BEFORE THE
OIL CONSERVATION COMMISSION
Roswell, New Mexico
April 16, 1958

CASE NO. 1365

TRANSCRIPT OF PROCEEDINGS

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ALBUQUERQUE, NEW MEXICO
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BEFORE THE
OIL CONSERVATION COMMISSION
Roswell, New Mexico
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IN THE MATTER OF:

CASE NO. 1365: Application of Cabot Carbon Company for a hearing de novo before the Oil Conservation Commission of New Mexico on its application for a dual completion. Applicant, in the above-styled cause, seeks an order authorizing the dual completion of its H.L. Lowe "B" Well No.1, located 467 feet from the South line and 850 feet from the East line of Section 26, Township 13 South, Range 37 East, Lea County, New Mexico, in such a manner as to permit the production of oil from both the King-Devonian Pool and King-Wolfcamp Pool through parallel strings of 1½" tubing.

BEFORE:

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

TRANSCRIPT OF PROCEEDINGS

MR. PORTER: Next case to be considered will be Case 1365.

MR. PAYNE: Application of Cabot Carbon Company for a hearing de novo before the Oil Conservation Commission of New Mexico on its application for a dual completion.

MR. CHRISTY: Sims Christy of Hervey, Dow & Hinkle, appearing for the Applicant, Cabot Carbon Company. This is an application before the Commission in connection with an oil-oil

dual completion. The application is in the King Field in Lea County. The request for the hearing is a de novo hearing, which is not in the nature of a quarrel with the Commission's ruling, but the fact that new and additional evidence has been uncovered which I believe may merit a reconsideration of the Commission's determination in the prior case. We have two witnesses, and if there are some additional questions which I don't feel that these witnesses are qualified to answer, I have other men present who may be able to, but for the moment, on direct examination, we have two witnesses.

(Witnesses sworn)

JOE M. DANIELS, JR.

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

DIRECT EXAMINATION

BY MR. CHRISTY:

Q Would you state your name and address, please?

A Joe M. Daniels, Jr. of Pampa, Texas.

Q By whom are you employed and in what capacity?

A I am employed by Cabot Carbon Company as their senior petroleum engineer.

Q Have you previously testified before the New Mexico Oil Conservation Commission as a mechanical and reservoir engineer in the matters which are the subject of this application?

A Yes, sir.

Q Are you familiar with the application filed in this matter?

A Yes, sir.

Q Do you consider all the facts stated in this application to be true and correct to the best of your knowledge?

A Yes, sir.

Q Will you please explain to the Commission the purpose of the application?

A The application is to dually complete as an oil-oil well the Cabot Carbon Company's H. L. Lowe "B" Well No. 1, which is located 467 feet from the south line and 850 feet from the east line of Section 26, Township 13 South, Range 37 East, N.M.P.M. Lea County, New Mexico, and is located in the King Pool.

We propose to perforate the five and a half inch casing opposite the Wolfcamp formation from 10,220 feet to 10,234 feet, and conduct production tests through straddle packers. If this interval is not productive, it will be squeezed off.

We then propose to test the Wolfcamp formation from 10,178 feet to 10,135 feet by perforating the five and one-half inch casing and conducting production tests through straddle packers.

If the Wolfcamp intervals are productive, we propose to set a temporary bridging plug at apporximately 10,300 feet to separate the Devonian and Wolfcamp formation in the well bore. The Wolfcamp intervals will be produced until the equipment for the dual completion can be obtained.

After arrival of the dual completion equipment, we propose to set packers at approximately 10,300 feet and a packer at 10,100 feet and produce each zone through inch and a half tubing.

Q Have you conducted tests on the subject well?

A Yes, sir.

Q Please explain the manner of completion of the well and the tests taken and the results obtained.

A The subject well has five and a half inch casing set at 12,320 feet and cemented with 700 sacks. The top of the cement was found to be 8,995 feet. The well was then drilled to a total depth of 12,437 feet and was later plugged back to 12,310 feet. The casing was perforated from 12,277 feet to 12,307 feet, and the well was potentialed.

The subject well was placed on production from the Devonian reservoir on August the 12th, 1957. On the initial potential test taken August the 9th, 1957, the well flowed 312 barrels of 47 degree API corrected gravity oil in twelve hours on a one-half inch choke.

On a drill stem test taken June the 26th, 1957, in the Wolfcamp formation from 10,115 feet, 10,191 feet, the tool was open for 100 minutes with gas to the surface in 7 minutes and oil to the surface in 55 minutes. The well flood 23 barrels of oil in 30 minutes. Reversed out all oil and gas and recovered below the circulating sub 300 feet of salty sulphur water. The initial flow pressure was 1,010 PSI; the final flowing pressure was 3160 PSI; and the 30-minute shut-in pressure was 3920 PSI.

Q Have the tests which you have taken indicate that the well is susceptible to production of oil in more than one zone?

A Yes, sir. The subject well was completed in and is still producing from the Devonian horizon. The Wolfcamp horizon was indicated to be productive by the previously mentioned drill stem test. The well to the east of the subject well has been producing from the Wolfcamp for several years. The east offset is the Forrest Oil Corporation H. L. Lowe Well No. 1, which was completed in October, 1951 in the Wolfcamp pay. The Forrest Well has a cumulative production of 179,895 barrels of 38 degree API oil as of February the 1st, 1958. In January, 1958, this well produced 694 barrels of oil, 1035 barrels of water with a gas-oil ratio of 268 cubic feet per barrel.

Q Will this proposed dual completion permit you to meet offset and protect obligations and protect correlative rights, and, if so, how?

A Yes, sir, it will. This is the subject well, and it is presently completed in the Devonian formation. This well is the Forrest Well and it is completed in the Wolfcamp. If we do not produce this, our subject well from the Wolfcamp, the Cabot Carbon Company, will suffer drainage from the Forrest Well. Should we abandon our Devonian pay in this well and produce from the Wolfcamp, then the royalty owners on this tract will suffer drainage from these Devonian wells down here. Therefore, this location should be producing from both the Devonian and the Wolfcamp.

Q Would you please identify Exhibit 1 and explain it briefly?

A Exhibit No. 1 is a plat of the area showing the location of our subject well and all offset wells. As I have said, the Forrest Well over here is completed in the Wolfcamp; our subject well H. L. Lowe "B" Well No. 1 is completed in the Wolfcamp. Recently we have completed the Lowe "C" 1 over here and it is producing from the Wolfcamp. All the wells south of here are producing from the Devonian with the exception of "C" 2 which is in the process of being completed in the Wolfcamp. It was formerly a Devonian well.

Q Now, will you please identify Exhibit No. 2 and explain it?

A Exhibit 2 is a diagrammatic sketch showing the proposed mechanical completion of the well in question. We propose to set a Baker Model "D" permanent type packer between two formations which will be approximately 10,300 feet. After this packer is set on a wire line well, we propose to make up some 2,000 feet of tail pipe which will be two-inch tubing above that well. We will have our seating element to set into the Baker Model "D" packer. Above that packer we will have approximately 200 feet of two-inch NU tubing which will be externally wrapped with fiber glass and plastic to serve as abrasion joint. This externally wrapped joint -- these joints will be opposite the Wolfcamp perforations and then we will -- on that first string of tubing we will then run above the 200 feet of tubing the Baker Model "C" packer which is a retrievable type packer, and above that we will have some 10,100 feet of inch and a

half tubing. This whole string and the two and the top packer will be run originally. Then when we run the second string of inch and a half tubing, it will seal into the upper packer or the Baker Model "C." All the tubing will be internally coated with plastic for paraffin control.

Q Are the two reservoirs in question separated in the subject well behind the pipe?

A Yes, sir. We have cement behind the five and half inch casing up to 8,995 feet. This cement top was found by a temperature survey.

Q How about the fresh water zones, are they protected in the other possible producing zones?

A Yes, sir. The cement behind the 8 5/8 intermediate casing was circulated to the surface. Its intermediate was set at 4,615 feet. The cement behind the 381 feet of 13 3/8 inch surface pipe was also circulated to the surface.

Q In your opinion, do you feel that there is a possibility of communication or migration of fluids between the Wolfcamp and Devonian in the annulus between the casing and the well bore?

A No, sir. As stated before, we have cement behind the producing string of casing and its top is some 1200 feet above the proposed Wolfcamp completion interval.

Q In your opinion, is the proposed dual completion installation in accordance with good engineering practices and principles?

A Yes.

Q Is it the type of dual completion customarily used in the Lea County area?

A I understand that there are quite a few dual string installations in Lea County. However, there are no installations using 1 1/2 inch tubing.

Q Has this type of installation proven successful in actual field tests in other areas?

A Yes, sir, there are numerous dual string installations using 1½ inch tubing in the Gulf Coast area.

Q Why has Cabot Carbon proposed using two strings of 1½ inch tubing when other operators use two-inch tubing?

A It is a matter of clearance. In wells with seven-inch casing, it is possible to use two strings of two-inch tubing, but it is a physical impossibility to get two strings of two-inch tubing in 5½ inch casing.

Q Then why did Cabot Carbon use 5½ inch casing in the King Pool rather than the seven-inch casing?

A When the subject well was commenced, all the wells in the area were producing from the Devonian with the exception of the Forrest-Lowe Well to the East, which was producing from the Wolfcamp. We did not expect to encounter this Wolfcamp production in the subject well, and as a consequence, the well was scheduled solely as a Devonian test. It is customary in the industry, and in accordance with good drilling practices, to drill a well for 5½ inch casing and in accordance with the drilling pattern, 8 5/8 inch casing was set

at 4,615 feet and thereafter we were limited to the size of the casing that we could use, which was 5½, since 7-inch casing will not pass through 8 5/8-inch casing.

Q As I understand, before you encountered this Wolfcamp production at 10,000 you were already limited by your setting a pipe at 4600 level?

A That is correct.

Q Will you please identify Exhibit No. 3 and explain it briefly?

A Exhibit 3 is a tabulation of the clearance --

Q Excuse me, Mr. Daniels. I believe Exhibit 3 contains four pages, is that correct?

A That's correct.

Q Please proceed.

A Exhibit 3 is a tabulation of the clearances between 5½ inches and twenty-three pound casing and various combinations of tubing sizes, plus a picture showing the meaning of clearance. Attached to this Exhibit are photostats giving manufacturers' dimensions of gas-lift valves and tubing joints. The 5½ inch twenty-three pound casing is used in this tabulation because it is the heaviest casing in our well and is located in the top 872 feet of our long casing string. All tubing run into this casing must pass through this heavy casing. The outside diameter of all 5½ inch casing is the same and heavier weight casings have greater wall thickness, and therefore, the heavier casings have a reduction in

inside diameter. The API has required all manufacturers of casing to guarantee a certain minimum inside diameter, called drift diameter. In other words, all casing of a certain size and weight has an inside diameter that can be no less than the prescribed minimum. For 5½-inch twenty-three pound per foot casing this inside drift diameter is 4.545 inches.

Various combinations of tubing are used to give the clearance available when running the second string of tubing into the hole after the first string is already in place. It must be pointed out that the collars on the second string of tubing must pass the collars on the first string of tubing already in the well when running the second string into the hole. This is when you have minimum clearance between the two collars and the casing.

I would like to demonstrate our problems here. I have two rods here and this is taped on here to represent the collars on our tubing joint, and as I have pointed out, we have our heaviest casing in the top 872 feet of our casing string, and there will be approximately 29 joints or tubing joints in the top 879 feet. On 72 feet of our first string there will be that many joints, so when we start our second string of tubing in the hole, there is a possibility that 29 joints will ultimately be passing each other simultaneously, and before we reach 10,100 feet, these possible 29 tubing joints will be passing simultaneously 307 times until we get the second string of tubing down to our packer at 10,100 feet, so you can see that we have to have clearance for our collars and not

the size of the tubing itself. But it is the collars of the tubing that are important.

Q I believe that is graphically demonstrated at Page 2 of Exhibit 3?

A Yes.

Q Could you use one string of 2-1/16 outside diameter string tubing and one string of 1½-inch tubing instead of two strings of one and a half tubing?

A We could run a string of two and a 16th inch tubing, which has an internal diameter of 1.75 inches, to the Devonian, and a string of inch and a half tubing, which has an internal diameter of 1.61 inches, to the Wolfcamp. This installation would be satisfactory as long as both zones were flowing and would give a clearance of 0.102 inches. Now, you can note that on Case 5 on the first page of Exhibit 3 we have a clearance of 0.102 inches; but when it becomes necessary to artifically lift the fluid from the Wolfcamp or the Devonian, we would have to remove both strings of tubing and replace them with inch and a half tubing in order to run gas lift valves. It is our opinion that the Wolfcamp formation will require artificial lift in the reasonable near future. Exhibit 3 shows -- Page 1 -- shows a total of five variation possibilities and we believe it, together with other exhibits, which I will discuss, will show that the most efficient and effective tubing combinations under the existing physical possibilities, is as outlined in this application.

Q Now, will you please identify and briefly explain Exhibits 4, 5 and 6?

A Exhibits 4 and 5 are a series of curves showing the comparison of the total pressure loss in various tubing -- various sizes of tubing, while producing various volumes of oil with a constant gas-oil ratio from various depths against zero surface pressure.

Exhibit 4 is for a depth of 10,000 feet and Exhibit 5 is for 12,000 feet of tubing.

Exhibit 6 is a tabulation of the data presented on the two sets of curves, plus the effect of changing the producing gas-oil ratio from 1000 to 1200 cubic feet per barrel.

Exhibits 4 and 5 are based upon a gas-oil ratio of 1,000 to 1, since this is approximately the GOR encountered in the subject well.

Q Now, will you explain to us these curves and the table and give the source of the information you have used in preparing Exhibits 4, 5 and 6?

A The physical principle involved in lifting vertically gas-liquid mixture such as oil and gas is complicated because the intake pressure must be sufficient not only to overcome flow resistance in the tubing and the surface choke, but must, in addition, be sufficient to support the total weight of the compressible mixture in the tubing.

The types of flow occurring in tubing when lifting a gas-

liquid mixture can best be described as follows, when starting at surface: At the lowest pressure, which will be at the surface mist flow will predominate and modified progressively by an upwardly moving oil film which clings to the inside surface of the pipe and increases in thickness and with depth. This film of liquid combined with mist flow in the center of the pipe has been described as annular flow. As depth increases, the film becomes so thick and wavy that it occasionally bridges across the tubing, resulting in slug flow. At still greater depths, slug flow merges into foam flow, and this flow merges into a single phase flow at the pressure beyond which all of the gas is in solution.

It has been found that for any constant gas-liquid ratio there is a rate of flow which requires minimum intake pressure for any tubing size.

The pressure loss in the tubing between inlet and outlet for two-phase flow is largely the result of the interaction of the flow resistance and slippage of gas through the oil, the resistance factor being least important when slippage is greatest and vice versa.

The term friction is often mentioned in these matters, and friction is a collective term including both resistance and slippage. Also column pressure, which is the weight of the mixture, is greatest at low gas-liquid ratios. Therefore, for any gas-liquid ratio and depth, there is a rate which requires minimum pressure, with lifting pressure with lower rates requiring more lifting pressure

because of slippage, and higher rates requiring more lifting pressure because of resistance.

Now, if you will please refer to Exhibit 4, you will note that inch and a half tubing is more effective in lifting gas and oil than two-inch tubing until the flow rate reaches 150 barrels per day. Above the flow rate of 150 barrels per day, two-inch tubing becomes more efficient to the extent of requiring some 100 pounds less inlet tubing pressure than the inch and a half tubing when lifting 275 barrels of oil per day, and the 275 barrels of oil per day is used because this has been the maximum allowable experienced in the King Pool.

Exhibit 5 shows the same trend as Exhibit 4.

This discussion on two-phase flow was obtained from an American Petroleum Institute paper prepared by Mr. W. E. Gilbert entitled "Flowing and Gas-Lift Well Performance." Mr. Gilbert is an engineer with Shell Oil Company, and he is located at the Hague. The summary of this two-phase flow can be noted in Exhibits 4 and 5, and as pointed out by Mr. Gilbert, and I quote:

> "In general, the smaller tubing sizes offer the advantage of lower intake pressure at comparatively low rates of flow, and therefore tend to prolong the flowing life of low gas-liquid ratio wells. The smaller tubing, however, limits rates of flow, especially for the higher gas-liquid ratios."

Q Do you have a copy of Mr. Gilbert's article for the Commission?

A Yes, sir, it is marked Exhibit 7.

Q Now, how do you propose to lift these fluids in the event artificial lifts become necessary?

A We propose to gas lift the oil. Gas lift valves are available for inch and a half tubing. Therefore, we will be able to artifically lift the oil from either pay or both pays with gas-lift. We will obtain our gas from the King Field Gasoline Plant. We have obtained assurances from gas lift manufacturers that we can lift large volumes of fluid from these pay depths when and if necessary.

Q Well now, have you considered using rod pumps as a method of lifting artifically?

A Yes, but it will require two and a half inch tubing to lift the required volume from this pay depth. The two and a half inch tubing would mean that only one zone could be produced at a time.

Q Will the surface equipment be so designed and installed that the reservoirs will be separately produced and their fluids separately tanked and gauged for absolutely no comingling?

A Yes, sir. Each producing zone will have its own separator and storage facilities.

Q Is this dual completion technique which you have requested in the application recognized and accepted in general by the oil industry and by other state regulatory bodies?

A Yes, sir. In Oklahoma, Texas and Louisiana, and I believe possibly Mississippi.

Q Do you feel that corrosion would be a possible objection

to your proposed manner of dual completion?

A No, sir. We have observed no corrosion in the King Pool.

Q Does this dual completion technique possess any more possibility for leakage or communication of the reservoirs than any other accepted method?

A No, sir.

Q Will Cabot Carbon be willing to make packer leakage tests, separation tests and other tests which might be required by the Commission to determine if there is any comingling or leakage?

A Yes, sir.

Q Under the proposed method of dualing, is it possible to make bottom hole pressures on each separate zone, and if so, will you please explain how?

A A bottom hole pressure bomb can be run to the bottom of the long string of tubing, or within 50 feet of the Devonian formation. A bomb can be run to the top of the upper packer in the short string of tubing, or within some 50 to 100 feet of the Wolfcamp formation.

Q Please briefly explain the proposed method to be used in running packer leakage tests.

A We are prepared to run any type of test as may be required by the Commission, either by running surface pressure determinations tests which is the general procedure for packer leakage tests in New Mexico or by conducting tests using a bottom hole pressure bomb.

Q Would it be possible to check for leakage across the packer separating the two pays at frequent intervals?

A Yes, sir. As we have stated before, we have separate facilities for each pay. The Wolfcamp pay has an oil gravity of 38 degrees API and the Devonian pay has an oil gravity of 47 degrees API. This 9 degree difference in gravity will provide a daily check for leakage, because any change in gravity will be noted by operating personnel and/or the pipeline gauger.

Q Have you made an estimate of oil reserves which will be recovered from the Wolfcamp?

A Yes, sir. I believe the recoverable oil reserves to be in the order of some 50,000 to 70,000 barrels.

Q What would it cost to drill a twin well to the Lowe "B" of the subject well to the Wolfcamp?

A Approximately $175,000.00.

Q And what will it cost to dually complete the Lowe "B" Well No. 1?

A Approximately $58,000.00.

Q Now, what are the economics involved when you compare the expected recovery of oil reserves with the cost of obtaining this oil from the Wolfcamp?

A The value of one barrel of oil to us, after royalty and tax, is $2.20 per barrel. If we assume 40 cents per barrel for lifting cost, which is reasonable, the revenue to be received from our expected oil reserves in the Wolfcamp is some $90,000.00 to

$126,000.00. If we drill a twin well, we will not get our money back. If we are permitted to dual the subject well, a reasonable profit may be expected.

Q Don't you think the ultimate recovery of the oil in the Devonian will be reduced as a result of dual completion?

A No, sir. The ultimate oil recovery from the Devonian will not be affected as a result of dual completion. I base this on two facts: (1) the producing efficiency using small tubing will improve flowing life of both pays and when necessary we can artifically produce either or both zones to depletion; (2) it is expected that the Wolfcamp will have a shorter producing life than the Devonian. Therefore, when necessary, we will plug off the Wolfcamp and produce the Devonian by any approved method.

Q Now, if this application for dualing is not approved, how could correlative rights that you mentioned before --

A Only by drilling a twin well on the same 40-acre tract, which would not be economical.

Q Were Exhibits 1 through 6 with the exception of 3 and 4 of Exhibit 3 prepared by you or under your supervision?

A Yes, sir.

Q And I believe Pages 3 and 4 of Exhibits 4 and 5 are photostats -- actual reproductions of the subjects you have mentioned?

A Yes.

Q Do you have a log of the well?

A Yes, sir. It is identified as Exhibit 8.

MR. CHRISTY: That's all we have. We offer in evidence Applicant's Exhibits 1 through 8 inclusive.

MR. PORTER: Without objection, Applicant's Exhibits 1 through 8 will be admitted.

Does anyone have a question of Mr. Daniels? Mr. Nutter.

CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. Daniels, did I understand you correctly to say that you estimate the reserves under your proposed Wolfcamp completion to be 75,000 barrels?

A Yes, sir.

Q And the reserves under the Forrest Well to the east are some 180,000 barrels?

A They have recovered that much so far, yes, sir.

Q In other words, you estimate that the -- oh, they have recovered that much?

A Yes, sir, they have already recovered practically, I believe it was 179,800 barrels, roughly 180,000.

Q How much remaining oil is underneath that Forrest Well?

A Well, it is rather hard to say. Possibly 20 to 30,000 barrels.

Q So ultimate recovery will be in the range of 200,000?

A Yes.

Q So that the Forrest Well to the east will have ultimate

production of some three times, three to four times what you expect to recover from your well?

A Yes.

Q Did Forrest Oil Company have any difficulty in completing their well in the Wolfcamp formation?

A Yes, sir, they did. I believe that they would perforate in the Wolfcamp and after they would acidize, the well would make water and oil and they would squeeze it off and reperforate it and the same thing would happen, and finally they came up to the top of this interval, porous interval to complete in.

Q Do you think that you will have any difficulty in completing your well in the Wolfcamp?

A There is a possibility that our lower sets of perforations will produce water, and if they do, we will squeeze that off and come up to the upper set of perforations, which have been drill stem tested.

Q Your estimate of reserves, fifty to seventy-five thousand barrels, is based on both sets of perforations?

A Yes, sir.

Q How much oil do you think there might be in the upper set of perforations that you propose?

A Possibly in the order of twenty to thirty thousand barrels.

Q Mr. Daniels, I note on your Exhibit No. 2 that you have proposed a two-inch tail pipe from the Wolfcamp formation on down --

A Yes, sir.

Q -- in the Devonian completion. Why have you used two-inch pipe in that tail pipe?

A Well, we have to -- above the upper packer we have to use two-inch in order to make it stiff, have stiff enough pipe in order that we can set our upper packer, and below there, we could very easily use inch and a half, but since we had, we would hate to go from inch and a half to two-inch and then back to inch and a half, but it is possible to do.

Q You are not using two-inch pipe in the tail pipe because it is more efficient to flow this type of flow through?

A No, sir.

Q What did you say was the source of the information that you drived the curves on Exhibit No. 4 and 5?

A They are from Mr. Gilbert's paper entitled "Flowing and Gas-Lift Well Performance," and it was presented at an API meeting, I believe, in 1954 out in Los Angeles, California.

Q Now, Mr. Gilbert in his paper presented the data that you drew these curves on?

A Yes, sir.

Q Where did Mr. Gilbert get the data that he presented?

A From actual tests in the field, and I believe there is one or two fellows that have done some basic research, and he used their information in conjunction with his actual field test.

Q Well now, I note that you show performance for various

rates of production in four different sizes. Did Mr. Gilbert, in his field tests, test all of these four sizes of tubing?

A I believe he did, yes, sir. I might add that this is the only article that I found or have been able to find of vertical lift on two-phase flow.

Q Mr. Daniels, I have read this paper that Mr. Gilbert wrote, and it is my understanding that he had data on one size of tubing by actual field test and the others were extrapolated from theoretical formulas, for the other sizes of tubing, is that correct?

A I don't know. I would have to look at the -- I have read it, but it has been several weeks ago. Yes, sir, you are correct.

Q And what size of tubing did Mr. Gilbert use in these field tests?

A I believe two-inch or two and a half inch.

Q He frequently refers to 2.87 five-inch tubing.

A That's two and a half inch tubing.

Q And he doesn't have any field performance on two-inch or one and a half, or one and a quarter inch tubing, does he?

A No, sir, it is all based upon his comparison with his larger size tubing.

Q Have you read any other articles on this subject of any authority, Mr. Daniels?

A This is the only article I have been able to find in the literature.

Q So you don't know whether other articles might indicate that the smaller size tubing might be less efficient?

A No, sir, I do not. All my testimony is based on the curves presented in this article.

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

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

QUESTIONS BY MR. UTZ:

Q Mr. Daniel, comparing gas lift recovery with annual pump recovery, what is the efficiency comparing the two?

A I don't believe I can answer that right off.

Q You do not know, then, whether you will get as much oil by gas-lift as you can by pump?

A I believe we can get as much oil by gas-lifting as we could by rod pump.

Q Just as much?

A Yes, sir.

Q You do not even consider pumping these wells?

A No, sir.

Q Mr. Daniel, are there any other wells or locations in the King Pool which you anticipate that you might dually complete?

A Yes, sir.

Q And what are those wells?

A This well, the Lowe "C" 1, is presently completed in the Wolfcamp.

Q What is the location?

A This one location east of the subject well is the Lowe "B" 1. I do not have the location on this plat.

Q Is that a completed well?

A Yes, sir, it is completed in the Wolfcamp, completed some two or three weeks ago, and then that well will possibly force this well, and this, our State --

MR. PORTER: By "this well," you are referring to Well No. 4?

A Yes, sir. No. 4. And we are in the process of completing in the Wolfcamp our State of New Mexico "C" 2, and that will force our Reed No. 2 to be a Wolfcamp, and then there are several other possibilities further south.

Q You lost me on that second well. I have the first one. The No. 4.

A And the second one will be the J. R. Reed Well No. 2 located right south of the subject well of this application.

Q You are in the process of completing that well now?

A No, sir, we are in the process of completing in the Wolfcamp Our State of New Mexico "C" 2.

Q What section is that in?

A 36.

Q There are three other wells which you anticipate which you might want to dual?

A There is the subject well for this application, and possibly these two, and then maybe later on we will have -- can find

some more somewhere.

Q The No. 4 Reed, is that a completed well?

A Yes, sir, it is completed in the Devonian.

Q When did you complete that well?

A Reed 4 was completed in November, 1957.

Q And your No. 2 Reed, is that a completed well?

A Yes, sir, it was completed in November, 1956, in the Devonian.

Q And you have not completed your 2 "C"?

A Our State 2 "C" is in the process of being completed in the Wolfcamp at the present time. It was originally a Devonian well.

Q Did you have a completion date on your 1 "B," Cabot 1 "B" or Lowe 1 "B?"

A Our Lowe "B" 1 was completed, it was placed on production on August the 12th, 1957, from the Devonian.

Q What size casing did you use in the No. 4 Well?

A Five and a half inch.

Q The No. 2 Well?

A The Reed 2, five and a half inch.

Q Are you using five and a half in the 2 "C?"

A Yes, sir, it has five and a half inch casing.

Q Therefore, you are in a position where none of these other three wells can be completed with any larger tubing than inch and a half?

A Inch and a half, yes, sir.

Q Why did you go ahead and complete the No. 4 and the No. 2 with five and a half inch casing?

A Our drilling program was set up to set up five and a half inch casing, and we were not sure that we would encounter any pay except the Devonian, and if we were going to have only one pay in the field, we thought it would be more economical to place five and a half inch casing, and by the time we reached -- the Wolfcamp was productive, we already had our intermediate casing set, and that would limit the size of the pipe that we could set thereafter, and we have always set eight and five-eights intermediate casing and you can't run anything but five and a half standard casing.

Q Your answer is that you were too far along with these other completions before you knew whether the Wolfcamp was productive?

A That's right.

Q One final question. I believe you stated that the Cabot Carbon Company would have a net profit, was it, of two dollars and twenty cents a barrel?

A Yes, sir, after taxes and royalty. We have some twenty-five percent royalty to pay.

Q What was the gross price of the oil when you made that calculation?

A Three dollars and eight cents a barrel.

MR. UTZ: That's all.

QUESTIONS BY MR. PORTER:

Q Mr. Daniel, I believe you testified that according to your belief your flow efficiency would be as great or greater in the inch and a half tubing as it would be in the two-inch tubing --

A Yes, sir.

Q -- down to this depth of 10,000 feet?

A Yes, sir.

Q And the expected allowable for that?

A Yes, sir, our Wolfcamp, using 33 barrels per unit, will have an allowable of around 154 barrels per day.

Q Also you testified that when you have to resort to artificial lift, that you propose to use gas-lift?

A Yes, sir.

Q Now, is it expected that -- first, let me ask you, can you gas-lift both zones simultaneously?

A Yes, sir, we can.

Q Do you expect to have to do this to lift them both at the same time, or do you expect the Wolfcamp to be depleted before --

A I expect that we will have to artifically lift the Wolfcamp and possibly the Devonian will still be flowing, and that the Wolfcamp will be abandoned -- will have to be plugged out before the Devonian.

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

QUESTIONS BY MR. FISHER:

Q Mr. Daniel, do you know what the producing mechanism of the Wolfcamp formation is?

A In the Wolfcamp?

Q Yes, sir.

A I believe it is a water drive.

Q What about the Devonian?

A It is a water drive.

Q Do you know the highest producing gas-oil ratio of any Wolfcamp oil well in that field?

A I believe around 990 to 1, to the best of my knowledge. The Forrest Well now has a ratio of around 260 or 70 cubic feet per barrel.

Q Do you have any idea how high the gas-oil ratio might be from your studies of the Wolfcamp in that particular pool?

A Well, this is pure speculation, but I would say somewhere between 1000 to 1200.

Q Then the gas-oil ratio wouldn't appreciably change these curves?

A No, sir.

MR. FISHER: That is all.

MR. PORTER: Anyone else have a question?

REDIRECT EXAMINATION

BY MR. CHRISTY:

Q Mr. Nutter asked you if this article was not based on actual field tests with the one and a half and one-quarter inch tub-

ing, but I believe you have testified that there have been actual field tests in other states; Texas, Oklahoma and Louisiana?

A I don't know about tests of flow rates, but they are using inch and a half tubing.

Q Two sets of them?

A Two sets of them.

Q Now, Mr. Utz asked you concerning rod pumps. I believe you previously testified that you could not use rod pumps and artificial lifts for both zones?

A That is correct.

Q Why?

A Because it will take two and a half inch tubing.

Q So if you use rod pumps you could only lift one?

A Yes, sir, that's right.

MR. CHRISTY: That is all.

MR. PORTER: Any further questions? Witness may be excused.

(Witness excused)

WALTER F. G. STEIN

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

DIRECT EXAMINATION

BY MR. CHRISTY:

Q Would you please state your name and address?

A My name is Walter F. G. Stein, and I am from Pampa, Texas.

Q By whom are you employed and in what capacity and how many years have you been employed in your present position?

A I am employed by the Cabot Carbon Company as chief petroleum engineer and have been in that capacity for the last ten years.

Q Have you previously testified before the New Mexico Oil Conservation Commission?

A No, sir, I have not.

Q Would you please state your professional qualifications as an engineer?

A I was graduated in 1929 in Germany after studying at the University of Berlin in the majors of physics and chemistry. After graduation, I was employed by the United Gas Company for approximately two years and then by Magnolia Petroleum for about six years in the Natural Gas and Gasoline Department. Then for three years I was petroleum engineer for the Texas Railroad Commission statewide and resided in Austin and Corpus Christie. Two years thereafter I operated out of Corpus Christie as a consultant and service engineer as a partner of the Stein-Henderson Engineering Company. After that I went to the Army for about six years, and except for those six years in the Army, I have been in the oil and gas business for twenty-nine years.

Q Are you a registered professional petroleum and chemical engineer?

A I am a registered petroleum and chemical engineer, and I have previously testified as an engineer before the Texas Railroad

Commission and the Oklahoma Corporation Commission, and the Kansas Corporation Commission.

MR. CHRISTIE: Does the Commission have questions concerning his qualifications?

MR. PORTER: We consider him well qualified as an expert.

Q Are you acquainted with the King Field in Lea County and the particular problems which Cabot Carbon Company has encountered with the operation of this field?

A Yes, sir. As chief petroleum engineer, I am assistant to the vice president in charge of oil-gas and gasoline operations, and I am presently responsible for the economic analysis of ventures in those three fields. I am acquainted with the problem in the King Field not only from the oil and gas production standpoint, but also from the -- with the problems that we encounter in the gasoline plant operation in the King Field.

Q Now, would you please tell us what installations Cabot has in this field?

A Well, sir, besides our investment in the oil wells and the producing facilities which we have to produce oil and gas from those wells, we have built a gasoline plant in this field far ahead of the full development of the field, shortly after our Fleet No. 1 which was our first well, was completed. We have built a gasoline plant for actually one reason only, and that is to eliminate waste in this field, so we would not waste either gas or liquid hydrocarbon which are contained in the gas.

Q Where is this plant located and what is its capacity?

A This plant is located in Section 35, and I believe the gentleman had a copy of this Exhibit. It is located right here on the Fleet lease in Section 35.

Q That would be in the south half of the southeast of Section 35?

A Yes, sir.

Q What is its capacity?

A The plant has an ultimate overall capacity of eight million, seven hundred five cubic feet. The refrigeration facilites which we have, and this is a refrigeration plant, is designed for six million cubic feet of gas per day. However, the compression facilities which we have installed at the present time are only for three million eight hundred thousand cubic feet per day.

Q Now, could you tell us a little about the operating problem which you have encountered in the plant with relation to the King Field?

A Yes, sir. As I mentioned before, as soon as our Fleet No. 1 Well was drilled, we contemplated the building of this gasoline plant. At that time the geological indications were such that we would have 16 Devonian wells. There was no mention of Wolfcamp except that we did have the Forrest Well in the field. The estimates made by other geological departments, engineering departments, were considerably higher. However, we felt reasonably sure that if we built a plant sufficient to handle the production of gas from 16

wells, that we would have a plant large enough to take care of the gas produced in the field now and at a future date when gas-oil ratio become greater. The drilling history of the field, however, shows that we only have 12 or possibly 13 Devonian wells, which is short of our estimate. Now, if we had had those 16 Devonian wells, and at that time the oil allowable was 275 barrels per day, these 16 wells would have yielded about four million four hundred thousand cubic feet per day, that is, assuming a gas-oil ratio of approximately 1000 cubic feet per barrel. We expected a cutback, however, saw the handwriting on the wall, and decided to reduce the initial capacity of the plant, which is limited by the compression facility, to three million eight hundred thousand cubic feet, and that is what we have in the plant now, three million eight hundred thousand feet. The expected reduction of production allowables throughout 1957 and 1958 did produce a gas allowable -- I mean gas volume available to the plant far below the $3,800,000 we needed to make the gasoline plant a successful venture. Eleven of the Devonian wells now have an allowable of 223 barrels against the estimated 250 and against the original allowable of 275 barrels, which is a considerable cut. One of the Devonian wells has an allowable of 163 barrels.

This gives us a maximum gas volume per day, 2,500,000 cubic feet per day, which is 1,300 MCF less than our anticipated daily throughput for which we designed compression facilities. That is about 33 per cent less than estimated originally. Now the pipelines to which we are connected to, one is El Paso Gas line and the other

one is Phillips' product line, are capable of taking all the products from the plant, the dry gas and the liquid hydrocarbon, from the processing of 8,750,000 cubic feet per day. I might say, in kind of a summary, a volume which would guarantee the successful operation of this gasoline plant over an extended period of time should be equal to the present compressor facilities of 3,800,000 cubic feet. The plant cost, including a small gathering system which extends to all the wells except the northeast one, was $865,000.00 and the plant now produces approximately 300 barrels of liquid hydrocarbons per day and gives permanent employment to five people in the plant.

Q Now, how much is your gas throughput at the present time?

A We started operations December, 1957, and have passed on an average of slightly over 2,250 MCF per day. For continued operation, of course, this volume is too small, insufficient, and we can't continue to operate and maintain the plant from the revenue we derived from the small volume.

Q Now, if no more gas is found or produced, what would be the result as to the continuation of gas extraction and processing operations in the field?

A Well, if this plant does not receive a large amount of gas, the operation of the plant, as I pointed out, is uneconomical and the plant would have to be shut down in a rather short time. Cabot has made a strenuous effort in trying to obtain additional gas around the King Field and hoped that the development in the immediate

area would be much more favorable and yield additional volumes. However, our hopes have not been fulfilled at all.

Q Mr. Stein, is there any gas in this area which could be presently made available to theplant so as to guarantee its continued operation?

A Yes, sir. From geological and engineering evidence, of which part was presented today, we know that there is a considerable amount of gas contained in the Wolfcamp pay, which at the present time is held behind the pipe in some of Cabot's wells. The total amount of Wolfcamp gas reserves is not known to me and I wouldn't be able to calculate it at the present time. However, we believe were this gas made available to the plant, it is probable that the amount is sufficient to supply the additional needed volumes for a successful operation of this plant. That would guarantee that the plant would more or less, and I think more so, operate until both the oil and gas in the Wolfcamp and in the Devonian is depleted, or in other words, the plant would operate for a lifetime of the field.

Q Now, Mr. Stein, is there any of the gas or liquid hydrocarbon being now produced in the field or to be produced from the subject well, are any of them being wasted?

A No, sir. The Cabot Carbon Company has connected its gathering system temporarily to every one of the batteries in the King Field with the exception of the Forrest Lowe Well. This well showed, at the beginning, on the instigation of the plant, that it was depleting in production, and right now I think that the latest

tests show there is only about 6,000 cubic feet of gas available at that well, which is very little above the fuel requirement of that well. The gas which we receive and process is sold to El Paso Natural Gas Company, with the exception of fuel which we return to the leases for their operation. Some of the returned fuel was used in the development of the King Field by being used as cleaning rig fuel. Now, we have installed our return system in such a way that the gas on the 850 pound pressure can be returned to the leases for gas-lift purposes. The gas that is processed in the plant has a hydrocarbon liquid content, including propane, from propane on up of about 6.7 gallons. We recover approximately 32 gallons of the liquid from the gas. The remaining in there is propane, and the total production of the plant is sold directly to Phillips Petroleum Company by a pipeline, and there is no flaring or burning of the liquids because both companies that buy from us have a hundred percent take contract and there is no flaring or burning of either gas or liquid in the field.

Q Now, Mr. Stein, would you briefly summarize for us what your testimony is with relation to the potential waste of the subject well in the field and the economic factors involved with Cabot in this plant in connection with the subject well and the field?

A Well, sir, we believe that the King Field is the first fieldin New Mexico in which the elimination of waste of both oil and gas was made totally effective before the field was ever completely defined. We made provisions in the early life of the field

to erect sufficient equipment to eliminate all waste, and this was done with an expenditure of a large amount of money, as I mentioned before on the part of Cabot Carbon Company wherein the company took a great risk as to the possibility of ever regaining its plant investment cost. Unfortunate circumstances such as we have experienced in the last year, the reduction of oil allowables and then the fact that the field was disappointing, that we didn't get the 16 Devonian locations, resulted in this lesser gas volume of which I spoke a while ago, and if it is not possible to gain additional gas for this plan, then economic and satisfactory operation of the plant is out of question. To abandon the plant now would immediately cause a waste in all the gas and liquid hydrocarbons that we now recover and put to use and would be flared, since the pipeline company could not use the sour -- the gas is sour -- could not use the sour nondehydrated and liquid-containing gas for normal pipeline requirement. The only, the one and only solution that I can see now, after having reviewed the field is this, to continue to prevent waste, would be that the Commission would allow Cabot to proceed with the dual completion of wells, which would solve this question of not having sufficient gas, and do that wherever it is indicated and possible.

MR. CHRISTY: No further questions.

MR. PORTER: Anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

BY MR. COOLEY:

Q Mr. Stein, has Cabot Carbon made any effort to procure gas from sources other than the King Field to run the plant?

A Yes, sir, I had a survey made of the Blanco Field, the Gladiola, north Gladiola, and Sinclair beat me to it, they got the gas.

Q To your knowledge, all available sources have now been taken up?

A As they show now, yes, sir.

MR. COOLEY: That's all.

MR. PORTER: How about the Blanco Field?

A It is being connected now to Sinclair's plant in the Gladiola.

MR. PORTER: Anyone else have a question?

MR. COOLEY: One question.

QUESTIONS BY MR. COOLEY:

Q Do you feel that if all the gas which is available in the King Field in both the Devonian and Wolfcamp were made available to this plant that it would then be economic to proceed and --

A Yes, sir. The difference in the plant which would make it from an uneconomic to economic venture is a million cubic feet, or million four, closer to a million four, and, of course, I figured it this way, that eventually the gas-oil ratios are going to become larger in the Devonian to some extent. Those fields are not going to have big ratios because of the water features of the reservoirs, and we will be able to add compressors too, but at this time we almost

have to have the three million eight, or a figure near it to continue operating the plant.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Stein, I believe you testified that your plant at present has approximately 300 barrels per day liquid output. Did you say who you are selling this to?

A Phillips Petroleum Company. It is sold as an S D product, a mixture of hydrocarbon and an extract of 65 percent propane, and that goes to Phillips Petroleum Company. Of course, they invested quite a bit of money in building the product line to our plant, too.

MR. PORTER: Any further questions?

MR. CHRISTY: That is all the applicant has.

MR. PORTER: I don't have any questions, but I would like to say I like to hear you talk. I don't believe I have ever heard a blend of German accent with a Texas drawl.

The witness may be excused.

(Witness excused)

MR. CHRISTY: That is all for the applicant. I laid down in front of the Commission this recent article which is on the gasoline plant which Mr. Stein has testified to. That is all the applicant has.

MR. PORTER: Does anyone else have any testimony to present in the case? Any statement concerning the case?

MR. DEHLINGER: Martin Dehlinger, with the Forrest Oil Corporation.

The Forrest Oil Corporation is interested in this case in view of their offsetting well to the subject well, and it is their opinion that they concur with the ideas of the Cabot Carbon Company and believe that the proposal for the dual completion of this well will be the most feasible way to protect the correlative rights and stop underground waste of the mineral resources of the state that has yet been suggested.

MR. TOMLINSON: W. P. Tomlinson with Atlantic Refining Company. Atlantic is an owner of an interest in this well. We support Cabot in this matter. There are two features of Cabot's plan for operation that appeal to us. One is its feasibility from a mechanical standpoint and producing standpoint, and, second, it is desirable from the economy and conservation standpoint to divert this gas through a gasoline plant at this time. We are concerned that we might not have a market for it at a later date, and certainly would like to see it developed. We,therefore, ask for your favorable consideration.

MR. PORTER: Anyone else have a statement? Anything further in the case?

MR. CHRISTY: I might state that Gulf, which is the only other offset owner, was notified and we have a registered receipt from Atlantic, Gulf and four of the offset operators.

MR. PORTER: Anything else? We will take the case under advisement.

At this time we will recess the hearing until 1:15, and I

believe the case will be considered immediately after noon will be 1420.

C E R T I F I C A T E

STATE OF NEW MEXICO)
: ss
COUNTY OF BERNALILLO)

I, J. A. TRUJILLO, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me in stenotype and reduced to typewritten transcript under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 8th day of May, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Joseph A. Trujillo
Notary Public

My commission expires:
October 5, 1960.