BEFORE THE
NEW MEXICO OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
April 10, 1974

EXAMINER HEARING

IN THE MATTER OF:

Application of Cities Service Oil Company for a unit agreement, Eddy County, New Mexico.

Case No. 5212

and

IN THE MATTER OF:

Application of Cities Service Oil Company for a pressure maintenance project, Eddy County, New Mexico.

Case No. 5213

BEFORE: Richard L. Stamets, Examiner.

TRANSCRIPT OF HEARING

A P P E A R A N C E S

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APPEARANCES CONTINUED

For the Applicant: W. Thomas Kellahin, Esq.
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I N D E X

E X H I B I T S

MR. STAMETS: Call the next case, 5212.

MR. DERRYBERRY: Case 5212, Application of Cities Service Oil Company for Compulsory Pooling, Eddy County, New Mexico.

MR. STAMETS: Call for appearances in this case.

MR. KELLAHIN: If the Examiner please, for purposes of taking the testimony in this case, we would like to consolidate Case 5212 and 5213.

MR. STAMETS: Is there any objection to the consolidation of these two cases?

Case Number 5212 and Case Number 5213 will be consolidated. Would you please read that case?

MR. DERRYBERRY: Case 5213, Application of Cities Service Oil Company for a pressure maintenance project, Eddy County, New Mexico.

MR. STAMETS: Are there any appearances?

MR. HINKLE: Clarence Hinkle of Hinkle, Bondurant, Cox and Eaton, appearing on behalf of Atlantic Richfield.

MR. KELLAHIN: Tom Kellahin and Jason Kellahin, Kellahin and Fox, Santa Fe, New Mexico, appearing on behalf of the applicant, Cities Service Oil Company.

MR. STAMETS: Are there any other appearances? Would all of the witnesses, both for Atlantic Richfield and

Cities Service stand and be sworn, please?

(THEREUPON, the witnesses were sworn.)

MR. STAMETS: Will you please proceed.

E. H. LOWREY

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

DIRECT EXAMINATION

BY MR. KELLAHIN:

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

A E.H. Lowrey, Cities Service Oil Company, Midland, Texas. I am a Reservoir Engineer on the regional staff.

Q Mr. Lowrey, have you previously testified before this Commission and had your qualifications as an expert witness accepted and made a matter of record?

A Yes, sir, I have.

Q Are you familiar with the facts surrounding the matters contained in the applications in cases 5212 and 5213?

A Yes, I am.

MR. KELLAHIN: If the Examiner please, we tender Mr. Lowrey as an expert.

MR. STAMETS: The witness's qualifications are accepted.

Q (Mr. Kellahin continuing.) Mr. Lowrey, will you please refer to what has been marked as exhibit, Applicant Exhibit Number One, and would you explain briefly for the benefit of the Examiner what Cities Service Oil Company is seeking in their application in application number 5212?

A. Cities Service is seeking approval of the unit which we have designated as Citgo Empire Abo Unit comprising approximately three hundred and sixty-one acres of Federal and State lands in Townships 17 and 18 South, Range 27 East, Empire Abo pool, Eddy County, New Mexico.

Q Briefly, Mr. Lowrey, what is the purpose of this particular unit agreement?

A. The purpose is to unitize this acreage for the purpose of a secondary recovery pressure and maintenance project, unitizing four leases of six wells.

Q Has the form used for the unit agreement been approved by the Oil Commission, USGS, and State Land Office?

A. The form and content of the unit agreement has been approved by -- has the preliminary approval of the USGS and the State Land Office as to form and content.

Q All right. Would you turn to Exhibit A in the appendix of your unit agreement and identify what information is contained there?

A. Exhibit A is a plat of the proposed unit area showing approximately three hundred and sixty one acres, a portion of the south half of Section 35, Township 17 South, Range 27 East, and a portion of the north half of Section 2, 18 South, 27 East, Eddy County. The current lease names and the well numbers are noted as are the proposed tract designations one through four.

Q. Would you turn the page and refer to appendix Exhibit B and explain briefly what that contains?

A. Exhibit B to the unit agreement is a list of the tracts involved. The description of the land. The number of acres. I have listed the basic royalty ownership, lessee of record, overriding royalties, working interest owner and percentage.

I note that tracts one and two are Federal tracts, comprising 280 acres. Three and four are both State tracts with 81.06 acres.

Cities Service Oil Company holds 100 per cent working interest in all four tracts.

Q. Mr. Lowrey, are you aware of what percentage of the overriding royalty interest that have ratified the agreement?

A. The working interest has been signed in the acreage

but the overriding royalty and royalty interests have not been signed.

Q. Please refer to appendix Exhibit Number C and explain what it is.

A. Exhibit C to the unit agreement lists the tract numbers and the unit participation per cent. The Federal tracts, tracts one and two, total 55.1075 per cent and the two State tracts, tracts three and four, total 44.8925 per cent.

Q. Mr. Lowrey, is the form of the unit agreement essentially the same as the unit agreements that have previously been approved by the Oil Conservation Commission?

A. Yes, we tied this unit agreement as closely as we could to other unit agreements and have taken it basically from the unit agreement concerning the Arco Empire Abo Unit which borders this unit to the south.

Q. Please refer to what has been marked as Applicant's Exhibit Number Two, and in relation to this exhibit in all of its composite parts, Mr. Lowrey, will you identify it and then explain briefly what the applicant is seeking in Case Number 5213?

A. This exhibit is a short engineering study of the Empire Abo pool, Eddy County, New Mexico.

Case 5213, Cities Service Oil Company seeks authority to institute a pressure maintenance project on its Citgo Empire Abo Unit, Eddy County, New Mexico, by the injection of gas into the Abo formation through a well to be drilled at an unorthodox location, nine hundred and ninety feet from the south line and twenty-six thirty-five feet from the east line of Section 35, Township 17 South, Range 27 East. Applicant further seeks the establishment of special rules for said pressure maintenance project including a provision for the operation of the project under a net GOR rule and the establishment of a gas injection credit bank.

Q Referring now to Exhibit Number Two, will you please identify it further and explain what information it contains?

A. This engineering study is based primarily on two previous studies. One, entitled the Empire Abo Field Engineering Subcommittee Study, Phase 1, August, 1968. The other study entitled the Field Management Study, Abo Reservoir, Empire Abo Field, Eddy County, New Mexico, dated October Two, 1970.

Q Was this particular engineering report either prepared by you directly or under your direction and supervision?

A. Yes, sir, it was.

Q. Please continue.

A. Beginning with the field history, the Empire Abo Pool is located approximately eight miles south of Artesia, New Mexico. It was discovered in November, 1957, and has been developed on forty-acre spacing.

The production from this field is a dolomitized carbonate reef of Permian age and the structure tends northeast by southwest.

The producing method has been primarily fluid expansion with a small assist from water influx.

The field contains approximately 8,993 productive acres and the original oil in place has been estimated at 466.7 million barrels.

A major portion of the field was unitized in 1973. The unit became effective October One, 1973, under order number R4549 and was designated the Arco Empire Abo Unit Pressure Maintenance Project. The objective of the Empire Abo Unit is to increase recovery by conserving reservoir energy and to maintain pressure by injecting residue gas.

Cities Service Oil Company is an unsigned participant in the Empire Abo Unit by virtue of either a working interest or an overriding royalty interest in the following

tracts: Tracts five, three, thirty, thirty-nine, thirty-five, and seventy-three.

Cities Service Oil Company operates four 100 per cent leases in the field which are not committed to the unit. These leases were not committed because the reserve numbers assigned to the tract in the engineering study were not correlative to producing history. The following tabulation illustrates the problem. The October, 1970, study showed a total primary reserve of 609,954 barrels as of January One, 1971. During the following three years, 716,079 barrels were produced. These four leases averaged a total of 508 barrels per day during January, 1974.

So, noting on the tabulation, and starting January One, 1971, with the reserves assigned to these leases and follow-through with production figures, you see on the bottom line the negative figure of 106 thousand barrels of oil is the reserve figure as of 1/1/74, based on Arco's study as of 1/1/71.

So, Cities Service proposes the formation of a royalty unit composed of these four leases in the Empire Abo Pool for the purpose of a supplemental recovery process by returning produced gas to the reservoir.

Our studies indicate that oil recovery from these

four leases could be increased by approximately 272 thousand barrels by unitizing and injecting gas produced over the pool limit of 2,000 cubic foot per barrel with credit for injected gas applied against the producing gas-oil ratio.

Gas injection will cease in the sixteenth year to coincide with operations in the Empire Abo Unit.

It is requested that oil and gas production be reported on a unit basis with full transfer privileges to permit the most efficient use of reservoir energy.

Approval is requested to drill a gas-injection well to be located 990 feet from the south line and 2640 feet from the east line of Section 35, Township 17 South, Range 27 East, Eddy County, New Mexico. This location conforms to Order Number R4549 applicable to the adjacent Empire Abo Unit.

Our objective is to inject gas into the top of the Abo formation and produce the unit wells from deep in the oil column.

Q At this point, Mr. Lowrey, is it also Cities Service's intention to seek an administrative procedure whereby other gas injection wells may be approved without hearing?

A. Yes.

Q. For the Examiner's information here, the advertise-

ment in Case 5213 notes a location of 990 from the south line and 2635 from the east line. The application we tendered had 2640 feet from the east line.

A. I think the offset of five feet was the offset of a line.

Q. Please continue.

A. The suggested tract participation is based on the following:

The ratio of gas production from each tract to the total of all tracts during the period February One, 1973, to July Thirty-one, 1973.

The ratio of gross acre feet underlying each tract to the total of all tracts is determined by the Empire Abo Field Engineering Subcommittee and shown in the report dated August, 1968.

The ratio of oil produced from each tract to the total from all tracts during the period February One, 1973 to July Thirty-one, 1973.

The ratio of original oil in place under each tract to the total in all tracts as reported in the Field Management Study, Empire Abo Field, dated October the second, 1970.

The ratio of oil and gas revenue from each tract to the total from all tracts during the period February One,

1973 to July Thirty-one, 1973.

Tract participation is the sum of 10 per cent of A, which is the ratio of gas production plus .225 of the remainder, B, C, D, and E, as I have just read.

There will be only one phase of unit participation. The tract numbers, lease names and tract participation are detailed in Table Number Six.

On page six, we see the tracts listed in numerical order and their tract participation. One, the Federal tracts total 55.1075 per cent and the State tracts 44.8925 per cent.

Table One is a tabulation of certain pertinent data on the proposed Citgo Empire Abo Unit. It is self-explanatory.

Table Two, there are the economic parameters of oil price, gas price, taxes and investments used to make the economics.

Table Three is the summary of the economics that I ran. In summary, again, the gross oil production shows an increase of 272,000. The gross gas 4,443 mmcf. And we can see the net cash production increasing by 2,886,000 dollars over a twenty-five year life.

Table Four is the estimated future production schedule for the proposed Citgo Empire Abo Unit listing oil

production, gas production in millions of barrels, gas injection, mmcf per year, and gas sales in mmcf per year.

Q. Please continue.

A. Table Five is merely the tabulation of certain well data on each of the six wells in the proposed unit. All depths are subsea and also included is a test on each well including the date and oil and the gas-oil ratio.

Table Number Six we referred to earlier and is a parameter table of each of the parameters used in the suggested participation table in the Citgo Empire Abo Unit, and it is self-explanatory.

Exhibit A is an engineering study and shows the map of the proposed area with the proposed injection well noted on tract one of the current Russell "C".

The south and east unit boundaries border in part on the Arco Empire Abo Unit.

Exhibit B is merely a location plat showing the location of the proposed unit to the Arco Empire Abo Unit.

Exhibit C is the Gross Reef Isopach of the oil column taken from the engineering subcommittee study, August, 1968, as a portion of the Empire Abo Field, Eddy County. Also noted in Section 35 is the location of the cross-section of AA Prime which is also a part of this study, east-

west cross-section through the Russell and Magruder leases.

Exhibit E is the performance history of the proposed Citgo Empire Abo area. Quite obviously the gas-oil ratio is increasing and consequently the oil rate will decrease and will continue to do so. The oil rate is in barrels per day and the gas-oil ratio is in standard cubic feet per barrel.

Exhibit F as I have previously mentioned is a cross-section of AA Prime running east-west through Cities Service Magruder fourteen and to Russell Number nine and ten and ending at Cities Service number thirteen.

Noted at the top -- of the top of the reef is the original gas-oil contact and at the base of the reef as determined by the previous studies. Also indicated are the prorated intervals on each of these four wells.

Q Please refer to what has been marked as Applicant's Exhibit Three and in using this exhibit explain for us how you propose to operate the gas bank account.

A. Exhibit Three is the proposed working for a gas bank account, Citgo Empire Abo Unit, Eddy County, New Mexico, and states or it is suggested that the volume of injected gas over and above 90 per cent of the available gas shall be credited to the gas bank account each month and carried

cumulatively forward.

The accumulated gas bank may be applied to the injection volume during any future month in which less than 90 per cent of the available gas is injected.

The gas bank balance shall not exceed a maximum of the average monthly total injection volumes for the previous three months not including the month being reported.

Available gas shall be defined as total produced gas less fuel requirements less the casing head gas allowable authorized by the pool rules.

I have tabulated a fifteen month period according to this proposed working as an example gas bank accumulation.

Under column one I have listed the produced gas. Column two, the fuel gas. Column three, the gas limit for 2,000 cubic feet for top allowable barrel. Column four is a column for available gas which is the produced gas less the fuel gas less the gas limits. Column five, I have listed 90 per cent of column four and 90 per cent of the available gas. In column six I have listed gas injected. In column seven is the bank change. Column eight is the accumulative bank account and column nine, I have listed what would be the bank limit or the maximum the gas bank could be.

I just used essentially random numbers. These are not production or injection figures but shows what happens to columns seven, eight and nine to illustrate what might happen in the injection work detail for reasons of mechanical failure or injection problems or problems with the compression facilities or something of this nature.

The thirteenth month the gas bank account itself gets down to 410 mcf due to problems starting in the ninth month and that the gas bank limit is always the average of the previous three months injection volume, of course not counting the month that we are reporting.

I think that this method of accounting for the gas bank will allow, except in cases of extreme amounts of down time or losing injection level or something of this nature, the bank account itself will never be zero. Never actually go to zero but will accumulate so there is a limit on it so it doesn't accumulate to astronomical numbers.

Q Mr. Lowrey, is this plan you proposed essentially the same as the one proposed by Arco?

A. The one that I am proposing is essentially the same as we suggested that Arco use and the order has not been written to my knowledge.

Q How does this differ from the Arco proposal?

A. The difference in this wording in this suggested gas bank and the one that we proposed in the gas bank in the Arco's Empire Abo Unit is mainly the definition of available gas. We are defining available gas as the total gas produced, less the fuel requirements required on the lease with the casing head gas allowable which is currently in effect for the pool.

Now, if I am not mistaken the Arco proposal or suggested wording for theirs, if the available gas was listed as all of the available residue less fuel requirements from the plant. So, they are sending all of their gas to the plant and taking back residue gas to be injected back in the Empire Abo Field as opposed to our injection of produced gas or wet gas.

Q. Are there any differences between your proposal and the Arco proposal in regards to balancing of the gas bank account?

A. Yes. Atlantic -- let me think a minute -- the Atlantic proposal was to credit to the gas bank 90 per cent and anything over, any injection over 90 per cent of the available residue.

Our proposal is that anything that we inject over 90 per cent of what is available will go into the gas bank

account.

Their proposal did not limit the maximum that the gas bank could accumulate where ours does. They propose to zero the bank account itself at the end of the twelve-month period, where we do not.

Q. Do you have anything else that you would like to add, Mr. Lowrey?

A. Yes. The performance history of this area shows an increase in gas-oil ratio accompanied by a decreasing oil rate.

With this in mind and considering the proposed method of operation in the adjoining Empire Abo Unit, we feel that the proposal for the Citgo unit is prudent.

In short, we propose to unitize these four leases into a gas injection well and inject produced gas that we are not allowed to sell and transfer allowables to optimize the oil production thereby increasing recovery and the cash production.

Injection of the portion of the produced gas will conserve reservoir energy and possibly delay or eliminate the need for artificial lift in this area.

We request to unitize these leases and operate with full transfer privileges. We also request permission to drill

a well to be located 990 from the south line and 2640 from the east line of Section 35, Township 17 South, and Range 27 East.

We further ask that a gas bank account be set up to allow continued production in the event of mechanical difficulties with the injection system.

We have need of as much flexibility as possible because any mechanical problem which develop with the compressors or the injection well will result in losing a large portion if not all of our injection capacity. The reason for this will be that there will be only one injection well and we propose to install two injection compressors and if one compressor goes down we have lost 50 per cent of our capacity and if the injection well is off we have lost 100 per cent of that.

Q In your opinion, Mr. Lowrey, will the approval of your application in Cases Number 5212 and 5213 be in the best interests of conservation, prevent waste, and protect the correlative rights of others?

A Yes, sir, I do.

MR. KELLAHIN: If the Commissioner please, we move the introduction of Exhibits One, Two and Three.

MR. STAMETS: Are there any objections to the

introduction of these exhibits? They will be so admitted.

MR. KELLAHIN: That concludes our direct examination.

MR. STAMETS: Are there any questions of this witness?

MR. HINKLE: Yes, I have a few.

CROSS EXAMINATION

BY MR. HINKLE:

Q I take it from the information which is portrayed here on your Exhibit Number Two, the plats which are attached showing the top of the reef and the Isopach map and all that there is no question but what this proposed area is a part of the Empire Abo Pool, is that correct? There is no question about that?

A No.

Q Now, on your Exhibit Two, referring to Table One, you have indicated original oil in place is 4,449,530 barrels.

You have also shown the accumulative oil as of 1/1/74 is 2,665,270.

MR. STAMETS: What page are you on?

MR. HINKLE: There is no page, it is just Table Number One.

MR. STAMETS: Okay, I've got it.

Q (Mr. Hinkle continuing.) And the remaining reserves

to 1/1/74 is 1,184,147.

Now, isn't it true that if you add the accumulative oil and the remaining reserves and divide it by the original oil in place it would give you anticipated recovery?

A. Percentage, as a percentage, yes.

Q. And what would that amount to?

A. I don't have that number readily available but we can just look at the numbers and see that it is going to be high. You will also note that there is an asterisk after the oil in place and this was taken from the Field Management Study Abo Reservoir and we talked about that before.

Q. The percentage as calculated out, isn't it true that it is about 86.56 per cent?

A. I will take your word for it. It is going to be 3,840,000 over 4.4. So it is going to high recovery.

Q. I believe you said that this report was made up from the engineering studies in connection with the Empire Abo study?

A. Certain data was taken from that, yes.

Q. Now, that estimated did it not that on the whole Empire Abo there would be about 53 per cent recovery, is that right?

A. I don't recall what the number was.

Q Well, I believe there is a record in that case and it shows 53 per cent.

A. Well, if that's what it shows, the study shows, that's fine.

Q Now, if that is true their estimate of 53 per cent and your estimate of 86.6 per cent, where is the additional oil coming from?

A. Well, I think this points up the difference in the problem in the first place. The 609,000 that they said was primary reserves under the lease and the fact that we have produced a 100,000 more barrels than they said was there on our primary reserves. Now, you can take the other numbers in those studies and the work that was done before and question them also as to which number is right.

It is doubtful in my mind, but I am sure there is oil left there since we have produced a 100,000 more than they said was left.

Q Now, have you made a study of the effect of the proposed Citgo pressure maintenance project as you proposed to operate it on the ultimate recovery of oil from the whole Empire Abo Field?

A. No, sir, I have not.

Q Now, have you made any calculation as to the barrels

of reservoir space which will be avoided by your proposed pressure maintenance project as compared to your current operation of the wells you propose to include in the unit?

A. Would you read that again, please?

Q. Have you made any calculations as to the barrels of reservoir space which will be avoided by your proposed pressure maintenance project as compared to current operation of the wells you propose to include in the unit?

In other words, the space you are going to avoid is going to be more or is it going to be less by this unit?

A. Well, it is going to be more because of the overall life of the project, about 252,000 barrels.

Q. You have no actual figures on that? You just know that it will be more and that's all?

A. Yes, I know that it will be more by at least 252 stock tank barrels. But the operation -- the difference in the operation will be the production of the oil because we are already allowed to sell 2,000 cubic feet per top allowable barrel and plan to inject the rest of it. The voidage or the life of the project will be the additional oil recovered.

Q. The 2,000 to 1 that you are allowed to top will be the difference?

A. No, the difference in the voidage is going to be the oil production because there is no difference. We are already allowed to sell the 2,000 to 1.

If this is unitized and we inject gas, we will re-inject anything over that so there really is no difference in the gas production because we are re-injecting anything over this 2,000.

I do not have the voidage calculations.

Q. Now, have you made a study of the volumes of gas, both the free gas and gas in solution now in place in the Abo formation underlying the proposed Citgo unit area?

A. I have been through those calculations. I don't have any of those numbers with me, no.

Q. You don't know or can't testify as to the volume of gas in place, now in place, under the proposed unit, in billions of feet?

A. No, I do not have a gas in place number currently, no. So I can't testify to that, any gas in place.

Q. You testified that the proposed unit area is a part of the Empire Abo Pool or field?

A. That's right.

Q. Now, in your opinion is there a communication between the Empire -- what is now the Empire Abo Unit and what

would be in the Citgo unit?

A. Yes.

Q. What do you consider the life of this pressure maintenance unit? You have indicated sixteen years here, but I think in the Empire Abo Unit they are figuring ten to twelve. Which do you think is correct?

A. Unless I am mistaken, I took --

Q. I mean, to where gas blowdown starts.

A. Or injection stops?

Q. Yes.

A. If I am not mistaken the last information I had on the Citgo Empire Abo -- I mean the Arco Empire Abo Unit, was about the same -- was the same time I used in here to start blowdown which is in 1988 or that would be thirteen or fourteen years.

So, obviously we are going to stop injecting gas at the same time the offsetting unit stops injecting gas.

Q. Now, referring back to your Exhibit Number Two and Table Number Four, does this show the amount of gas you expect to sell during the pre-blowdown phase of your unit operation?

A. The last column, Gas Sales, is in mmcf per year of gas sales.

Q The first sixteen years would show a total of what, in sales?

A. Well, I could multiply it out for you. It is sixteen times 621.96.

Q And that would be about 9.3 billion cubic feet of gas?

A. Approximately.

Q And you say you have no estimate now of the gas in place?

A. No, sir, not with me I don't.

Q Now, you propose to sell the gas which you produce at a ratio of 2,000 to 1 and that amounts to about 1711 mcf per day?

A. That's right.

Q Now, if that is the case, is it reasonable to estimate that you will probably produce in addition to the 1711, 3300 mcf per day on the average.

A. Depending on what the producing ratio is.

Q Do you think that is a reasonable estimate?

A. Yes, at the start of the project that is probably correct.

Q Is it also reasonable to anticipate that there will be about 10 per cent of that that will be lost one way or

another or consumed which would be about another 330 mcf's per day that would be lost or consumed in connection with operations such as used for heater treaters, compressors, shrinkage due to liquid knockout and so forth?

A. There will be some fuel usage, yes. As far as what the percentage, the number you gave me, I don't know. There will be shrinkage. Now, what other losses there will be I can't say. But there will be fuel usage on the lease which we are using now.

Q. Now, you take this 1711 mcf per day plus this 330 feet you mentioned per day.

A. No, you mentioned it, I didn't.

Q. Well, I might have, but you said that that was probably reasonable -- that would total 2,041 mcf per day which is not going to be returned to the reservoir. Is that right?

A. That's right.

Q. Now, if you take that, and that is on a daily basis, and if you take that for a year that would amount to 744 billion mcf's of gas per year, would it not?

A. Approximately.

Q. Now, if we assume that the life of the project is twelve years, based upon the 744 million mcf per year, this

would amount to approximately 8.9 billion cubic feet, would it not?

A. That is correct. If you multiply twelve times 744, you get approximately 8.9.

Q. And that gas would not have been returned to the reservoir?

A. That is correct.

Q. Now, you propose to sell according to your testimony here during that time approximately 9.3 billion cubic feet. You are not going to -- anyway, there will be about 8.9 billion cubic feet that will not go back to the reservoir?

A. Over a fifteen year period at 6.2 million per year, yes.

Q. And you have testified that you do not know how much or you have not calculated the volume of gas in place?

A. No, sir, I do not have those with me.

Q. All right. Can you make an estimate as to the gas in place under your proposed Citgo unit? In your opinion is the 8.9 billion not going back in the reservoir, more or less than the gas in place at the present time?

A. Without numbers with me I am not going to make any guesses about how much gas is in place.

Q. Now, is it true that under the Empire Abo Unit

under their proposed plan of operation they will have the injection wells, gas injection wells, located approximately one mile east and one mile west of the Citgo unit?

A. Yes, they are supposedly along the north side of the unit, that is correct.

Q. Now, Mr. Lowrey, I believe you have testified that in your opinion the approval of this special maintenance project would be in the interest of conservation and would protect the correlative rights?

A. Yes.

Q. How, in your opinion, would this protect correlative rights?

A. Well, I think the area in question on the north edge of the Empire Abo Field must be operated in competition with the Arco Empire Abo Unit. Since they are injecting gas in the top of the structure, maintains pressure, and since they are transferring allowables so they can produce their lowest gas-oil ratio well and conserving reservoir energy and increasing their oil recovery rate and hopefully accumulated recovery, I think we have to at least have to be operating in competition with them.

I don't think we can allow our leases to sit there with gas injection offsetting them and eventually gassed out

by an offsetting gas injection well without doing something to compete with them.

So, we have to have some kind of regulations to allow us to compete in some manner with the Atlantic unit offsetting it.

If we do not, then I am fairly certain in the future that the offsetting injection will get to the Cities Service leases and we are going to have nothing but gas production there and the oil production will rapidly decrease and undoubtedly part of it will drain from our leases onto the Arco Empire Abo.

Q. Well, you know do you not, that under the regulations that govern the Empire Abo Unit that they are required to re-inject all produced gas except that which is unavoidably lost back in the unit?

A. No. If I am not mistaken they inject all of the residue gas coming back from the plant, produced gas after shrinkage.

Q. Now, on the other hand you propose to sell all of the gas that can be produced at 2,000 to 1 ratio. Now, why isn't Cities Service willing to re-inject that like Arco back into the area?

A. Well, because in studying the area and very simply,

the economics say that this is the best method, economically, and reserve-wise for us to operate.

Q. Doesn't this give an unfair advantage to Cities Service in this case?

A. Well, I suppose if you wanted to -- there is that difference that we are proposing to sell and we are selling right now and can continue to sell.

Q. Do you think that that protects correlative rights?

A. Well, the order is already written and you can't change the order now and we are allowed to sell 2,000 top allowable barrels. I don't feel that whatever is done the 2,000 to 1 per top allowable barrels that the rules say that we are allowed to produce and sell right now is going to hurt the large unit offsetting us very much in any shape or form. But I can't argue that there is that difference and we are selling gas and they are not.

Q. Have you filed a proposed plan of operation with the USGS for this unit?

A. Yes, we have preliminary approval from them -- they have been filed with the State Land Commission.

Q. But not with USGS?

MR. KELLAHIN: May we go off the record a moment?

MR. STAMETS: Yes.

(THEREUPON, the hearing was in recess.)

MR. STAMETS: You may continue.

A. The answer to your question, the plan of operation has not been sent to the USGS.

Q. And it has not been approved by the USGS?

A. No, we have not had approval from either one. But they have been notified and we have discussed with them and the engineering studies have been sent to them and the plan of operation has been submitted to the Land Commissioner.

MR. HINKLE: That's all of our cross examination.

THE WITNESS: There is one other note that I would like to make if I may. The previous testimony before the Commission, I think Atlantic testified that their shrinkage through the plant would be in the neighborhood of 32 per cent. So that the residue coming back to them was approximately 68 per cent of the produced gas. We feel that our operation will be more flexible in this sense in that we have proposed to inject produced gas and therefore are not tied to the gasoline plant and are not dependent on a long distribution system or anything like this. We have eliminated one of the areas of possible problems.

REDIRECT EXAMINATION

BY MR. KELLAHIN:

Q Mr. Lowrey, there are two points I wanted to reiterate. One, was concerning the reservoir voidage. Would the reservoir voidage under your proposed plan of operations exceed that authorized by existing pool rules?

A I don't know whether the pool rules say anything about what the voidage should be. Our gas voidage will not exceed what we are already authorized.

Q That is what I meant to say. That's all of the questions I have.

CROSS EXAMINATION

BY MR. STAMETS:

Q Mr. Lowrey, the unit oil allowable that you are seeking would be a top oil allowable for the Empire Abo Pool for each of the six wells?

A I am sorry, would you ask the question again, please?

Q You are seeking an allowable for the unit, is that correct?

A Yes.

Q And is the allowable that you are seeking for the unit the sum of a top allowable assigned to each of the existing wells?

A I suppose that would be the maximum allowable it

could be, yes.

Q And of course this would be the maximum which would depend on the volume of gas re-injected?

A Yes, that's right. It would simply be tied to gas production and injection for oil allowable which essentially is the way it is now. We are allowed to sell 2,000 for top allowable barrel so the oil allowable is tied to gas production.

Q Okay. Do you propose that there be an allowable transfer between the wells in the preliminary stage where you are injecting no gas?

A Yes, this would be the ideal situation for us.

Q What allowable would we be talking about at this time? Would we be talking about the calculated maximum allowable which could be assigned these wells with the 2,000 to 1 GOR factor being assigned on a unit operation basis rather than on a well basis?

A If the transfer privileges are granted the allowable assigned on a unit basis, then we would tie the oil production to whatever the gas production would be but the gas production would be limited by the 2,000 top allowable barrel. So, you can see that if we handle the operation properly and the wells right, we should be able to produce

more oil with the transfer privileges because some of the wells will produce at a lower gas-oil ratio than others.

Q. But your proposal wouldn't actually decrease the total amount of gas coming out of that particular area? Would it have the result of the increase of gas --

A. Before the injection begins?

Q. Yes.

A. No, not the sum of the four leases -- are still tied to the 2,000 times top allowable barrels which is something like 1711 or 12 mcf per day and that's all we can produce.

Q. All of these wells are currently producing at the maximum casing head gas allowable?

A. Well, yes, they are tied to -- I don't know what the actual production is. But they are all tied -- they are limited because they are not top allowable wells and we are limited by the 1711 per day which is 2,000 times -- I don't know what the production is. But we are producing as much gas as we are allowed to sell.

Q. So, your answer to that is that you are currently producing at the maximum casing head gas well?

A. Yes, that is right.

Q. Now, no more gas would be coming out of this unit

operation?

A. No.

Q. Would you actually be getting more oil in this preliminary operation?

A. Well, provided that the transfer privileges were granted. Some wells produce 3,000 gas-oil ratio, and some produce 46 or 4800. So, if you would lump them altogether and transfer the allowables around with the gas production remaining the same, total gas production, then oil production could be increased since by restricting high gas-oil ratio wells and producing the low gas-oil ratio wells. I hope that I have made myself clear.

Q. Yes, you have. I think I understand it. It has been made clear on the cross that you do intend to sell all gas which we are currently referring to as casing head gas allowables?

A. Yes, that is right.

Q. And that is after re-injection has started?

A. Yes.

Q. Now, would you just describe in general what a pressure maintenance project is?

A. Well, this is a term that is used for a lot of projects that are not.

The term pressure maintenance infers that you are maintaining a pressure. I have seen very few of them in my tenure in the oil business. But this is what the term pressure maintenance infers is that you are going to maintain the pressure.

Q. Could it also mean that in actuality that you are slowing down the rate of pressure in the line?

A. That is actually what happens, yes. The unit south of us, the Arco unit, is termed a pressure maintenance project. But they are not maintaining the pressure either. Cities Service has several projects in Texas that we call pressure maintenance projects which are gas injection projects. But the pressure is not maintained, the decline is slow perhaps, but it is not maintained as the term infers.

Q. Mr. Lowrey, if you take out higher rates of oil production you can take out the same amount of gas production and if you take out more gas production to make up for what you lose in your heater treaters or compressors, then you are currently taking out of the reservoir and how could this be classified as a pressure maintenance project?

A. That was my intent in the foregoing discussion that this nor any other pressure maintenance that I have ever seen actually maintains pressure. It simply slows the

decline.

Q. Would this actually slow the decline in this area or would it increase the decline?

Let's consider this a moment. This is totally isolated from any other reservoir and if you take out more oil than you are currently taking out and if you are taking out more gas than you are currently taking out will that not result in a greater decline in the pressure?

A. That is correct.

Q. So, under the method of operation that you propose here, isn't it true it shouldn't be called a pressure maintenance project?

A. Well, we can call it anything we like. But I think it is plain what we want to do.

Q. Well, if we are saying that a pressure maintenance project is an attempt to maintain the present reservoir or slow the rate of decline could we call this a pressure maintenance project?

A. No, not under the terms used here today.

Q. The only reason you have chosen not to return the current casing head allowable gas to the reservoir is economics?

A. That is right.

Q Have you made any calculations to determine whether or not your return of this gas to the reservoir would cause any greater ultimate recovery from the unit?

A You are talking returning the 2,000 to 1 limit for top allowable barrel?

Q Right. Essentially all produced gas except what you would lose in operation. Would that result in any greater recovery of oil in this unit?

A I am sure that it would, but I don't know what the numbers would be.

Q Has there been any consideration of the installation of a small plant to recover the liquid from this gas before it returns to the ground?

A No, this has not been considered.

Q Do you know if any such plants are available?

A I'm sure that there are.

Q Could you say from your own knowledge that if this were done the recovery from the unit would be enhanced?

A By essentially sending the gas through a gasoline plant recovering the liquid would the recovery from the area be increased?

Q Right.

A Are you talking about stock tank barrels of oil?

Q. I am talking about total recovery of gas and liquids from the reservoir.

A. I don't know.

Q. You don't know?

A. No.

MR. STAMETS: That's all of the questions I have at this time. However, you may wish to recall this witness for additional questions before the hearing is over.

MR. KELLAHIN: I have one question concerning something you said about pressure maintenance projects.

Mr. Lowry, is Arco's proposed pressure maintenance project returning -- how much of the gas is Arco returning to the pool, what percentage?

A. Approximately, and hopefully, and their plan is to return approximately 68 per cent which is available residue after shrinkage and approximately 32 per cent is as leakage.

Q. (Mr. Kellahin continuing.) And under their project are they taking more or less oil?

A. More or less than what? Than originally planned?

Q. That's correct.

A. Yes, they plan to increase the recovery.

MR. KELLAHIN: That's all.

MR. STAMETS: Are there any other questions of this witness?

MR. KELLAHIN: No, I think not.

MR. STAMETS: You may be excused.

(THEREUPON, the witness was excused.)

MR. KELLAHIN: We have one more brief witness.

E. F. MOTTER

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

DIRECT EXAMINATION

BY MR. JASON KELLAHIN:

Q Would you state your name please?

A. E. F. Motter, M-O-T-T-E-R.

Q And by whom are you employed and in what position, Mr. Motter?

A. I am employed by Cities Service Oil Company and I am Manager of Engineering, Southwest Region, and I live in Midland, Texas.

Q Are you a Petroleum Engineer?

A. No, sir, I am a Mechanical Engineer, but I have taken several courses in petroleum engineering at other schools but I don't have a degree in petroleum engineering.

Q Have you testified before the Conservation Commission

and had your qualifications accepted as a matter of record?

A. Yes, and I might mention that I am registered as a Petroleum Engineer in New Mexico and Texas --

Q. Mr. Motter, are you familiar with the application before the Commission in connection with the pressure maintenance projects of Citgo Empire Abo Unit?

A. Very much so.

Q. Are you familiar with the offsetting units?

A. Yes, we've followed this closely.

MR. KELLAHIN: Are the witness's qualifications accepted?

MR. STAMETS: The qualifications of the witness are acceptable.

Q. (Mr. Kellahin continuing.) Mr. Motter, in connection with the Arco Unit was Cities Service asked to join the unit?

A. Most certainly, several times. As a matter of fact, Arco and we discussed the situation numerous times and even offered to purchase our property.

Q. Cities Service elected not to join the unit insofar as the area involved in the application is concerned?

A. Yes, I think Mr. Lowrey made that fairly clear. I have nothing to add to that.

Q. Now, Cities Service is the owner of or has a working interest of the -- had royalty interests in other property other than this unit, did they not?

A. This is one of the reasons why I wanted to make a comment or two. We operated several other properties. These were, or would have been, windows in the Atlantic Unit.

We felt that in most cases we got a pretty good shake on participation. We transferred these properties to other working interest owners in the unit who were committing their property to the Arco Unit.

This enabled these properties to go into the unit without any windows or anything of this nature. Those are the leases on page three that Mr. Lowrey referred to.

I want to make this point clear. We had tried not to stay in or prevent any progress on this thing.

We felt that we did not get a fair shake on the leases to the north and kept those out a hundred per cent. But all of those other leases were transferred -- in the case of the Hudson "A" and "B" were transferred to AMCO. In the lease of Ohio State "B" was transferred to Marathon. They since have been committed to the unit.

It would be our intent once -- that is, if the Commission and USGS sees fit -- to form our small unit and we would go ahead and sign Arco's agreement so that we could commit our interests to their lease.

Their contract is written so that we cannot make a partial commitment. We had to commit everything or nothing.

Q. Cities Service is ready to sign that agreement?

A. Yes, once we can get these properties set aside and a separate deal.

I had one other small comment that I would like to make in view of this last dissertation here about the amount of gas that was going back.

I think that Mr. Lowrey covered it fairly well but we operated a number of these projects. In fact, we operate one offsetting Atlantic over in Ector County, Texas.

Any time you have anything mechanical you have problems. We more or less elected here to try to avoid our own gasoline plant and put our own gas back and this will be rich gas rather than taking it over and take a shrinkage and have it come back.

In the last few years, when all of the no-flare orders came out, we have experienced a lot of downtime with gasoline plants.

To carry this a little bit further, if you utilize just the figures that we have on Table Four, Cities Service returned 63 per cent of the gas being used to the reservoir as opposed to 68 per cent Arco would return after shrinkage.

MR. KELLAHIN: That's all the questions I have of the witness.

MR. STAMETS: Are there any other questions of this witness?

MR. HINKLE: I might ask a question of Mr. Motter.

CROSS EXAMINATION

BY MR. HINKLE:

Q. Had Cities Service committed the tracts which you proposed to put in the Citgo Unit and committed those to the Empire Abo Unit. Do you have any idea what Cities Service's percentage of the whole unit might be and what their current oil production would be?

A. Well, yes. I know what our interest would have been including all of the leases. As I said, we haven't committed but we have made arrangements so that part of these leases could be. We felt that this interest was not great enough, the Magruder "A", the Russell "C", that we are talking about -- we thought we could do better on our own.

Frankly, I will admit that if we had committed

everything we would be receiving more income today than we were prior to the time of the unit. But we feel that we can better ourselves.

Any time an engineering committee comes up and says that you have got 600,000 and some-odd barrels of oil and you have already produced 700 and some-odd thousand, you have reason to have a little doubt in your mind as to whether the whole picture up there was correct.

Q As a matter of fact, if you committed all of these properties to the unit, wouldn't you be receiving about 790 barrels of oil per day?

A. Probably true. In fact, we are enjoying that on the leases we have committed. We are enjoying a very nice income and we are thankful for every dollar that is coming in.

MR. HINKLE: That's all.

MR. STAMETS: Any other questions?

The witness may be excused.

(THEREUPON, the witness was excused.)

MR. KELLAHIN: We have one witness that will probably take a half an hour or so.

MR. STAMETS: Maybe we had better come back after lunch. We will be in recess until one-fifteen.

(THEREUPON, the Hearing was in recess.)

STATE OF NEW MEXICO)
)ss.
COUNTY OF SANTA FE)

I, SIDNEY F. MORRISH, Court Reporter, do hereby certify that the foregoing and attached Transcript of Hearing before the New Mexico Oil Conservation Commission was reported by me, and the same is a true and correct record of the said proceedings, to the best of my knowledge, skill and ability.

SIDNEY F. MORRISH, Court Reporter

MR. STAMETS: The Hearing will please come to order. Mr. Hinkle?

MR. HINKLE: We have one witness

HUGH CHRISTIANSON

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

DIRECT EXAMINATION

BY MR. HINKLE:

Q State your name, your residence and by whom you are employed?

A Hugh Christianson, reside in Midland, Texas, and I'm employed by Atlantic Richfield Company.

Q What is your position with Atlantic Richfield?

A I believe they call me an Area Engineer right at the moment. Last week it was something else.

Q You have previously testified before the Commission and qualified as a Petroleum Engineer?

A That is correct.

Q And you were the principal witness in the original Hearing of the Empire Abo unit in pressure maintenance?

A Yes, sir, that is correct.

Q You have appeared as a witness on behalf of the

working-interest owners in the Unit at several hearings since that time?

A Yes, sir, that is correct.

Q You have made a continuing study of the Empire-Abo area since the beginning?

A I have, that is correct.

MR. HINKLE: Are his qualifications acceptable?

MR. STAMETS: Any questions of the Witness' qualifications?

MR. KELLAHIN: No.

MR. STAMETS: They are.

BY MR. HINKLE:

Q You are appearing here on behalf of not Atlantic Richfield but Atlantic Richfield as operator of the Unit?

A Yes, sir, that is correct.

Q Does Atlantic Richfield, as operator, have any objection to the formation of the proposed Citgo Unit?

A Well, certainly Arco favors unitization in gas injection tending toward pressure maintenance for this reservoir, however, we would like to state our position as to how we believe this should be done in order to tend to increase ultimate recovery from the reservoir and promote equity.

Q (Interrupting) This will be brought out in your evidence?

A (Continuing) Between the two separate units. Yes, that is right, and this will be brought out in our evidence.

Q Have you prepared,or has there been prepared under your direction,exhibits for introduction in this case?

A Yes, sir, there has.

Q And they are the ones that have been marked Exhibits 1 through 5, Atlantic Richfield?

A That's correct.

Q Now, refer to Exhibit 1 and explain what this is and what it shows.

A Okay. Excuse me, I have hay fever.

Well, Exhibit 1 is simply a map showing the entire Empire-Abo Unit area as approved by the USGS and State lands for unitization. The green-colored tracts is that area known as the Citgo Unit or proposed Citgo Unit that Cities Service is proposing here today be formed into a unit for gas injection. The white area, which makes up the bulk of the map, is the current outline of the Arco Empire-Abo Unit; the red tracts are those tracts which remain outside of either the Citgo Unit or the Arco

Unit; the red-circled wells are those wells that the Arco Unit has on production at the present time. All wells that are not red circled, although capable of producing oil, are shut-in at the present time in the interests of reservoir efficiency and conservation.

Q They are high oil-gas ratio wells?

A For the most part. Some of them are high-water-cut wells.

Q Do you have any further comment with respect to this Exhibit?

A Well, I only mentioned what probably Cities' structure map, with their report presented earlier, brought out; it was to say that the proposed unit area is on the back-reef, up-dip side of the reservoir; that is the greatest dip in the area is toward the south, south-east here, with the structurely high area back at the Citgo proposed unit dipping on down to the south.

Q Now refer to Exhibit Number 2 and explain what this shows.

A Exhibit Number 2 is a tabulation which illustrates how the Arco Empire-Abo Unit is currently operating the nine wells which are immediate assets to the proposed Citgo Unit, and simply shows how in January of '74 the production is

coming from the Citgo Unit well itself and I might mention for the Examiner's benefit that these nine Arco Unit wells are all the immediate offsets around the green area.

Q As shown on Exhibit 1?

A Shown on Exhibit 1. Exhibit 1 will show you that we have shut-in three of the Arco Unit wells because they're high gas-oil ratio inefficient producers.

Looking at Exhibit 2, daily oil rates, Column 2 for Sub-item B, which is Arco's, you'll see that three more wells are curtailed in oil production because they are either at high GOR or showing tendencies toward high gas-oil ratio so we have cut back their production somewhat. Three wells there on the Arco Unit are producing at the 284 barrel-per-day limit allowed by the Commission rules as offsets to non-unit properties. In conjunction with this situation I might mention that as you look at the gas-oil ratios, Column 3 under (a), proposed Citgo Unit area, you see the ratios vary from a low of 24.20 cubic feet per barrel for the Wright A State No. 4 to a high I believe of 48.6 cubic feet per barrel on the Citgo Magruder 813. I might mention that had Cities Service decided to join the Unit with this group of wells we would have all of them shut-in now except

possibly Wright A State No. 4 on the basis that currently they are inefficient producers from the reservoir. But then, I want to point out a little further, we do have, of course, the individual daily oil rates in Column 2 being produced by each of these wells and I want to point out the total line for under Item A, proposed Citgo Unit area. We see Column 2 total that the daily oil rate is 510 barrels a day, the gas-oil ratio for January for Citgo combined-unit wells, 3492 cubic feet per barrel; there's not any water being produced. The reservoir-net-voidage rate is calculated by the formula Attachment A that we submitted with our own Unit, and reservoir-net-voidage rate; then, using the daily oil rate for January of 510 and the gas-oil ratio and no-water production, we find that Cities Service is voiding 3486 reservoir barrels per day of space under their current operation in January. Looking over Column 7 we find that this is dividing Column 6 by six wells; we find that this figures out to 581 reservoir barrels per day per well for the six Citgo wells. Now, moving over to Column 8, which is a reservoir-voidage-efficiency factor, again this is one that we have reported on to the Commission from time to time at various hearings about how our Unit was doing on this factor, and this factor

is simply Column 6, reservoir-net-voidage rates, divided by Column 2, daily-oil rates,and when you divide 3486 by 510 you get a factor of 6.83. In other words, the Citgo proposed unit as a whole is voiding 6.83 reservoir barrels for every stock-tank barrel of oil it produces, as it actually produces in January of '74. Then we look down here at the nine offset wells to the Citgo tract in the Arco Unit, we find in Column 2 that three of these wells zero daily-oil rates because they're shut-in; three more of them are producing at rates of 122 to 47 barrels a day because their GORs are either up or showing tendencies in that direction; the gas-oil ratios are shown in Column 3 to vary from the top allowable 284 wells from 751 cubic feet a barrel to 1094 cubic feet a barrel, and the highest ratio well is one well that's producing at 3400 cubic feet per barrel, but we have that one cut back to production of only 47 stock-tank barrels of oil per day. The net result, looking down here at the total for the Arco Empire-Abo Unit, we find those nine wells have a daily oil rate of 1096 barrels per day; an average gas-oil ratio of 1107 cubic feet per barrel compared to the offset Citgo tract shown up above of 3492 cubic feet per barrel, all these wells producing no water.

In Column 5 we find the daily-oil rate per well for those Arco Unit wells is 142 versus 85 for Citgo, and in moving over into the key column, reservoir-net-voidage rate, a measure here of the efficiency the Arco Empire-Abo Unit is voiding, 2061 net-reservoir barrels per day to gain this 1096 barrel oil production wherein the Citgo Unit properties are voiding 3486 net-reservoir barrels per day produced their 510 barrels of stock-tank oil. Putting the reservoir-voidage rate on a per-well basis we find that, over in Column 7, the Citgo Unit area is voiding at 581 reservoir barrels per day per well and the average of the nine immediate offsets to the Citgo Unit are voiding at 229 reservoir barrels per day per well. In Column 8, reservoir-voidage-efficiency factor, we find that these nine wells which are on the Arco Unit are at a factor of 1.88 reservoir-barrel space voided per barrel stock-tank oil produced and this compares to the 6.83 for Citgo or in the neighborhood of 3-and-a-half times more efficient in production situation on merely the nine offsets to the Citgo Unit tract.

Q Refer to Exhibit 3 and explain that?

A Exhibit 3 is a tabulation which shows production and voidage efficiency under several different modes of

operation. This particular type of presentation has been made to the Commission before, and at least Columns 2 through 6 are the type of information you have seen before. Let me go ahead through here and make some comparisons. I think what we're going to be driving at with this Exhibit is to indicate that basically it shows that the Citgo proposal does not appear to be a conservation project as we view a conservation project. But, let's move ahead and discuss what we've got here. On Line A, this is the Arco Unit, January 1974, actual production. First Column, Line A, we see 221 wells; this is the basic number of wells in the Arco Unit. The daily-oil rate for January, barrels of oil per day, is 32,891 barrels; the average gas-oil ratio, cubic feet per barrel of oil, 977. The daily water rates, 1386 barrels of water per day. Using again our full-line Attachment A with the original Order R-4549, we take these figures and calculate that the reservoir-net-voidage rate in reservoir barrels per day from the Arco Unit is 56,319 reservoir barrels per day. Now, our allowed rate set by the Commission as the average voidage for 1972 is 56,513 reservoir barrels per day, so you can see we are maintained just within our allowed rate based on the average for 1972. Now, I might point out that in

actuality, and we asked for this limit at our original hearing in September of 1973, which is the last month just prior to unitization, because gas-oil ratios had gone up by that time over what they had been in 1972, the actual calculated voidage for September '73 for all properties which went into the Arco Unit was 61,802 barrels per day reservoir space. So in actuality, although we are right at the 1972 average voidage, we have actually brought into effect quite a reduction in voidage over what was going on immediately prior to unitization. In fact, 61,800 barrels a day to 56,319 or a reduction of something like 55 or 100 barrels of reservoir space voided.

Q Hugh, what was the figure allowed by the --

A (Interrupting) County Commission?

Q Yes.

A 56,513.

Q Thank you.

A As I say, that was based on the average voidage for 1972 for all the properties that went into the Arco Unit. Okay, now, when you look in Column 6 at our reservoir-voidage-efficiency factor you see the 31.71 reservoir barrels per stock-tank barrel. This is what efficiency factor we're operating at in January of '74.

Now, this same factor immediately prior to unitization in September, for which I just gave you the voidage figure for the Unit, was 2.66 reservoir barrels. I don't have this in the table but, in other words, although we increased the oil rate from 23,252 to 32,891 barrels per day, we reduced the voidage-efficiency factor from 2.66 reservoir barrels per stock-tank barrel down to 1.71. So we had a sizeable reduction, and, of course, the lower you get with reservoir-voidage-efficiency factor simply means you're voiding less space per barrel of production and therefore you're holding the pressure up longer and you get this increased effect in a gravity drainage reservoir; the longer you can hold the pressure up relative to oil production the more recovery you are going to have. This is another way of stating the fact that you have a flattening in the pressure curve and the flattening is because of this improved efficiency factor.

Okay, moving to Column 7 here we simply took the total 56,319 reservoir-net-voidage rate divided by those 221 wells over there in Column 1 and got a figure of 255 reservoir barrels per day, reservoir-voidage rate, just putting it on a per well basis.

Column 8 puts the allowable production of 56,513

that we talked about a while ago and divides that by 221 wells so we see that the allowable-voidage rate on a per-well basis is 256 reservoir barrels per day per well. Okay, let's drop down now and take a look at Item 3, Line C, which is the Citgo Unit Area, January, 1974, and we see pretty much a repetition of the figures that we talked about on Exhibit 2 previously. Citgo has six wells and produced 510 barrels per day and had a gas-oil ratio in January of '74 of 34.92; they didn't produce any water and this resulted in a reservoir-net-voidage rate of 3486 reservoir barrels per day giving them a reservoir-voidage-efficiency factor in Column 6 of 6.83, comparing again to the Arco Unit voidage-efficiency factor of 1.71 up above on Line A.

Now, moving over to Column 7 we see that on Column 7, Line C, reservoir-voidage rate per well for Citgo, which is dividing Column 5, 3486, by Column No. 1, number of wells, six, and you get a figure here of 581 reservoir barrels per day per well. This is the way Citgo was operating their six wells in January of 1974.

All right, let's look at Column 8, which is the allowable-voidage rate per well in reservoir barrels per day. Now, the number you see there is 552 reservoir barrels per

day per well with a double asterisk. Down here at the bottom the double asterisk says this is the daily reservoir-voidage rate of a top-allowable well, 142 barrels per day at maximum gas-oil ratio of 2000 to 1. Now, actually neither the present field rules nor the Citgo rules set any limit on reservoir voidage. Now, I'm talking about the Citgo rules that they are proposing for their unit. Now, they don't set a limit for reservoir voidage per se and the Commission does not set one now on any Empire-Abo property outside our unitized area. There is one on our unitized area and it's 256 barrels per day per well. It is shown up here in Line A, Column 8. All right. Now, at any rate, no reservoir-voidage limit is set, but our own unit has one, of course; it is 256. But, in effect, the Commission, by limiting the top-allowable rate to 142 and the gas oil ratio to 2000, in effect you are setting a limit of 552 reservoir barrels per day, so this is an effective reservoir limit that's in effect on all non-unit property in the Empire-Abo reservoir.

Now, you can drop back over here to Line C, Column 7 and see that in January the total Citgo property slipped in their reservoir voidage to a little above that limit. 581 reservoir barrels per day was voided per well; that

is to say an effective 552 shown over in Column 8, Line C. Of course, this is one of those things with balancing.

Now, they will probably have to shut-in a well next month to get their gas production back in line. This is going on out there in their production right now. But I want to call your attention to that effective reservoir-voidage limit that the Commission, in effect, has now on non-unit and the fact that it's more than double what the unit voidage limit is. Voidage rate per well per day is another way of talking about reservoir efficiency.

Okay, let me drop back up here to Line B again which is Arco Unit, mid '74. In essence this is an estimate of what we'll be doing once we are injecting all available residue gas as it says over here on the left-hand side, Line B, and we have 221 wells; we anticipate, if the Commission grants our latest request for a small allowable increase of 300 and some barrels a day, we anticipate an allowable of 40,555 barrels per day in Column 2. Our ratios we expect to be 1100 to 1; daily water rate we are predicting 6415 barrels of water per day. This all translates, using the reservoir-voidage formula in Column 5 to a net-reservoir-voidage rate of 28,668 reservoir barrels per day and I want to point out the comparison

that this will be something like half what we are voiding right now and what we are voiding right now is some 5500 barrels per day less than what the unit area was voiding prior to unitization. Of course, this dramatic reduction in reservoir voidage results in a much improved reservoir-voidage-efficiency factor, which is, of course, going to help to maintain the pressure even more, tend toward pressure maintenance much more, and this factor shown in Column 6, Line B, is .71 reservoir barrels per stock-tank barrel. This will be a reservoir-voidage rate per well shown in Column 7 of 130 reservoir barrels per day per well as compared to our 1972 asset-allowable-voidage rate per well of 256 shown over here in Column 8. So that's how we anticipate the Arco Unit will be performing when we start injecting all available residue gas and the present date for that is expected to be June, the first of June of this year.

Okay, now let's look down at "D" which is the Citgo Unit, Citgo rules, and the wording there defines the situation, which is they will sell-- and this is their proposal -- they will sell a top-allowable gas which is 1711 mcf per day and inject all additional produced gas, and I want to emphasize that in this sort of situation their

ratio of gas injected to gas produced would be about 34 percent. You heard Mr. Motter mention a number of 63 percent that they will wind up injecting over the life of the project, but during the early years of their project, while they will be producing the bulk of their oil, they will be much closer on their ratio of gas injected to gas produced to this 34 percent. It will be later on in life when the gas-oil ratios will be clear out of sight for them, that in order to maximize their oil production, you know, they'll be injecting everything above this 1711, so as your oil increases, naturally their percent of gas injected over gas produced, the way they're defining it, is going to go up, but they're still going to be selling that 1711, and I want also to point out that they actually will not be able to inject all additional produced gas above 1711 because they're going to lose gas to leased fuel, and there will be liquid shrinkage as they go through two or three stages to try to compress their gas to say 50 lbs. to 1600 to 1800 required to inject it in the formation. Liquids are going to come out; they're going to have a heck of a time with them; I can't imagine what they're going to do with those liquids because they're going to be wild liquids. I think they would be ahead to

produce some kind of a gas plant myself. Goodness knows what they're going to do with them if they don't put in a gas plant to get those liquids, but at any rate, they're not going to have them available to reinject into the formation. One way or another they will have to run through stock tanks or handle them some way.

Okay, so all we're saying is they're going to start out and through the life of their project, if they do have a project of the type they are asking for, in the early life they are going to be making maximum oil, their ratio of gas injected to gas produced is going to be more down like one third rather than 63 percent. It may average out to 63 percent over the life of this project, I don't have any figures on that.

Okay, but let's go ahead here and look again at Line D Sub (a) which is the Citgo Unit. Citgo says they propose today, and our estimate for them in mid 1974, now this is the same conditions that Arco Unit estimate up here in Line B was made for that we just went over, we see that they'll have six wells and if they produce those six wells at the top oil allowables that they have right now, in other words, some of their wells, their test capacities have been such when you add up all their allowables and test capacities

you get 661 barrels oil per day right now. I think they are asking for 142 times 6 which would be 852 barrels a day. Perhaps they will be able to produce that, I don't know, but this is simply a test case that we ran through here and the 852 case I might say will result in more reservoir net voidage and this is what we're eventually going to be coming around to. In any event, it will result in more reservoir-net voidage in which case we're looking at right here, but we looked at this as a realistic amount of oil that they might be expected to make in the middle of '74 sometime.

Okay, 651 barrels of oil per day, six wells, based on extrapolated gas-oil-ratio performance, from their production, we expect that their ratio would be around 4200 to 1 in mid '74. It's 3500 right now; it was 2000 in the middle of '72, average for '72. You can see how it is going up. It's increasing all the time. Let's say it was around 3000 in the middle of '73, so it's a progressive increase in gas-oil ratio as you can expect in a situation here where you have a gas cap moving in on a back-reef-up-structure series of locations.

Okay, with 651 barrels of oil per day at 4200 cubic feet per barrel the reservoir-net voidage rate then calculates

to be 3603 reservoir barrels per day. Now, if you look back up in Line C, Column 5, you will see that their actual January calculated reservoir-net-voidage rate was 3486 reservoir barrels per day, so we see that at this 4200 to 1 gas-oil ratio and 651 barrels of oil a day they will actually be, even though they are injecting all gas above this 1711 with our estimate of 10 percent shrinkage due to fuel, etc., taken out of that, even though they are doing that they are actually voiding more space of reservoir barrels per day than they are right now. They've got them a gas-cycling project going all right but they're voiding more space. It's not hard to see. I mean the Examiner's line of questioning was really pointed in that direction this morning, and as pointed out, the gas volumes are actually going to be at least as much as present or maybe a little bit more and the oil rates seem to go up, so it looks like the reservoir voidage can't go any way but up. That's straight forward and when you plug the numbers in the formula and calculate it out, sure enough, that's the way it comes out; that voidage goes from 3486 reservoir barrels per day to 3603. Now, over here in Column 6 the reservoir-voidage-efficiency factor does drop a little bit because they're injecting a lot of gas, that's true, and it

drops from 6.83 reservoir barrels per stock-tank barrel in January to 5.53 reservoir barrels per stock-tank barrel. I want to compare that on up here in Line B, Column 6, to what we anticipate the Arco Unit's reservoir efficiency to be in the neighborhood of .71 or approximately 8 times more efficient on the reservoir-voidage-efficiency factor in the Arco Unit than in Citgo.

Now, if we move on over to Column 7, which is the reservoir-voidage rate per well in reservoir barrels per day, we're still on Line D(a) for the Unit under Citgo rules in mid '74, we see that this production 651 oil per day and 4200 gas-oil ratio results in a reservoir-voidage rate of 4603 barrels and when we divide that by the six wells we come out with 600 reservoir barrels per day per well. This is what the net-voidage rate will be after Citgo gets going with its injection project at an oil rate of 651 and gas oil ratio of 4200. Now, I want to draw your attention to the number 552 in Column 8, Line C, which I just discussed a while ago, was the current effective reservoir-voidage limit for a non-unit well as set, in effect, by the Commission, with its oil limits and its gas-oil ratios. So, in effect, the Citgo Unit will be operating at greater than any particular non-unit well that's

not being used. In other words, we'll be voiding more reservoir space per well than a non-unit well just sitting out there producing what the Commission will allow it to produce right now, because any old non-unit well, regardless of whether it's all gas or a top-allowable -oil-gas well, will be voiding about 552 barrels of reservoir space per day, the Citgo Unit per well. The Citgo Unit per well will be voiding 600 reservoir barrels per day per well so I can't really see where the conservation is in that particular situation.

Okay, moving down to Line C(b), which is an estimate in 1977 and let's just look at what we estimate in 1977 if the Citgo Unit continues operating under the Citgo rules selling 1711 mcf per day injecting all additional produced gas less ten percent shrinkage for a lot of different things we talked about. All right, we see that, and this is capital gains Line B, 1977 estimated -- we've still got six wells -- based on our extrapolations, we think they'll be making 170 barrels of oil a day and their gas-oil ratio will be 30,000 to 1. This is simply an estimated capacity. We're running this line through to show you this general situation, particularly as to reservoir-voidage efficiency and if the oil rate is greater than that the

voidage situation will be worse. That's all I can really say. This is to give us a feel for what might happen down the road. So here we have 170 barrels a day at a 30,000 to 1 gas-oil ratio. And keep in mind now they are still injecting everything above that 1711 but they're losing that shrinkage and fuel and so on.

Okay, and so the reservoir-net-voidage rate is 5025 reservoir barrels per day and in Column 6 you see this figures to a reservoir-voidage-efficiency factor of 29.51 reservoir barrels per stock-tank barrel, so you see that actually the reservoir-voidage-efficiency factor was pretty poor, certainly compared to our Unit in mid 1974 at 5.5 reservoir barrels per stock-tank barrel produced. Well, it's going to be horrendous here at 29.5 reservoir barrels voidage per barrel stock-tank oil produced. I might point out here that if Arco were to produce the big unit this way with these kinds of inefficient reservoir-voidage factors, I can say right now we would lose almost all of the additional 30,000,000 barrels of oil we're talking about recovering. This is essentially almost-- well its primary operation, relatively speaking, in terms of voidage efficiency anyway.

Now, we drop over here in 1977, which again is Line D,

Line (b), and we look at, moving on to the right, the 29.5 factor reservoir-voidage rate per well will have gone up to 837 reservoir barrels per day per well. That's just simply dividing Column 5, 5025, by six wells and you get that; and then moving out here in Column 8, no limit, I'm just saying that there is no limit in the sort of rules that Citgo's asking for. They're not asking for any kind of voidage limit and in effect it's unlimited. The only limit is how much gas they can inject into their injection well or what the capacities of their compressors are or mechanical problems that they might have. It's essentially no limit in terms of voidage rate whereas in looking back up in Column 8 you see that, in effect, the Commission's rules limit a non-unit tract to 552 reservoir barrels per day per well and by ruling the Commission has limited the Arco Unit to 256 reservoir barrels per day per well, and Citgo wants to go ahead and operate with no limit in the same reservoir we're in. We have already heard testimony from their witness that they are connected to our portion of the reservoir.

Okay, moving on to Line E, which is a Citgo Unit if operated under Arco Unit rules. This is simply if they're playing under the same ball game we are. In other words,

the very same rules, all the same rules. Inject all the available residue gas from their plant. Okay, we see in Line E(a) we have run through some calculations for them in mid 1974 and these, of course, are estimates because we are not there yet naturally. I want you to jump all the way over to Column 5, Line E(a) and you see the number there 1559 with an asterisk and dropping down below you see this is the average 1972 voidage rate for the combined Arco and Citgo Unit areas apportioned to the Citgo Unit on a per-well basis. We just took the total voidages for the two areas, put them together, and divided by the total number of wells, and Citgo has six wells out of 206 plus 21 which is a factor something like 2.68, 2.65 percent or something like that and so then we said okay, you can have that. We feel that this percent of the total voidage at least comes out to be 1559 because in mid '74 you see we would be operating up there in Line B at 28,668 barrels per day. Okay, so that's how their voidage was set, based on the average voidage for 1972, which is what we're limited with, but it's got to be apportioned to them on some basis and we chose a per-well basis. There are other basis which we could chose. But, anyway, if we start with this number in our voidage formula and we use

the same gas oil ratio we've been using for Citgo's properties all along, in mid '74 or 4200 cubic feet per barrel over here in Column 3, Line E(a) then the result of oil rate that they would be able to produce comes out to be 547 barrels of oil per day that we see in Column 2.

In other words, if Citgo's properties were unitized and operated the same way we are operating our Unit, with reinjection of all available residue gas, and we're living with a voidage formula calculated as I've just described, based on 1972 voidage, then they would be able to produce 547 barrels of oil per day, which is an increase on their January production of 510 and actually they have not been averaging that well on their oil rate because they've had to shut-in a well from time to time. I think the month before it was 470 or something like that. It bounces around due to their gas problems.

Okay, so that's what they would be producing. We move over here to Line E(a), Column 6, we see that the reservoir-voidage efficiency would be down to a much more respectable number of 2.85 reservoir barrels per stock-tank barrel compared to the 5.53 up here shown for them under their own plan and compared to the 0.71 that the big unit Arco operated will be operating under. Still, about

four times as inefficient as the Arco Unit but nevertheless much better.

Over here in Column 7 then this reservoir-voidage rate per well is simply the 1559 barrels in Column 5 divided by the six wells and that comes out to be 260 barrels per day. So, of course, if the Commission set this 1559-reservoir-barrel limit that would be in effect setting a 260-barrel-per-well limit and if you look back up here this is very close to what the big unit Arco Unit is operating under by Commission rule right now. We're operating under a limit of 256 reservoir barrels per day per well; they would be operating under a limit of 260 reservoir barrels per day per well, a little bit more than we've got. Okay, and then we'll just look at what would happen down the road. Again, in 1977, our estimates, comparing again to their Line D(b), we see that in 1977 they would of course still be living with the 1559 reservoir-net-voidage rate limit just like we'd be living with the 56,513 that we've got, but because their gas-oil ratio would be up to 30,000 to 1, that 1559 would result in a permitted daily oil rate of 63 barrels of oil per day. The reservoir-voidage-efficiency factor unfortunately would not be the greatest at 24.7 but essentially they're in virtual blow-down condition at this time anyway.

But, of course, you're still limiting them to the 260 per day shown over here to the right. So this simply shows you the conditions, and you can compare them to Line D(b), which shows that they would be voiding 5000 reservoir barrels per day under their own rules at 1977. Under this limit they would be limited to this 1559.

Q Now, refer to Exhibit 4 and explain that.

A Okay. Exhibit 4 says across the top, "For the Arco and Citgo Units," and shows each Unit's share of reservoir voidage compared to its share of hydrocarbon pore volume and its share of well camp. We've got some of the same kind of figures that we've been looking at before; over here on the left we say "Unit Operating Plant," and let's go through a line here to familiarize you with the situation. Under Unit Operating Plant, up here in I, this is production for January, 1974, (a) Arco Unit the daily oil rate -- these are actual numbers -- the daily oil rate 32,891 barrels, the Citgo Unit area produced the 510 that we're plenty familiar with by now in barrels per day. The net reservoir-voidage rate then, also from previous exhibits, Arco in January voided 56,319 reservoir barrels per day, Citgo 3486, the total voidage then simply adding up 56,000 and 3000 plus and we get this number down here of 59,805,

The total net reservoir-voidage rate between the two units, total of the two units; this is how much it states the two of them together voided per day on the average in actual production in January of 1974. Then Column 3 compares reservoir-voidage-efficiency factors which is simply Column 2 divided by Column 1. We see the familiar 1.71 reservoir barrels per stock-tank barrel for the Arco Unit and again a familiar 6.83 reservoir barrels per stock-tank barrel for the Citgo Unit. Then moving over to Column 4 we are figuring the voidage as shown in Column 2 in terms of percent of the total net reservoir-voidage rate for the combined Arco Unit plus the Citgo Unit. In other words, Line 1(a) which reads 94.17, was arrived at by dividing Line 1(a), Column 2, 56,319, by the total for Line 1(a) and 1(b) or 59,805; multiplying that result by 100 percent and you get 94.17. So, in other words, the Arco Unit was voiding 94.17 percent of the total reservoir space that's being voided by the two Units and then dropping down on Line I-B you see the Citgo Unit was voiding 5.83 percent of the total reservoir space being voided. Of course, the two add up to a hundred and the thing we want to do here is take a look at, first of all, the comparison over here in Column 5 with Column 4. Column 5 is percent of total

reservoir hydrocarbon pore volume for the Arco Unit plus the Citgo Unit in terms of percent, and we see that the Arco Unit -- and these numbers are based on the Engineering Committee numbers as worked up by Arco, of course, but the basic-hydrocarbon-pore-volume numbers were derived from Engineering Committee work, and I might point out that the Citgo engineers were quite active in that work in net pay picking, porosity analysis, and so on -- but at any rate the Arco Unit has 98.78 percent of the combined two Unit areas' total reservoir hydrocarbon pore volume. The Citgo Unit has 1.22 percent; the two together add up to a hundred. Now I want to compare the Citgo Unit area, Line I-B in Column 4, in January is voiding 5.83 percent of the reservoir hydrocarbon pore volume. They have 1.22 percent of the actual reservoir hydrocarbon pore volume underneath their tracts so they're voiding it at something greater than 4 times the no-drainage situation. There's yet another look at how -- and this is, of course, under current operation as it's going now -- so to get a feel for how this has affected the situation up till now, cumulative oil production from all these properties which the Citgo Unit proposes to put in this Unit through February 1st, '74, is 2,681,611 barrels of oil. This is actual oil in the tanks, measured.

The original oil in place -- based on the basic Engineering Committee work -- the original oil in place under all these green tracts that Citgo proposes to unitize, and this number I believe is in their report, one of the tables, 4,449,530 barrels of oil is their original oil in place under their tracts. So if you divide their production by their oil in place, that is divide 2,681,611 barrels of oil produced and measured in the tanks and sold through February 1st, by 4,449,530 barrels of oil originally in place, and you multiply that result by 100 percent, you find that Cities has produced 60.3 percent of their original oil in place under those tracts as of February 1st, 1974.

I might point out that the entire Empire-Abo pool as of that same time would produce about 26 percent of the total original oil in place underneath the Empire-Abo pool. So, all I'm saying is that this points out that this type of inequitable drainage situation has been going on. It has to have been going on all the time for Citgo properties to have recovered 60 percent and still be making 500 barrels of oil a day, and I might point out further that as has been heard in testimony before this Commission, the Unit, the big Arco Unit as a whole, expects, if we have a successful pressure-maintenance project, to ultimately

recover approximately 53 percent of their original oil in place from the entire Unit area and this is, if you'll notice, less than the percentage that Cities has already recovered from their properties.

Okay. Now, in Column 6 I just showed percentage of the total well count for the Arco Unit plus the Citgo Unit and this simply, we've got 221 wells, they've got six, and it works out that we've got 97.36 percent of the wells and they've got 2.64 percent of the wells.

In II, production from mid-1974 estimate, Line A is the Arco Unit and these are some numbers we've also looked at before. 40,555 is what we hope our daily oil allowable will be. If it is, and everything else is as we predicted in some of the earlier exhibits, we'll be voiding 28,668 reservoir barrels per day -- keep in mind these are estimated numbers now, naturally they're future, dealing with the future -- the reservoir-voidage-efficiency factor is estimated to be .71, our percent then -- let's don't go to that yet -- let me just drop down to II-B because II basically is comparing the Arco Unit and the Citgo Unit under the Citgo Unit operated under the Citgo Rules of production as we project for mid-1974. Okay, so let's look at Line B now, I have gone through Column 3 for II-A, let's look at

II-B which is a Citgo Unit operated under Citgo rules, sell 1711 mcf per day, injects all additional produced gas, and a daily oil rate there again 651, the net reservoir-voidage rate, again we have seen that before, 3303 reservoir barrels per day. Efficiencies, again ours will be in the area of .71 reservoir barrels per stock-tank barrel and theirs will be some 8 times as inefficient at 5.5 reservoir barrels per stock-tank barrel. We look over here and we see that an unusual thing has happened in terms of their percent of net reservoir voidage between the two Units; we look back up here at Line I-B we see that they were getting in January 5.83 percent of the combined two areas' voidage; under the Citgo rules here they will be getting 11.16 percent of the combined two-unit voidage and, of course, the main reason being our voidage will drop down so dramatically because we're injecting all available residue gas. Our voidage drops from 56,000 barrels a day in the big Unit down to 28,668. Their voidage goes up 3486 reservoir barrels per day to 3603 but the percent voidage of theirs almost doubles from 5.83 to 11.16, and percentage of voidage between two areas is the name of the game when you're talking about where fluids are going to drain where pressures are going to get lower. If you're withdrawing,

as they would be, at 11.16 percent of the combined withdrawals, and you have 1.22 percent of the reservoir hydrocarbon pore volume as shown over here in Column 5, then it's pretty obvious what's going to be happening. You're going to be pulling your pressure down in your area and since the two areas are connected the fluid's have got to move in the direction of lower pressures and, of course, it will move in that direction and it's been doing it as this 60 percent recovery, 60 percent of original oil-in-place recovery, which the Citgo tract shows already. Actually, the fact that these comparisons of oil produced to original oil in place are not the only indication that fluids have been migrating into the Citgo Unit area before now. Pressure data shows it too. They've got real good pressures on all their wells I think, just about every one take nearly every year. Of course, we've got pressures around and it shows their pressure is well down from the surrounding area of the Unit. Of course, you can't have fluids be drawing down like this without pulling the pressure down in your area. As I said before, fluids flow in the direction of lower pressure.

Okay, now the thing that will happen also, as far as recovery from the reservoir as a whole is concerned,

we've got a poor situation here right now. As far as you've been shown, they're voiding excessively in terms of their reservoir space right now, the way they are producing now, relative to the Unit, and it's going to get worse with their proposed project. I kind of look at this thing as kind of like we had a big inner tube and Arco is going to be sitting right over here trying to pump the darn thing up with a hand pump and there's a hole in that inner tube right over here where the green tracts are right now and there's somebody there working with an ice pick trying to make that hole bigger while we're pumping it up. So, it creates a problem in terms of recovery. What can tend to happen here, of course, with this pressure sinking increasingly so in this green Citgo area, is to actually retard drainage to some extent. Of course, the fluids are going to be moving laterally toward that low pressure without any question. I mean oil and gas both. But to the same extent, you know there's a tendency in a drainage reservoir for oil to move down-dip and be recovered structurally low in this, but of course a localized area of increased withdrawals retards that fluid movement and it can result in damage to recovery.

Okay, moving on to III, Production from Mid-1974.

Again we're comparing Arco Unit and Citgo Unit but this time under Arco rules. That is the Citgo Unit and the Arco Unit would both operate under the same rules, the ones we have now. So the Citgo Unit would then be injecting all available residue gas and with their voidage limit set at 1559 reservoir barrels per day, based on the 1972 voidage from both Units. Okay, we see that Citgo's voidage here in Column 2 then is 1559 resulting in an oil production of 547 stock-tank barrels per day. We're still voiding in our Unit the same 28,668 and this reduces the total voidage from the reservoir to 30,227, a reduction of about 2000 barrels in total voidage from the two Units. Naturally this is moving in a direction of more efficiency. The reservoir-voidage-efficiency factors reflect this; the same .71 for the Arco Unit, a much improved 2.85 over in Column 3 versus the 5.53 operating under Citgo Unit, Citgo rules up above. Also the relative voidage difference between the two Units, now Citgo is voiding about 5 percent of the net reservoir voidage of both units and the Arco Unit is voiding about 95 percent shown over here in Column 4. This is still a four-fold plus greater voidage than the Citgo share of reservoir hydrocarbon pore volume but nevertheless it is a much better situation than we saw up here in II Line B.

I might point out that that five percent is still essentially doubled what their voidage or per well count, forget about hydrocarbon-pore volume for the moment just for the sake of argument, and you'll see that even on well count, which could be equated to the same thing as surface acres since there's 40 acres of well here, they've got 2.64 percent of the well count and even if their pay was just as good as everybody elses in the whole Unit, and they should be entitled to no more than 2.64 which they're getting under this 1559, they're getting 5.16 of the total voidage.

Okay, let's move to IV, Production From Mid-1974, and this is just simply a postulated case of what could take place if the basis for allocation between the two Units were reservoir voidage to be the same as each Unit's share of the reservoir hydrocarbon pore volume. In other words, 1.22 percent of the reservoir hydrocarbon pore volume is what the Citgo Unit properties have. Let's plug that in and see how much oil they would be able to produce in a gas-oil ratio of 4200 to 1 in mid-1974. We plug that in we find that they would be allowed a reservoir-net-voidage rate of 354. In other words, with our Arco Unit voidage of 28,668 functioning as 98.78 percent of the total voidage, that leaves them with their 1.22 percent 354 barrels of

voidage. You back calculate with a 4200 GOR in the voidage equation and then you get that they would be able to produce 137 barrels of oil per day. You might call this the absolute no-drainage situation. The same share of the voidage their voiding exactly the same space as they have hydrocarbon pore volume, therefore fluids will not move across the boundaries between the two, and that's the note I see at the bottom of the page.

Q Do you have any recommendations to make to the Commission as far as adoption of rules are concerned for the operation of the proposed pressure-maintenance project of Citgo?

A Well, yes, basically --

Q (Interrupting) I am referring to Exhibit 5.

A Exhibit 5 is such a list of recommendations for the Citgo Empire-Abo Unit and actually the rules outlined here in summary form conform, as best I was able to line them up, to the same rules as Atlantic Richfield in the Arco Unit are living with. The rules that are in effect for the Arco Empire-Abo pressure-maintenance-project area. To enumerate them, (1) Reservoir voidage to ge determined from a formula, such as Attachment A to Order R-4549, with the table of fluid properties such as

Attachment B to Order R-4549. (2) Reservoir voidage calculated by use of the formula mentioned above to be limited to no more than 1559 reservoir barrels per day on the average 1972 reservoir voidage for the combined Arco Citgo Unit apportioned to the Citgo Unit on the basis of well count. (3) The Citgo Unit be required to inject all available plant residue gas just as the Arco Unit is required to do right now. (4) Allowables and voidages to be nominated and transferred on an individual well basis just as we're doing. (5) Injected residue gas above 90 percent of all available residue gas to be used as a gas bank for all allowable credit during times when mechanical problems diminish or prevent gas injection and balancing zero in the gas bank balance be on an annual basis. (6) Arco respectfully requests the Commission to investigate the possible requirement that some portion of any additional allowable be justified on the basis of percent of available residue gas actually injected as we have in our Order Rule R-4549 and found again in Rule 4. (7) No well in the Citgo project area which directly or diagonally offsets the well not committed to the Citgo Unit, but is using the same common source of supply, should be allowed to produce more than two top unit allowables from the Empire-Abo pool.

This is the same rule the Arco Unit has. (8) New injection and producing wells should be located no closer than 660 feet to the outer boundary of said unit or ten feet to any quarter, quarter section on inner boundary with no gas or water injection well to be located closer than 1650 feet to a tract not committed to the Unit and on which is located a well producing from the same common source of supply, and (9) submittal of an annual plan of operation with emphasis on corrosion control as injection of sour gas at high pressures can cause severe corrosion problems.

Q Now, Mr. Christianson, in your opinion will the approval of this proposed pressure maintenance project for Citgo be in the interests of conservation and will it protect correlative rights?

A Now, you're saying as proposed by Citgo?

Q Yes, sir.

A In my opinion, no, it will not.

Q State, briefly, the reasons why you reached that conclusion.

A Well, Arco and I believe separate but adjoining units in the same reservoir should each be governed by the same set of rules and we feel that such rules and practices should tend to promote added recovery from the reservoir

as a whole and that such rules, particularly as regards reservoir voidage rates, should be so written as to tend to promote equity in correlative rights between the two adjoining units. In Atlantic Richfield's opinion the operation of the Citgo Unit as proposed by Citgo would increase Citgo voidage above current levels, would tend to reduce oil recovery from the Abo reservoir as a whole and would eventually result in Citgo's production of gas-cap gas that had been originally injected by the Arco Unit. In addition, the NMOCC would then be relinquishing control over the Citgo Unit reservoir-voidage situation with this open-ended voidage situation that was pointed out here earlier. Now, I might point out in this connection, as in terms of whether or not this statement about eventually resulting in Citgo production of gas-cap gas, I think that a look at the report, plus testimony in cross examination of the Citgo Unit a while ago, indicated a number somewhere around at least 9,000,000,000 cubic feet of gas net would be voided from the reservoir in about a 12-year period I believe, perhaps it was 16, I don't know. At any rate, it was a period prior to when the reservoir as a whole would go on blow-down if the actual volume is not terribly critical. We have done a little looking, so this is how much gas will

be voided from the reservoir by the Citgo Unit as more or less testified to by the Citgo witness earlier; around 9,000,000,000 cubic feet. Our calculations based on curve pressures and current pore volumes underneath the Citgo tract indicate in the neighborhood of no more than 4,000,000,000 cubic feet of gas in place under the Citgo tracts at the present time.

Q Originally or now?

A Right now. We can't talk about what might have been there originally. We're dealing with what's there right now and this is in the neighborhood of 4,000,000,000 cubic feet of gas.

Q Where is this additional gas going to come from?

A Of course, they're talking about producing and voiding beyond what they would inject. This 1711 mcf a day, you can of course argue about how much shrinkage beyond that there will be, but the 1711 is what they definitely said they would sell and that is going to add up to 8,000,000,000 or so I imagine over this time period we're talking about. Oh, anyway they're going to produce 8, 9 billion extra gas voided from the reservoir and there is about 4,000,000,000 in place under their tract right now. Well, of course, this ties in with some of the voidage

comparisons I was making earlier, and the only place that gas can come from is the big unit which adjoins it and which is connected, which I certainly believe and which we've had testimony from the Citgo witness that the two unit areas are connected.

Q And that in itself, in your opinion, is a violation of correlative rights?

A Yes, sir, I would say that it is, in my opinion.

Now, we move ahead further in this summation. We feel that if the Citgo Unit is governed by the same voidage formula and controls as the Arco Unit it will give the NMOCC a means to reduce Citgo Unit reservoir voidage below present levels, admittedly somewhat inefficient as we have seen here, resulting in more efficient operations of the reservoir and tending to increase the ultimate oil recovery from the pool and I mean that the same thing that operate on them, when you set them a voidage limit like you've set us a voidage limit, then they're going to be going out there and spending money to work over wells and try to get as low in the reef as they can and produce at as low a gas-oil ratio as they can because they've got that 1559 barrel a day voidage number staring them in the face and we've got a number staring us in the

face and believe me it creates quite an incentive to go for the low-ratio wells in terms of production, and this is what you'd want to do in this reservoir if you want to maximize ultimate recovery. So setting a voidage limit is quite a carrot in front of an operator to try to get his ratio down as low as possible whereas in a gas-siphon type operation this is not as critical. About the only thing that's critical is how much gas can you get in that injection well. Now, okay, as I wanted to say again, in setting a reservoir voidage limit for the Citgo Unit Atlantic Richfield recommends the NMOCC use its best judgment after a complete review of the facts, however, we strongly recommend a voidage limit no greater than 1559 reservoir barrels per day be granted to the Citgo Unit, and just as is the Arco Unit the Citgo Unit should be required to inject back into the Abo gas cap all available plant residue gas. That completes my summation.

MR. HINKLE: We would like to offer into evidence Exhibits 1 through 5.

MR. STAMETS: Is there any objection to Exhibits 1 through 5?

MR. KELLAHIN: No objection

(Whereupon, Exhibits 1 through 5 were marked for identification and admitted into evidence.)

MR. STAMETS: Are there questions of this Witness?

MR. KELLAHIN: Mr. Examiner, I do have some questions of the Witness.

CROSS EXAMINATION

BY MR. KELLAHIN:

Q Mr. Christianson, I believe at the outset you said that our Exhibits show the Arco Unit is structurally higher than the balance of the Arco Unit, is that correct?

A Yes, the Citgo Unit is structurally higher than what?

Q Than the offsetting acreage to the south?

(Whereupon, a discussion was held off the record.)

A I'm sorry, would you repeat that?

Q I believe you said that the Arco Unit is structurally higher, I mean the Citgo Unit is structurally higher than the acreage offsetting it to the South?

A It's structurally higher than the down-dip acreage I'll say.

Q Where is the down-dip acreage?

A It's on the level with the acreage along the strike of the reef, that is to the northeast and the southwest.

Q Where would that be in relation to the acreage directly offsetting the Citgo Unit?

A Where would that be?

Q Yes.

A Well, it would be on our Unit map in locations H-12, I-12, J-12. You're structurally level to the -- this is a real general sort of thing -- the general strike of the structure is northeast to southwest along the top of it.

(Whereupon, a discussion was held off the record.)

BY MR. KELLAHIN:

A (Continuing) As I understood the question, Mr. Kellahin, you wanted to know what specific areas of the Unit would be structurally approximately level to the Citgo Unit, is that correct?

Q Yes, sir.

A Well, let me say basically that I think this is probably more important than identifying any particular tracts, but the strike of the structure runs more or less

northeast and southwest across the top part of the reef and so the properties to the northeast of the green Citgo area and to the southwest of the green Citgo area would be essentially structurally flat with the Citgo area. The properties to the south and southeast of the green Citgo area would be down-dip from the Citgo area.

Q Well now, taking for example the Amoco 1861-B and J-14, would that be essentially flat to the offsetting --

A (Interrupting) Is that off our Exhibit 2 or what?

Q It's off your Exhibit 1.

A Exhibit 1? Amoco what now?

Q 61-B and J-14.

A Yes, that is J-14; old tract 61-B.

Q Yes, sir. Is that essentially flat to the offsetting well to the north?

A No, it's probably down structure. I imagine your structure map will show. Now, you've got a map on top of the reef. I'm sure that it's down structure somewhat from the green property to the north.

Q That's not a steeply tilted structure, however, is it?

A Well, it depends on how you define steeply; no

it's not really, not on the basis of the reef and that's really what's controlling the gravity drainage situation, it's -- I don't know what -- 5 or 6 feet. Heck, I've testified to it at one time but I can't remember. Well, the base of the reef is dipping some five or six degrees. Don't pin me to the wall on that.

Q With that degree of dip, we'll say five or six detrees, and that is not direct dip from the Arco Unit -- I mean the Citgo Unit -- then where is your down-dip drainage occurring?

A Down-dip drainage?

Q Which you testified to.

A Oh, it's occurring in this general area. Down-dip drainage is moving sort of south southeast away from the Citgo tract.

Q So the Citgo tract has been drained in the past, has it not?

A I can't possibly see how it can be when you look at the numbers I just mentioned earlier that it has produced 60 percent of its original oil in place.

Q We'll come to the 60 percent later, just answer my question. Do you feel that any down-dip drainage has occurred from the Citgo Unit?

A If any occurred it was oil that was there temporarily on its way from some other property to another property which occurs in a gravity-drainage reservoir. When you've got these kinds of recoveries compared to the average for the Unit, the net drainage has got to have been in Citgo's favor. It's not hard to explain; you got in early, you've got real good wells, there's good permeability but they don't have a whole lot of pay so there's not a lot of oil in place, but that rate is really there. You guys, and Carper before you, have been able to really pump the wells, make the good rates, produce the maximum that the Commission allowed always, and as a result you've had that pressure sink that shows up in every annual pressure survey, and when there's a pressure sink there is movement of fluid, oil and gas, in the reservoir in the direction of the low pressure.

Q Have you finished?

A I beg your pardon?

Q Have you finished?

A I'm sorry.

Q Have you finished?

A Yes. I guess that's all. I might as well stop there as anywhere.

Q I would appreciate it if you would just answer the questions. If there is something else that ought to be brought out Mr. Hinkle is quite capable of asking it.

A Yes, sir.

Q Now, you say that Cities Service got in there early; how do their wells compare in date to the wells immediately offsetting which you have on your Exhibit No. 2?

A I really don't have the exact times of completion except, you know, I know which well No. M-14 was the initial discovery well, which is the old Amoco-Malco A-1, you see it's immediately south of the Citgo property and development moved north and northeast around that well. They very quickly drilled, I think, the Number 2 and found they're right on the edge of the down-dip edge of the reservoir so they start moving back to the north. As a result, your properties, you didn't operate them at that time, I believe Carper did, had offsets pretty early in the game so you moved in and started drilling and started producing.

Q The date of production then really doesn't have anything to do with the drainage, does it?

A Date of production?

Q Yes, sir.

A Well, not necessarily, no, but what does have something to do with it is how much oil you have produced to date compared to how much oil you've got in place under your tract, which is 60 percent as of February 1st, 1974.

Q Mr. Christianson, I'll come to the oil in place later. Let's just talk about --

MR. STAMETS: Mr. Christianson, we have heard very considerable, lengthy testimony and it's getting late in the afternoon; we have some other people waiting to get on. If you would make your answers as short as reasonably possible, then if Mr. Hinkle has anything on redirect he can take care of it then. I certainly would appreciate it.

MR. CHRISTIANSON: Yes, well I see no point in wasting time talking about when particular areas were developed especially. I just threw that in as one I knew that Carper was --

MR. HINKLE: (Interrupting) Just answer specifically his questions without amplifications and reasons, and if necessary we can go ahead on rebuttal.

MR. KELLAHIN: I don't want the Examiner to feel that I'm wasting time; the Witness did testify that we got in there early and caused the drainage.

MR. STAMETS: Get on as quickly as you can.

MR. CHRISTIANSON: Getting in there early had very little to do with it; you always produced within the legal limits.

MR. KELLAHIN: Mr. Christianson, I didn't ask you a question.

MR. CHRISTIANSON: Okay.

BY MR. KELLAHIN:

Q Now, referring to your Exhibit No. 2, you have nine wells listed, Arco's Empire Unit directly offsetting the Citgo Unit and three of those are shut-in. What was their production of oil, daily rate, immediately before the shut-in?

A I don't have that information, I'm sorry.

Q They were shut-in because they're high GOR wells?

A Oh heck, I could go through -- actually I've got a tabulation. Some of them were not high-rate wells. I've got our computer print-out here somewhere if you really want to get into it, and I can give you the latest test data, oil, gas and water on each of those wells. Well this is what we're --

(Whereupon, a discussion was held off the record.)

BY MR. KELLAHIN:

Q You can't give me the production immediately before, detailed production?

A I can give you what the wells tested for in the latest 24 hour test we had prior to shutting them in if you care to have that.

Q You can give it to me just on the H-12, I-12 and the H-17.

A The H-12, the I-12 and the what?

Q H-17.

A H-17. Okay. This thing is what we turn into the Commission every month and it's 12 feet long. Okay, let's see. On the H-12 the oil was 42, no water, and the gas-oil ratio was 6524 cubic feet per barrel; on the H-17 the 24-hour test was 140 barrels of oil per day, gas-oil ratio 5293 cubic feet per barrel; on the I-12 the latest test was 180 barrels of oil per day, the gas-oil ratio 1717 cubic feet per barrel.

Q Do you know whether the wells were actually being produced at that rate before they were shut-in?

A Were what?

Q Whether those wells were being produced at that rate before being shut-in?

A I would have to go to the September production; those wells were not operated by Arco. I'd have to go to the Commission's September --

Q (Interrupting) You don't know?

A (Continuing) Schedule. I don't know exactly, however I doubt very seriously if Amoco was shutting-in under competive operation, was curtailing or shutting-in any high-oil-rate wells.

Q Now, with reference again to your Exhibit No. 2 you show production of something over, well, 284 barrels per day for three of the wells, J-13, 14 and 15?

A Yes, sir.

Q In you opinion is that causing any drainage to Cities Service?

A Drainage from Cities Service?

Q Yes, sir.

A Not when you look at the reservoir voidage.

Q I'm not talking about reservoir voidage, I'm talking about the migration of oil.

A That's what I'm talking about. The migration of oil has to do with what percent voidage you're voiding in terms of your --

Q (Interrupting) It also has to do with pressure --

A (Continuing) Space between the two wells. That's right, it also has to do with pressure.

Q Now those wells are not down structure are they?

A Wells J-13, J-14 and J-15?

Q Yes, sir.

A Yes. Actually, possibly the J-13 might be about flat to your lowest structural well which should be your Wright A State No. 4, and the other two wells you mentioned, the J-14 and J-15, without question, in my opinion, are lower on the structure than any Citgo well.

Q So, on the basis of gravity alone there could be drainage couldn't there?

A I don't necessarily concede that there could be. I'm going to have to get back to what reflects drainage in a reservoir situation and that is realtive voidage, relative to how much volume you've got under your reservoir.

Q You're not considering at all oil in place migrating from one place to the other in that connotation then, are you?

A Well sure it's migrating. It's migrating all over out there. We can't control that especially, and it's migrated, of course, in the direction of low pressure.

Q Do you know what your reservoir voidage was prior

to the formation of Unit on these nine wells? Have you calculated that?

A No, I don't think I've got that although -- no, we haven't got that.

Q You have taken the wells in the Cities Service Unit, the Citgo Unit on the basis of their present production in all of your Exhibits, have you not?

A January, 1974, was on the basis of their present production.

Q And that's the figure you've used throughout your testimony?

A No, in going through I mentioned in each case where I was making some type of projection about what would be produced in the future; I've got on the line a little "est." which means "estimate" and there we were estimating both the oil rate and the gas-oil ratio that your tracts would be averaging.

Q In making your estimate did you give any consideration to the transfer of allowables on the Citgo Unit for the purpose of reducing GORs?

A Only to the extent that I feel with the situation you have out there now, that is as shown in my Exhibit No. 2, all your wells are high-ratio and based on the performance

I've seen of other high gas-oil-ratio wells I don't feel that you have a whole lot of option or a whole lot of room available to really transfer and lower your ratios to any great extent. I think you will get some low ratio early because you'll go to a higher rate on your two low-ratio wells and this will lower your ratio, but within a few months it should be back up to this trend, this 4200 which we used.

Q Just on the basis of the figures you have on your Exhibit, the Magruder A No. 13 could be curtailed for the purpose of reducing the GOR, couldn't it?

A Could be curtailed?

Q Production be curtailed.

A Are you talking about Exhibit 2?

Q I'm talking about Exhibit 2.

A The Magruder A-13 could be curtailed and what?

Q To reduce the GORs.

A I don't know whether the GOR might come down. You're not producing at a tremendously high rate now; 54 barrels a day, and it's got a 4800 gas-oil ratio.

Q Some of the others could be curtailed to transfer allowables to lower GOR wells, could they not?

A Yes. You mean you could say, shut-in, say

curtail or shut-in the Magruder A-13?

Q Yes.

A Oh yes, you could improve your situation. I was taking into consideration in these estimates that you probably would have a short-term improvement in gas-oil ratio, but I think it will start moving back up and actually 4200 to 1 is not a high ratio compared to the way your ratios have been going up, based on historical increases over the past few years.

Q Now, turning to your Exhibit No. 3. Here again you have used the January Cities Service production as the basis for this, have you not?

A No, January production stands all alone on its line. That's just what you're doing in January.

Q I see.

A It's not the basis for anything else except I've been comparing back and forth to what we were doing in January in our Unit.

Q How many producing wells are in Arco's Unit at the present time?

A I believe about 144; I might be off one way or the other.

Q Do you use 221 wells to average all of your

computations?

A This is right. This is how many we had at the start. We've shut-in the difference between 221 and 144; at least that many.

Q Well, that would change the Column 7 figure, reservoir voidage rate per well?

A No. It's entirely on how you want to define it. We're talking about per well in terms of what might be used for proration. I'll bet you you're not going to fail to use every one of your six wells to get all the allowable you can. You're not just transferring allowables from one of your wells you just finished asking about.

Q Does your figure include injection wells, your 221 figure?

A No, it doesn't.

Q It does not include that?

A It does not include injection wells.

Q On Citgo Unit you make a 1977 estimate. Hve you made such an estimate on the Arco Unit?

A Yes, as a matter of fact I have, would you like to hear it?

Q I think in the interests of time I would ask that you supply that to the Commission and send me a copy of it

rather than my going into it at this moment.

MR. KELLAHIN: Is that satisfactory, Mr. Examiner?

MR. STAMETS: That's satisfactory.

MR. CHRISTIANSON: You want the 1977 Arco Unit estimated performance?

MR. KELLAHIN: On D and E on your Exhibit No. 3.

MR. CHRISTIANSON: The same parameters as are on Exhibit No. 3?

MR. KELLAHIN: That is correct.

MR. HINKLE: Do you want us to send that directly to the Commission and a copy to you?

MR. KELLAHIN: I would appreciate it, yes, sir, if that is satisfactory.

BY MR. KELLAHIN:

Q In connection with your reservoir voidage I assume you have taken credit for the gas injection on the Arco Unit?

A Yes, I'll say.

Q And you are giving Citgo credit the same way?

A Oh yes.

Q On the same basis?

A On the same percentage.

Q I believe you testified in connection with

Exhibit 3, that the Commission, by adopting a GOR of 2000 to 1, had set an allowable reservoir voidage?

A Well, in effect it is a reservoir voidage limit, yes.

Q Is it your testimony then that Cities Service is violating the Commission's rules?

A I'm only pointing out what I calculated. No, you're not avoiding the rules as such, although you were over this month, but the Commission allows you some grace.

Q They allow us the 2000 to 1 ratio don't they?

A Right, and you have say, you can get over --

MR. STAMETS: (Interrupting) Mr. Christianson, this is not answering Mr. Kellahin's question. A simple yes or no will be sufficient. This is adding to the record without benefiting the record.

BY MR. KELLAHIN:

Q The Commission hasn't actually set a reservoir-voidage rate of 552 reservoir barrels?

A No. what they have said is what you said, 2000 and 142. 2000 cubic feet of gas per barrel of top-allowable oil produced and the top allowable is 142 barrels a day per well.

Q When did you start injection in this Unit?

A We haven't started yet as I mentioned in my testimony.

Q So anything you had in regard to the Arco Unit in January, 1974, has no credit for injection?

A Oh, that's right. No. It's strictly as it stands now shutting-in high gas-oil ratio wells producing low gas-oil ratio.

Q And that's the sum and total of what you have done?

A This is what we have done to date.

Q As I understand you will be injecting gas by June, is that right?

A That's right. The equipment is going in out there right now.

Q And that's the basis of your Column B on Exhibit No. 3?

A Exhibit 3, Line B?

Q Yes, sir.

A Yes, that's right. We expect to be, as it says here, injecting all available residue gas.

Q Will all available residue gas be injected by that date?

A Right.

Q And that means 68 percent of all produced gas, I believe, according to your testimony?

A As I testified previously we can't be pinned down to an exact percentage because of various factors which I testified to previously before the Commission. I don't know whether we want to go into them now, but they're on the record. It would be around that number.

Q Now, you say in your testimony that Citgo will only be injecting 34 percent. Are you familiar with Table No. 4 in our Exhibit?

A No, I'm not.

Q Doesn't that reflect that 63 percent of the gas is going to be injected from the outset?

A How much?

Q 63 percent?

A I don't know what -- you're talking about for the 1974?

Q '75.

A I beg your pardon.

Q 1975.

A My calculations don't deal with '75 so we're talking about apples and oranges.

Q Well, you just made the flat statement, Mr.

Christianson, as I understand you, and if I'm in error correct me, that at the outset and during the early life of this project Cities Service will only be injecting 34 percent.

A This is what you will be injecting at a gas-oil ratio -- we have to define how I calculated this.

Q Okay. How did you calculate it?

A Based on oil-gas ratio of 4200 to 1 a daily oil rate of 651 barrels per day selling 1711 mcf per day, losing 10 percent of the rest above that due to various factors which were discussed earlier, then your net-gas injection will be about 34 percent of the total gas produced.

Q And that's just based on the figures you've used on the present operations of Cities Service as of January, 1974?

A No. No, that's based on what we're forecasting for you for mid-1974.

Q Well, going back, you have an oil production, you have gas production, you've got a GOR. Those are all based on January, 1974?

A No.

Q What are they based on?

A It's based on our estimates of what you will be able to make in mid-1974.

Q Did you hear the testimony this morning that we wouldn't inject until 1975?

A Well, you appreciate that we were unable to, we didn't have copies of this report. In fact we couldn't find out scarcely anything about what you were planning and so we had to make some estimates and we felt that this number is probably, I mean that this is early in terms of when you actually get the equipment in there, but what we're trying to do here is show the Commission the relative situation and the quibbling about dates is in my opinion immaterial.

Q Yes, sir, I would agree, quibbling about dates is immaterial, but our Exhibit, Table No. 4 does not agree with your conclusion, does it?

A I wouldn't say that. I don't think they're the same, they're not the same. For example you've got the whole year 1974 all in one lump; you've got '75. I don't know, I would have to study it. I can't give you an opinion --

Q (Interrupting) You don't know at this point?

A I don't know what you have done there really.

MR. STAMETS: Mr. Christianson, on Table No. 4 for the year 1975, the Citgo Exhibit indicates they'll produce 1543 mmcf; it indicates they will inject 1022 mmcf. Just eyeballing that, what percentage would you say that is gas injected?

MR. CHRISTIANSON: That's 60 percent or so.

MR. STAMETS: Thank you. That's all I need to know about that.

MR. CHRISTIANSON: 1000 over 1600; it would be somewhere around 60 percent.

BY MR. KELLAHIN:

Q Now, let's get into some questions about this reservoir voidage. You have in your Exhibit No. 4 used percent total of reservoir hydrocarbon pore volume for Arco's Unit and Citgo's. Your pore volume calculation, is that based on that 1970 Engineering Study?

A It's based on the Arco report, really, which simply uses the 1970 Study.

Q You made your computations from that Study, though, is that correct?

A Right. Well, it's actually from parameters that were used in unitization; oil in place and so on.

Q I understand that, that was my next question,

but to make this perfectly clear, the parameters used in unitization were in your reservoir study based on the 1970 Engineering Study, is that correct?

A Oh, they were, the parameters used in the basis for the relative percents of oil in place were the Engineering Committee Study done in 1970.

Q And that's the theory that you've used in your engineering report in your Exhibit No. 4?

A Right, in terms of percentages.

Q In terms of percentages. That is the basis of the figures which you were going to assign a participation factor to Cities Service in the Arco Unit, is it not?

A What, do you mean the hydrocarbon pore volume?

Q Yes, sir, part of the basis for the figures.

A Actually, no, not really; it's just here for comparison.

Q I'm not talking about this particular Exhibit at the moment, Mr. Christianson. You're talking about hydrocarbon pore volume.

A Yes.

Q And you say that was one of the parameters in your Unit?

A That's right.

Q And that was for determining the participation factor to the various owners in the Unit?

A Oh, yes.

Q And that was what you proposed that Cities Service accept?

A That's right.

Q And they did not accept it?

A That is correct, for these tracts that are in question.

Q And did you participate in any of that --

A Engineering?

Q Yes, sir.

A Oh, yes.

Q Did you participate in the negotiation of the Unit on the basis of participation?

A Yes, sir, I did.

Q And was it not a fact that Cities Service declined to join the Unit because they felt that you did not assign them sufficient reserves?

A I think that was one of their stated reasons, yes.

Q Now, in connection with that, the study, that 1970 Study, and I don't expect you to remember the figures

exactly, but it showed primary reserves of 609,914 barrels, does that sound approximately right?

A Are you talking about the October 2, 1970 Study which is the Arco study?

Q Yes, sir.

A I imagine. I can't remember. I haven't really checked; you might be entirely right, I wouldn't quarrel.

Q And would you quarrel with the fact that during the following three years Cities Service produced 715,079 barrels in that same tract?

A No, I couldn't quarrel with that either.

Q Would that seem to indicate that the pore volume calculation used was incorrect?

A No, I would say that had nothing to do with the pore volume calculations.

Q That's recovery.

A That's production versus predicted production.

Q Well, you were attempting to assign them on the basis of that Study, 609,000 barrels, were you not, primary?

A Yes, but this was based on projections by two different numeric models, one run by Arco and one run by Amoco, and directly original oil in place, or oil in place, or pore volume under you tract had very little to do with

what the model recoveries were from your wells.

Q The pore volume did enter into the calculations of the reserves to be assigned to that tract, did it not? I think you just testified to that.

A Yes, there were other parameters that involved reserves and pore volume entered in. In fact primary recovery was scarcely in some of the parameters that did get into the calculations.

Q But then you testified that Cities Service had recovered 60 percent of the oil under their tract?

A That's right.

Q Is that a normal recovery for the Empire-Abo?

A No, as I say the average recovery for the entire Empire-Abo Unit is about 26 percent right now of the total original oil in place under the whole area.

Q Wouldn't the 60 percent recovery seem to indicate that there is something wrong with the calculations under the Cities Service tract?

A Not to me.

Q You think they actually recovered 60 percent?

A Oh, yes, sure. That fluid can move around out there.

Q Do you think they're going to recover 100 percent?

A Well, do you want to know, for example, one of the reasons why I feel this way or would that be dragging things out?

Q Are you testifying --

A (Interrupting) There is a separate independent set of data that confirms that there is nothing wrong with the oil in place under your tract.

Q That's not before the Commission.

A We don't want that, okay.

Q You testified that pressure data shows that Cities Service wells are draining. What pressure data are you talking about?

A I'm talking about the annual surveys that are taken on all the wells. Annual pressure surveys that are taken on the wells.

Q What pressure threshold are you talking about across the lease line at that point?

A Pressure threshold?

Q Pressure decline, pressure difference?

A Oh, I don't know, it's on the order of 150 pounds with the Citgo properties being lower.

Q Now what wells are you talking about on those pressures?

A Virtually all the Citgo wells. The closer you get to the main unit in general the higher the Citgo well pressures are. As you move toward the back row of Citgo wells they are at a lower pressure than the two good wells down there.

Q Now, you say the back row, are you talking about the north end?

A Yes, I'm talking about the north row of four wells; you can make the general statement about them that their pressures on the average would be somewhat lower than the two southernmost Citgo tract wells.

Q That would indicate then that any migration is coming in from the north, not from the south wouldn't it?

A Not to me, no. It just means that the pressure sink is greater back there. It's moving across; it can be moving across the southernmost wells toward the northernmost wells.

Q Those wells that are producing 284 barrels a day, do you have any pressures on them?

A Not recently, no.

Q What do you mean by not recently?

A But the latest survey -- of course they weren't producing 284 -- but at the latest survey their pressures

were higher than the average for the Citgo properties.

Q They were higher?

A Oh yes.

Q They directly offset the Citgo properties?

A Yes, sure. I'm not sure which of those wells have actually been pressure-tested recently.

Q How much higher are you talking about? Do you have any figures?

A I don't know. I would just say higher; I don't think it's tremendously important, the exact amount.

Q Now, I believe in your recommendations you said that Cities Service should process the gas. What plants are available for processing?

A There are at least two plants available right at the moment to process gas.

Q Whose are they?

A The Empire-Abo plant and the Artesia plant.

Q Well now, who owns those plants?

A Phillips I believe owns, I'm not sure whether complete, most, probably all of the Artesia plant. The Empire-Abo plant is owned 50 percent by Amoco and they operate it, and 50 percent by Arco.

Q I believe in connection with Exhibit No. 5 you

added some information to the effect that there were 4,000,000,000 cubic feet of gas under the Citgo Unit at the present time?

A I beg your pardon?

Q I believe that you testified, it has nothing to do with Exhibit 5, you were referring to it, but I believe you testified that there was 4,000,000,000 cubic feet of gas under the Citgo Unit at the present time. Is that your testimony?

A Yes, sir.

Q Did you make a calculation on that?

A Yes, sir.

Q What did you base that calculation on?

A I beg your pardon?

Q What did you base that calculation on?

A Well, we actually looked at two different ways. We made an estimate where the gas-oil contact might be and then, based on numeric model indications of what the gas and oil saturations were above and below gas-oil contact. We calculated the amount of solution gas based on the current pressures that you've got in there and the amount of solution gas in place, which I think at current pressures is around 713 cubic feet per barrel, and then using a

gas-storage factor or a gas-formation-volume factor in terms of reservoir barrels per mcf, we estimated or calculated what volume of free gas was there, and when we made this calculation, adding in solution gas and free gas we got 3.78 billion cubic feet in place. Again, this is using hydrocarbon pore volume that you've been talking about. I'll go ahead and save you that trouble.

Q Thank you.

A Okay, then we made one more calculation. We just made the bald assumption that all that hydrocarbon pore volume was occupied by gas, and when we made that assumption we came out 3.72 billion cubic feet of gas if all your pay, under your tracts, is gas saturated then you've got 3.72 billion and if there's a gas oil contact there, which of course we think there is, and the saturation varies as much as the numeric model said they would, then you've got 3.78 billion so we said you've got certainly somewhere in the neighborhood of 4,000,000,000 cubic feet of gas in place under that tract right now.

Q You've already answered my other question in connection with that, so turning to Exhibit No. 5, the last paragraph, you called for emphasis on corrosion control, that the injected sour-gas-type pressures can

cause problems. Has Arco Unit sweetened their gas? Are they planning to remove the sulphur?

A Yes, actually the gas will be sweetened all through our plant, yes.

Q Is that a normal operation for a pressure-maintenance project?

A Well, no, it probably isn't. We've got the sweetening facilities.

Q If you didn't have that you wouldn't sweeten it, is that correct?

A Well, that's probably true.

Q The price of sulphur would hardly warrent it, would it?

A That's probably true, although I'm not an expert in that area.

MR. KELLAHIN: That's all I have, thank you Mr. Examiner.

MR. STAMETS: I have one question myself. If Cities Service is allowed a unit allowable equal to the top unit allowable for oil and the top unit casing-head allowable times the number of wells, durin; the period when no gas is being injected, will drainage occur from the Arco Unit into the Cities Service Unit?

MR. CHRISTIANSON: It it's allowed a top what?

MR. STAMETS: If the Unit is assigned an allowable equal to the top unit oil allowable for a well in the Empire-Abo field the top casing-head allowable times the number of wells. Before the gas is reinjected, would this cause drainage from the Atlantic Richfield Unit into the Cities Service Unit?

MR. CHRISTIANSON: In essence that sounds to me as if, getting back to reservoir voidage, you're talking about 552 barrels a day per well; moreorless, no matter how you slice it, oil or gas, that's how it comes out in terms of reservoir voidage. Of course, this is essentially what is going on right now if we stay within --

MR. STAMETS: (Interrupting) Can you answer yes or no?

MR. CHRISTIANSON: Not without doing some calculations. Let me give you my best estmate. I think that it will be a condition about like is going on now, and as my testimony has shown, they are voiding more reservoir space now than their share of hydrocarbon pore volume or their share on well count.

MR. STAMETS: That would be a yes answer.

MR. CHRISTIANSON: And so, in my opinion, the

tendency would still be for drainage to occur from the Arco Unit toward the Citgo Unit.

MR. STAMETS: Are there any other questions of this Witness? He may be excused. Is there any other direct testimony in this case?

I would like to ask just a few brief questions of Mr. Lowrey.

(Mr. Lowrey is recalled)

FURTHER EXAMINATION

BY MR. STAMETS:

Q Mr. Lowrey, I note that the proposed injection well is at a non-standard location.

A That is correct.

Q Is this to try and get the well nearly in the center part of the Unit?

A Yes, sir. We wanted to get up on the structure as far as we could and still comply with the 1650 distance from the Unit.

Q And that's the reason for the non-standard location?

A Yes.

Q Now, there was some discussion about the possibility of drilling additional injection wells. Do you

have a proposed minimum distance from the Unit boundary line that those should be drilled? In the original Atlantic Richfield Order they were prohibited from drilling within so many feet of the outer boundary of the Unit. Have you got a proposal such as that?

A No, we're not recommending anything different than that. We do not plan any other injection wells at this time except one.

Q If you would drill another one where would it be located? High in the center?

A As high on the structure as we could, yes.

Q Would Cities Service file a pressure-maintenance report in some sort of a form which would indicate the allowable desired for the next proration period on each of these wells?

A Yes.

Q What kind of treatment or equipment would you use in your injection well to prevent sour-gas corrosion?

A That has not been determined to be a severe problem as yet. This would just have to be an operational problem that's taken care of when the time comes. There may be a severe corrosion problem and it may have to be sweetened, I don't know.

Q What would you do, install a corrosion two-pond type system?

A Yes, we would have to determine what kind of problem we had first.

Q And this would be reported to the Commission?

A Yes, if they desire.

MR. STAMETS: Any other questions of this Witness? He may be excused.

Anything further in this case?

MR. GRADICK: I would like to make a short statement.

MR. STAMETS: Mr. Gradick.

MR. GRADICK: My name is Gene Gradick and I'm a Petroleum Engineer Senior Grade with Amoco Production Company and we have a working interest in the Empire-Abo Unit.

We support Arco's position and we feel that conclusion has been shown that drainage has been occurring in favor of Citgo's proposed Unit. We have been aware of this occurring but were willing to pay the price in view of the fact that Citgo was making an effort to unitize these properties. We felt that they would initiate a program to protect correlative rights and promote conservation,

however, it is evident now by their own testimony that that program will not promote conservation and will actually increase the existing inequitable drainage. If Citgo's proposal is adopted, the Empire-Abo Unit must carefully consider means to protect its correlative rights and should a revision in Arco's plan mold of operations result, then potentially substantial oil reserves can be lost.

MR. STAMETS: Other statements?

MR. KELLAHIN: I would like to make a brief statement.

MR. STAMETS: You certainly may.

MR. KELLAHIN: If the Examiner please, there was some testimony that the Witness didn't have access to this report. It was made available to their management, whether he got it or not; I assume he didn't; he so testified.

In connection with the question of drainage, the statement just made said there was conclusive proof of drainage. There is no proof whatever of drainage in this record. There is no pressure information offered. The Witness merely made a statement that the pressures down to the south were higher than those to the north. How much higher, what the pressure is, whether it would be

offset by any gravity drainage or not, we have absolutely no information so the pressure and drainage must just have to be completely disregarded for there is nothing in the record to support it.

Now, if Cities Service continues to operate their properties under the present rules,they would be in a far better position than under Arco's proposal, so why unitize it or why have pressure-maintenance programs? Cities Service feels that it is essential that this gas be reinjected into this reservoir and that in the interests of an efficient operation, over the long life of this pool, their proposal will actually result in less reservoir voidage than the present program. Now, there has been a lot of confusion about how much Cities Service is going to reinject. I think our Table No. 4 in the Exhibit clearly shows they are going to reinject 63 percent of all of the produced gas. Arco's testimony in the previous case indicates they're going to reinject approximately 68 percent of the produced gas so when we're talking about how much is being reinjected here we're talking about a pretty small difference between the two projects.

Now, when we get into this question of the rights of Cities Service to produce the volumes they're talking

about producing the thing always comes right back to Arco's calculations of the reserves in place under Cities Service tract based on their hydrocarbon-pore-volume-calculation which was rejected by Cities Service as their reason for not joining this Unit in the first place and there is testimony in the record of the previous case to this effect. We don't agree with their calculation and everything that has been offered here today is based solely on that calculation insofar as the voiding of the reservoir space is concerned. We don't feel that Arco has made a case against Cities Service in this matter. They haven't shown that they're going to be damaged in any way at all. Certainly if they haven't shown any drainage has occurred or is going to occur as a result of what Cities Service proposes, so on that basis we ask that the Application of Cities Service be approved. We made our proposal, we made a rather definite proposal. Actually we don't feel there's any room for compromise between the two proposals. Naturally we want to have an operation that will be compatible to that of Arco, but it doesn't necessarily mean that we're going to operate in exactly the same fashion, either, as long as the end result is going to come out approximately the same.

MR. HINKLE: I would like to make mine very short.

In this case we've got the big unit and the little unit, no question but what they're in the same reservoir. The Arco Unit is operating as has been demonstrated, we have had hearings before the Commission here to show that it is operating very efficiently under certain rules. Now, they come in, Citgo, and want to operate their Unit under different rules. I think it has been clearly pointed out by the testimony of Atlantic Richfield in this case, the operator, that to operate under the proposed rules will violate correlative rights. Now, the only testimony in this record that Cities Service has to support the fact that it would not violate correlative rights is simply the statement of Mr. Lowrey, and in his opinion, it would not. Now, I think the burden is on Cities Service to point out specifically where the rights would be protected, and we have, I think overwhelmingly shown that correlative rights would be violated. That's all.

MR. STAMETS: Anything further in this case?

We will take the case under advisement.

STATE OF NEW MEXICO)
) SS.
COUNTY OF SANTA FE)

I, RICHARD L. NYE, Court Reporter, do hereby certify that the foregoing and attached Transcript of Hearing before the New Mexico Oil Conservation Commission was reported by me, and the same is a true and correct record of the said proceedings, to the best of my knowledge, skill and ability.

RICHARD L. NYE, Court Reporter

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 5212, heard by me on 4-10, 1974.

Examiner
New Mexico Oil Conservation Commission

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NEW MEXICO OIL CONSERVATION COMMISSION

EXAMINER HEARING

SANTA FE, NEW MEXICO

Hearing Date APRIL 10, 1974 TIME: 9 A.M.

NAME	REPRESENTING	LOCATION
J. E. Sperling	Modrall Sperling et al	Alb.
[illegible]	Cities Service	Midland
E W Kenney	Cities Service	"
Wm. Burt	Montgomery et al	Santa Fe
John Seery	Mobil Oil	Midland
[illegible]	[illegible]	[illegible]
E. R. Kendrick	El Paso Natural Gas	El Paso
Don A Baker	El Paso Natural Gas Co	El Paso
Neil J. Beck	" " " "	" "
Randy J. Woodward	[illegible]	[illegible]
Jason Kellahin	Kellahin & Fox	Santa Fe
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