is with that idea in mind that we believe that credit should be received for injection into the Weber. And also for the fact you arenot taking greater reservoir withdrawals than the adjoining properties.

Mr. Winterburn makes a lot of statements as to why the gas injection program wouldn't work at Rangely. I think

these are very speculative. There is no foundation for them. We have other operations within our company and other companies to indicate that this type of operation will work very successfully and we have, as a matter of fact, the history at Rangely itself. So I don't think that one should speculate to the extent of saying that gas injection will not work, when, as a matter of fact, the evidence is substantially in the other direction. In regard to Mr. Winterburn's statements as to why he thinks gas injection will not work I want to say that I am not in disagreement as to the facts. We both use the same basic information, the same gas-oil ratios. He says the gas-oil ratio goes up and therefore the gas injection is no good. I say this is exactly what you should expect and when you figure out the performance and the numerous comparative theories you will find out that it works very well.

My point is that these comments with regard to gas-oil ratios is going up 200% or 300% is not pertinent to a gas injection program.

Of course, all these comments are based upon the premise that gas injection in the Weber is not advisable and will, as a matter of act, decrease the recovery of oil. I think this has no foundation. Mr. Winterburn mentions a figure of 63 million barrels of oil which will not be produced. I do not understand this. I do not think there is any foundation for such a figure and I think anyone is to

consider this very seriously that one should have some basis for arriving at this figure.

BY MR. KNOWLES:

Q. Isn't it just enough to say that you don't understand that figure rather than challenge it by saying there is nothing behind it?

A. I say there is nothing present, no foundation for it.

Q. Except the basis of experience to which he testified.

A. Well, I don't know what experience that would allow him to come up with this loss of 63 million barrels at Rangely, by gas-oil ratio control.

MR. KNOWLES: Do You want to explain?

MR. WINTERBURN: Ididn't say that in the first place.

CHAIRMAN DOWNING: Let him finish and if you want to rebut it let us know.

MR. KNOWLES: All right.

A. We think that the suggested Rule 3 of the U. P. has some drawback. You will recall that the difference between our recommendations is that we recommend a thousand ratio limit and they recommend twice the field average. It may be necessary at some future date in the operations of Rangely Field to increase the gas-oil ratio limit above a thousand but I think it is premature to say at this time

that one should automatically provide for an increase in that limit because, in effect,with production at high rates gas-oil ratios are going to increase that average gas-oil ratio and that will permit a larger one. The thing kind of snowballs on you.

The best plan should be a review of this from time to time and for the present year and 1953 the thousand gas-oil ratio, an appropriate gas-oil ratio limit, should be used.

Of course, all through here we have the idea that the gas must be produced in order to allow the oil to be produced. Other witnesses besides Mr. Winterburn have indicated that in a natural depletion type reservoir it is the natural history of the gas-oil ratio to go up. This is so. I don't think there is any argument among anybody on that point. But the point is that there are some wells that are prematurely at a high ratio and these wells should be restricted. If they are producing wastefully above the thousand gas-oil ratio limit -- and it does not follow that all wells are following their natural history of gas-oil ratios -- some correction can be made for that.

Now, it is true that the gas-oil ratio is in some measure a measure of the state of depletion. But it is not good conservation and equitable to allow one well or one group of wells that have a high-ratio to produce unrestricted, because the reason they have high gas-oil ratios -- excluding

for the moment the wells affected by the gas cap -- is because the pressure is lower and the gas has been released from solution and the gas-oil ratio has increased, and because there is a low gas-oil ratio it will drain oil from the higher pressure areas and that oil will not be produced as efficiently. So, as a matter of fact, certain wells should be restricted so that the normal wells in the field that are producing at the appropriate ratio at this time can do so and the other wells will not take undue reservoir withdrawals from the reservoir.

I have overlooked Mr. Oliver's testimony. I would like to point out my main objection goes to the word "Indiscriminate" which appeared throughout. I do not think that anybody involved at Rangely intends to carry out an indiscriminate and piece-meal gas injection program. A gas injection program under the three-unit plan can be followed in an orderly manner and most of the benefits of a field-wide gas injection plan would be appreciated and that all the good practices that one could use in a field-wide program could be used in a three-unit plan.

Mr. Oliver comments on the fact that there appears to be no definite lateral continuity in the reservoir from one well to the next in the Weber formation, or perhaps involving several wells. I agree with this as indicated in my exhibit No. 5. But I think, as I have pointed out, this is a fortunate situation because it is a natural correction

which nature has provided to a rather poor situation and the net result of which is a fairly good performance.

Mr. Oliver also commented on the increase of gas-oil ratio of offset wells to the injection program and says that this indicates that the injected gas has not gone into solution, into the oil, but has migrated from the injected well to the first line of offset wells and is now making its appearance in the secondary line of offset wells. Well, this is exactly what it is supposed to do. It was never anticipated that any appreciable amount of gas would go into solution and the performance of the injection plan is exactly what it should be.

Mr. Oliver refers to the program of indiscriminate injection which is not only hazardous but could also do irreparable damage to the reservoir as a whole. Now, if this injection program is indiscriminate presumably it could do all these things. But I am sure any program will be a well-planned, orderly program and I do not see the hazards could be any greater or amount to anything either in the injection provided for under the present order or under a field-wide unitization.

Mr. Osborne has iterated the comments of several of their other witnesses in saying that the pilot program is more and more discouraging, and that gas injection under such a program could not work out successfully. He says

that he feels that it could work and any increase in ultimate recovery of oil is wishful thinking and not sound reasoning.

I would like to say that it is our experience and the experience of many others that it indicates that we should expect gas injection to work at Rangely. This is based upon sound theory and sound reasoning. It is not wishful thinking. As a matter of fact it was based upon actual performance at Rangely.

Mr. Boatright has quoted from the publication of the Standard Oil of New Jersey describing the characterisitics of a natural depletion type reservoir and I don't think I could question this. I certainly agree that that is the way they behave. But I certainly got the impression, the inference, that because of reservoir depletion, natural reservoir depletion that one was stuck with it and one could not improve the situation and one could not inject gas and, as a matter of fact, increase the ultimate recovery of oil.

BY MR. WALSHE:

Q. In that type of reservoir, you still think there should be an equalized withdrawal from all parts of the field as a conservation measure, don't you?

A. Yes, I do.

MR. WALSHE: We have drawn up suggested amendments to Order 2-1 and I would like to go over them. There are some changes other than in Rule 3. I would like to offer

this suggestion as California Exhibit No. 8.

(Whereupon, a document was marked as California Co. Exhibit No. 8 for identification.)

Q. Mr. Vitter, we will take up No. 6 in the order. This merely recites the position of The California Company in so far as fixing appropriate gas-oil ratios and designating that ratio as a criterion of waste has been revised to spell it out to show that any well that is producing with less than a thousand cubic feet per barrel of oil is not causing waste and any well producing with a gas-oil ratio in excess of a thousand cubic feet per barrel is causing waste and should be limited or restricted to the gas limit. Do you agree with that, in your opinion, in Rangely?

A. I certainly do.

Q. There have been several statements as to the requirement that gas be returned to increase ultimate recovery of oil. Is that a finding of fact and are you of the opinion that it is a correct finding?

A. Yes, I am.

We have omitted from this order the last finding as to the 20 million cubic feet of gas which was being flared as constituting waste. We are doing that primarily because we do not think it is waste and it is a controversial question of fact and we think it ought to be omitted from this order.

Q. Now, as to Rule 3, Mr. Vitter, in Section (A), I think that we have merely clarified that so as to be in line with findings in No. 6. Is that correct?

A. That is correct.

Q. And I think the only additional feature that we have added is Rule 3 (F) which is more or less a producing problem recognizing that you can't produce a well in the exact number of cubic feet in any one day and this allows a tolerance, I think, of five days production which must be either made up or cut down during the following month?

A. Yes.

Q. Do you concur that it is a proper operating regulation at Rangely?

A. Yes, as a proper regulating matter, we think this is desirable and does not in any way influence the spirit and intent of the rest of the order.

Q. Reiterating again, that this order does not require the injection of gas into the Weber sand pool but in order to get credit for high gas-oil ratio wells you feel that gas must be put back into the Weber in order to maintain your volumetric withdrawal equalities between the wells?

A. That is correct.

MR. WALSHE: That completes our testimony.

BY COMMISSIONER BARB:

Q. Mr. Vitter, you spoke of using gas-oil ratios or relatively equal gas-oil ratios over the field in order to

equalize the rates of withdrawal. Do you think the regulation based on pressures instead of gas-oil ratios or a combination of both might accomplish that better?

A. Well, I didn't intend to say that the gas-oil ratio should be used in order to -- gas-oil ratio limitation shoud be used in the order to prorate oil production. As a matter of fact, we have stayed away from that by restricting our recommendation to wells that are producing with excessive gas-oil ratios. The matter of using pressures as a factor, of course, has been done in other fields and in other states. We have not recommended it here because for the same reason we have not recommended a general proration of oil in the Rangely Field on the basis that this is not provided for in the law. Furthermore, there is a practical difficulty in using pressures at Rangely due to the fact that it is a very tight formation. It is sometimes difficult to get bottom hole pressures which are representative of the reservoir. We have consistently, for five years, used 72 hours shut in pressures. This works very adequately in a good part of the field but in the east end of the field we feel that pressures measured even after 72 hours are not representative of the reservoir.

BY MR. WALSHE:

Q. Mr. Vitter, in response to that latter question, you responded that we didn't want to put a top limit on wells that may be producing at a proper rate or because you must

consider bottom hole pressures and sand thickness and several other factors which would get us into quite a complicated problem that we didn't think it was necessary at this time. Is that correct?

A. That's correct. It would be very involved. There would be a lot of other factors to take into consideration.

CHAIRMAN DOWNING: Are there any more questions of this witness?

MR. STAYTON: Mr. Chairman, we have a number of questions that I want to ask, but I want to find out what our procedure will be. Do you propose to adjourn and come back this evening?

MR. KNOWLES: Yes, and we want time for rebuttal. What I had in mind, take it or leave it, is this. We will save time in the long run if we adjourn until in the morning and we can expeditiously get through with whatever is left instead of trying to get through tonight if we don't get a chance to coordinate what we intend to present.

CHAIRMAN DOWNING: Well the trouble is that the members of the Commission will be inconvenienced by being here tomorrow. We would rather try to get through tonight. How many witnesses do you have, Mr. Walshe?

MR. WALSHE: That completes it.

CHAIRMAN DOWNING: How about Phillips.

MR. JURGIS: There are no witnesses for Phillips.

MR. KNOWLES: Stanolind will have two witnesses.

CHAIRMAN DOWNING: Are there any other witnesses?

MR. STAYTON: We will have witnesses in rebuttal, Mr. Chairman.

CHAIRMAN DOWNING: How many?

MR. STAYTON: I will have one.

MR. KNOWLES: Mr. Winterburn will go on for a few minutes.

CHAIRMAN DOWNING: I don't think rebuttal will take a great while. I think we can get through.

M R. KNOWLES: You don't want us to argue tonight?

CHAIRMAN DOWNING: You are going to have briefs. We will recess at this time and return at 7:30 this evening.

(Whereupon, a recess was taken until 7:30 p. m. this same day.)

EVENING SESSION

Pursuant to recess, the hearing convened at 7:30 o'clock p. m., Tuesday, April 15, 1952, whereupon, the following proceedings were had, to-wit:

CHAIRMAN DOWNING: The hearing will come to order. You gentlemen may proceed.

A. L. VITTER

resumed the stand for further examination and testified as follows:

CROSS EXAMINATION

BY MR. STAYTON:

Q. Mr.Vitter, I didn't appear at the two previous hearings and for that reason I am not acquainted with your qualifications. I would just like to touch on that very, very briefly. What degrees do you have, just for my information?

A. I have a Bachelor of Science degree from the University of Notre Dame, 1935. I then returned to undergraduate work and got a Master of Science degree in work in physics in 1937; the B.S. was in electrical engineering.

Q. Where did you get those degrees?

A. At the University of Notre Dame.

Q. Did you go to any other university?

A. During the war I was associated with Harvard University and the Massachusetts Institute of Technology in the

role not of student but of staff member.

Q. What was your work there?

A. Electronics.

Q. Does Notre Dame offer a degree in petroleum engineering?

A. No, it does not.

Q. Did you study any geology when you were there?

A. No.

Q. Did they offer any associate courses in petroleum engineering?

A. No.

Q. You taught for a year, I believe, after you got out of school. Where was that, at Harvard?

A. One year at the University of Notre Dame. That carried us through 1938. Then I went to work for the Department of Conservation of the State of Louisiana, which is a regulatory body in the State of Louisiana with a similar responsibility to this Colorado Oil and Gas Commission. I worked for the State of Louisiana Conservation Department for three and a half years, until the spring of 1952, when I went into war research at Harvard M.I.T.

Q. What was the nature of that research?

A. Electronics.

Q. While you were with the Conservation Commission in Louisiana, how many fields did you intensively study with

injection in mind looking to increase inultimate recovery resultin therefrom?

A. Oh, probably half a dozen.

Q. Name them, please, sir.

A. Tepetate, Cotton Valley, Reo Platte, North Tepetate.

Q. Well, are any of those fields in -- in fact, none of them are similar to the field we are studying here, are they?

A. No, there are not too many things in common.

Q. Since you have been with the California Company, how many fields have you given an intensive study to with respect to injection and increasing ultimate recovery thereby for the California Company?

A. In Louisiana, the St. John's Field, which is a unitized field. In Mississippi, Cranfield Field, Brookhaven Field, Malalieu Field. In Colorado, Rangely, Wilson Creek. In Wyoming, Neiber Dome. Those are the fields in which at some time or other I have given some consideration to some form of secondary recovery or pressure maintenance.

Q. Well, I know, of course, you have given some consideration to numerous fields. What I had in mind is how many fields have you studied intensively, like this one?

A. . . . North Cowden, St. John, Cranfield, Brookhaven, Malalieu; I would say those five were quite intensive.

Q. How many of them are like this one?

A. In what respect?

Q. Well, you name the field that is most comparable to this one?

A. Well, our Brookhaven Field in Mississippi has many characteristics in common. It, however, doesn't have nearly as thick a section as this.

Q. How thick is the section?

A. On the order of 30 to 50 feet thick.

Q. How thick is this section?

A. Around 130 feet or so.

Q. Is that 50 feet the effective thickness or the total section?

A. The total.

Q. Now, in your P65 well -- I presume that is the way you call these designations. They are not familiar to me. However, did you penetrate that Weber formation in that well as shown on your Exhibit No. 5? that well?

A. We penetrated it to approximately subsea datum of a minus 1100.

Q. That is infill section?

A. Well, let's see. The top of the section is approximately at 750, so that would be a penetration of approximately 350 feet.

Q. All right, sir, what about your P64 Well?

A. P64 has a top Weber at approximately 630 feet so we penetrated about 470 feet of Weber.

Q. 470 feet of Weber?

A. Yes.

Q. P63 well, and get P58 while you are up there.

A. P63, top of the Weber about 520, so that we penetrated approximately 580 feet of gross Weber section.

Q. P58, did you give me that?

A. That would be approximately 670 feet of penetration.

Q. Did you run electric logs on all those wells? I presume you did, or some of them anyway.

A. Those are all later wells, as you can see from the number of the wells. I mean the numbers of the wells, they were drilled in sequence. And at that time I am pretty sure we did not run electric logs for the simple reason that we had cored the section completely with approximately 100% recovery and obtained all the information we thought was pertinent. That gave us a lot more information than an electric log could possibly give us. And furthermore, we did that coring with oil-base mud and, as you may know, the electric log some quite severe limitations in oil base mud.

Q. Then you have cored the whole section. Did you happen to core a substantial part of the section in any of these wells or was it in some other well that you cored?

A. I can't be sure. Maybe I can find a record here.

But I would say in general our practice was to have it all cored.

Q. You said it was all cored. Is that correct?

A. Yes, it was our practice to core the entire section after we set 7-inch casing.

Q. And have it analyzed?

A. And have it analyzed.

Q. In your exhibit No. 5, although you have cored the entire section on each one of these wells, you show, I believe, how many feet of section?

A. Approximately 15 feet, I think it is. A very small section.

Q. In other words, although you have a section that you have cored in each of those wells ranging from over 200 to over 500 feet, your exhibit, No. 5, shows 15 feet of it?

A. Yes, Exhibit No. 5 is not or was not representative of the entire section. It is representative of just that 15 feet. And you may recall that in my direct testimony I said that the reason we chose this section is that it was one of the rare sections that we could find covering a distance of four wells.

Q. Well, since this section covered only 15 feet, of course, it is not the or may not be representative of the whole section. Is that correct?

A. As it stands, the exhibit by itself perhaps doesn't. But I of my own knowledge know that it is representative of what you will find generally.

Q. In other words -- well, do you have your logs with you on those wells or do you have your core data on them?

A. No, they occupy about two file cabinets and I don't have them here with me. We have copies in Denver so that we can get them.

Q. On Exhibit 5, the pink section that you show there which is your section of the very best permeability, is it not?

A. Yes.

Q. That covers a wide range all the way from 5 millidarcies -- the pink covers a range from 5 millidarcies on up to however high it goes, one is 90 some, maybe higher. Is that true?

A. I don't recall how far up it goes.

Q. Look on it there, section 1?

A. Yes, it goes as high as 90. That's right.

Q. And then in the third well you have got an 81?

A. That's right.

Q. I didn't understand exactly. In fact, I didn't understand at all, Mr. Vitter. Being a layman in this technical stuff, Mr. Vitter is beyond me. What is the purpose of that exhibit? What is it intended to reflect?

A. It is intended to reflect the natural correction that goes on within the reservoir in a sand of this type that we have in the Weber sand. It corrects in regard to the sweeping of oil by gas, in other words; other witnesses have testified before this Commission that the Weber sand is very erratic, and it had a great deal of varyiations in permeabilities and this is certainly so. But what they have not brought out and what I attempted to bring out in this exhibit is that the saving grace of this poor permeability distribution is that it can not be correlated very far from one portion of the field to the other. So, as a matter of fact, the gas will not just simply go through the most permeable section and keep on going, but with time and distance there will be a natural correction of this irregular flushing of the oil by the gas and that it will be corrected very materially, and that it is very misleading to look at a section in any one well and say, therefore, that gas injection will not work satisfactorily. And that is what Exhibit No. 5 attempts to bring out, and it attempts to bring it out by showing that these permeable sections do not just run all the way through from one well to the other and by showing the natural averaging that occurs within the reservoir. Nature has provided a natural correction to that rather poor situation. And the permeability distribution you see on the far right is, as a matter of fact, a pretty fair permeability

distribution and far superior to what you would find if you looked at my No. 1.

Q. All right, sir, then, as I gather from your testimony, what that is supposed to show is that while your gas that you are injecting may start out in a permeable section and proceed through that highly permeable zone that it would not go too far in that zone before it is going to encounter some difficulty. Is that correct?

A. That's right.

Q. Now, what I want to know is this. Why wouldn't the very physical factors that made it select that zone in the first place, when it encounters some difficulty then go into the next zone, next most permeable zone and go through that?

A. It will, to some extent. When it finds that it can't go much further, it will tend to go into this less permeable zone as shown by the blue. So that rather poor zone will correct itself and this is the exact thing that is a saving grace of the situation.

Q. Well, now, if these permeable streaks extend, though, from your injection well to the well bore, if it encounters one of these impermeable sections or runs into a dead end, why wouldn't it go up the well bore?

A. It can.

Q. Not only can, it does, doesn't it? A lot of it?

A. It will in time when your section is swept out. In other words, it is possible for some of this gas in this section to come over to this red section over there. But at the same time there is some horizontal -- I mean vertical permeability which will give you correction within the formation even before it gets to the well bore.

Q. All right. Let's take your well number 65 there, which is P65, at the extreme left hand and let's make an injection well out of it.

Q. That's what it is.

Q. It is an injection well then? You put gas in there and it gets into one of these permeable streaks and goes over to P64. Is that right?

A. Yes, it will.

Q. And when it gets to P64, if it is confined to a more or less permeable streak in that big section that you have in this well, what is there to keep a large percentage of that gas after it reaches P64 from going right up the well bore? Isn't that the point of least resistance?

A. There isn't anything. Before it gets there it runs into a less permeable section so it runs into difficulty before it gets there.

Q. What is the most permeable section you have on p65? Isn't it down there at 58?

A. Yes, right here.

Q. 58 millidarcies. Now, what is that going to run into before it gets to P64 and goes up the well bore?

A. What is it going to run into?

Q. Yes. I don't see anything for it to run into there. There is a nice permeable streak there.

A. Some of it will get right over to P64 and that is the sort of thing that alarms some people.

Q. But it doesn't alarm you?

A. No, because I have seen that situation correct itself in several other operations?

Q. In what other operations have you seen it?

A. Brookhaven.

Q. Brookhaven. Now, how long have you studied Brookhaven to the extent you have studied this reservoir?

A. Quite comparably. We have been studying Brookhaven for some five years.

Q. Where is Brookhaven?

A. In the State of Mississippi, near the town of Brookhaven, Mississippi.

Q. Is that the one that youhave a section that is much shallower than this?

A. No, much deeper.

Q. I didn't mean that. I mean the extent of your section is not as great?

A. You mean thickness?

Q. Do you have 700 feet of thickness?

A. No.

Q. What do you have?

A. We have 40 to 60 foot of thickness.

Q. Total?

A. Total.

Q. In other words, you have a field that is, as compared to this field, you have a relatively thin section?

A. Comparatively, yes.

Q. It is less than one-tenth of this section?

A. Not as far as the effective sand is concerned, no, sir; about a third.

Q. I am talking now about the gross. In so far as the gross is concerned it is less than one-tenth? Isn't that right?

A. Somewhere between a fifth and a tenth.

Q. Any water drive in that field?

A. A small amount.

Q. Any gas cap?

A. No.

Q. What is the permeability range?

A. About 300 millidarcies.

Q. Average?

A. Average.

Q. You are not telling this Commission that field has got anything to do with this one, are you?

A. It has quite a few problems in common, yes.

Q. Are youtelling this Commission that you are experienced in a field with an average permeability of 300? You don't need a corrective factor with an average permeability of 300 millidarcies.

A. You fail to bring out permeability being very poor, just as it is in Rangely. And, as a matter of fact, that is much more important than the average permeability; which is average permeability from an economic point of view. But gas flooding to gas permeability is much more important.

Q. What is thepermeability there?

A. It varies. Approximately .8 in both places.

Q. I don't understand your "varies." I said -- I thought permeability varied from some millidarcy to some other millidarcy. I don't follow you. I can't follow that.

Q. There is a specific definition of permeability variation, which I presume you are asking about?

Q. No, I am not familiar with it.

A. But in general terms of the layman it is permeability variation. Whereas here at Rangely it varies from, oh, a few tenths of a millidarcy up to three or four hundred millidarcies with an average of perhaps 50 or so. At Brrokhaven it varies from, say, one millidarcy up to six or seven hundred millidarcies and has an average of about three hundred millidarcies.

Q. If you take your section there that you have, anyway you want to consider it, it is much more permeable section than youhave here?

A. It is more permeable.

Q. The real basis for your testimony here, that this gas is going to get this corrective influence after it starts through one of these permeable streaks that that is going to be corrected, is the primary basis of that is your experience at Brookhaven?

A. No, sir, we have seen it happen in other places.

Q. I see. Well, I thought that was the one most nearly like this?

A. Yes, in answer to your specific question.

Q. That being the one more nearly like that, if you have any basis for it in what has happened in other fields, that is the one that would be moste nearly in support of it, themost nearly like it?

A. But we have most all the actual infomation at Rangely here.

Q. I will come to that in a minute. Now, speaking of that -- digressing for a minute -- I believe your testimony was that when you drilled these infill wells where you had 40-acre spacing that you found that your bottom hole pressure was substantially what it was in the surrounding wells. Is that correct?

A. That is correct.

Q. And in your opinion the well will rather effectively drain 40 acres. Is that correct?

A. That is correct.

Q. Now, how does that drainage, in so far as this oil is concerned, how does that perform, Mr. Vitter? You take the low permeability stuff. Does the oil from there bleed into these more permeable sections and into the fractures and then proceed to the well bore? I have heard other witnesses state that. I just wondered what your idea was.

A. Yes, to the extent that the tight section is connected with the permeable, which it is, in a good part of the section. The tighter section does feed into the more permeable section and into the well bore and in some restricted areas of the field this is further supplemented by fracturing.

Q. In other words, in order to get this effective drainage you get through fractures and it is through the permeable streaks and oil bleeding into these fractures and bleeding into the well bores, in part.

Q. In part? Where do you get the rest of it?

A. Some of it comes in through the tight streaks.

Q. It goes right on across the horizontal plain. Is that right?

A. Where there is a tight section in the well, those

sections do produce oil, yes, sir.

Q. If a well will effectively drain at least 40 acres and maybe more, based upon your testimony in so far as oil is concerned, if you inject gas into this reservoir, isn't the gas going to perform just like the oil does and wouldn't it seek these permeable streaks and these fractures and then proceed from the input well into a well bore just like the oil does, except it goes easier? Isn't that right?

A. Well, it is a sort of a different situation. You sort of pull it along when you are producing oil in oil wells and in injection wells you are pushing it. It is a slightly different arrangement.

Q. Do you mean whereas oil, because you are pulling it to a well bore, seeks a more permeable section and through an input well it is going to go some other way?

A. I don't follow you.

Q. I don't follow you. I thought if you produce oil from a well, and if it comes to the well through these permeable streaks and through these fractures --

A. In part.

Q. -- and impermeable sections in part, bleeding their oil into these fractures and into these permeable streaks that is the way you got efficient drainage of this 40-acre area by the well. That is what I want to know. When you inject gas into the well, won't it go through these same

permeable streaks and fractures that the oil might bleed through?

A. Except to the extent that it is interfered with as described by Exhibit 5.

Q. If a well will efficiently drain an area of 40 acres, it isn't interfered with. If a well will drain 40 acres and it goes through a permeable streak and something happens and it finally goes to the well bore, if it finds enough of those things, in your testimony to effectively drain 40 acres?

A. I don't follow you at all.

Q. How does it?

A. I don't think my testimony said anything at all about that.

Q. You wouldn't say that a well will effectively drain 40 acres?

A. Yes.

Q. How does it get to the well bore?

A. Through sand which has some permeability.

Q. All right, it is going through the more permeable sections?

A. Some of it will and some through the less permeable.

Q. Most of it comes to the well bore through the fractures and the more permeable sections, the greater part of the oil that gets there.

A. The more permeable section produces more oil.

Q. Most of it migrates from this 40-acre area into the well bore, does it not, by reason of that?

A. You are speaking about permeability right at the well? That is one thing. But you must understand you have a situation back from the well bore that I have described in Exhibit No. 5 which tends to correct that situation.

Q. Well, you mean that the oil starts out through a permeable streak toward the well bore and then it meets some block. Is that right?

A. It may.

Q. Well, if your well effectively drains 40 acres, it is not going to meet too many of those blocks or it is not going to effectively drain it.

A. There aren't any blocks shown on Exhibit 5, there is an interchange between more permeable and less permeable sections.

Q. And the gas is going to find the same route. That is the only point I am trying to mek. When you put it in through an injection well it will tend to follow the same route the oil will. That is correct, is it not?

A. I am not sure I understand. That is approximately correct.

Q. It will have no more trouble proceeding to the well bore. In fact, it will have less trouble because it is

gas, than the oil would. Is that correct? And through the same channel?

A. Approximately so, keeping in mind this Exhibit 5.

Q. All right, now, have you got your Exhibit 6 there?

A. Yes, sir.

Q. Now, on that exhibit, as I understand it, can you take a thousand to one gas-oil ratio as showing the break through? In other words, when you found out where this input well or input gas has broken through on another well, did you just select a thousand to one ratio as the break through time?

A. Yes, that is the basis of those areas; the delineation of those areas.

Q. Now, I believe there was another exhibit put on up there where instead of taking an arbitrary figure like a thousand to one they calculated the area in which the gas had migrated after injection by getting the wells of abnormal increase. Do you remember that picture that was put up on the board?

A. This one up there?

Q. Yes.

A. Yes, I remember it.

Q. Is it your opinion that in order to select an area in which your gas has penetrated, that is from an engineering standpoint, it is better to just select an arbitrary gas-

oil ratio of a thousand to one rather than determining the break through with reference to wells that show an abnormal brdak through of gas-oil ratios?

A. Yes, because for reasons --

Q. Why?

A. -- I related to the Commission that in a homogeneous sand, where you don't have the variation in permeability, that is, where the gas gets to the next well and abruptly the gas-oil ratio changes from the normal solution ratio which we will say is, in the case of Rangely, approximately 2500 and the ratio jumps abruptly that amount as soon as the gas gts there. This is something that happens from the fact that as the gas front gets to the first well your gas saturation in this area abruptly goes from zero to, say, 15.6 percent. And when the gas saturation is 15.6 percent, the permeability of the gas very abruptly increases considerably and therefore because of that the gas-oil ratio will very abruptly, increase . From then on out that particular well will increase in ratio from 25 hundred on up as more and more gas is swept through there because as more gas is swept through there more oil is flushed out, the residual gas saturation, or I should say the gas saturation increases too in the case of approximately 22% ultimately. And the gas-oil ratio continues to increase. I have chosen 1,000 as a criterion because it represents a reasonable average between this solution ratio, break through of gas-oil ratio, 300. and 2500.

And also it is chosen because, from a practical point of view, it is probably the lowest ratio that you can, with some assurance, say indicates that that well has had some injection gas put into it.

Q. In other words, you can't say a well gives no evidence of producing any injected gas until it reaches a gas-oil ratio of a thousand to one. Is that your opinion?

A. No, it isn't. I say that there is some, due to the productioncharacteristics of these wells, considerable question as to the significance of, for instance, a 600 cas-oil ratio, because you can measure these wells one day and go back the next week and measure something a little bit differently, maybe 800 or 400. We think that when you have measured a thousand that you have substantial information to the effect that injected gas has reached that well.

Q. Well, in other words, you think there is no doubt about it then. Is that correct?

A. That is correct.

Q. And if you are in error and it has reached it before then, of course, some of your injected gas has gone up the well bore. Is that correct?

A. That is correct.

Q. Then when you calculate the space that your gas has covered -- your 600 million cubic feet or however many you have injected -- and fix that area, you are in error by

whatever amount of gas has gone up the well bore?

A. About 2% in this case.

Q. About 2%. What about the time factor? Does it reach all these wells at the same time? How do you take care of that? Suppose a well gets to a thousand to one gas-oil ratio and that it shows a break through, I presume, --

A. That's correct.

Q. Now, that well, of course, is producing. Now, let's say it takes it a month or two months to reach some other well. They didn't all break through at the same time, did they?

A. No, sir.

Q. How do you take account of the fact that some of the wells have been producing during this period and producing injected gas? What allowance do you make for that gas that is being produced when you calculate the space?

A. We can only figure out the produced gas by taking the difference between the actual ratio and the solution ratio and the amount of oil produced in that well and say that that amount of gas is injected gas which has been produced from that well. And in this particular well, the case of P65, that amount of gas, that is injected gas, only amounts to 2% of the injected gas and we didn't calculate that on the exhibit, by showing it, because it was not significant.

Q. How much does it amount to in the other area? Do

you recall? Was it 2%? pt 3

A. I don't know off hand.

Q. I believe you have your area extending right up to well 65 in section 21, in the well up to the north or northeast?

A. 56, yes, sir. It is right in section 21.

Q. No, I am talking about well 64. I have it wrong. In 22. You just barely have it up there. Is that right?

A. That is right.

Q. Now, all your other break through's you have drawn you line intermediately through the break through well and the next well. Is that correct?

A. Yes, sir.

Q. Why didn't you do it on that particular one? Why didn't you go up there intermediately between 64 and that next well up there to the north, if you followed the same system you followed on the other?

A. Well 64 had a gas-oil ratio of 1037. If you wanted to draw that area just a little bit differently and out there I wouldn't argue on it. It wouldn't make too much difference.

Q. Likewise you wouldn't argue with me if I took well 45, in section 21, that has a ratio of 955 and put it in there; you wouldn't argue much about that, would you?

A. Well, we drew this extent of the injected gas on

the basis of what the ratio was in well 22, which was 1223; in 45-23, which was 955, and we drew it in there where we thought that it was consistent with those measurements, and the same with respect to 11-21.

Q. Well, then, couldn't you sum up that exhibit, Mr. Vitter, by saying that the area you show there would be subject to considerable change through difference of opinions of different engineers by drawing it, whether they went half way between this well or whether they took 900 or a thousand as the break through point or whether they attempted to get the breakthrough point in some other manner? That is correct, is it not?

A. Let's take those one at a time, now.

Q. In other words, if you take 900 cubic feet instead of a thousand, of course, your area will be larger because you inlcude more wells, I presume. Is that right?

A. Well, yes. But what you would do, as this program proceeded further, would be to also extend the area which is, say, encompassed by a 2500 foot ratio or 5,000 foot ratio or whatever seems to be indicated, then you would also use that information to tie into your theoretical analysis and compare the actual performance with the theoretical performance so you would more or less relieve yourself of being tied down to only that thousand criterion, which we have done

in other cases has proofed rather satisfactory.

Q. Now, I though I understood youto say when you were talking about your gas-oil ratio limits you mentioned something about equal withdrawals. Was I correct in that or did I misunderstand? It has some value in equalizing withdrawals from the reservoir.

A. I don't believe I said that this gas-oil ratio limitation was a means toward affecting proration on equal withdrawals. I thinkwhat I said was that in those cases where wells were producing excess amounts of gas that this thousand gas-oil ratio limit was a means of keeping those wells from producing an excess amount of reservoir withdrawals as compared with offseting wells.

Q. How much reservoir space will be voided with a well with exactly a thousand cubic foot ratio under the rule that you propose, just approximately?

A. How much reservoir space --

Q. Yes, will be voided by a well with exactly a thousand cubic feet per day ratio? Let's see, it can produce 150 barrels, can it not?

A. 150 barrels and you want to know the reservoir space?

Q. Yes. In other words, it will produce 150 thousand cubic feet of gas and 150 barrels of oil. How much is that in reservoir space at some pressure that you want to select there?

A. It would be approximately 175 barrels of reservoir space.

Q. All right, now, a 400 barrel well with a ratio of 990 cubic feet. How much will be voided at the same pressure?

A. About 500 barrels.

Q. Somewhere in the ratio of three to one?

A. Approximately.

Q. -- as far as the reservoir space is concerned. And under the rule you propose you could have such production? You could have such production under the rule that you propose. Is that right?

A. You could, but a 400 barrel well in Rangely would not be typical.

Q. No, I know it wouldn't be typical, but there are wells that will make that, are there not?

A. Oh, yes.

Q. How much did you say you had expended on packers? A hundred thousand dollars?

A. Approximately one hundred thousand.

Q. Have you made any attempt, that is, while you have had this pilot injection program which involves how much injection per day?

A. You understand these two things are not at all related?

Q. I understand that.

A. So, what is your question?

Q. I say how much gas have you been injecting in the reservoir?

A. Well, we have injected --

Q. A million and a half a day?

A. Approximately a million and a half a day.

Q. Have you made any estimate of what your packer cost might be if you were injecting 20 million cubic feet into the reservoir and attempting to cut off any of these channels that would bring in substantial amounts of input gas into a well bore? Have you made any calculation of what that might cost?

A. No, we wouldn't do it quite that way. We are gling to inject gas on a pretty big scale we will have to have a fielx-wide unit or three-units or something of that nature substantially large and we could overcome many of the problems we have now on excessive gas-oil ratios that were presently overcoming by setting packers, by selective production.

Q. In other words, to do this thing, to have field-wide injection and get your 20 million feet back, you do have to have unitization, either field-wide, which is probably preferable, or under your three-unit plan?

A. Well, I don't want to limit it to either of those two. You have to have some substantial sized lease, such as we do have in the joint California fee and Texas-U.P. fee properties upon which we started our pilot program.

Q. Well, I thought you just stated in answer to my previous question, when I asked you about packers, the way you were going to take care of the situation would be that you would have unitization either on a field-wide basis or on some other basis, say, of three individual units covering the field?

A. Yes.

Q. Did I understand that? And then, if I did, wouldn't it follow from that that really in order to make field-wide injection, in order to get this 20 million cubic feet back into the ground, you really ought to have either one plan or the other or something that unitizes the reservoir?

A. Eventually. Of course, we can go on for a period of maybe a couple of years without having to do that.

Q. Without harming anybody? Without affecting any cross-lease drainage?

A. On some of our large leases, yes.

Q. I see. That is what I wanted to ask you right there. You mentioned North Cowden where they had three units. Was that a field you ---

A. No, I didn't say they had three units. They have many units.

Q. Anyway, they have multiple units?

A. Yes.

Q. Are you familiar with the ruls and regulations of

of the Commission of Texas?

A. We don't operate in Texas and I have just general knowledge of their operations, no first hand information.

Q. Do you know that in Texas, before you can have an injection program, whether you have got one unit or ten units or field-wide, that the Commission controls the location of every input well, controls the amount of gas that you put into the reservoir, controls your oil allowable, and darn near controls everything you do with respect to the reservoir? Are you familiar with the rules they put on your back when you go into a unitization program?

A. I know they have a lot of controls, yes, sir.

Q. Now, in order to have any kind of efficient unitization of this field, whether you have got three units or -- well, if you have three units don't you have to have somebody that's got some control of the situation?

A. I believe I said so earlier in the evening.

Q. In other words, it would be necessary for the Commission, if you had three units, to some way control what you are doing in each of the three units so you can keep your horses going down the same road. Isn't that correct?

A. That's correct.

Q. Now, is it your opinion that this Commission, under the statute that governs it, has the authority to control one of these units after you create it?

A. Well, I am not thoroughly versed on what the Colorado law is. But it is my understanding that they do not have any control after a unit is formed. Whether that is so or not I don't know.

Q. If they don't have any control and you formed three units then you have got three units, one of which can go in one direction and another in another and so forth as far as those particular units are concerned. Is that correct?

A. If the Colorado Oil and Gas Commission is the only governmental agency involved.

Q. Well, it is certainly the one we are addressing ourselves to now.

CHAIRMAN DOWNING: The U. S. G. S. is here also.

Q. (By Mr. Stayton) What if you don't have any unitization at all, Mr. Vitter, and every man just goes out and injects where he wants to, to put this 20 million cubic feet back, that is even far worse than having the three units, is it not, unless you get somebody to control the injection program?

A. That is a hypothetical question. It is quite true it has no bearing on your situation in Rangely.

Q. Oh, it has no bearing on that?

A. No, the Commission has certain controls on that injection.

Q. Well, I thought under the order that you propose you

get credit for any gas you put back in the reservoir. I saw nothing in the order that required you to get any permit from the Commission before you inject the gas or get any order allowing you to put only so much back through a particular injection well. I thought all you had to do was drill your well and "cock her back" and put the gas in the reservoir.

CHAIRMAN DOWNING: Let me interject a moment. I wish counsel wouldn't argue so much with the witness so far as the legal questions are concerned. This witness is not a lawyer and I don't know that we care particularly to hear about our powers until we hear the legal argument.

MR. STAYTON: All right, sir.

CHAIRMAN DOWNING: The reason I raise the point is because of the element of time.

MR. STAYTON: Well, Mr. Chairman, I really didn't want to go into your powers. I want to get into the facts. There is nothing in this proposed order that provides for this.

CHAIRMAN DOWNING: The proposed order speaks for itself.

Q. (By Mr. Stayton) Now, Mr.Vitter, I believe you stated that one of these injection wells, ifyou formed these three units, one of the injection wells is right on the line, isn't it, or something someone stated to that effect?

A. I stated that it was close to the east line. It is about 1900 feet north of the line and about 3,000 feet west of the line.

Q. If you inject gas into that well, if you form these three units, eventually that will have some effect on the neighboring unit to the east, will it not?

A. I don't know whether we would continue the pilot program the way it stands if we form a west unit. If we did it would be a rather minor part ofthe whole west unit operation.

Q. You may choose to abandone that?

A. Maybe.

Q. And you may choose not to, is that correct?

A. That's correct.

MR. STAYTON: That is all.

BY DR. BOATRIGHT:

Q. Mr. Vitter, I believe you made a statement that a well producing at a gas-oil ratio of greater than a thousand cubic feet of oil per barrel that that is wastefully?

A. Yes, sir.

Q. Will you explain why?

A. Well, as you so ably described the history of a natural depletion gype reservoir to theCommission, there is a normal rise in gas-oil ratio during the life of the field as it is depleted. At Rangely right now, the normal ratio is

probably of the order of about 500 cubic feet per barrel. We have recommended a thousand as a reasonable "chopping off" place over which we can say with some assurance that such a well is producing excessive gas.

Q. What assurance have you got?

A. Well, if we say 500 there is some question in the measurement of gas-oil ratios in the field due to the heading characteristics of the well and the natural limitation on the measurement of gas and oil that perhaps your measurements are only good to, say, 20%.

Q. What is the accuracy? what is the guaranteed accuracy of an orifice meter?

A. Well, under ideal conditions, onw would ordinarily say an orifice meter is good to about 3%.

Q. Don't you keep your meters in good condition?

A. Yes, we do.

Q. Don't you ever correct on gas? Don't you specify that if they are over 3% correction will be made?

A. I don't know that we do, but I wouldn't be surprised.

Q. And you can gage how close in the tanks?

A. About a quarter of an inch.

Q. What is the size of those tanks?

A. A thousand barrels; 5.6 barrels to the inch.

Q. How many barrels do those tanks hold?

A. A thousand barrels.

Q. And what does a quarter of an inch represent?

A. About a barrel and a half.

Q. What is that in percentage?

A. Percentage of what?

A. Total content of that oil?

A. Of the tank?

Q. Yes.

Q. When it is full?

Q. Yes.

A. About a twentieth of a percent.

Q. And the wells are producing how much a day on the average?

A. 140 barrels.

Q. Suppose you made a quarter of an inch error. I think that is high. You can measure an eighth of an inch because you have a below gas-oil ratio, your measurement should be very low. Isn't that right?

A. I think you can measure the oil production to within a barrel and a half on a 24-hour gage. Of course, we gage them sometimes at 8 hours and sometimes 4 hours.

Q. So that is 1%, isn't it?

A. Something like about 1%.

Q. So if you add 1% and 4% -- you can't possibly be over plus or minus 4% on the measurement?

A. Oh, yes, on heading characteristics. When you say the orifice meter is good to 3% you must have a gas flow which is fairly uniform and not going up and down.

Q. How much experience have you had with meters?

A. I have had, oh, probably a couple of years experience in testing gas wells. As a matter of fact, I have published a couple of articles on testing.

Q. Can you calculate an orifice meter chart?

A. Yes, I can.

Q. What type of meters do you use?

A. Oh, we use several.

Do you mean the make?

Q. Yes. Do you mean to tell the Commission you can't gage those wells within any greater accuracy than 20%?

A. I think perhaps you have missed what I am trying to get at.

Q. I don't think I have.

A. You can measure it at any one time, what that well is producing, within a reasonable accuracy, but whether that is representative, I mean the well is changing from time to time, its heading, one thing and another, and as a matter of fact, you will find if you test that well from week to week or month to monththere will be a variation easily of 20% or 30%.

Q. How do you measure your gas off of your lease?

A. Gas off the lease?

Q. Yes, or do you measure it from the individual wells or off the lease?

A. We measure the bulk gas and we have facilities for testing each individual well.

Q. How often do you test them?

A. We test the wells individually monthly. We measure the gas all the time off the lease.

Q. So you have got a double check, don't you, on your actual individual well tests?

A. We know what the sum total of the lease is doing.

Q. What does the accuracy of the individual well tests compared to your lease check out to be?

A. When you put in all these fluctuations from test to test, it averages out pretty well. It may check within four or five percent.

Q. Where is your 20% that you just got through telling the Commission?

A. Individual measurements.

Q. But, if it averages out over the months to what your actual test was, why did you make the statement that you have got a 20% possible error in there?

A. Because you may easily have error in your individual well measurement. You may be 20% high one time and 15% low the next time and that overall, with all these wells in the battery and all, the several tests you make on them,

these errors tend to counteract each other. So in the overall when you try to balance out the battery you may be off only 4% or 5%.

Q. All right, but you just got through telling us that your actual well tests have seldom checked out more than 4 or 5 percent plus or minus, less than your lease average.

A. I am talking about a month's period.

Q. Yes. But the individual well tests are made on 24-hour basis?

A. Yes, and some cases less.

Q. All right now, let's get back to that thousand to one ratio.

CHAIRMAN DOWNING: The Commission doesn't care to listen to two experts cross examining each other. With this arbument we will be here all night. Let's get down to the facts. I dislike curtailing it at all but I want everyone to have a fair hearing and get their case in fully. Some of these people came from long distances and I would like to finish. Please don't arbue with the witness. Ask him specific questions but do not argue.

MR. BOARTRIGHT: I am sorry if I appear to be arguing, but this is an important point. They have arbitrarily taken a thousand feet per barrel as a criterion of whether it is wasteful or not. That is the crux of this whole matter.

chairman downing; You are arguing with the witness. Now, let's get the facts and we will try to judge as best we can what the facts are.

MR. VITTER: I might clarify the matter if I would say that in previous hearings that you did not appear at, we brought forth one of the reasons for recommending the thousand ratio. It is quite common and quite practicable and feasible as evidenced by the actions of the other regulatory bodies such as Louisiana, Arkansas, Texas, Mississippi, to provide a gas-oil ratio limit which was of the order of twice the solution ratio. I think that is borne out in Texas and states I could mention.

MR. BOATRIGHT: And just for your information, I will tell you how that figure was arrived at. That figure of two thousand feet per barrel was set arbitrarily and it just so happens in an average field in Texas from which there are wide variations it happens to work out about two to one. As a matter of fact, there are a lot of fields in Texas that are assigned gas-oil ratios of ten thousand to one and I can name one of them offhand. in County, and numerous other fields in the state of Texas which are limited to solution ratio.

MR. WALSHE: If this witness would like to testify on that data , I think, --

CHAIRMAN DOWNING: I think he has been testifying for the lazt two or three minutes. Please avoid testifying

as to your opinion.

MR. BOATRIGHT: Did you know that?

A. Did I know what?

Q. (By Mr. Boatright) Did you know what I just told you?

A. You kind of lost me. I am not sure I knew what you were talking about.

MR. STAYTON: That is all. We are through.

CHAIRMAN DOWNING: Are there any other questions? Call your next witness.

(The witness withdrew.)

Let me as again. We want to accommodate everyone and get through and that is why we are here tonight and during this cross examination there was entirely too much argument.

MR. WALSHE: We are finished.

CHAIRMAN DOWNING: How about Stanolind?

MR. LAUGHLIN: (Stanolind) I would like first, Mr. Chairman, to call on Mr. Jenkinson who wants to make a statement on behalf of the Stanolind Company with respect to unitization, which is the subject of this hearing.

MR. JENKINSON: I want to make the position of Stanolind clear in connection with the efforts to unitize the Rangely Field. We are very much in favor of field-wide unitization. Over the period from 1946 until the present

time we have consistently made efforts to cooperate in every way in the unitization of the field. The last two proposals for field-wide-unitization were not acceptable to us.

The California proposal was not acceptable because we didn't think that it protected the equities of all of the operators.

The Texas proposal was least acceptable to us in that it had some proposals for everyone to operate their own properties, to check the operator, and advised a small advisory committee of five people and other unacceptable phases. However, the most objectionable of all was the form of participation which our engineer will go into in later testimony. We are convinced that under the present conditions it is very nearly impossible at this time to form a field-wide unit.

We are supporting and would like to continue to support the three-unit plan proposed by The California Company. We have taken steps to proceed along these lines. The Califonis Company, Phillips and Stanolind have worked out a unit agreement and a unit operating agreement covering both the west unit and the east unit which is acceptable to all. California, I understand, have already done some of their part. We are taking steps to d o our part in the near future. I see no reason in spit of some of the testimony submitted why partial unitization will not work. We have two very good

examples of it in Texas as in the field that we have just completed units on. One of them is Cedar Lake, where we unitized just about half the field and have been injecting gas for about a year and a half. We are now negotiating with our neighbors who are not unitized to cooperatively inject with us. And they have shown interest and we think we will accomplish that.

In the Tri-Bar Field we have four lease owners. Three of us got together and formed a unit. Before the unit was ever signed we sat down with the other operator, the Humble, and worked out an equitable and fair cooperative injection program. And I see no reason why that can not be done here.

That is about all I have to say.

CHAIRMAN DOWNING: The Union Pacific expressed a very great desire for unitization a little while ago and offered to make concessions, as I understood it, to bring about a unitization. How do you feel? Are you willing to make concessions to the other group in an effort to get together or is this a case where everybody has got to have his way 100%?

MR. JENKINSON: Mr. Downing, in answer to your question, we made concessions in the past. In fact I sat in one meeting where all the operators made concessions except one and we have made concessions in the past. I don't

think we are called on for any further concessions.

CHAIRMAN DOWNING: I wouldn't go into the detail of it but I suggested that an appraiser be brought in. Why can't that be done? I don't know of a better man than Max Ball. He is a Colorado man. We all know him. Why don't you call in somebody like him and have him get you together and give him power to appraise. All this is a question, as I understand, entirely of appraisal of relative values of several groups of properties. Can't you do that? Can't you agree on an appraiser or three or five? Then put it all up to them.

MR. JENKINSON: Maybe our company is a little conceited like all of us are conceited about the caliver of their engineers. We feel that our engineers are quite capable of figuring out values. I wouldn't say for the company that we wouldn't agree to that inasmuch as Mr. Osborne stated they would resort to it only as a last resort. But he refuses to go along with the three-unit plan, which I admit is not as good as field-wide unitization. But I think most everyone except a few people agree it will benefit the ultimate recovery to a certain extent.

CHAIRMAN DOWNING: Who is your next witness?

MR. LAUGHLIN: I would like to call Mr. Richards. He was called at the last hearing and sworn and qualified as an expert.

CHAIRMAN DOWNING: Make it as brief as possible so we can finish.

S. B. RICHARDS

recalled as a witness for the Stanolind Oil & Gas Company, having been previously sworn, upon his oat testified as follows:

DIRECT EXAMINATION

BY MR. LAUGHLIN:

Q. You have the first portion of your testimony in written form, Mr.Richards?

A. Yes, sir.

Q. Would you kindly read it, please?

A. We desire to introduce into the record statements regarding the behavior of individual wells and of the reservoir as a whole for the solution drive type of reservoir, statements regarding the proper operation of wells in the solution drive reservoir, and statements regarding the proper operation of the Rangely Weber reservoir which we consider to be operating predominantly under solution drive.

Prior to production from a solution drive type of reservoir, the reservoir contains oil with gas in solution under pressure and, by definition, the reservoir is a closed trap, or sealed off around the productive limits so that no fluids can enter the portion of the reservoir containing oil. When a barrel of oil and its contained solution gas is

withdrawn from the reservoir, the pressure decreases in the reservoir and the solution gas remaining in the reservoir expands, reaching a volume sufficient to occupy the space previously filled by the barrel of oil withdrawn. As this process continues, the pressure in the reservoir becomes lower and lower and, after reaching a certain point, known as the bubble point, gas begins to come out of the oil in the reservoir and occupy space as free gas. By occupying space as free gas, the gas is then subject to being produced without moving oil to the well bores and with the oil that is being produced due to the expansion of the gas that does remain in solution.

If there is a gas cap present and it is not produced significantly, this gas cap expands continually as the oil is withdrawn from the reservoir, forcing oil ahead of it.

Before reaching the bubble point, the gas produced with the oil is solution gas and the produced gas-oil ratio approximates the solution gas-oil ratio. After the reservoir pressure goes below the bubble point pressure, the gas produced with each barrel of oil is the solution gas contained in that barrel of oil plus some of the free gas that has come out of solution from barrels of oil still remaining in the reservoir. Consequently, at this point, the produced gas-oil ratio begins to climb above the solution gas-oil ratio and continues to rise until most of the free gas has been pro-

duced. This process will take place, unless gas or water is injected into the reservoir at some stage in the producing life of the reservoir, regardless of how fast the reservoir as a whole is produced.

Under idealized conditions of uniform sand conditions and uniform withdrawals per well, all wells producing from such a reservoir will have the same gas-oil ratio, and if they do, and further, if no gas is produced from the gas cap to diminish its reservoir sweeping effect, maximum recovery will be obtained from this type of reservoir. In the interests of maximum recovery and conservation, therefore, every practical step should be taken to prevent production of gas cap gas and to keep the gas-oil ratios from individual wells as uniform as possible and also as low as possible.

Under actual field producing conditions, however, due to sand conditions or past production practices, some wells will produce considerably higher than the proper ratio at that time for the reservoir as a whole and actually, in order to obtain maximum recovery from the reservoir, such wells should be shut in until the rest of the field catches up with those wells in regard to gas-oil ratios. However, shutting in such wells entirely is an unreasonably strict conservation measure and in most states, such wells are restricted in their production below that allowed for a normal

gas-oil ratio well and this tends to allow the rest of the field to catch up over a period of time with the high gas-oil ratio wells.

We now wish to call your attention to the situation in the Rangely Weber pool:

1. Testimony developed during previous Rangely hearings indicates that the Weber pool is operating predominantly under solution drive.

2. The original average solution gas-oil ratio in the Weber reservoir was approximately 330 cubic feet per barrel.

3. After producing approximately 100 million barrels of oil, the bottom hole pressure has been reduced appreciably and the average field gas-oil ratio has increased to approximately 600 cubic feet per barrel.

4. A large number of wells in the field are producing with gas-oil ratios above 600 cubic feet per barrel and an appreciable number (81) are producing with ratios in excess of one thousand cubic feet per barrel.

Since the field average ratio is approximately 600 cubic feet per barrel, it appears proper to restrict the production from all wells producing with a ratio in excess of 600 cubic feet per barrel to be consistent with the line of reasoning presented above. However, we feel that a reasonable tolerance should be granted and that it be de-

clared that all wells producing with a gas-oil ratio of over one thousand cubic feet per barrel at the present time are producing gas wastefully and should be restricted in production below that allowed wells producing with a ratio below one thousand cubic feet per barrel. Since the top per-well production allocated by the purchasers averages approximately 150 barrels of oil per day, then a well with a gas-oil ratio below one thousand cubic feet per barrel produces up to approximately150 thousand cubic feet of gas per day. In view of this, it is considered proper and in the best interests of conservation to restrict the high gas-oil ratio wells to a gas production of 150 thousand cubic feet per day and whatever amount of oil that can be produced with that amount of gas.

It may be seen, of course, that if no restriction is placed on the wells producing with a gas-oil ratio below one thousand cubic feet per barrel, some of these wells may be produced at very high rates of oil and gas per day to make the total lease allowable. High rates of production from individual wells are conducive to abnormally increasing the gas-oil ratio from individual wells and Stanolind representatives in previous Rangely hearings have advocated that each well in the field be restricted to a gas production of 150 thousand cubic feet of gas per day as being an additional conservation measure beyond the restriction only on wells

producing gas wastefully at present, those producing with a gas-oil ratio in excess of one thousand cubic feet per barrel. We are still of the opinion that a gas restriction on the high gas-oil ratio wells is a conservation measure which will aid in increasing ultimate production from the Weber reservoir and that a gas production restriction on all wells in the field will aid even further in obtaining maximum ultimate recovery from the Weber reservoir. Unless there are some restrictive measures on the operation of the field, ultimate recovery will be decreased by several million barrels.

Q. Mr. Richards, do Commissions in other states use gas-oil ratio limits to restrict excessive gas production?

A. Yes, they do. After taking testimony on the operation of reservoirs, they set up gas-oil ratio limits of one thousand or two thousand. The States of Texas in the Slaughter Field; Oklahoma, Sholom-Alechom Field; Louisiana, the Big Creek Field; Mississippi, Arkansas and others.

Q. Are their solution type pools the same as the states which are so restricted?

A. Yes, they are the same type pool we have here at Rangely.

Q. Mr. Winterburn, in his testimony concluded that the Weber formation at Rangely is highly fractured. Do you agree with that conclusion?

A. I was amazed today by the entirely new concept of the

Weber reservoir which I heard for the first time today. From all of the testimony put on here today I can picture the Weber reservoir as nothing but a large system of fractures in a majority of the reservoir and some of the testimony indicates the whole reservoir is nothing but fractures.

Normally, in telling whether or not there are fractures in a field you have four guideposts to go by.

If you core the well -- and most of the wells in the Rangely Field have been cored solidly -- you see the fractures in the cores. In coring or drilling through the formation, if you have fractures, you lose circulation in the actual production of the well; I mean the actual productivity index of the capacity of a well is much higher than you would calculate from the millidarcy-feet of sand because you have been unable to calculate the effect of the fracturs.

A well that is completed in a fracture zone has a high rate of capacity and it declines very rapidly from that capacity as the fractures themselves are drained and can decline within a matter of weeks or months to a low production capacity equivalent to the capacity of the tight formations that are feeding into that fracture system of conduits.

I have followed the development and operation of Rangely Field since its development program started, I believe, in 1943. Stanolind has drilled 116 wells in this field,

scattered from one end to the other. I recall no serious loss of circulation while drilling through the Weber formation.

I was personally in the field when a number of cores were taken and we used a 50-foot core barrel and I failed to see the large amount of fractures which were spoken of today.

We found that we could not diamnond core in a formation in which there are fractures because of the wedging of the fractures in the fracture formation in the core barrel prevent the proper use of the diamond core barrel. And we had no such experience in our operations in the Rangely Field. In view of that, I can not conceive of this new concept of the Weber reservoir being a mass of fractures.

It appears to me to be a tight sandstone formation with variations in permeability and porosity similar to a number of other fields that we have.

Q. How about the PI tests with respect to experience at Rangely?

A. The productivity index tests have shown productivity of the wells to be close to the calculated productivity. None of the productivity indexes in the field are very high, I think something in the order of three and a half is about the highest we have on record.

Q. From your study and knowledge of the Rangely Weber formation, how will the permeability of the formation affect the gas injection project?

A. Ever since the development of the Rangely Field began, we have made intensive studies of well logs and core analysis in an attempt to correlate permeability zones from one well to another. We have been unable to do so. At present, to my personal knowledge, a profile which you find in one well you can not find five feet from that well. The permeability will be high at one point and will grade into lower permeability at another point and, in fact, the distribution of permeabilities will be so heterogeneous as to be homogeneous. In the practical effect, I considered the Weber reservoir to be homogeneous. There is, of course, no such thing as a perfectly uniform sand porosity and permeability and I found nothing strange in the distribution of porosity and permeability in the Weber Reservoir.

Q. The matter of water injection proposals has been mentioned here today on several occasions. Would you care to comment on water injection?

A. I was again amazed by the statements regarding water injection as being more feasible than gas injection. I can not grant the fracture system, but, assuming we do have this fracture system of numerous conduits running throughout the reservoir feeding into the well bores and, as other witnesses have stated, that if you attempted gas injection it would go through these conduits, sweep the oil out of them and by filling up the conduits with gas would prevent oil from coming

out of the tighter portions. However, they state that we can inject water through those same conduits in the same reservoir and apparently, for some reason with which I am not familiar, the water would not go through these conduits but would go through a better portion of the reservoir and sweep the oil ahead of it much more efficiently than would gas. It is not consistent with their presentation of the type of formation we have and its being non-feasible for gas injection.

I also recall in drilling in the Weber formation, the early wells, we used a water-base mud. We found that that water base mud caused a water block of the Weber reservoir and we had to resort to using oil-base mud in drilling and completing all the wells. Whether or not this water blocking effect of water on the Weber reservoir would be unfavorable for water injection, I don't know. But it appears that it would be discouraging for water injection operations. We are not averse to making tests of water injection and at some stage of the life of the reservoir it may be possible to use water injection. But I do not see how it can be proposed as a more likely substitute for gas injection to increase recovery from the reservoir.

Q. The Texas Company and the Union Pacific have suggested a gas-oil ratio limit in the Weber formation which is, as I recall, double the field average. If I understood Mr. Boatright correctly he advocated no gas-oil ratio

limit. What comments can you make with respect to those proposals?

A. The Texas-U.P. proposal gives an initial gas-oil ratio limit quite close to the thousand to one we are advocating. They come up with twelve hundred. That would give you a tolerance at this point of 600 cubic feet per barrel while we are allowing a tolerance of 400 cubic feet per barrel;as the field gas-oil ratio increases under their provision, the tolerance would become increasingly greater to the point where if you had a field gas-oil average of two thousand to one you would have a tolerance of 2,000 cubic feet and when you have a field gas-oil ratio of one thousand to one up to ten thousand to one or a tolerance of five thousand to one. This seems undely large for a tolerance.

Also, the method in which they propose to operate it, by taking tests every quarter and revising it calls for an unusual amount of book work and the close supervision of a great number of regulatory employees which we think would make it impractical.

The gas-oil ratio is not rising so rapidly that the limit of one thousand to one would not be practical for a year or probably two years and could always be changed upon a hearing before this Commission.

In regard to the Sharples proposal that there be no gas-oil ratio limit placed on the field, we are, of course,

opposed to that. As I pointed out, some wells in the field can produce at very high gas-oil ratios and are making an inefficient use of reservoir energy. I would have no objection to that if each one of the 478 wells in the field was enclosed on its 40-acre boundary by a wall of concrete so there is no migration of energy between the wells, it would be perfectly all right for this well to produce at any gas-oil ratio. But in a reservoir of this type, where we have communication between wells, some wells will produce at a lower more efficient gas-oil ratio. If you restrict production of high gas-oil ratios the oil will migrate toward the low ratio wells and will be produced where you are using more efficiently the energy.

Q. Do you know of any other state that employs gas-oil ratios based on a field average?

A. No, I know of no other state that has adopted a program such as is presented by the Texas-U.P.

Q. In Mr. Winterburn's statement today, among other things, he said that the present suspended rule has forced Texas-U.P. to curtail their production of oil thereby causing them damage, financial damage. What has been the effect of thatrule on Stanolind?

A. It has also caused Stanolind to restrict production from their wells to the extent where we are losing several thousand barrels and about two or three times that amount in

dollars per month from our operations. However, we felt it was to the best interst of conservation and made no complaint on that score.

Q. Do you have an opinion, Mr. Richards, with respect to the present gas injection project referring particularly to the amount of gas injected and its indication in the off-set wells?

A.We made a very intensive study from the data we had available on the two pilot injection experiments. From that we concluded that the gas injection experiments were progressing very satisfactorily and were encouraging enough that Stanoline dould join in a field-wide unit or in partial unitization to take advantage of the benefits of gas injection. We believe that it will result in appreciable increases in ultimate recovery, either on a field wide basis or on a partial unit basis.

Q. If I remember Mr. Boatright's testimony accurately, he stated that no gas injection project would be beneficial. Do you agree with that conclusion?

MR. STAYTON: He didn't say that.

MR. BOATRIGHT: I beg your pardon. There isn't anything in the record that says that.

A. I also got the impression that Mr. Boatright stated there are few if any gas injection or pressure maintenance proposals that were beneficial. Our company is engaged in a

large number, of which I am actively working on two in the Rocky Mountain region -- one is the Salt Creek Field which is a depletion type reservoir, in which injection has been in effect since 1942. All our data indicates that we are increasing recovery by at least 25%. We are also conducting a nitrogen injection project in the Elk Basin at this time in the Tensleep sand which is a volumetric drive. We are increasing recovery by, we estimate, better than 30%.

I would also like to point out that the Salt Creek Field is only a partial unit. At the time gas injection operations were started they had partial units on one-fourth of the field. The Salt Creek unit was formed in the year 1939 covering about the thorthern two-thirds of the field and that is the only unit in the field and we are only conducting gas injection operations in that northern two-thirds of the field. There has been no waste or loss or damage that we know of and we have increased recovery, as I say, by something like 25%.

MR. LAUGHLIN: I didn't intend to misquote you, Mr. Boatright.

MR. BOATRIGHT: I am sure it wasn't right. But I would like the Commission, before they accept that statement, to check my testimony.

CHAIRMAN DOWNING: The record shows what was said. The witness wasn't influenced by what was said. He has stated

his opinion on gas injection and that is what we want to know.

A. I consider the Rangely Weber reservoir no strange, unusual type of reservoir completely stratified with fractures; it is no different from any other type of reservoir. From the type of formation we have there, I believe gas injection operations can be successfully conducted and will result in an appreciable increase in ultimate recovery?

BY CHAIRMAN DOWNING:

Q. Have you any idea what the percentage might be?

A. Based upon industry experience it will be 10% to 25%. As I stated, our experience in the Salt Creek Field has been 25%. There is no reason why instituting gas injection at this stage of the life of the reservoir should not obtain recovery something like 25% increase, increase in ultimate recovery.

BY MR. BRETSCHNEIDER:

Q. The Salt Creek Field has a different temperature gravity, does it not?

A. The temperature gravity is about 37 degrees. In the Salt Creek Field the sand is something like 200 feet thick. It is not completely uniform. You have a difference or variation in permeability like you have at Rangely. I can conceive maybe, comparing Rangely with Salt Creek, is is simply a second Salt Creek sand. In other words, being 5

or 7 hundfed feet thick compared to 200 feet of sand at Salt Creek.

Q. It is more comparable to the Tensleep sand, though, in Whoming? The Weber sand?

A. The Weber sand is called the Tensleep sand when you cross the line.

Q. The condition or trend of the reservoir in the Tensleep sand, as you spoke of it in the ElkBasin and the Tensleep sand in the Salt Creek, is simimar to the Weber before correction where perhaps you might call it one of these fracture porosity pools in the Tensleep, is there anything there that might be comparable to Rangely?

A. By a far stretch we might call the Tensleep at Elk Basin comparable to what you have at Rangely of permeability running from zero to five or six hundred millidarcies. The sand is only two hundred feet thick there as compared to much thicker here and the productivity of the sand is more uniform throughout the field than we have at Rangely. We are still trying to find out what we have there and we can't make a comparison.

Q. Too new?

A. Yes, sir.

Q. But it is considered to be a fracture porosity, isn't it?

A. Yes, sir, from our coring data in comparisons with PI's we conclude there is some fracture porosity there.

BY MR. LAUGHLIN:

Q. Mr. Richards, do you feel that storing gas in the Dakota formation is feasible from a practicable standpoint?

A. I don't have too much ogjection to the storing of the gas in the Dakota formation. It will be expensive and will require the mudding in of a large number of wells and in some cases cement jobs to retain the gas in the Dakota formation and make certain it is sealed off in all the well bores. I am a little dubious about the experiment, however, since we had an experiment in the Hastings' field when we tried a similar gas storing project in a water sand. We put in appreciable amounts of gas into this water sand and upon attempting to return it we got an almost insignificant amount of gas back. We are afraid that the same situation might obtain in the Dakota sand. Also, I see no reason why credit should be given to Weber sand production for storing gas in another reservoir. You might as well get credit for selling it or burning it. The reason why the credit is put into the rules is to encourage operators to return reservoir energy to the reservoir. In view of thos facts, I believe that the injection of the gas into the Dakota would be a very hazardous experiment. It would be probably uneconomically attractive because it would take a lot of money to gather gather the gas, compress it, put it into injection wells from which you would receive no return for an indefinitely long

time and may never get your gas back and conceivably never get a market for it.

Q. Now, would you comment on the formula for participation in the unitization plan proposed by the Texas Company and the Union Pacific?

A. From an engineering standpoint we believe the proposal of the Texas and the Union Pacific Companies for field-wide unitization to be inequitable for the following reasons:

1. Their forecast considers the future producing capacity of present high ratio wells, and wells within the gas cap area, to decline at the same rate as wells with normal gas-oil ratios. Forecasting productivity in this manner is not correct as the oil producing capacity of high ratio wells will decline at a faster rate than wells having low or normal gas-oil ratios.

2. From our review of their forecast, it appears that the future producing ability of provicient wells, that is, those capable of producing the present top average per-well rate of 150 barrels per day, was treated in two different ways. For example, their forecast of the Union Pacific fee lease utilized productivity index data from well tests as a starting basis. For other leases classified as proficient, the forecast utilized as a starting basis estimates of producing capacity as obtained from core analysis data. These two procedures are not directly comparable and could easily result in inequities.

3. The forecast of the Union-Pacific lease is based on capacity immediately after an all-out shooting program in 1951. It has been our experience that the major benefits of shooting are dissipated within a relatively short period of time when compared to the life of the well, and generally is a means of recovering reserve over a shorter period of time rather than contributing any large increase in ultimate recovery. Thus, following the flush production effect of the shooting program, the Union-Pacific lease may be expected to decline at a fast rate. They have a production rate which shows that the production from the wells are holding up at a higher rate than anticipated by reference to Engineering studies. But we are of the opinion that the shooting program was changed by the program they had in effect such as enlarging the tubing, increasing pumping strokes and making other mechanical changes in the well as well as additions to the well.

4. All leases indicated to be on any decline were treated collectively, regardless of location or without consideration to actual decline experienced by an individual lease. This procedure does not recognize the workover possibilities of an individual lease and, in not recognizing the actual decline of a given lease, will undoubtedly result in many inequities.

5. The Texas-Union Pacific propoasl as received

was incomplete and had not progressed to the point of presenting lease participation factors. Any formula must be analyzed on a lease basis before it can be considered sound from an engineering standpoint.

6. A forecast of four years to establish participation is of very short duration to establish equities. For example, what is now a high capacity lease may have sufficient excess capacity to produce at an average well rate of 150 barrels per day for four years. Yet following this four year period, its capacity could soon fall below the 150 barrels per day rate and its decline could be much more rapid than many present leases on decline. This could mean that what is now a proficient lease may be producing less oil per well some ten years hence than a lease whose present average well capacity is less than 150 barrels per day. This situation is a fundamental weakness of any forecast and illustrates that factors more nearly related to the potential reserve of a lease should be considered, if at all possible, such as bottom hole pressure, oil in place and current production.

Q. Should it develop that there are three units formed at Rangely, what is your opinion with respect to whether or not injection wells can be so located that the correlative rights of the parties can be protected?

A. Yes, it was pointed out by Mr. Vitter that three

units will be of sufficient magnitude that you could locate your injection well away from your lease lines and operate the seven thousand acre unit as more or less of a separate field. There is plenty of room in all three units in which to locate injection wells and you have a combined or mutual program which would result in increasing ultimate recovery which would admittedly not be as well as a complete field-wide unit.

Q. Do you have any other comment you might wish to make?

A. I have one other comment. Again, in respect to the fracture theory, previous testimony put on by some of the early witnesses was that the extension of the gas cap southward from the crest of the reservoir was due to gas channeling down through the fractures to the lower producing wells. Mr. Boatright stated in his opinion the gas-oil ratio on a well could be due to either one of two factors, a high gas-oil ratio could be due either to gas channeling to that well from the gas cap or to the well having reached an advanced stage of depletion so that the natural gas-oil ratio had risen to a higher point. This second point, that some of the wells in that southern portion of the crest had reached the stage of higher depletion and were producing at a higher gas-oil ratio due to that effect rather than the channeling of gas through the fractures was not brought out,

a possibility that was not present. It was stated that high gas-oil ratios could only be due to gas going through this massive fracturing system, which I was first introduced to today.

MR. LAUGHLIN: That is all.

CHAIRMAN DOWNING: How many more witnesses do you have?

MR. LAUGHLIN: This is the last witness for Stanolind.

CHAIRMAN DOWNING: Has Phillips any witnesses?

MR. KURGIS: We will stand upon the testimony given in prior hearings which I understand to be incorporated here. Our position remains as stated in prior hearings.

CHAIRMAN DOWNING: To what extent do you wish to cross examine this witness?

MR. STAYTON: I just want to ask two questions and no argument; just cross examination.

CROSS EXAMINATION

BY MR. STAYTON:

Q. Mr. Richards, do you know of any field that is comparable to this reservoir, as far as gas-oil ratios are concerned, where they have entered into an injection program without any unitization in whole or in part?

A. Yes, sir.

Q. Where is that?

A. In the Salt Creek Field.

Q. I thought you said they had a partial unitization?

A. No, we commenced gas injection operations in the Salt Creek Field in 1926 by a cooperative agreement among some of the lease owners at that time. They found the results were so good that they were able to unitize and get a number of other leases in the field in 1939 to form a partial unit, as I stated, in that northern two-thirds of the field.

Q. In other words, they have a partial unit now and they started through a cooperative effort of the agreement of lease owners or lessees. Is that correct?

A. Yes, sir.

Q. Well, if we do not have any form of unitization either in whole or in part, in order to make this effective you have to have some kind of cooperation between the lessees. I mean, can you just run out there and start injecting this gas and will it do any good if you do?

A. We think it will. We hope it will. It is better than nothing.

Q. Better than nothing but not as good as either partial unitization and, of course, not as good as unitization in its entirety?

A. That is about number 3 or 4 on the list of possibilities.

Q. That was my first question. My second question, Mr. Richards, is this: Did I understand you correctly to state that the very purpose of a gas-oil ratio limitation is by reducing the ratios or reducing the production of certain higher ratio wells sothat the oil in that property will migrate to some more efficient property where it can be produced more efficiently?

A. Yes, sir.

Q. So the net result of it is that there is migration then from lease to lease under that sort of a program? That is the very purpose of it?

A. Right, and we are stopping another migration that we have if we don't put in this restriction; you are allowing the well with the high-gas-oil ratio to produce unlimited volumes of gas and oil creating a low pressure area at that point and migration from the other leases, we will say, from the more efficiently operated portion of the field. There is probably such a thing as good drainage and bad drainage. I mean if it is drainage on your land it is good and if it goes to somebody else it is bad.

Q. I thought that is what you had in mind.

A. Yes.

MR. STAYTON: That is all.

A. The drainage we are trying to prevent is what we hope is in the best interest of conservation.

(The witness withdrew.)

CHAIRMAN DOWNING: Now, how about rebuttal?

MR. KNOWLES: Instead of cross examining the witness we would like to put Mr. Winterburn on and let him have not to exceed fifteen minutes.

MR. STAYTON: We will waive to Mr. Winterburn.

CHAIRMAN DOWNING: There will be only one rebuttal witness?

MR. KNOWLES: Yes, sir.

READ WINTERBURN

recalled by The Union Pacific Railroad Company in rebuttal, testified as follows:

REDIRECT EXAMINATION

BY MR. KNOWLES:

Q. Proceed in your own way.

A. First, in connection witn Mr.Vitter's testimony, I don't want to try to cover all the points at issue here, but I think I could suggest to the Commission that if they re-read the evidence we have filed here they will see where there were many misleading statements in his discussion of our plan, and if they rely on his discussion of it they will have a completely erroneous idea.

Q. When you say what we have filed, you mean the statements made in the plan?

A. That's right. In the first place they completely ignore the principal evidence upon which the whole forecast

was made, which was the productivity survey of all of the wells. They continue to make the same false assumptions made by the Committee in December 1950, that the wells have been producing at capacity at all times. If you will look at the graph which they filed as evidence you will see that the production rate which has been at about 130 barrels a day per well -- I don't know the field total, --

Q. Which exhibit is that?

A. Number 1. -- was increased substantially immediately after that meeting and before any wells had been re-worked. And they implied that all the increase accomplished during the year was due to re-working wells whereas, if you study the productivity of the individual wells as listed in the plan, you will find that only 25 hundred barrels a day out of a total capacity of 30 thousand barrels for the lease -- for the combined leases was due to increases obtained through shooting wells during the year. In other words, it was about one-twelfth of our capacity which was due to that -- or of their actual capacity was due to that, of their maximum production rate now. The reasons we haven't always produced at competitive rates are chiefly difficulties in disposing of the oil and limitation of our equipment.

I think by the time this year's production record is available their forecast will be so completely discredited that there will be no need to give it any more consideration.

Now, the original purpose of this production forecast, as I always understood it, was to estimate the amount of oil that could be produced under competitive conditions as a measure of the recoverable oil that was present under the property and to assume that the wellswould be restricted for gas limitation and one thing and another was not supposed to enter into it. And, although the report of the Committee which set forth this forecast of December,1950, stated that a correction had been applied to the capacity of the wells located in the top of the structure where there might be high ratios, we examined the actual work sheet of the Committee and looked at some of the leases located within the area and supposed to be treated that way and it wasn't done. So that that is the reason we say that that correction hasn't been complied with.

The remarks in connection with the performance of the gas injection project are based upon incorrect data. Much of that has been brought out by cross examination by Sharples.

There is further evidence of mistakes that they made in determining the areas that -- if you notice the area around U. P. 57-21 well on their map, that fails to indicate the long tongue extending southward. And both of those wells included in that tongue extending beyond their limits are above a thousand ration -- were ab ove a thousand

during February. They must have had incorrect data. The area around the California Company injection well does not indicate the area affected by injected gas because a ratio of 700 there has fully as much significance in indicating by-passing of gas as a thousand does around the U.P. 57-21 because it is a greater increase from the 200 ratio that obtained there than the increase represented by a thousand around the U. P. well. Furthermore, the fact that on a conservative basis we have computed the 85% of the injected gas as now being produced from surrounding wells indicates that a great proportion of the gas that has been injected from the start has been produced. Their computation makes no allowance for any such production.

The misunderstanding that Mr. Vitter has regarding the 63 million barrels, the statement that he made that I had testified, and Mr. Pierson, that the 63 million barrels produced was incorrect. I think if you read the record you will see that we said that the wells affected in the high gas-oil ratio area was so high, the gas-oil ratio, it had reserves of 63 million barrels and a large portion of it would not be produced if the wells were shut in.

The argument relating to the hetrogeneity of the Weber formation has no significance at all in the consideration of the injection of gas into the four hundred feet of zone. They only consider 15 feet of the 400 feet. And the

fact that Mr. Vitter has been able to even assume that that 15 feet was a continuous for over a mile, as he shows there, is something very open to question.

Q. That is referring to Exhibit No. 5?

A. 5. Showing 15 feet of core analysis, colored. Those are some of the main comments I had in relation to Mr. Vitter's testimony.

In connection with Mr. Richard, he gave the impression that we had said that the whole Webber reservoir was fractured. We don't know exactly how much of it was fractured but the study that Mr. Pierson made has only shown to us to date that the portion colored in yellow, inside the orange line, is fractured. And how much more was fractured remains to be seen.

Q. Whose line is that orange line?

A. That is the Rangely Engineering Committee, and it was just put on there to indicate an area of fracture in the shallower zones and suggests possible areas of fracturing in the Weber, but we have never considered that proof that the Weber was all fractured within that area.

The performance of the gas cap gas upon which Mr. Pierson based his conclusions and Mr. Richards suggests that the difference in ratios might be attributable to a difference in depletion was disproved by one of the most forceful points in Mr. Piersnn's testimony, which was comparable areas within and without the so-called high-gas-oil gas ratio were found to have no greater depletion in terms of oil in place for the one within the yellow area, and this study of

Mr.

areas within and without the so-called high gas-oil ratio were found to have no greater depletion in terms of oil in place for the one within the yellow area, and this study of Mr. Pierson should be particularly regarded as being an independent opinion without any purpose in influencing the Commission in their decision because it was made as a field study for the purpose of determining operating policies in the field. And the conclusions were arrived at before this Commission ever had a hearing and they are presented just as they were arrived at at that time.

In connection with Mr. Richards' remarks relating to our method of making the forecast, he stated that the production increase in shot wells were greater than the effect of the shot because of a campaign of lowering the tubing and increasing the pumping speed and so forth. This is not true because actually the increase in PI which resulted in shot wells were greater than the increase in productions which were obtained. And the only question is one of bigger equipment and so forth in getting more oil out of those wells than we are now.

The review of productivity which Texas-U. P. made in their wells, I think, are certainly accurate within ten or fifteen percent. And as far as being physically able to deliver the amount shown in the forecast, it is largely a question of equipment and being able to dispose of the

oil produced and the limiting rules which may be applied. And there is work going on now to accomplish the increase in the oil production capacity. Those are the most important things I wanted to bring out.

MR.KNOWLES: Before we close, I saw Mr. McLaughlin here.

MR. McLAUGHLIN: I am afraid I am thoroughly convused. I am not an expert and this testimony has all been so conflicting I believe they are both right.

CHAIRMAN DOWNING: Does anyone else have anything to say? The next question, then, is argument. How about that?

Mr. KNOWLES: Would you like to have that tonight?

CHAIRMAN DOWNING: If you want to.

MR. KNOWLES: I thought we had come to the conclusion we were to wait until the record is out and then at some limited time after that get the written summary to you of our contentions because it would be very difficult for us to avoid repetition here of so many things.

CHAIRMAN DOWNING: How about you, Mr. Walshe?

MR. WALSHE: We have no objection to that, Mr. Downing. Frankly I think that this case needs much argument. It is just the two fundamental differences of opinion between engineers. We have been trying and we are still earnestly trying to get something done at Rangely and we prefer field-

wide unitization but we have tried for five years and we still can't get field-wide unitization and in order to get something done in order to foster the ideals of this Commission to get something done at Rangely we are suggesting the alternative plan of three units. It is our considered opinion that this three-unit plan is the best hope right now of getting something done at Rangely to increase ultimate recovery. If it is not doen then, I think we might as well go ahead and produce it as any other oil field under your Order 2-1.

CHAIRMAN DOWNING: Would three weeks give you sufficient time?

MR. KNOWLES: We would like three weeks after we get the transcript.

MR. WALSHE: You have an emergency order that expires on the 25th.

CHAIRMAN DOWNING: We can continue making those as long as you people don't object.

MR. WALSHE: If you have four in that Order 2-1 to amend we would like to see it go back into effect as soon as possible and not two or three months that it might take to get this record back.

CHAIRMAN DOWNING: Suppose we understand that the emergency order will be continued on the 25th?

MR. SARGENT: 15 days. That emergency order will

continue in effect until the Commission has finally disposed of this application for re-hearing. That is the spirit of the emergency order.

CHAIRMAN DOWNING: We would like, of course, to get this disposed of as soon as possible. But certainly the time to file your brief, I assume, should commence from the time the testimony is in your hands. But after the testimony is in your hands, don't you think you can make your statements in a week?

MR. KNOWLES: You see, none of the companies have all their offices here in Denver. We have to depend on the Los Angeles office for a great deal of the argument to be worked up and I don't think a week's time would be possible at all. I think three weeks is very reasonable as a time in which to do that. I don't see that delay here is going to make very much difference. I don't think that it should be assumed that The California Company is the only company that is desirous of unitizing that field. It would appear that nobody else made any efforts except themselves but Idon't believe that is borne out by the facts of the case.

CHAIRMAN DOWNING: I think you are both sincere in your desire to unitize the field. I think you both have tried. I think you both are too darned stubborn. So get the briefs in as soon as you can.

MR. WALSHE: I just want to call your attention to

one thing, the fact that this Board must render a decision within thirty days after this hearing.

CHAIRMAN DOWNING: This hearing will be adjourned. We will not close the hearing now when we adjourn tonight. We will adjourn to a day fixed so that this hearing will not be closed but will be continued and the time will not commence to run until it is submitted.

How much time do you think you ought to have?

MR. WALSHE: I don't want any time. I am willing for the Board to render its decision right now.

CHAIRMAN DOWNING: Shall we make it two weeks after the record is completed. Now, when will it be completed?

THE REPORTER: In about two weeks, maybe sooner but I doubt it.

CHAIRMAN DOWNING: I assume you will get it and each make your separate statement within that time and will you want time to reply to one another?

MR. KNOWLES: I don't believe that is necessary. They will be simultaneous briefs.

MR. SARGENT: It is my understanding that the Union Pacific will also come forward with the results of their study on the Dakota sand.

MR. OSBORNE: That will be in our submission.

CHAIRMAN DOWNING: During this time, if anyone wants to file more statements or anything, we will be glad to have them, but I think we have enough.

We will adjourn this hearing until the 22nd day of May. That will give you sufficient time for your briefs. You may be present if you wish and I think possibly the attorneys ought to be present on that date so that should the Commission have any further question they may ask the attorneys.

MR. LAUGHLIN: May I ask two questions?

CHAIRMAN DOWNING: Yes.

MR. LAUGHLIN: Is there going to be additional evidence submitted in the briefs? If so, I think all other parties should be entitled to take a look at it.

CHAIRMAN DOWNING: Undoubtedly if anybody wants to file anything in the way of evidence they should furnish copies to all who need it.

MR. LAUGHLIN: At least everybody that is at this hearing.

MR. WALSHE: I don't want to interfere with the informal and nice way you are conducting these hearings but there is such a thing as just letting additional evidence come in by means of argument and briefs where they are not submitted to anybody else. Your order is in court now under attack for certain sloppy methods of preparing and so forth. I think we ought to pin this thing down. I would like you to tell me what you want in a brief now. Am I going to argue evidence all over again? Am I going to argue the

qualifications of one of the witnesses like it was put in the record?

CHAIRMAN DOWNING: I think what we would like would be first a statement, a very succinct statement of your positions, each one of you. I think we would like a little emphasis placed on our powers, on the law. That is something that ought to be argued. But I don't think it will be necessary to discuss the credibility of witnesses or anything of that sort. I don't want to burden you with a great big long brief because there would not only be a burden on you but also on us. And I think we have a general understanding. But we would like to have each of you point out succinctly what you want us to do and why, and something on the law.

MR. WALSHE: We understand.

CHAIRMAN DOWNING: Let's leave it this way. If there is any additional evidence, it may be the other side will, and on the 22nd day of May, if you want to present it we will be in session and this matter will be our matter up for hearing. I hope there will be no other except the study that the Union Pacific is making. We have already given them the authority or the permission to file it. Is that satisfactory to everybody? (No response.)

Now, as we close, let me thank all of you for this most able presentation. I think the members of the Commission and I have only one criticism -- it isn't really a

criticism -- both sides presented their case so darn ably that maybe we are a little bit confused. But we will do the best we can and that is all anybody can do.

If there is nothing else to be presented at this time the hearing is recessed to the 22nd day of May.

(Whereupon, at 10:00 o'clock p. m., Tuesday, April 22, 1952, the above-entitled hearing was recessed to the 22nd day of May, 1952, at 10 o'clock a. m.)

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C E R T I F I C A T E

I, Harold E. Hastings, certified shorthand reporter, hereby certify that I personally recorded in shorthand the proceedings in the foregoing matter in the first instance and that I later transcribed the same and that the foregoing record is true and correct to the best of my knowledge and belief.

Done at Denver, Colorado, this 5th day of May, 1952.

Harold E. Hastings
Certified Shorthand Reporter
616 South Ogden Street
Denver 9, Colorado

Phone
RAce 3126