BEFORE THE OIL AND GAS CONSERVATION COMMISSION

OF THE STATE OF COLORADO

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IN THE MATTER OF THE INVESTIGATION TO TAKE MEASURES TO PREVENT WASTE OF OIL AND GAS IN THE "D" AND "J" SANDS OF THE LITTLE BEAVER FIELD, IN WASHINGTON AND ADAMS COUNTIES, COLORADO.

CAUSE NO. 30

BEFORE:

Mr. Warwick Downing, Chairman
Mr. H. C. Bretschneider, Commissioner
Mr. Russell H. Volk, Commissioner
Mr. F. M. Van Tuyl, Commissioner
Mr. A. J. Jersin, Deputy Director
Mr. D. V. Rogers, Petroleum Engineer
Mr. J. E. Cronin, Secretary
Miss Annabel Hogsett, Assistant Secretary.

PURSUANT TO NOTICE the above-entitled matter came duly on for hearing at the Senate Chambers, State Capitol, Denver, Colorado, at the hour of 10:00 o'clock a.m., March 16, 1954.

APPEARANCES

THE ATTORNEY GENERAL OF COLORADO FOR THE OIL AND GAS CONSERVATION COMMISSION: by
Mr. Wilbur Rocchio, Assistant Attorney General.

THE LION OIL COMPANY: by
Mr. B. L. Allen, El Dorado, Arkansas,
Mr. Frank Richardson, El Dorado, Arkansas,
Mr. R. I. Williams, Denver, Colorado,
Mr. Frank Zimmerman, El Dorado, Arkansas,
Mr. Bruce E. Roll, Denver, Colorado.

THE R. A. GOODALL COMPANY: by
Mr. Harry A. Trueblood, Jr., Denver, Colorado,
Mr. A. J. Di Salio, Denver, Colorado.

THE DENVER BASIN OIL COMPANY: by
Mr. Harold Dunn, Brush, Colorado,
Mr. C. H. Anderson, Brush, Colorado.

THE COLORADO INTERSTATE GAS COMPANY: by
Mr. L. M. Poe, Colorado Springs, Colorado,
Mr. S. C. Barrett, Colorado Springs, Colorado,
Mr. H. G. Van Horn, Colorado Springs, Colorado.

THE CONTINENTAL OIL COMPANY: by
Mr. R. C. Hawley, Denver, Colorado,
Mr. C. C. Frye, Denver, Colorado,
Mr. C. H. Hesser, Denver, Colorado.

HUNTZINGER-WALKER: by
Mr. Homer G. Huntzinger, Denver, Colorado.

STANOLIND OIL & GAS COMPANY: by
Mr. Robert B. Giles, Casper, Wyoming.

DENVER BASIN: by
Mr. Warren Longley, Boulder, Colorado.

COL-TEX OIL INCORPORATED: by
Mr. Wesley G. Gish, Tulsa, Oklahoma.

TRIANGLE J OIL COMPANY: by
Mr. Melvin Frasier, Denver, Colorado,
Mr. Elmer W. Frasier, Denver, Colorado.

BRITISH AMERICAN OIL PRODUCING COMPANY: by
Mr. Thomas M. Hogan, Denver, Colorado,
Mr. Don W. Conaway, Denver, Colorado,
Mr. Glenn M. Stearns, Dallas, Texas.

CHAIRMAN DOWNING: Will the meeting come to order please. Gentlemen, I needn't read the call of this meeting. As you know it is a matter we are investigating as to how to take measures to prevent waste in the Little Beaver Field. The Order and Notice no doubt you have all read and I need not take the time now to repeat it. I might mention the Legislature meets tomorrow and we must be out of here at 3:00 o'clock at the latest and we would like to get out by noon; that is, they would like to have us out by noon.

Now I hope that this meeting will be in the nature of a get together meeting. I think we all believe in conservation. Conservation, of course, means just one thing, namely, to get out of the ground the greatest possible amount of oil, and you have a bigger interest in that than has this Commission or the State. I am sure, while we may disagree somewhat as to methods, I am sure that we will all have the same objective. In fact at this time I don't think there is any question at all about the extreme value of control of reservoir energy, which is conservation, and that is controlled of course by the orders under scientific guidance, and they are orders that ought to have your approval as well as ours. Take for instance the East Texas Field, by conservation methods it will produce between six and seven billion barrels of oil instead of 2 billion, which it might have produced if the old methods were left to be followed. At one of the last meetings held in Colorado at Estes Park,

eminent engineers presented figures to show that the result of conservation up to that time had meant an increase of 10 billion barrels of oil. It was that increase of oil that gave us the oil that enabled us to win the war. I just make these preliminary remarks and I hope they will be endorsed.

Now as to the procedure to follow, we have called on you to present a lot of information. That is the first step. Might I ask how you wish to present the information called for, whether you want to act as a group or separately.

MR. ROCCHIO: Judge, we made a suggestion in our notice that one operator in each reservoir be appointed to submit the data on that reservoir. I wonder if they will follow that.

CHAIRMAN DOWNING: I think that is a good plan.

MR. ALLEN: My name is B. L. Allen, with Lion Oil Company. Our company has met with most of the other operators and I believe the plan has been devised which will be in keeping with your suggestion. One gentleman will present with respect to the "D" sand of the Little Beaver Field all of the factual data, that is Mr. Trueblood, of the Goodall Oil Company. Lion Oil Company will present the factual data with respect to the "J" sand of the same field. After the factual data has been presented Lion Oil Company, whom I represent, will make certain recommendations and I am satisfied that the other operators in each of the two sands will likewise make recommendations, but

the factual data will be presented by one person with respect to each of the sands.

CHAIRMAN DOWNING: I think maybe the next step is to ask for appearances. Will each of you who are here arise and state your name and the company or interest you represent.

MR. POE: Mr. L. M. Poe for Colorado Interstate Gas Company, Mr. S. C. Barrett and Mr. H. G. Van Horn.

MR. ROCCHIO: Judge, wouldn't it be better if we circulated written appearances?

CHAIRMAN DOWNING: Yes, why don't you follow through and see that they all sign the appearance blanks. I might state we have given notice in the proper manner and as provided by our statute and our regulations and I declare that the meeting is called after proper notice and with jurisdiction to determine the matters stated in the notice.

MR. HAWLEY: May it please the Commission, Continental Oil Company is represented by Mr. C. C. Frye and Mr. C. H. Hesser, our production engineers, and myself, R. C. Hawley of the legal department. Before the testimony gets into effect I thought it might be wise to state to the Commission that in the interest of conservation as a temporary operator plans are now being made, in fact the plans are being drafted, for the building of a gas plant for the Little Beaver and the Badger Creek Fields and at the present time we are circulating agreements to all interested parties and these agreements have been executed

already by several of the interested parties to the effect that it will be permissible for us to build this plant for the purpose of picking up the gas at the separators and bringing it in to boost the pressure so that the gas will be of commercial value and we will be able to find a market for it.

CHAIRMAN DOWNING: Do these plans contemplate any reinjection of the gas into the reservoir?

MR. HAWLEY: No, not at this time.

CHAIRMAN DOWNING: All right. I might ask if anyone else wants to make an opening statement or a statement of position, in other words, a very brief statement of what they think or what they want to present. Hearing none, you may proceed.

HARRY TRUEBLOOD

called as a witness on behalf of the Goodall Oil Company, being first duly sworn according to law, upon his oath testified as follows:

DIRECT TESTIMONY

THE WITNESS: My name is Harry Trueblood. I represent the Goodall Oil Company. At the present time I am representing as chairman of the Little Beaver "D" Sand Engineering Committee. The Committee's information to the Oil and Gas Commission that they requested is in the form of a little basic field data for the "D" sand reservoir.

Now upon first appearance you will see that we have tried to present this as simply as possible in numbered order, whereas the Commission requested a tremendous amount of information in the 30-day notice in which unfortunately it would probably take the largest oil company reservoir engineering department a year to gather the information. We attempted to fulfill everything we possibly could from the field data. I will read this in order to get it into the record.

I would like to stress again that this pertains only to the "D" sand and that the Little Beaver "D" Sand Engineering Committee was formed for the purpose of gathering significant basic field data for possible future unitization or at least for the increased knowledge of the field. There are no conclusions or recommendations on behalf of the committee to this Commission inasmuch as engineers have varying conclusions that they can gather from just pertinent data, so it is our intention just to present the pertinent data and then have each company represented in the "D" sand present their ideas and conclusions and any recommendations for the Commission to take toward establishing a sound engineering protection history in the Little Beaver Field in the future.

The basic field data of the "D" sand, you will note Item No. 1, the discovery date was May 12, 1952, Wheatlake No. 1. Its initial production was established on June 25, 1952. It's producing from the "D" or Muddy sand. The total number of

producing oil wells at the present time are 67. Now the sand thickness varies in this field from zero to 50 feet effective saturation. The oil-water contact varies from a minus 616 to a minus 618. The gravity of the crude oil varies from 39.5 to 42.0 API standard conditions. The gravity of the gas varies throughout the field but is approximately a plus or minus 1.0, which is extremely well.

No. 8 is the initial static bottom hole pressure. We do not have this but we have put in this information concerning the drill stem test shut in pressure from the Hubbird No. 1-W Goodall-Ward taken in September of 1952. The accuracy of this is questionable. It is the feeling of most members on the committee that it should be somewhere in the neighborhood of 1250 initial.

The structural features, if you will see here attached is a small map and for the benefit of everyone else we have a larger one here. I don't know where we can put it up, but we do have a larger structural map, and the probable producing area we have outlined on this structural map. It is shown on the structural contour map with contour intervals of 10 feet and the producing area is outlined in this dashed line around the outside edge. That was what the Commission desired and as you can see at the present time we have very few additional wells to drill in the Little Beaver Field from the standpoint of developing additional knowledge.

For the additional gas-oil ratios we have a peculiar problem in this field in that we have two separate reservoirs in the "D" sand, at least that is the general consensus of opinion that they are two of slightly different characteristics. We have what we call the first bench or upper bench of the "D" sand and what we call the main body or second bench development. Throughout the field on the west and southwest sides, the upper bench carries water. Its oil-water contact has not been definitely defined for purposes of general consideration. The first bench has a different gas-oil ratio than does the main body, but for the purposes of the field the wells have been completed. Where they do have upper bench production, that is upper and main body wells, that unfortunately gives them a somewhat higher ratio as a well without any waste because the initial ratio was higher in the upper bench.

I am digressing there in giving a few opinions, but I am trying to do that for clarification. A, the main body producing horizon only has a plus or minus 400 cubic feet per barrel. It has varied from well to well before we ever lowered the pressure in the reservoir very much. B, the main and upper bench producing bodies combined as plus or minus, 1000 cubic feet per barrel. Now that was found in some of the Lion, Continental, Downing wells in the southwest quarter of 32 where they completed their wells in both the main and upper bench.

The Committee has agreed as a whole that the reservoir

mechanism in this particular field in the "D" sand is definitely beyond any doubt a solution gas type reservoir or a gas depletion drive, as you may wish. The Committee has taken the core analysis data available and arithmetically averaged the different analyses available and all the footage concerned and have come up with the following data: A, the average porosity in the field in the "D" sand is 20.68. The average residual oil saturation is 12.16. The average permeability is 283.6 millidarcies. The average total water saturation, and note that this is total water saturation which is more or less meaningless, but is a report of the core analysis companies in giving the total water involved is 35.79.

Now we have put an estimated formation volume factor of 1.32. This is subject to argument by all concerned. Different ones can arrive at their own estimated formation volume factor. We have brought in this for our consideration. The interstitial water saturation in the field we do not know. There has been no measurements available, only interstitial water, it's still a guess. The estimated total oil in place, the total oil in place for the different operators, have varied anywhere from 36 to 44 million barrels. This is as you can see rather close to each other, it's within 25%. Actually different calculations can be made to vary this even more.

The estimated oil to be recovered by competitive operation from the past production history and data, this will

be presented by a Lion Oil Company representative, Mr. Zimmerman, and a graph which he has drawn up at the present time. Item 17, cumulative production as of March 1, 1954, is 2,695,695 barrels. The average static bottom hole pressure as of March 1, 1954, is 713 PSIG.

Now the Committee wishes to point out that this is not exactly right inasmuch as in order to make our appearance before this Commission we took the arithmetic average of the wells which we had reports on at that time. We had a bottom hole pressure survey on March 1, 1954, which was regularly scheduled anyway and the results were not completely available. However, if you will see your map attached where it shows the bottom hole pressure map dated 3-1-54, the volumetrically weighted bottom hole pressure is 742 pounds, which is significant. If you notice the north end where there has been a little withdrawal, the pressures are a little higher than the rest of the field. However, these can subsequently be changed somewhat inasmuch as we do have additional pressure information from our wells at the present time and it is somewhat lower, but not significant.

The average daily production during February, 1954, per well per day was 94.5; that is barrels of oil per day per well, which may or may not be excessive, that is for the Commission to determine. The recent gas-oil ratios, we have an attached tabulation of the recent gas-oil ratios for the

Commission from the Goodall Oil Company, the Goodall-Ward interest on the Hubbird lease, the Lion Oil Company and the Continental Oil Company. Now the additional companies in the field were attempting to get gas-oil ratios but unfortunately we were struck by blizzards before we could get them so they will have to be delivered.

Roughly looking at these gas-oil ratios you can make your own decisions, but if you will remember our figures of plus or minus 400 cubic feet per barrel you see that actually our gas in most wells has not begun to move at the present time. The average daily production, barrels of oil per day per well, July through September was 186 barrels of oil per day per well. We submit that information in order for you to compare the pressure maps. Also you can take an arithmetic figure of barrels produced per pound per square inch pressure drop and if you take the three bottom hole pressure maps available and subtract the difference in pressure drop you will see that apparently at this stage of the game that the 186 or the 112.5 had no effect whatsoever on the amount of barrels produced per pound per square inch pressure drop.

Now that diverts me into a conclusion and opinion which at this time I will not present, but I will let Mr. Zimmerman of the Lion Oil Company present a little more factual data and then let him take up his opinions and suggestions to the Commission and they might allow the different operators in the "D"

sand to have a few words on what they draw as to their way of conclusion and any recommendations they might have from this factual data they presented.

CHAIRMAN DOWNING: Thank you very much. Does anybody wish to ask him any questions? If not, that is all.

(Witness excused.)

MR. ALLEN: Mr. Chairman, on behalf of Lion Oil Company we would like to present at this time Mr. Robert I. Williams, the regional manager who will give the Commission some general information with respect to operations in the field.

ROBERT I. WILLIAMS

called as a witness on behalf of the Lion Oil Company, being first duly sworn according to law, upon his oath testified as follows:

DIRECT TESTIMONY

THE WITNESS: My name is R. I. Williams of Lion Oil Company. I would like to elaborate just a little bit about what the gentleman said pertaining to the gasoline plant which is under way in the Little Beaver area. On March 9 orders were placed for compressors for this plant which totaled 2500 horsepower, and they expect delivery in June, 1954. It is expected that the gathering system and these compression facilities will be completed and in operation by October 1, 1954. Along with the program for the gasoline plant we have been progressing

with our investigation of unitizing the Little Beaver "D" sand reservoir in order to provide a maximum ultimate recovery of oil and gas from the reservoir. The geological committee was formed and first met on November 6, 1953, and immediately began to compile the necessary data. This committee did an excellent job and by the first of February it completed their assigned projects, which were then turned over to the Engineering Committee for the purpose of assembling additional information and data which will be presented to the operators in the near future.

It is hoped that before long we can say that unitization of the Little Beaver "D" sand reservoir is well on its way to accomplishment. By unitizing the "D" sand reservoir it will make it possible to begin a pressure maintenance program which will include the injection of additional energy into the reservoir, which will maintain the reservoir pressure and thereby increase the ultimate recovery of oil and gas in this reservoir. It is believed that a conservative estimate of the results of this program would be that we could double the recovery over which we could expect by competitive operation. As can readily be seen, this project which will be accomplished through the cooperation of the operators, royalty owners, and State will greatly increase the revenue to all parties concerned. Thank you.

CHAIRMAN DOWNING: Thank you.

(Witness excused.)

CHAIRMAN DOWNING: Does anyone else want to say something at this part of our hearing?

MR. ALLEN: Sir, Lion Oil Company has one further witness. He prepared some exhibits and we would like to call him at this time, if we may.

CHAIRMAN DOWNING: Proceed.

O. F. ZIMMERMAN

called as a witness on behalf of the Lion Oil Company, being first duly sworn according to law, upon his oath testified as follows:

MR. ALLEN: Mr. Chairman, Mr. Zimmerman is employed by Lion Oil Company as a Reservoir Engineer. He is an expert in that field, we submit, and we would like for the record to reflect his qualifications as such in order that his opinion in that capacity might be received.

CHAIRMAN DOWNING: We will accept him in that capacity if there is no objection.

MR. ALLEN: If you don't mind, sir, may I ask him a few questions?

CHAIRMAN DOWNING: Go ahead.

DIRECT EXAMINATION

BY MR. ALLEN:

Q. Mr. Zimmerman, have you prepared an exhibit in connection with the "D" sand of the Little Beaver Field?

A. Yes, sir.

Q. Would you pass that to the Commission.

A. We have several small copies here, probably enough to be distributed. This exhibit that is being passed out is the same exhibit illustrated on the blackboard in a little larger scale. The performance prediction illustrated on the board is for a solution gas drive reservoir, which we feel is the controlling and principal type of producing mechanism that is operative in the Little Beaver "D" sand reservoir. It might be well to point out some of the general features of such a prediction. There are probably people here who are well acquainted with this sort of calculation; there also are probably people who are not so well acquainted.

If for any oil and gas reservoir certain data concerning the characteristics of the fluid in the reservoir and the characteristics of the rock making up the reservoir are known with reasonable accuracy, this sort of a calculation can be made. Its principal purpose is to estimate with reasonable accuracy the expected ultimate recovery from the reservoir. A number of assumptions necessarily must be made in performing the types of calculations going into the construction of the two curves that you see. One, that the characteristics of the fluid and the rock as measured in the laboratory are truly representative of the field. Second, that the reservoir rock is homogeneous, that the reservoir fluid is homogeneous, and

that the depletion of the reservoir will occur uniformly throughout the reservoir; and that there will be no significant forces operating in the field other than those taken into account in the calculations.

Now the specific features of the exhibit on the board -- if it's all right I will go over there and point some of those out and try to talk loud enough so you can hear me. Plotted along the bottom scale is the amount of oil produced at any stage of depletion of the reservoir. This is plotted as a fraction of original oil in place. The purpose of plotting it in that manner, of course, is that once you determined the point of depletion of all energy in the reservoir, a recovery factor is estimated. Plotted along this scale is reservoir pressure. This is zero, 200, 400, 600, so on to 1400.

The initial pressure, this is the pressure decline prediction, this is not performance, it is a prediction of future performance. It illustrates that the initial pressure was in the order of 1250 to 1260 pounds; that it would drop sharply during the initial phase of operations of the reservoir due to the principal mechanism of production being expansion of fluid. Then the rate of decline would change sharply at around 1050 to 1100 pounds and from that point on there would be a gradually increasing rate of slope out to an abandonment pressure at which point reservoir energy will be depleted.

Plotted on this scale against fraction of oil produced

is a prediction of gas-oil ratio behavior of the "D" sand. It illustrates that for a period of time the gas-oil ratio will not increase, then there will be a very gradual increase, eventually a very sharp and rapid increase in gas-oil ratio as we approach depletion of the field. It might be of interest to point out that we are now at or on the verge of a very critical point in the "D" sand reservoir and that is the point at which gas coming out of solution has built up a sufficient saturation in the reservoir so that it will become mobile and will become increasingly mobile as the saturation increases. That is the cause of a constantly increasing gas-oil ratio and a constantly increasing rate of slope of the reservoir pressure prediction. The indicated ultimate recovery from this reservoir is between 25 and 28 per cent of the initial reservoir oil in place under a solution gas producing mechanism.

Q. Mr. Zimmerman, is the chart which you have prepared with your prediction, is that customarily done in the fields with the drive of the type experienced in the Little Beaver "D" sand pool?

A. Lion Oil Company always attempts to gather sufficient factual data and basic data to construct this sort of a prediction if it is at all possible.

Q. Mr. Zimmerman, do you have on behalf of your company any recommendations to this Commission as to the rate of production from the "D" sand as requested in the call for this

hearing?

A. Yes, sir. First I would like to say that I believe the data we have available on the "D" sand is well within acceptable accuracy, that the assumptions we have made in constructing this prediction concerning the minor role, if any, to be played by such forces as water drive and gravity drive are valid assumptions, and that the fractional recovery that we have estimated is a reasonable estimate of ultimate recovery from the "D" sand reservoir with no other energy source available to move oil to the wells. The specific recommendation, Lion Oil Company recommends an oil allowable of 100 barrels of oil per day per well, and a top limit on gas production of 150,000 cubic feet per day from any well. Now this means that any well may produce 100 barrels of oil per day so long as it does not exceed the gas limit of 150,000 cubic feet per day, and that if it cannot produce 100 barrels of oil per day within that gas limit its allowable will be only that amount of oil it can produce within the 150,000 cubic foot gas limit.

Now in connection with that recommendation we would like to further recommend that the Commission require quarterly gas-oil ratio tests on each well and that the Commission set the allowable for the next quarterly period based upon those tests.

Q. Mr. Zimmerman, you have recommended this rate of production. I will ask you to state if you will your reasons for those recommendations on behalf of your company.

A. Actually we have only one basic reason for the recommendation and that is the desire to produce the greatest quantity of oil possible from the reservoir under the producing mechanisms that are available for use. Lion has oil producing operations in seven states now and we have found that oil is getting harder and harder to find and that furthermore it costs more, each new barrel of discovery costs more than it has cost in the past. The Little Beaver Field is a sizable reserve and it is located in a relatively new producing area.

Lion Oil Company wishes to see the field operated in a manner which will ultimately provide the greatest recovery and we think our recommendations are a step in that direction. Solution gas and free gas which has come out of the formation appears to be the only sources of energy which will effectively move oil to the producing wells in the "D" sand. In order to produce the most oil per unit of solution and free gas produced, a method should be utilized prior to a program of fluid injection and pressure maintenance which will produce the oil at as low a gas-oil ratio as possible. Wells with high ratios should have their rates curtailed within practical limits; as much of the oil as possible should be produced from low ratio or the most efficient wells.

I believe the Lion Oil Company proposal will accomplish those results within practical limits. We have, along with the other operators, been working toward ultimate unitization

of the "D" sand reservoir almost from the date of discovery. We feel that a recovery of less than 30 per cent of the original oil in place as indicated on this performance prediction is not good. We would like to see the recovery be much greater than that. We think that with unitization and a program of fluid injection and pressure maintenance a much greater recovery can be accomplished. In order to leave the field with as much of its natural energy as possible at the time of unitization, if it is accomplished, we feel that rates should be curtailed and that we should conserve as much energy as can be done practically by control of gas-oil ratio and oil withdrawals.

CHAIRMAN DOWNING: Do you care to give us an estimate of what the ultimate recovery would be if your figures and suggestions are followed, a wild guess?

THE WITNESS: We have estimated that under the solution gas drive mechanism there will be say a maximum of 25, well, we will say in the range of 25 to 30 per cent of the original oil in place produced, and that means of course that if there is 40 million barrels of oil in place that the recovery will vary somewhere say from 10 to perhaps as high as 15 million barrels. Now we further feel that the unitized fluid injection program could well increase the recovery up to the order of 40 to 50 or perhaps as high as 60 per cent of the original oil in place.

BY MR. ROCCHIO:

Q. Mr. Zimmerman, under those figures of gas production in the allowable, your recommendations as to both oil and gas, will there be any leases in Little Beaver that will be cut back in their production as a result of this recommendation?

A. I believe there will be a few, yes, sir.

Q. Could you tell us what those are, what the data would be?

A. The recommendation of 100 barrels a day of oil and 150,000 cubic feet of gas means that a well producing more than that quantity of gas will be cut back, that is if it produces more than that quantity of gas, in producing 100 barrels of oil will be cut back. Therefore, you can look at the tabulation of gas-oil ratios that are shown and any well which is producing with a gas-oil ratio in excess of 1500 cubic feet per barrel will have a penalty allowable. Now the well tests that have been submitted by Mr. Trueblood's testimony indicate that the Continental Oil Company will have no penalty allowables; that the Goodall Oil Company will have no penalty allowables; that the Lion Oil Company will have one penalty allowable; and the Lion Wagers No. 2 which has a ratio of 2172 cubic feet per barrel.

Q. How about those other leases such as the Denver Basin, do you have those figures?

A. There are probably some others. I have only indicated the wells for which I have gas-oil ratios. Now if there are

other gas-oil ratios available we can certainly point them out. Now we are talking about the Little Beaver "D" sand only and any well having a gas-oil ratio in excess of 1500 cubic feet per barrel would be allowed to produce less than 100 barrels of oil per day.

BY MR. FRYE:

Q. I noticed, Mr. Zimmerman, that you indicated that the expected recovery was 25 to 30 per cent under the gas drive mechanism. You didn't mean to imply, did you, that there was any change in the rate of production that would in itself affect that percentage recovery?

A. I do not mean to imply at all that a solution gas drive reservoir is rate sensitive, I think that is your question, except in so far as it becomes rate sensitive if gas-oil ratio is ignored.

Q. How would it become rate sensitive if gas-oil ratio is ignored?

A. The prediction that is illustrated assumes, as I attempted to point out, that depletion of the reservoir will occur uniformly throughout the reservoir. It indicates further that a well producing with a gas-oil ratio in excess of the predicted gas-oil ratio for the particular stage of depletion under consideration is producing at an efficiency less than the average efficiency of the reservoir; therefore, it is producing fewer barrels of oil per unit of gas produced.

Q. If the allowable rate were set at 300 barrels per well per day and with the same maximum ratio limitations, would that affect your estimate of the ultimate recovery by solution gas drive?

A. No, sir, it would not.

MR. FRYE: That is all.

BY MR. HAWLEY:

Q. Mr. Zimmerman, that 150,000 cubic feet allowable, is that in excess of the gas that would be used or what was sold or used for lease operations, camp operations, and things like that or not?

A. The recommendation that Lion has made is for a production of 150,000 cubic feet per day in total.

Q. That would mean for any phase of the operation for that well?

A. I think that in any changed conditions which might come up in the future that our recommendation could very well be changed. That is in the event of the successful completion of the gasoline plant or the successful culmination of efforts to secure markets for some other salable products, then we would have to look anew at this thing.

MR. ALLEN: Mr. Zimmerman, the matter of the gas-oil ratio to barrels of oil produced will according to your prediction and in your opinion change in the future as the reservoir is further depleted, is that right, sir?

THE WITNESS: As you observe performance of the reservoir, the validity of the prediction illustrated will be confirmed or disproved, and should it be disproved, of course, it would be modified accordingly. This prediction depends entirely on the assumption that the fluid characteristics and rock characteristics are accurately known.

MR. TRUEBLOOD: Mr. Zimmerman, I believe what Mr. Frye was getting at, and I would like to reaffirm, that Lion Oil Company's recommendation for 100 barrels per well per day is not necessarily what we like to term an MER of an individual well, but that actually in effect you have said that the most efficient wells should be produced with the less efficient wells having penalty on them, isn't that correct, regardless of the amount of oil production?

MR. ROCCHIO: Or the gas sets the limits.

THE WITNESS: We think that 100 barrels of oil per day is the reasonable rate of take. That wasn't presented as you ask as an MER.

MR. ROCCHIO: Mr. Zimmerman, under present competitive production with no gas limit or gas-oil ratio limit at all, the reservoir is as you termed it sensitive at that point, is it not? If someone were producing in that field as just let's say pulling as heavily as he could pull, then it becomes sensitive?

THE WITNESS: The prediction assumes that depletion

will be uniform. If the actual operation of the field is such that it is not uniform then the prediction loses some of its validity in accordance with the degree of non-uniformity. That is in speaking of uniformity, of course, I mean that the increase in producing gas-oil ratio from all wells will be relatively the same. There is no way to avoid under solution gas drive mechanism an increasing ratio, but the inefficiency comes about if one in the field would be produced at a ratio greatly in excess of the other end of the field if that condition could come about.

MR. ROCCHIO: Is there any evidence of gas cap in this reservoir?

THE WITNESS: No, sir.

MR. ROCCHIO: Any evidence of water drive?

THE WITNESS: None to date. It's my opinion that there is no effective water drive and probably no water drive at this time. That will more likely be settled on that as we observe performance.

MR. ALLEN: Mr. Zimmerman, one further question in connection with your performance prediction chart. I will ask you whether or not that chart would still be valid if in the operation of this field you shut in an efficient well, and by that term I mean a well with a low gas-oil ratio, and produce only the wells having a high gas-oil ratio?

THE WITNESS: If you produce only the wells having a

gas-oil ratio that is high, or higher than is predicted for the stage of depletion in the reservoir at any time, then the estimate of ultimate recovery is no longer valid. The reason, of course, that it isn't is because we are straying from the assumptions that are necessarily made in order to make this sort of a calculation.

MR. ALLEN: So your ultimate recovery would then be less?

THE WITNESS: It would be less.

COMMISSIONER BRETSCHNEIDER: Mr. Zimmerman, I don't quite understand, and if you will, explain how you arrive at 100 barrels per day and 150,000 cubic feet per well per day. I understand that the gas-oil ratio you suggest there penalizes about three wells in the field. Were they the factor on which you fixed 150,000 cubic feet?

THE WITNESS: No, sir. The 150,000 cubic feet had as part of its background at least the emergency order that was issued by the Commission. It seemed on an examination that it was a reasonable rate of gas take per well. The 100 barrels is not a calculated number, it is approximately the amount of oil that is being taken at this time from the average well, I believe. I think that the average well now is taking perhaps even a little less than 100 barrels of oil per day. There are wells producing more than that but I believe the average well is producing slightly under 100 barrels of oil per day. We as

I indicated have several things as background and one is the desire to not change the producing mechanism greatly in the "D" sand if it appears that it is being fairly reasonably or efficiently exploited at this time.

COMMISSIONER VOLK: Mr. Zimmerman, could you produce these wells at the rate of 200 barrels per day and still not lose any MER?

THE WITNESS: I don't believe I quite understand.

COMMISSIONER VOLK: Would it make any difference if you produce the wells at the rate of 200 barrels a day as far as your ultimate recovery was concerned?

THE WITNESS: It would only make a difference if in order to produce 200 barrels of oil a day from the well it would have to be produced at an excessive gas-oil ratio; that is, you would use more units of energy in the form of gas production per barrel of oil produced.

COMMISSIONER VOLK: What you are saying then is you use more than twice as much gas to produce 200 barrels a day than you would use to produce 100 barrels per day. If your gas-oil ratio was 1000 to 1 to produce at the rate of 100 barrels a day it would be over 1000 to 1 if it produced 200 barrels per day, the same well?

THE WITNESS: Not necessarily, no, sir.

COMMISSIONER BRETSCHNEIDER: Do you have a figure, Mr. Zimmerman, that represents an estimate of how much gas is

being flared there now out of this horizon?

THE WITNESS: I don't have an estimate of the total gas being flared from the reservoir. I can give you a rough estimate of how much gas is being flared from the Lion wells.

MR. JERSIN: With this variation in gas-oil ratio throughout the entire field, your penalty by gas-oil ratios and your production of 100 barrels a day would give you a more uniform rate of withdrawal from the entire reservoir?

THE WITNESS: That is what we feel.

COMMISSIONER BRETSCHNEIDER: Would it reach that considering that only a few wells are affected by your suggestion?

THE WITNESS: Our prediction indicates we are only approaching a critical stage and as time goes on more and more wells would become affected by the limited allowable formula.

MR. ROCCHIO: The three wells affected is just all the information you have; there may be others, is that correct?

THE WITNESS: I think I only had one well before me here. There is possibly some more gas-oil ratio information that I don't have here.

MR. ALLEN: Mr. Zimmerman, you spoke of the prospects of unitization of this sand. I will ask you whether or not it's important if unitization is effective and the question of maintenance is employed, it is important to have the reservoir at the time that operation begins as nearly as possible as it could have been at this time to its original condition?

THE WITNESS: Well, the thing you point your finger at most definitely in this case would be the higher we keep our pressure at the time of unitization the lower will be the lifting costs that we will be faced with, that is under unitization, then we could very well look forward to flowing a large fraction of the total recovery; where if we deplete the pressure we will either have to build it back up, which is more expensive, or have higher lifting costs.

MR. ALLEN: Now, Mr. Zimmerman, on behalf of your company you made these recommendations. I will ask you whether or not your recommendations would necessarily be the same if unitization was not in prospect?

THE WITNESS: No, sir, I don't believe I could make the same recommendation. I am not sure, because it's a hypothetical question, but one of the very important reasons to us for making this recommendation is to preserve natural reservoir energy pending its position.

MR. ROCCHIO: Mr. Zimmerman, without the emergency order of the Commission or the recommendations of Lion and you continue to produce the field strictly on a competitive basis, what would be the recovery estimates that you would have? Would it raise your graph or would it be less?

THE WITNESS: If I could validly make the same assumptions under competitive operations the recovery would be the same. Under competitive operations I am in doubt that

there would be as much control of efficiency in the form of attempting to keep the producing gas-oil ratio as nearly as possible at a uniform level, therefore, depending on what assumptions I made I probably would come out with a smaller recovery.

MR. ROCCHIO: It appears to be less, doesn't it?

THE WITNESS: Yes, but the degree I hesitate to say.

MR. ROCCHIO: Do you believe that there will be an increased ultimate recovery in this field by your recommendations if there is no unitization?

THE WITNESS: I think that if the gas-oil ratios are controlled throughout the life of the reservoir to keep them uniform and not greatly in excess of the predicted gas-oil ratio for any stage of depletion on this prediction, that the recovery will be as indicated, I mean in the order of 28%.

MR. ROCCHIO: Greater than under this situation?

THE WITNESS: Greater than with no gas-oil ratio control.

MR. ROCCHIO: Do you have any idea or could you estimate in your opinion of what that increase would be? I don't care how you put it, percentage, barrels, or what.

THE WITNESS: I would prefer not to because it would be strictly a guess and it wouldn't mean anything to me. I would say that it would depend on how great was the variance in actual performance of this reservoir from the predicted ideal performance under solution gas drive.

COMMISSIONER VOLK: Mr. Zimmerman, may I ask you another question. You expect to water flood this field, is that correct, after you have lost the primary method of expulsion?

THE WITNESS: Water flooding is one method that is being investigated and will certainly be considered by all of the operators in connection with the current attempts to approach a reasonable way to unitize the field.

COMMISSIONER VOLK: May I put the question this way: You expect to water flood rather than to go to the cost of repressuring with gas or creating any free gas cap, is that correct?

THE WITNESS: I can't really answer the question because we don't know whether there will be water available with which to water flood. We are attempting to find out. We further don't know how much, if any, gas would be available for gas injection should we want to go to the gas injection process. The approach generally of the committees have been formed in trying to determine the advisability in unitization, how it should be accomplished to try to calculate the manner in which the greatest ultimate recovery can be obtained, and that will be the method. We will certainly attempt to apply if we have the kind of fluid, gas or water, that will be required. I am sorry but I can't really answer the question.

COMMISSIONER VOLK: What I am attempting to bring out

is the fact that the most gas we can conserve at the present time would be that much more gas of a beneficial use. You are holding that gas to 150,000 cubic feet per day. Unless that gas could be used for reinjection the lower we hold that the more we are going to conserve gas, is that correct?

THE WITNESS: Yes, sir, that is correct.

COMMISSIONER VOLK: And if you are going to water flooding then you are not going to use the gas for repressuring.

THE WITNESS: But it has commercial value if a market is developed for it. That is it will be the same as to waste something of commercial value to the operators at this point when within a few short months we might have market for it.

COMMISSIONER VOLK: The lower you hold your gas, the more conservation you will have, isn't that correct?

THE WITNESS: That is my opinion.

COMMISSIONER BRETSCHNEIDER: Is there any argument to produce the 150,000 to some other figure? The reason I ask the question, I notice on this report here on these pumping wells your gas-oil ratio is universally quite low. Is that a regulated gas-oil ratio by virtue of the fact the operator himself wants to produce so much oil or is that what the well should produce?

THE WITNESS: The gas-oil ratios from well to well as indicated on here vary. They depend on a number of things, one of which is the state of depletion around that well. That

is those are localized conditions that cause wide variations in gas-oil ratios. I might mention that is one of the things we would like to avoid and that is to have wide variations in the rate of the saturation to the reservoir.

COMMISSIONER VAN TUYL: Mr. Zimmerman, has this subject of unitization passed beyond the committee stage? Have any of the operators been approached and urged to join in on a unitization program?

THE WITNESS: The general approach to unitization of the Little Beaver "D" sand was the formation of various committees. The directing committee is called an "Operators Committee". It is composed of people from representing each operator who has authority to make decisions necessary to say yes or no, let's go one way or the other. Then, of course, working under that committee are various other committees. One is a geological committee which is charged with investigating the geological features of the reservoir; an engineering committee which is charged with investigating the best possible way to produce the reservoir and the best possible way to apply the unitization recovery mechanism, whatever it turns out to be.

MR. TRUEBLOOD: Mr. Zimmerman, in your opinion has there been any avoidable waste in the Little Beaver Field to date as pertains to oil production?

THE WITNESS: If there have been wells producing with gas-oil ratios in excess of the gas-oil ratio which should

exist at the stage of depletion existing in the Little Beaver sand, then there has been waste. I think that the waste which has existed, if any, in the Little Beaver sand has been very small to date and probably, well, within the realm of practical expectation. This is a very efficient reservoir, I might say that.

CHAIRMAN DOWNING: Any further questions? If not, thank you, Mr. Zimmerman, for your statement.

(Witness excused.)

CHAIRMAN DOWNING: Any further testimony, presentation, or information you wish to give the Commission on the "D" sand before we close that feature of the hearing?

MR. TRUEBLOOD: Gentlemen, in order to put this on a definite operators' basis and their own opinions, Lion has put forth their recommendation. The Goodall Oil Company certainly would be desirous of staying within the limits of best conservation practices. The one thing that we wish to point out to the Commission is this: That in the past in our estimation there has been no waste in the Little Beaver Field and that various people have been extremely critical of the production practices in the Little Beaver Field and that we maintain there has been little or no waste in existence at the present time in so far as it is an avoidable waste.

First of all I would like to point out that the rate of production has very little to do with the ultimate recovery

of oil in a gas depletion type reservoir, that is the rate of oil production, so long as it is uniform. So long as the gas-oil ratios are uniform the only thing that affects the ultimate recovery of oil in a gas depletion type reservoir so long as gas-oil ratios are equal and withdrawal is equal is the ratio the viscosity of the oil to the viscosity of the gas below saturation pressure. That is all, not the rate of production, gentlemen. This is beyond our control short of secondary recovery operations.

The only thing that is under our control and is under the Commission's control is to produce this field uniformly to depletion. Unless we can institute some sort of secondary recovery or pressure maintenance operations amongst the operators it will require a unitization on the part of the royalty owners as well as the operators. It has to be as equitable as possible and when you have several operators and several royalty owners you have several differences of opinion.

During the past five months we have undertaken amongst the operators to find out something about our reservoir by producing our wells at possibly 100 barrels of oil per day. We have done that in order to take a bottom hole pressure after the interim period and compare it with the bottom hole pressure of an interim period of July through September in which the rate of production was 186 barrels per well of oil per day. This is considerably under the present emergency order of

Cause 30

150,000 cubic feet of gas per well per day. It is the contention of the Goodall Oil Company and several individuals that there has been no waste under that situation.

Furthermore, I might point out to you that the pipeline is at the present time filled to capacity and that the oil operators are going to be further cut throughout the Denver-Julesburg Basin, as will the Little Beaver Field operators; that the Little Beaver Field operators have made plans and are currently making an engineering investigation and are actually going through with building a gas compression plant for the purpose of gathering low pressure gas and selling this gas to the gas transmission company.

Now this work has been hindered in the past, not by indifference of the operators, but because of the fact that it was a questionable economic venture to conserve this low pressure gas because of the available gas reserves in the Little Beaver Field area. With the advent of the Adena Field and several other fields in the area it has made it more of an economical venture, although we still don't expect to make any money out of it other than to conserve gas.

It is our contention that the gas-oil ratio determinations are extremely important and necessary from this point on and that at least a semiannual ratio test by each operator should be made and made as public record. The bottom hole pressure surveys which we have conducted in the past have been

very frequent and we find now that we are almost fully convinced that we have a gas depletion type well, so we have no help from the influx of water from the west nor do we have a gas cap which will expand and further aid our production. Very probably a pressure survey once per year will be satisfactory henceforward.

Further study should be made by the operators and is being made on the economic feasibility of unitization and secondary recovery operations. It is our contention, the Goodall Oil Company's contention, that the so-called maximum efficient rate of production of a well in a gas depletion type reservoir is the capacity of the well, regardless of what the gas-oil ratio is in a gas depletion type reservoir so long as it is uniform with other wells surrounding it, which in effect is what Mr. Zimmerman pointed out on this graph over here. We know that at the present time that if all the gas-oil ratios were the same in the Little Beaver, that during the past six months we had a comparable interim period there in which we produced 186 barrels of oil per well and 100 and one-half and it made very little difference on the effect of the reservoir pressure declines or barrels of oil produced.

You can plot it on a semi-log relationship and see that it falls in a straight line over the three surveys, that we have pressure surveys that we have done. The only reason that we would join with Lion Oil Company in their recommendation

of 100 barrels of oil per well per day is strictly from the standpoint of the possibility that we may be able to unitize this field and that we are working toward that. We would agree and would have to agree that the limitation of the total amount of gas produced from the various wells should be equal from the standpoint of ultimate recovery, and very possibly if we don't unitize this field that the Goodall Oil Company or one of the other oil companies will come back and request a new hearing with new allowables based on a more compatible basis of acre feet of sand in relation to the total reservoir, so long as the gas-oil ratios are kept somewhat the same.

Certainly a person who has 10 acre feet of sand should not be allowed to produce the same amount of oil as a person that has 100 acre feet of sand, that stands to reason because he is draining his neighbors oil; but at the present time for the next six months or so while we are trying to work out this unitization program certainly we would agree with Lion Oil Company that that should be done.

Now we feel that certainly 100 barrels a well per day is warranted. We further feel that the Commission should be kept advised and that the various operators should be kept advised of the ratios of the various wells and that each operator should take it upon himself to see to it that most of his oil is taken out of his most efficient wells. That is very hard to do in a common tank battery as we have in this field

as you might well know from the standpoint of actual physical production and operations. If the Commission will go along with what the operators feel is at least a good attempt to get more oil out of the ground from the standpoint of having an ideal reservoir conditions or best reservoir conditions as a result of slowing down the production of the wells until such time as unitization occurs, why, it is felt by the Goodall Oil Company and some of the other oil companies that this is a good thing for the State of Colorado as well as for ourselves.

As you well know, gentlemen, agreements in a field among many operators are frowned upon by the State of Colorado, the United States Government, and other people. We prefer to say that we have not had any gentleman's agreement to date. Perhaps a gentleman's agreement through the help of the Commission might aid us somewhat until such time as we can instigate secondary recovery operations.

We recommend to the Commission that the operation as a whole go along with the Lion Oil Company recommendation for at least a period of the next six months in order to give us more time to try to accomplish secondary recovery operations.

CHAIRMAN DOWNING: Thank you. Any questions? Does anyone else wish to give any testimony in this hearing before we close the "D" hearing, at least temporarily? If not, let's next take up the "J" sand.

First there are a large number of operators here in

the "D" sand or a considerable number. We would kind of like to take a poll on this suggestion of 100 barrels a day top limit and 150,000 cubic feet a day of gas. Who here favors that sort of order by the Commission? Will you rise. (Three persons stood.) Be seated, thank you. How many of you oppose such an order? Would you please rise.

MR. FRYE: Our attorney, Mr. Hawley, has a point with relation to the recommendation to be made. We didn't think the Commission should enter an order just as recommended.

MR. HAWLEY: If it please the Commission, Judge Downing, we were wondering about the legality of such an order. We know that the Commission has the power to conserve and to prevent waste, but where there would be no necessary association between the prevention of waste and simply an order stating that 150,000 cubic feet for a maximum of gas and 100 barrels on oil, if that perhaps wouldn't be contrary to the provisions of our Colorado Conservation Act, in that there would be perhaps no association between that and waste. I believe the testimony has been brought out that the ultimate recovery would be approximately the same whether it was two or three hundred barrels a day, and we know from the Rangely Case that the Commission has the power to order a reinjection of gas.

CHAIRMAN DOWNING: Do you have any doubt yourself as to our power?

MR. HAWLEY: I have little doubt, your Honor. I was

just questioning the point now whether reinjection in Rangely was to prevent the waste of the gas.

CHAIRMAN DOWNING: If we make any order we will have the advice of the Attorney General and Mr. Rocchio who has been assigned to advise us of these matters. If the order in his opinion is not legal it will not be made.

MR. HAWLEY: I just wondered if Mr. Rocchio might have any opinion on that.

MR. ROCCHIO: Whatever we do we consider it legal. From an engineering standpoint, how does Continental feel?

MR. FRYE: I'm sorry, I didn't hear your question.

MR. ROCCHIO: From an engineering standpoint, forgetting the legal aspects of this, how does Continental feel?

MR. FRYE: From an engineering standpoint we feel that some reasonable limitation of gas production may be advantageous in directly increasing recovery, but any limitation on oil production is totally irrelevant.

CHAIRMAN DOWNING: All right, I think we have covered this discussion very thoroughly and thank you very much to those who made this presentation on it.

Now let's take up "J".

MR. ALLEN: Judge Downing, we have one witness who will present the factual data with respect to the "J" sand and then we would like to follow him with another witness to make the recommendation. As a member of the Committee, Mr. Roll has

prepared in tabular form similar to the matter in which Mr. Trueblood prepared the factual data with respect to the "D" sand, and Mr. Roll is an employee of Lion Oil Company as a Petroleum Engineer and we would like to have him present the factual data.

BRUCE ROLL

called as a witness on behalf of the Lion Oil Company, being first duly sworn according to law, upon his oath testified as follows:

DIRECT EXAMINATION

CHAIRMAN DOWNING: Subject to objection, you are accepted as an expert. Proceed.

THE WITNESS: This tabulation is on the Little Beaver "J" sand field and the field data is tabulated here similar to what Mr. Trueblood presented for the "D" sand. The discovery date and well for the field, the gas discovery well was in Snowden-Tucker No. 1 Hough Well. The discovery date was May 1, 1951. The oil discovery was Bill Tomberlin No. 1 and Hogsett and it was on June 30, 1953. The producing horizon first bench was the "J" sand, which is in the Dakota group. The number of wells are 12 wells in the area, and five completed wells in the oil area and gas area plus one which is drilling at the present time. In the gas area alone there are four completed wells.

The average sand thickness for the oil area is 9 feet and for the gas area is 12 feet. The oil-water contact is variable. The subsea depth runs from a minus 715 to a minus 750. Gravity of crude oil from 41 to 42 degrees API. Standard conditions gravity of the gas is .807. That is gas from the gas cap I believe that was measured by Colorado Interstate out of one of the gas wells in the gas cap alone. The gravity of the gas in the oil zone is considerably higher than that.

The initial static bottom hole pressure 1360 PSIG. The structural features as you will notice from the large map upon the board there, it shows the blue is the water -- the only evidence of water is coming from that end of the field -- and the pink represents the oil zone, the green represents the gas zone, and the crosshatched or striped area which doesn't show up too clearly there represents the overlap of the gas and oil zone; in other words, in that area we have the gas-oil contact present.

The probable producing area in the oil area is approximately 900 acres; the gas area consists of approximately 1350 acres. The gas-oil ratios, the initial solution gas-oil ratio was 435 cubic feet per barrel. That was determined from a fluid analysis from one of our own wells. The reservoir mechanism is a gas cap expansion definitely, and perhaps a water drive but it is unknown at this time. A gravity drive is unknown but probably small, but does exist. Core analysis

data was determined from the average of each core analysis that was available from the different wells in the field. The average porosity is approximately 22%, the average permeability is approximately 1100 millidarcies, residual oil saturation is approximately 10.2%, average total water saturation approximately 35%, and the interstitial water saturation has not been determined at this time.

The estimated total oil in place, we have made several different calculations on that by volumetric analysis and material balance and our estimate is between 7 1/2 to 8 1/2 million stock tank barrels. Estimated gas in place is from 11 million to 12 million MCF. Estimated recoverable hydrocarbons, the gas cap expansion recovery can vary from 15 to 35 per cent of the oil in place and 70 to 80 per cent of your gas in place. By water flood this recovery would be increased probably 40 to 50 per cent for the oil and your gas recovery would remain the same, even though we had water flood it would be 70 to 80 per cent. Note that the ultimate recovery by gas cap expansion would depend on the effectiveness of the expanding gas cap in sweeping out the oil which in turn would depend on the rate of depletion of the gas cap and on the degree of coning of gas from the gas cap and coning of water from the bottom water.

Cumulative production March 1, 1954, is 407,000 barrels of oil. The average bottom hole pressure, which was taken around March 1, 1954, was 1318 PSIG. The recent gas-oil

ratios have been tabulated just for our use only in the "J" sand and are attached to the factual data as distributed already.

MR. ALLEN: Sir, we would like for the chart which Mr. Roll prepared to be marked as an exhibit in his testimony and I believe I neglected to request the performance prediction made by Mr. Zimmerman be also made an exhibit.

CHAIRMAN DOWNING: If there is no objection it will be so ordered. Any further questions?

MR. ALLEN: No further questions.

CHAIRMAN DOWNING: Any further questions by anyone else? If not, proceed.

(Witness excused.)

MR. ALLEN: We would like to call as our next witness the same Mr. Zimmerman who testified earlier this morning.

FRANK ZIMMERMAN

having been previously duly sworn, was recalled and testified further as follows:

DIRECT EXAMINATION

BY MR. ALLEN:

Q. Mr. Zimmerman, have you prepared with respect to the "J" sand in the Little Beaver Field a performance prediction chart comparable to the chart that you prepared with respect to the "D" sand?

A. Yes, sir, I have.

Q. Do you have copies there for the Commission?

A. Yes, sir.

Q. I will ask you if you will, sir, to explain that chart.

A. The remarks that were made about the solution gas drive prediction on the "D" sand reservoir concerning the validity of the basic data and the assumptions concerning the homogeneity of the reservoir rock and fluid are equally as important in this calculation. There are other factors which must be taken into account, however, in this case. One of the most significant assumptions in constructing these curves that are illustrated is that effective control of gas-oil ratios will occur, that the rate of oil withdrawals will be such that no coning and channeling of gas cap materials will occur, or that such control would be exercised to minimize that which occurs. The specific features of this particular prediction are similar to those pointed out for the "D" sand with respect to the functions plotted. That is along the bottom of the exhibit is plotted the fraction of oil, oil in place produced at any time; and along the left hand scale is reservoir pressure, along the right hand scale is gas-oil ratio.

This particular curve is the calculated function of reservoir pressure against depletion of the reservoir illustrating how the pressure will decline under the assumptions made in making this calculation. This illustrates the performance of gas-oil ratio, indicating that it will remain low for a

considerable period of time if the assumptions made are correct and that it will increase very rapidly at the point or near the point where the total energy of the reservoir will be depleted.

The significant thing illustrated on this curve is that the maximum amount of oil to be recovered under this producing mechanism is in the order of 30 to 35 per cent. Now I say that that is the maximum amount to be recovered because this calculation and this curve assumes that all of the gas cap gas will be utilized to its maximum efficiency to produce oil before it is produced itself. That is that rates will be controlled so that coning of gas will be eliminated or minimized and that no withdrawals will occur from the gas cap material as such.

Now, of course, if there are withdrawals from the gas cap that means that this pressure will decline faster. If the rate of withdrawal from the oil wells is at a high enough rate, which causes excessive coning, the gas-oil ratio total will go up faster and the total energy of course will be depleted sooner, therefore, recovery will be less. In other words, this is maximum.

The amount by which the actual recovery will be less than that predicted will depend entirely on how this reservoir is handled. That is the rate of depletion of the gas cap energy

prior to its utilization for producing oil will certainly have a bearing on ultimate recovery. The degree of gas coning and channeling obviously will have a large effect on ultimate recovery. It's my opinion that the recovery indicated by the "J" sand performance prediction should be reasonably expected if the reservoir would be depleted at such a rate that would be low enough to avoid all coning of gas and if further the gas cap material is used to produce oil before it is used for any other purpose.

This reservoir is relatively new. It's newer than the "D" sand. As more history becomes available to us on the effectiveness of the expanding gas cap and as more information becomes available on the degree of coning to be expected, further recommendations concerning rates and further studies, of course, can and will be made.

MR. ALLEN: We would like to introduce Mr. Zimmerman's prediction performance chart as an exhibit to his testimony at this point.

Q. Mr. Zimmerman, do you have any recommendations to make to this Commission as to a rate of withdrawal to be made from this reservoir, the "J" sand?

A. Lion Oil Company recommends an oil allowable of 150 barrels of oil per well per day.

CHAIRMAN DOWNING: What is that?

THE WITNESS: 150 barrels of oil per day per well.

The top minimum of gas production of 150,000 cubic feet. Here again this means that any well not able to produce 150 barrels per day and 150,000 cubic feet of gas will have its oil allowable reduced accordingly. We further recommend that the Commission require quarterly gas-oil ratios on each well; that is the allowable for the next quarter on the basis of the new test. This recommendation is made for a period which you might call a test period of three months or 90 days, during which time we hope to be able to observe the effects of the other possible mechanisms operating in the reservoir and decide more accurately on the validity of our recommended rate.

Q. You made a recommendation, Mr. Zimmerman, and I will ask you to state for the Commission your basis and reasons for that recommendation, if you will.

A. The fundamental reason for this recommendation, of course, is the same as the fundamental reason on the "D" sand and that is Lion Oil Company has a desire to produce the maximum possible oil from any reservoir in which we operate and therefore any recommendation that we make will be what we feel will accomplish that result.

We further know that in the Little Beaver "J" sand reservoir there are at least two sources of energy naturally occurring which will act to produce oil from the reservoir: Those are gas cap expansion and solution gas drive. There may be a third source, natural water drive. If there is an effective

water drive the only way to efficiently utilize it would be to produce the reservoir at rates not exceeding the rate of water encroachment.

By producing at our recommended rate I believe we stand a good chance of observing whether or not such a water drive exists and of further securing additional data which will allow us to plan the depletion of the reservoir in the most efficient manner. We do know that this reservoir has been produced in the past at rates which are too high to properly appraise the effectiveness of all the natural forces moving oil in the reservoir. We have noted higher ratios on our wells at higher rates of oil production. We interpret that as a sure sign of gas cap coning or channeling.

We have also noted a rapid increase of water production on one Lion Oil Company well in spite of the fact that withdrawals from that particular well have been quite small; that is, the rate of water encroachment into the well has not been commensurate with the rate of withdrawal from the well, which does indicate undue channeling or coning of water. It is my opinion that this is definitely a rate sensitive reservoir. It has a relatively thin oil column and a very high permeability. It has both, which of course are conducive under improper production control to gas coning, water coning, inefficient operation of the reservoir, and lower recovery.

We don't pretend to know the exact rate at which we

can avoid all reasonable inefficient occurrences in the reservoir. I believe, however, that a rate of 150 barrels of oil per day and 150,000 cubic feet of gas per day is a step in the right direction and it can very well be an efficient rate. We think that this test period should lie on that matter.

In this reservoir we are also thinking about and working towards the possible ultimate unitization of the reservoir and some sort of fluid injection program. We believe that the natural energy in the reservoir in this case also should be preserved pending the outcome of these unitization efforts. It's an obvious fact that gas in this reservoir should be conserved at this time if for no other reason than to make it an economically salable product at the time the market becomes available for it.

CHAIRMAN DOWNING: Any questions?

COMMISSIONER VAN TUYL: What is the maximum amount of oil being produced from any one well in this oil belt at the present time?

THE WITNESS: I don't believe I can answer that question because actually I don't know. I only know the rates at which Lion Oil Company has produced its wells. Lion has produced wells at a rate which is slightly in excess of last month of 100 barrels of oil per day. Now the maximum rate, I cannot answer that.

COMMISSIONER VAN TUYL: There is no control here as a

result of pipeline take, is there, on the amount of oil being produced by any operator?

THE WITNESS: Yes, sir, I think there definitely is pipeline control of runs.

COMMISSIONER VAN TUYL: You say there is pipeline control?

THE WITNESS: I believe I am right. Is that not right for the "J" sand as well as the "D" sand? Unless someone else can answer, I can't definitely answer the question.

COMMISSIONER VAN TUYL: Does all this oil go into the pipeline or is some of the oil trucked out?

THE WITNESS: You are asking questions just a little bit out of my field. I think that probably the majority of it is being piped out. Perhaps someone can answer those questions.

MR. WILLIAMS: The majority I think is being trucked out.

COMMISSIONER VAN TUYL: No further questions.

COMMISSIONER BRETSCHNEIDER: How many wells would be affected under your recommendation?

MR. RICHARDSON: I would like to make a correction there. As far as I know all of Lion Oil Company's oil is being sold through the pipeline and as far as I know the other operators are, but I am not sure about that.

MR. JOHNSON: I would like to ask one question. I own an interest in the Hogsett lease on the Bill Tomberlin, who is not here today, and we have some of those operators to contend

with. You say 150 barrels a day. He is producing approximately 40 per cent of the 450,000 barrels out of three wells. He sells it at $2.95 a barrel. You are going to have him to contend with whatever you set it at. What's your basis for 150 barrels? And at the same time on one well he has 600 something oil-gas ratio and 900 on one and 2000 on the other, which was about the ratio when the wells came in before he produced 200,000. How are you going to convince him that 150 barrels a day should be the MER? I am for the 150, but we are going to have to contend with him. We might have to go to court, and if you get it too low I think we will.

THE WITNESS: The recommendation, of course, as I indicated is not a recommendation for MER, it's a recommended rate at which we think we should be able to properly evaluate all forces acting in this reservoir. It's further by virtue of having a very large gas cap, even if there is no water encroachment, it is definitely a rate sensitive reservoir. That is the degree of coning of gas from time to time will depend on the rate of withdrawals from the wells. The 150 barrel rate is a rate that we feel should allow us to properly evaluate what is happening. We don't feel that very large rates will allow us to do so.

MR. JOHNSON: I am not a witness, but I want to say that I am for the 150 barrels.

MR. ROCCHIO: Mr. Johnson, as far as convincing any

given operator in the field is concerned, the Commission I believe has jurisdiction over the Little Beaver and any other field in the State of Colorado. We have issued proper notice under our statute. If Mr. Tomberlin desires to object or to be for or against any order issued by this Commission, he has had his opportunity, and that is today. Whatever order this Commission makes -- I don't know what they will do -- but whatever order they make Mr. Tomberlin will be bound by that in our opinion and if he does or doesn't observe it is entirely up to him, then we follow whatever procedure is available at that point, whether he disagrees engineeringwise or not.

MR. JOHNSON: May I ask one question. Is this 150,000 feet and 150 barrels a day, this would be a set proration as far as oil is concerned?

MR. ROCCHIO: That is what their recommendation appears to be. They are stating it both in terms of gas and in terms of oil. What the Commission will do may be another thing.

COMMISSIONER BRETSCHNEIDER: I asked one question. Can you answer?

THE WITNESS: The question was asked as to how many wells would be affected?

COMMISSIONER BRETSCHNEIDER: Yes.

THE WITNESS: I can answer with respect to Lion Oil Company wells that there will be three wells: Lion Flessner

No. 1, Lion Flessner No. 9, Lion Flessner No. 11. I can't answer with respect to the other wells; I don't have any other information.

COMMISSIONER BRETSCHNEIDER: Mr. Johnson, do you have the gas-oil ratio on Tomberlin wells?

MR. JOHNSON: Your engineer I believe has it there, do you not?

MR. JERSIN: You just stated them, didn't you, Mr. Johnson, 2000 on one?

THE WITNESS: That well would be affected.

MR. JOHNSON: That is 2001 on the No. 1 well.

MR. ROCCHIO: That is the only one that would be affected under their recommendation?

MR. JOHNSON: That is right. Let me ask one other question while I am up here then. Suppose you have three wells and you would run most of your oil out of two wells and shut the other one in. What would be the case?

COMMISSIONER VOLK: That is perfectly all right. Allow so much for three wells on a lease would be 450,000 cubic feet per day. You naturally would want to take it out of the most efficient wells.

MR. JOHNSON: I have asked that question because I have had this to contend with. I am for the lower allowables from an economic standpoint.

MR. ALLEN: If I may I would like for a brief moment

to make a statement of Lion Oil Company's position with respect to this matter. We are happy to be out in the State of Colorado and enjoying some of this good production. As our witnesses said we are going to be selfish about it, that is, we want to get all of the oil out there that can be gotten within practical limits, and we think that selfishness is conservation and that is the keynote on which this meeting was opened by you. We earnestly submit the recommendations we have made be adopted. We feel that as the witnesses state they are steps in the direction of conservation. We want to preserve these reservoirs as well as we can up to the date on which it can be unitized and we certainly hope it can be and we are going to do all in our efforts to see that it is unitized because our experience in the other states in which we operate is that unitization is the best plan and pressure maintenance is the most selfish claim. We hope that the reservoir will be preserved under our recommendations until such time as that can be adopted, and we appreciate the opportunity of being heard.

CHAIRMAN DOWNING: Thank you for that statement. Certainly we will do anything we can to help unitization.

(Witness excused.)

CHAIRMAN DOWNING: Is there any other testimony? Do any of you here want to offer testimony or press opposition either by standing or otherwise to the recommendations made by the Lion Oil Company? In other words, no one here wishes to

oppose those recommendations?

MR. ROCCHIO: Is anybody in favor of them?

MR. GISH: Col-Tex favors those recommendations.

MR. JOHNSON: Your Honor, I want 200 barrels per well.

CHAIRMAN DOWNING: In other words, 200 barrels instead of 150 would be entirely satisfactory?

MR. JOHNSON: That is right.

CHAIRMAN DOWNING: All right, if there is no other testimony--

MR. ROCCHIO: There is, Judge, Interstate has some testimony.

MR. BARRETT: I am S. C. Barrett from Colorado Interstate. We have been--

CHAIRMAN DOWNING: Is this mere statement or testimony?

MR. BARRETT: Just a mere statement. We have been trying to purchase the gas available in Little Beaver and the Adena area since the first wells were brought in up there. We have worked with all the producers who were willing to work with us, and we have made the proposal which has been accepted by quite a large percentage of the producers up there. I thought it might be helpful in the thinking of the Commission for them to know our attitude on possible purchases from this area. We have proposed to lay a line from our two 20-inch mains coming into Denver up to Little Beaver, on to Adena, and on up to serve the Town of Fort Morgan. We are quite anxious to

consummate these contracts as quickly as we can. We have been working with the major plant owners and are now engaged in trying to finalize those contracts. We are hopeful that the contracts can be executed quickly so that the line can be installed and gas run as quickly as your compressor plant is complete.

There are a couple of things that have bothered both the producers and us on getting together on a contract. One of them is, of course, how much gas is going to be available. We are certain that the gas reserves in the area are more than adequate to justify a line up there. The only question is how much per day will be produced. We have a selfish motive also. We would like to see the most gas produced from the reservoir that is possible to recover. It's to our advantage that that gas be produced over a relatively long time. It's impossible to finance a pipeline where your gas is produced at terrific daily rates in the early stages of development or production and very low rates during the latter years. So as quickly as the producers can get together, as quickly as they can know how much gas will be available, then we can design and construct our system and are more than anxious to get that job behind us.

CHAIRMAN DOWNING: Any questions? All right, any other testimony or any other statements before we close this hearing? Hearing none, the hearing will be closed.

We have decided at this time to continue in effect

the emergency order until we have time to consider the evidence and reach a decision.

(Whereupon the hearing in Cause No. 30 was adjourned at 12:00 o'clock, March 16, 1954.)

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C E R T I F I C A T E

I, Donald E. Weimer, 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 20th day of March, 1954.

Donald E. Weimer

Certified Shorthand Reporter
2027 Newport Street
Denver 7, Colorado

Phone
FR 0358