NEW MEXICO OIL CONSERVATION COMMISSION

STATE LAND OFFICE BUILDING

STATE OF NEW MEXICO

CASE NO. 10508

IN THE MATTER OF:

Case 10508 Being Called By the Oil Conservation Commission on Its Own Motion Pursuant to the Provisions of Division Order No. R-6446-B, Which Approved the Bravo Dome Carbon Dioxide Gas Unit Agreement in Harding, Union and Quay Counties, New Mexico.

BEFORE:

CHAIRMAN WILLIAM LEMAY

COMMISSIONER GARY CARLSON

COMMISSIONER BILL WEISS

FLORENE DAVIDSON, Senior Staff Specialist

State Land Office Building

Thursday, July 16, 1992

REPORTED BY:

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Certified Shorthand Reporter
for the State of New Mexico

ORIGINAL

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I N D E X

E X H I B I T S

CHAIRMAN LEMAY: Good morning. We're ready to go.

This is the Oil Conservation Commission. My name is Bill LeMay. On my left is Commissioner Bill Weiss; on my right, Commissioner Gary Carlson, representing the Commissioner of Public Lands of the State of New Mexico. I want to welcome all of you here.

Before we get started, it may not be appropriate, but I would like to recognize a person I've known for quite a few years. He's sitting at the front table here, Dan Currens. I knew him as an engineer. He's now a lawyer, and I don't know if that's good or bad. I liked him better as an engineer, but he's a pretty fair lawyer. He's lived with this project for I don't know how many years and I understand he's retiring September 1st?

MR. CURRENS: That's correct.

CHAIRMAN LEMAY: I want to tell you personally how much I've enjoyed working with you all through the years, and I hope that we'll be seeing you as a consultant maybe or something back here?

MR. CURRENS: I certainly hope you do,

too.

MR. STOVALL: He said he's going to charge what he's worth now.

MR. CURRENS: There's some doubt as to whether or not I can get by on that salary. I appreciate your comments and I certainly echo them back to you. I've enjoyed knowing you for many years and working with you. Thank you.

CHAIRMAN LEMAY: We appreciate all the service you've given to the state, and we hope you'll come back.

MR. CURRENS: Thank you.

CHAIRMAN LEMAY: Okay. We shall begin by calling Case No. 10508.

[Proceedings in Case No. 10462 not reported herein.]

CHAIRMAN LEMAY: Before we get into Case 10508, I would like to make a couple of announcements. The August docket will also contain the proration hearing for the following six months, so those of you that need to, kind of plan ahead a little bit.

I think we have one other de novo on that docket, the Nearburg and Yates case, so it will be those three.

We also plan on scheduling, again for your edification and planning in September, probably two days. We have four de novo cases concerning oil and potash, and we're going to be honoring those applications on our September docket.

Okay. We shall now call Case No. 10508.

MR. STOVALL: In the matter of Case 10508 being called by the Oil Conservation Commission on its own motion pursuant to the provisions of Division Order No. R-6446-B, which approved the Bravo Dome Carbon Dioxide Gas Unit Agreement in Harding, Union and Quay Counties, New Mexico, to permit Amoco Production Company, the operator of said unit, to review operations and demonstrate to the Commission that its operations within the unit are resulting in the prevention of waste and the protection of correlative rights on a continuing basis.

CHAIRMAN LEMAY: Appearances in Case No. 10508.

MR. CARR: May it please the Commission, my name is William F. Carr with the Santa Fe law firm, Campbell, Carr, Berge and

Sheridan. We represent Amoco Production Company. I'm appearing in association with Daniel R. Currens, attorney for Amoco, from Houston, and we have three witnesses.

CHAIRMAN LEMAY: Additional appearances in the case? Will the witnesses giving testimony kindly stand, raise your right hand, and Mr. Stovall will swear you in.

[And all witnesses were duly sworn.]

CHAIRMAN LEMAY: Thank you.

Mr. Carr.

MR. CARR: May it please the Commission, Amoco is here today to demonstrate to you that our operations in the Bravo Dome Unit continue to prevent waste and to protect correlative rights.

We also will provide a brief update of our operations in this unit during the last four years.

To fully convey to you the big picture of Bravo Dome, to show you what we believe is an unusually successful unitization effort, it's important to not only focus on what has happened just during the last four years, but also to direct your attention to events which have

occurred back as far as the original formation of this unit.

I think it's fair to say that when this unit was originally contemplated, it was a major undertaking, even for companies the size of Amoco and the other working interest owners involved. This is the largest gas unit in the world. It contains over a million acres.

When early decisions had to be made about this unit, we were operating with relatively limited data. We didn't know, in fact, how to produce CO_2, we didn't know what would be required to treat it, we didn't know how it could be transported. In fact, we didn't even know how it would really work in the reservoir in enhanced oil recovery projects. But it was apparent to us there was a potential for carbon dioxide in tertiary recovery operations.

Because of these uncertainties, because of the size of the potential unit area, because of the remoteness of this unit to the fields in which CO_2 could realistically be used, it was decided by the working interest owners that unitized development was appropriate.

So, late in the 1970s, they met, they

developed a unit agreement whereby they could share not only the benefits of this development but also share the burdens. Now, this agreement, as perhaps you know, has always been a voluntary unit agreement.

It does contains certain unique provisions and one of those is important to this process here today, for the working interest owners provided in their unit contract that the unit could not become effective back in 1980 until first it had received the blessing, the approval, of the New Mexico Oil Conservation Commission.

So, in 1980 there were two hearings before the Commission, and the Commission twice approved this plan for unitization. Following OCD approval, approval was obtained from the land office and from the Bureau of Land Management and the unit became effective November 1, 1980.

This Commission, however, has maintained a continuing role in this unitization effort in several ways. One thing requires that at least once every four years, Amoco return to you and demonstrate that its operations continue to prevent waste and to protect correlative

rights, and for that reason we're standing before you here today to report to you on our operation of the unit.

We will call three witnesses. The first is Herb Wacker. Mr. Wacker is a geological associate in Amoco's North Permian Basin Unit, and it is his duty to evaluate and define the reservoir at Bravo Dome. He's going to share with you his latest geological interpretations on the deposition, structure and physical geology in this area. We will show you what we've done, particularly focusing on what has been done during the last four years to understand the tough formation in Bravo Dome.

Now, even though development of carbon dioxide is necessarily tied to the price of oil, I think we are going to be able to show you that we have continued in aggressive and active way to develop data and an understanding of the reservoir that is necessary if we're going to effectively carry out our obligations as operator of this unit to move toward full development of all portions of this reservoir that can be commercially produced.

We then will call an engineering

witness, Mr. Jim Collier. He's a senior petroleum engineering associate for Amoco. He's going to show you that Amoco continues to develop carbon dioxide as a marketable commodity, and we're doing this by employing the most economical and efficient production methods, thereby maximizing recovery, enhancing revenues and at the same time protecting the environment.

He will finally review the financial benefits that are coming from the Bravo Dome Unit operation, focusing on royalties not only to the state but to others, and also reviewing the new taxes that have been generated by this effort.

Finally we're going to call Mr. Ron Krenek, who is our manager of our CO_2 sales and supply. He's going to review our efforts to successfully compete in this marketplace to obtain new contracts for carbon dioxide.

At the conclusion of this hearing, we're convinced we will have demonstrated that we are operating this unit in an efficient and effective way, that what we see today is a unit that is working as we hoped it would in 1980, and that you'll be able to see that we are continuing to prevent waste and to protect correlative

rights on a continuing basis.

Mr. Currens will call the witnesses for Amoco.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

MR. CURRENS: Mr. Chairman, will I be picked up all right here, or do I need to use the podium?

CHAIRMAN LEMAY: Your choice.

MR. CURRENS: I would call first Mr. Herb Wacker.

HERBERT J. WACKER

Having been first duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. CURRENS:

Q. Mr. Wacker, will you state your name for the record, please.

A. Herbert J. Wacker.

Q. By whom are you employed?

A. Amoco Production Corporation, Houston, Texas.

Q. In what capacity?

A. I'm the reservoir geologist for the Bravo Dome Unit.

Q. Have you ever testified before this

Commission before?

A. I have not.

Q. Then let's review your education and work background in the field of geology. Tell us about your education in the field of geology.

A. I received a bachelor of science in geology from Texas Christian University in 1970, and a master of science in geology from the University of Texas at El Paso in 1972.

Q. Upon receipt of that master's degree, what did you do?

A. I was assigned to the New Mexico Operations Group in the Exploration Department for two years.

Q. Have you been with Amoco ever since?

A. Yes, I have.

Q. Why don't you very briefly describe the nature of your assignments in the roughly 20 years you've been with Amoco.

A. Since then I have held both technical and supervisory positions in the Michigan Basin for four years, East Texas for five years, the Eastern United States New Ventures Group for two years, and I've worked the Permian Basin for six years.

Q. Were you recently assigned to do a project concerning Bravo Dome?

A. Yes, I was, slightly over a year and a half ago.

Q. What assignment were you given?

A. The assignment was to understand the reservoir at Bravo Dome.

Q. For this last year and a half, that has been your primary work assignment and function?

A. Yes, sir, it has.

Q. About what percentage of your time have you spent on that?

A. About 80 percent.

Q. With respect to this hearing today, have you brought us certain exhibits that have been prepared to help us understand the studies that you've made to this point?

A. Yes, I have.

MR. CURRENS: I would submit Mr. Wacker's qualifications as an expert geologist in this matter.

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. Let's turn our attention to what is marked as Amoco's Wacker Exhibit No. 1.

MR. CURRENS: I believe all of the Commissioners have a book up there. The books contain the exhibits of all of the witnesses. Some of them are in reduced form as compared to what we'll be showing on the board.

Q. What do you show on Exhibit No. 1, Mr. Wacker?

A. Exhibit No. 1 shows the location of Bravo Dome Gas Unit in the northeastern quadrant of New Mexico.

Q. Just for purposes of locating and getting everyone oriented as to where we are talking about, is that right?

A. That's right.

Q. Okay. Now it's this area that has been the focal point of the geologic study that you've been making, is that right?

A. Yes, it has.

Q. How does a geologist start in to conducting a study of an area such as this?

A. Our first job is to try and get a feel for the deposition environments that are present there by looking at the rocks, and then we begin to build a geological picture in our minds to show others what we have.

Q. Well, let's see if we have some examples of how you start that process, then. What's your Exhibit 2?

A. Exhibit 2 is a diagram of the middle Pennsylvanian. The block diagram shows the general configuration of the Sierra Grande Uplift which was in Northeastern New Mexico, and the Palo Duro Basin which goes from Eastern New Mexico on in to Texas.

It shows the general topography as a geologist would imagine it, at a time about 310 million years ago.

Q. So this is sort of a mind model that you have to start looking at the rock and the depositional nature of the area that you're interested in?

A. That's right.

Q. Where do you start looking at these things? From the top or from the bottom?

A. Generally we start at the bottom. Particularly in the case of the Bravo Dome Unit, the unitized interval is from the base of the Cimarron anhydrite to the top of the granite. And in this part of the world, for the most part, the granite wash, which is middle Pennsylvanian

in age, covers that early part of the unit.

Q. Okay. So that's the oldest rocks, probably, in Bravo Dome that you're looking at in this model?

A. That's right.

Q. What can you look at next? What's your next time sequence?

A. Moving up into the late Pennsylvanian, you can again see the presence of the Sierra Grande Uplift and the Palo Duro Basin.

Q. You're looking at your Exhibit No. 3?

A. Yes, sir, I am. You can see that we still have what we call alluvial fans. These are the fans that wash out from mountains and carry coarse pebbles and cobbles. There are braided streams that develop across a broad, flat area.

It probably didn't look too different from what we see around the area of Santa Fe today. If you look in the streams, they're full of cobbles and pebbles. There was some relief, and that relief is expressed in the coarse grain granite wash that we see in the lower part of the section of Bravo Dome.

Q. Okay. And, at a later time?

A. At a later time, in the early Permian,

you can see that the Sierra Grande Uplift, as we understand it, was deeply eroded and probably wasn't much more than low hills.

Q. You're talking about what's depicted on your Exhibit 4?

A. That's right. It's on the right-hand side of Exhibit 4. On the left-hand side of Exhibit 4 we see the Palo Duro Basin, and you can see what we call ephemeral streams, going from one side of the Sierra Grande Uplift on into the Palo Duro. "Ephemeral" means there's water in them sometimes.

These streams carry rather fine grain sediments through the unit area, and represent the upper part of the unitized interval that we call the Tubb formation.

MR. STOVALL: Mr. Wacker, let me interrupt you for just a minute. I think you referred to the "Sierra Grande Uplift" as being the right side, and the "Palo Duro Basin" as the left side, and I think that can be confusing when you read the transcript down the road later on.

The Sierra Grande is on the left, right? I think you had them backwards, and that's all I'm trying to do is--

THE WITNESS: Oh, I'm sorry. You're right. Thank you very much. I do appreciate that.

MR. CURRENS: You're looking at them from different directions.

MR. STOVALL: You're holding them up and looking the same way at them.

THE WITNESS: I'm afraid so.

Q. In that case, the Sierra Grande Uplift would really be to the western portion or northern portion or northwestern portion of this exhibit, and the Palo Duro Basin would be back in an easterly sensing, would it not?

A. Yes, sir, it would.

Q. Okay. Now, having looked at these three models, does that generally encompass the kind of time period that you would be looking at, geologically, in this area?

A. Yes, it does. It covers about 40 million years. Most of the time it was very, very arid. The sediments that were laid down were what we commonly refer to as continental type red beds.

Q. I notice a name "B. I. May," or a notation "B. I. May" on all three of these last

exhibits, 2, 3 and 4. What's that significance?

A. Bruce May was a geologist with Amoco and is a geologist with Amoco that developed these models early on in the description of Bravo Dome. We feel that they still hold true in their description of the dome, and represent the work that was done at that time that still holds true for Bravo Dome.

Q. So the model that you're looking at is the same sort of model that Mr. May was looking at initially out here, and you both think that's the appropriate starting place?

A. Yes, sir, we do.

Q. Was there anything else you wanted to cover on Exhibits 2, 3 or 4?

A. No, sir.

Q. All right. Now, with this idea in mind of what these depositional models might have, what sort of things do geologists next move to in trying to assess and understand an area?

A. Our next job is to understand exactly what the logs, that are taken from the drilling wells, have to show us and tell us about those depositional environments.

Q. Have you prepared a type log to use in

this proceeding so that we'll all be on a constant nomenclature, so to speak?

A. Yes, sir, I have.

Q. Would that be your Exhibit 5?

A. Yes, sir, it would be.

Q. Would you explain that?

A. Exhibit 5 is the electric log from the Amoco Production State FD, also known as the Bravo Dome 2031-231 D.

Q. The well name's up at the top of this exhibit?

A. It is.

Q. I would like to take a little bit of time with this because we're going to have a number of cross-sections following this, and if we identify all the parts and components here, we won't have to mess with them later on.

So, you have the name up here on the top of the well log?

A. Yes, sir, I do. Down the left-hand side, as we look at it, there's a gamma ray log. It's a correlation tool that we use to tie one well to the other. On the right-hand side is the porosity tool. In this case, it's a neutron porosity log.

The location of this particular well is shown in the lower left-hand side of the exhibit.

Q. Is that the map area with the large yellow colored-in portion?

A. Yes. That's true. The large yellow area is Bravo Dome, and the location of the well is shown in a small red plus with a T next to it.

Q. When you say the large yellow area is Bravo Dome, do you mean the outline, the exterior boundary of the Bravo Dome Carbon Dioxide Gas Unit?

A. It is the exterior outline.

Q. Okay. I notice further, or you mentioned the symbol. Is that same symbol the one shown at the very top of the log?

A. Yes, it is.

Q. Okay. Why don't you go on to the symbols that are in the right-hand legend portion, on the bottom of this.

A. On the right-hand side I you have an explanation of the well symbols that we'll use particularly for the Bravo Dome area. Since we're dealing with carbon dioxide gas, I think it's important to shape that out just a little.

The first notation underneath the well

symbol explanation is an open circle with a C2 next to it. That stands for currently producing carbon dioxide gas well.

Immediately under that is what we commonly know as a well with a gas show. In this case it represents a carbon dioxide gas show.

Underneath that is what looks like a dry hole symbol with a T next to it. The notation here is the state's notation of temporarily abandoned. These series of wells are wells that are currently not productive but completed as producers. They are not hooked up or on line, and we'll talk about that later on.

Underneath that is the standard dry hole symbol.

Q. So you might characterize those that are completed in the carbon dioxide producing horizon as active and inactive, with the active wells being the ones with the circle and the 2?

A. Yes.

Q. And the ones with the T being inactive producers?

A. That's right, they are inactive producers.

Q. Okay. Having covered much of the

material that will be of interest on some of the following exhibits as to the setup and outline, why don't we go ahead and talk about the meat of what you show here.

A. Okay. The color coding is important in that it helps us see the shape and distribution of different lithologic units within the reservoir.

The Cimarron anhydrite shown here in purple, represents the unit, the seal above the reservoir at Bravo Dome.

Immediately underneath it is the Tubb formation. I show here an upper Tubb in yellow. That bright yellow is characteristic of what I would call the true Tubb formation, as we carry in down into the Permian Basin.

Underneath that is a rock unit that, perhaps more accurately is called Abo, but for purposes of the unit description I'm going to call it upper, middle and lower Tubb formation. I think that's important in the consistency of the testimony.

The middle Tubb is shown here in a tan, the lower Tubb is shown in a cinnamon color. Underneath that is a thin bed which is granite

wash, and it's brown. That encompasses the entire unitized interval. Below that is granite basement.

Q. Okay. And this kind of a depiction will follow through in the rest of your exhibits?

A. Yes, it will.

Q. All right. Now, you said it was important to visualize this as you take the work you've done on down into the Permian Basin. Isn't that kind of a new twist in the way of looking at things in this Bravo Dome area?

A. Yes, it is. In the past we've tried to work hard to understand the relationships well-to-well and within the existing producing unit. I think sometimes it's exciting to see such a large unit and understand it in that context.

By backing away, I can see even more detail in the way the Bravo Dome Unit was laid out geologically.

Q. Has that been the basis on which you've started your current study?

A. Yes, it has.

Q. Why don't we move on and see how that ties together a little bit. I think your next

exhibit is Exhibit No. 6, and I believe we've already taped that one on the wall.

A. Yes.

MR. CURRENS: Can you see all of the exhibit okay here, or do I need to move the easel a little bit?

CHAIRMAN LEMAY: I can see it.

A. Our understanding of the stratigraphic relationships of Bravo Dome has benefited from the regional analysis. What I have here is a cross-section that goes from the Empire-Abo trend almost all the way to Clayton, New Mexico. That encompasses a distance of about 275 miles.

Q. You have your inset map here again, and the trace on the inset map you have goes off the whole east side of the state, basically, from Texas to Colorado almost?

A. Yes, it does.

Q. And that geographic area is one that you are depicting here in your cross-section, geologically?

A. That's true.

Q. Why don't you go ahead and take us through that. I believe we've covered the legend fairly well and don't need to go back to that.

A. That's fine.

Q. Why don't you tell us what it is we're looking at.

A. Okay. On the wall is a full display of the geologic work that I've done along the eastern side of New Mexico. On the larger display, I have both the porosity log and the correlation log, as well as lithology information that sits in colored display down the center of the log. These are descriptions of cuttings from the wells.

These cuttings, in combination with the correlation and porosity logs, help me describe and make the correlations through this part of New Mexico. In the books you'll only find the correlation part of the log, but this is going to be preserved for you at any time, and if you wish, you're welcome to it. That refers to the larger, long cross-section here.

What we show, most importantly, are two unconformities. One unconformity lies at the base of the Clearfork and the Tubb. It's also shown and corresponds to the top of the Abo formation. This particular unconformity was identified by Ron Broadhead in a publication in

December of 1988, New Mexico Bureau of Mines and Mineral Resources Publication Bulletin 119.

Q. Now, that is material that has been published and a view that's come out since our last four-year review, has it not?

A. That's true.

Q. So you've taken the latest type of material in thinking to integrate into this to help you with your study, is that right?

A. Yes. It has been quite helpful. I see also an additional unconformity at the top of the Tubb which goes through a similar lithologic change; in other words, from sandstone to evaporites, as the change from Abo to Clearfork.

And then we have the same kind of change from sandstone to evaporites in the change from the Tubb formation to the Cimarron anhydrite.

Q. Let's get something in the record here about the part of the cross-section you're talking about. Give us a--

A. The two wells that give us the best clue are the Amoco Baker and the Amoco Blackburn Farms. In the books, those correspond to wells No. 7 and 8, and on this larger display they

correspond to Wells No. 11 and 12. This is about the middle of Quay County.

Q. Okay. They're south of the Bravo Dome Unit area?

A. It is substantially south of the Bravo Dome area where I've been able to define the cross-sections.

Q. In fact, on the cross-section, have you marked the logs of wells that are within the Bravo Dome Unit area?

A. Yes, I have. In blue, on the far right-hand side or north side of the cross-section, I've underscored the Bravo Dome wells with a blue line, that also indicates the Bravo Dome Carbon Dioxide Gas Unit.

Q. Why don't you keep on moving northwards, then.

A. Okay. Probably the most important thing we've seen in the identification of these two unconformities is that the true Tubb is present over part of the unit but not all of it. It actually truncates mid-way in the unit, and you can see that where the yellow disappears between two wells.

The lower part of the unit is described

again, as I call it middle and lower Tubb, but it's truly Abo in formation. Again, later on in the testimony I'll refer to that as middle and lower Tubb.

Q. Okay. This is something that you discover by moving out of the local area then?

A. Yes, it is.

Q. So what's been popularly called Tubb through all of this time up there is a little broader encompassing thing than that single, one nomenclature that's attached?

A. Yes, it is. In Bruce May's testimony, he did talk about the Tubb, the unitized interval containing perhaps Tubb and Abo; and certainly Ron Broadhead's work talks about the Abo being present in the Bravo Dome area.

Q. Okay. Now, what's the significance of this in understanding Bravo Dome and understanding the reservoirs up there?

A. That's a good question. In the earlier work, the thought was that the changes across Bravo Dome were the result of changes in depositional environment going from a fluvial to a more lacustrine environment, but those changes were part of a general facies track trend.

What I can see based on my correlations is that there are three separate units. Each one has the potential of having different reservoir characteristics. We need to understand each of those and how facies changes take place within each of those depositional units.

Also, need to understand where one unit is truncated underneath the Cimarron anhydrite and how other units continue underneath the Cimarron anhydrite as stratigraphic units.

Q. So, in going to stratigraphic work here, you believe that you're making a great deal of progress in understanding the reservoir?

A. Yes. This is a new way to look at the Dome, and I think it will make for a better understanding and description in the long run. It is going to be substantially more detailed than what we had before.

Q. So we're sort of sub-dissecting the Tubb now, where it's been a rather gross looking phase?

A. That's true.

Q. Do you have anything else that we need to cover with respect to Exhibit 6?

A. No, sir, I don't.

Q. Having moved from the south end of the state all the way up to Bravo Dome, do you then focus your looking in the Bravo Dome area itself?

A. Once we see this long, regional view, it is important to look at the detail. I've prepared four cross-sections that help show the network that I'm going to use to help build the stratigraphic information to understand the reservoir at Bravo Dome.

Q. Let's start looking at that network of cross-sections, then. I believe the next one would be Exhibit 7. I was simply going to say that I see the familiar setup of the map of the area, the unit being depicted, and a red trace of the cross-section which I observe to be on the eastern side of the unit.

And with that, why don't you go ahead to the description of what is shown here.

A. Yes. This is a detailed and larger scale cross-section, as we see it on display here. It goes from the south, on the left, to the north on the right, and in it you can see how the upper part of the Tubb truncates from south to north across the unit.

You can also see how the unconformity

has cut out the upper part of this Tubb and actually eaten into or eroded away part of the middle Tubb unit. In general, you can see that the isopach of the Tubb formation thins from one side to the other, as we go north.

Also, as we go from south to north, the granite wash section expands substantially. This is a characteristic of the eastern side of the Bravo Dome Unit and shows that its a broad structural nose from south to north.

Q. Now, when you say that the isopach thins in this area, you're speaking in the geologic sense of how much rock you have?

A. That's right. It deals only with the stratigraphic interval and does not relate to anything else.

Q. So we're assessing the rock thickness and not which portion of that rock may or may not be cut, in your work at this time?

A. That's true.

Q. Anything else here?

A. No, sir.

Q. Let's continue to build the network and look at Exhibit No. 8.

A. These two cross-sections, and the

others that I'll show you, are all at the same scale. This one is parallel to the one to the east, it is on the west side of Bravo Dome, and goes from south to north.

You can see that the overall thickness of the Tubb formation has thinned quite a bit even at its thickest point. It's less than 300 feet and it thins to less than 50 feet as we move to the northern side of the cross-section.

Again, you can see the rapid truncation of the unit that I call the upper Tubb. You can see the truncation to some degree in some places of the middle Tubb, and you can also see the characteristics of the lower Tubb there. The granite wash is an infill formation, and it has a variable thickness based on the topography underneath it.

Q. Anything else we should particularly note on this one?

A. Just that we're closer to the Sierra Grande Uplift, and that makes for the difference in the total isopach. We'll see those kinds of things better in the east/west cross-section.

Q. Let's look at that cross-section. I believe this will be your Exhibit No. 9, Wacker

No. 9. I will note, in addition to the regular depiction of the location of the cross-section, it bears a striking resemblance to a bear fetish, similar to one that I have at home that people were so kind to give me.

A. This east/west cross-section, across the northern part of the Dome, shows how the upper Tubb is now totally truncated. The Cimarron sits immediately upon the middle Tubb which, in other parts of the basin we might refer to as Abo, and the lower Tubb is likewise truncated as we move from the east to the west towards the Sierra Grande Uplift. You can get a good feel here for how effective the Sierra Grande Uplift was in truncating some of those beds.

The unconformities on these diagrams, through all of the diagrams, are shown by wiggly lines. In this case, the unconformity at the top of the middle Tubb is a red, wiggly line. The unconformity at the top of the upper Tubb is a blue wiggly line. We saw those in the other cross-sections and we'll see those in the next.

Also on this cross-section you can see the stratigraphic response to a structural

feature that we have in the Bravo Dome area called the graben. The graben is a thick low, a deep low, structurally, where a lot of the granite wash was deposited.

East of that there's a forest, and that's why this particular well had granite quite a bit higher.

Q. By which particular well?

A. I'm sorry. Let me look. That would be the Amoco State GT #3 from the east, which has a much more shallower granite section than the Bravo Dome Gas Unit 2332-241, which is immediately next to it. They are only six miles apart, and they do show substantial structural relief between them.

Q. Thank you. Did I interrupt anything that you were needing to still cover there?

A. No, that was fine.

Q. Let's move on down to a fourth cross-section that you have in your network, your Exhibit No. 10.

A. This Exhibit No. 10 is, likewise, an east/west cross-section across the southern part of the Dome this time. We're much further south and, as a result, we're much closer to the

structural--the paleostructural high of the Bravo Dome. I say "paleo" in that at the time of the Cimarron, this was probably one of the highest topographic areas.

You can see the Cimarron anhydrite, again, in purple. You can see the unconformity line immediately underneath the Cimarron is blue, with yellow underneath it. This is the true Tubb in the Bravo Dome Unit. It carries from the east all the way to the west in this part of the Bravo Dome Unit.

You can likewise see that the total Tubb interval is quite thick. Out here it's over 600 feet thick. As we move further west, towards the Sierra Grande Uplift, it thins to 200 feet on the west side of Bravo Dome.

Q. All right, sir. Now, all of the things we've been discussing to this point have been a stratigraphic assessment of the rock in the Bravo Dome Unit area?

A. Yes.

Q. You feel that that's a good step forward in understanding the reservoir rock itself, is that right?

A. Yes. The stratigraphic understanding

of the rocks of Bravo Dome will give us a clue to the shape of the container that we call the reservoir that is Bravo Dome.

Q. Well, speaking of the shape of the container, I've been used to, over many years, looking at structures. Have you paid some attention to the structure that we have out here as well?

A. Yes, sir, I have.

Q. Have you prepared a structure map?

A. I have.

Q. How have you done that?

A. The structure map is a combination of geological picks that I've made in about 200 wells, in conjunction with work that Jim Wiles has done, and his work has been presented here at the court, and also a substantial amount of geophysical added points, that help shape out the unit.

I feel the integration of both geological and geophysical points helps give us a much more accurate view of what the configuration of the unit--the topographic configuration of the unit is, in the subsurface.

Q. Is that another step forwards that

we've taken since the last review period? Did it go to the geophysics?

A. It is, in the sense that we're refining the tops and making precise the formation tops. Yes, it is.

Q. Do we have geophysical data now available to us that we didn't have then, or is it simply a method of analyzing it and the opportunity to do so?

A. Right now we're in the process of continuing to evaluate the seismic data that we did have in 1988, using some new techniques called a geologic and geophysical workstation. The product name of this workstation is Sun workstation, and it's a very large personal computer, perhaps as big as some of the old mainframe computers that companies used to have.

Q. Is this some technology that's just recently come into play, and that we've acquired to be able to use in this and other kinds of work?

A. Yes, it is. In fact, we're working with the companies that developed the software to process the kinds of things we're doing here at Bravo Dome.

Q. So you're trying to integrate all of the latest thinking and all of the latest techniques into your geological assessment work?

A. We are. We are desperately trying to do things just right to make it fit together the way it ought to fit together for Bravo Dome, the stratigraphy and the understanding of the reservoir.

Q. I laid the foundation for your structure map a minute ago. Perhaps you have that as your Exhibit 11. Could put it up there and tell us what it shows?

A. Yes, sir. This structure map uses the same well code as we've used on all of the cross-sections.

In addition to that, I've shown the display of seismic lines and geophysical datums. The geophysical datums are shown on the large display as black triangles. In the book they're shown as small red triangles.

The well locations, datums that I used, are present in the book as noted red circles or red symbols.

In addition to that, I've shown the distribution of the over a thousand miles of

seismic line on both the large scale and the small scale maps as thin blue lines, noted one by one, with a small crystal-looking feature at the end of each line. The crystal-looking features help us identify the lines that we've shot at Bravo Dome.

Q. Okay, that's your setup. Broadly, describe the structure for us, please.

A. Thank you. The structure does come shallower and higher topographically to the northwest. It drops off to the southeast as a structural nose. It fades very quickly to the north and east as we saw on the geologic cross-sections and also on this topographic map.

To the south, as we go into the Tucumcari Basin, the unit is rather broad and flat. We can see a fold that goes across Bravo Dome in the current producing area, and we can see some deep low. This is the graben area. It's in the north, northeast/central part of the unit. And just to the east of that is a broad topographic high that we call the horst.

Q. All right, sir. Anything else with respect to any of these 11 exhibits that we've used to this point?

A. No, sir.

MR. CURRENS: If the Commissioners please, I have one other photograph that we'd just like to tell you what it is but we don't intend to put it in as an exhibit. I'll do that now.

Q. We've mounted on the easel on the other side of the room, what, Mr. Wacker?

A. This is a satellite photo. It's called a land-sat photo. It was taken from about 270 miles in space. It is a photograph of the Bravo Dome Unit showing 50 miles on a side that go approximately from Clayton to Tucumcari.

You can see Logan and Ute Reservoir. You can see--I've forgotten the name of that reservoir--Concha. Thank you. This is Turkey Mountain and Sierra Grande Peak. You can see the highways.

In fact, you can even go so far as to see the playing field in Clayton, New Mexico. And when we showed this to the students in New Mexico, they were ecstatic. They said, "We've got to have copies," and we've made some for them.

Q. In conjunction with this, you've

prepared a little overlay that points out some of those features so that underneath it the land-sat photo is not messed with in any way?

A. That's true.

MR. CURRENS: I thought we would leave that up there for anybody's curiosity. They're welcome to look at it at the break or any time this morning. And let me return to his regular testimony now, if I may.

Q. Why don't you give us a summary of your work to date; where you are, what your assignment is, and how you've done it?

A. What I've been able to show you is a network of geologic cross-sections. This network will form the foundation for picking tops throughout the Bravo Dome Unit. I have tops on over 400 wells yet to depict throughout the whole unit. We need to incorporate over 1100 miles of seismic. That's enough seismic to stretch from here into the Pacific Ocean.

We've drilled as much wells as to go from here to Albuquerque and back, twice. It's important to understand the magnitude of the size of Bravo Dome. In that sense, I feel I've come a long way in understanding that we're

incorporating it geophysically, geologically and a way to do it just right, and that really is our most important concern for the benefit of Amoco, the working interest owners, the state, the royalty owners, everyone involved.

MR. CURRENS: With that, I would offer Exhibits 1 through 11 of Mr. Wacker's, and offer Mr. Wacker for questions.

CHAIRMAN LEMAY: Thank you. Without objection, Exhibits 1 through 11 will be added into the record.

Questions of Mr. Wacker?

COMMISSIONER CARLSON: No.

CHAIRMAN LEMAY: Commissioner Weiss?

EXAMINATION

BY COMMISSIONER WEISS:

Q. What size workstation will handle the data that you just described?

A. The workstation that I have on my desk has three gigabites. It ties to a server with 17 gigabites. I'm able to manipulate the geologic data.

I have a companion that I'm working with who has a comparable workstation to mine. It also has three gigabites, and he is doing the

processing of the seismic and evaluation and mapping of the geophysical data.

So those two things, those two workstations together, in combination with what we call a server, help construct the geologic interpretation.

COMMISSIONER WEISS: Thank you. No other questions.

CHAIRMAN LEMAY: Two questions, Mr. Wacker.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. What you define as, I guess, upper, middle, lower Tubb, can you tell us a little about the lithology, what kind of rocks are present there?

A. That's a good point. The upper part of the Tubb is rather fine grain. If I had to find a place that looked like that, it would be Baja California. The bay in Baja California has very fine grain sands. The sediments have come from a long way, perhaps reworked.

I've seen sand grains as fine as dust which actually, as a rock, still compare and carry porosity. It would be like the dust that

filters in through the window of your window pane when a dust storm comes through.

Coarser than that we certainly have, and that makes for a larger part of the reservoir in the upper and middle part of the Tubb.

As we go lower, the grain size, just by looking at core, seems to coarsen quite a bit. It's less organized. It's just makes for a coarser grained rock. The porosities seem to change somewhat.

Our job is to try and pull all that together and understand how it makes a different as a reservoir.

Q. No anhydrite within the--

A. We have seen anhydrite pebbles, nodules, that type of thing. We've picked up a little bit in the way of carbonate rock; not as beds, but as cements. In fact, one of the directions that we're looking at right now are the carbon-oxygen isotopes of the cements and comparing them with the carbon dioxide that's present in those particular wells, and trying to understand whether or not there's a relationship there.

There are a number of different

geochemical avenues that we're trying to get a better feel for the reservoir, what makes it work and why it changes the way it does.

Q. Could you make a rough comparison with the lithology there as compared to, say, the Pecos Slope Abo, where you have sandstones?

A. From what I know, and I have not studied the Pecos Slope Abo, there are fluvial channels in the Pecos Slope Abo and the permeability is very, very low. Our permeability is generally higher, and I think our porosity is higher, too, but I really have not studied Pecos Slope to comment effectively.

Q. Just one final question. I'm curious, you can trace the Cimarron anhydrite all the way into the 1630 area of the Permian Basin, as a unit?

A. I call it a Cimarron marker. If you look at it, we can walk through the large scale--I think you would like that--I feel I can make a pick that is correlative to the top of the Cimarron almost all the way to the Empire-Abo area, yes. It's a marker in what we would normally call Clearfork, but it's generally anhydritic, and I seem to be able to pick it on

logs.

CHAIRMAN LEMAY: Additional questions of the witness? If not, he may be excused. Thank you.

MR. CURRENS: My next witness will be Mr. Collier. We'll give them minute here to change, if we can?

CHAIRMAN LEMAY: Oh, sure.

JAMES W. (JIM) COLLIER, JR.

Having been first duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. CURRENS:

Q. Will you state your name for the record, please?

A. My name is James W. Collier.

Q. By whom are you employed, Mr. Collier?

A. I work for Amoco Production Company in Houston, Texas.

Q. What do you do with Amoco Production Company?

A. I'm a senior petroleum engineering associate assigned to the Regulatory Affairs Group in Houston.

Q. As part of your assignment there, would

your responsibilities include New Mexico and, more specifically, the Bravo Dome area?

A. Yes, sir, it does.

Q. You've testified before this Commission before, have you not?

A. Yes, sir.

Q. And your qualifications as an expert petroleum engineer are a matter of public record?

A. They are.

Q. Your testimony today is going to cover a number of operational factors and phases of our Bravo Dome activity, as well as some of its historical events?

A. Yes, it is.

MR. CURRENS: I would submit Mr. Collier as qualified to testify at this hearing.

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. What's your Exhibit No. 1, Mr. Collier?

MR. CURRENS: His exhibits will be marked "C-1, 2, 3, 4" and so on, whereas Mr. Wacker's were marked with "W."

A. All right. My first exhibit in the book is labeled C-1. It's a folded map of the

unit. If you would turn to that and unfold it this is a map of the Bravo Dome Unit.

I've shown the exterior boundary of the unit with a heavy bold line. This unit is located in Union, Harding and Quay Counties, New Mexico. It contains slightly over a million acres.

There are several symbols I would like to review with you to define what I've shown here. First off, there's a conventional gas well symbol. That's a standard industry symbol for a gas well. Those are the current CO_2 well completions in Bravo Dome. There are 369 of those completions in the unit at this time.

Q. Does that include wells, both active and inactive, as were described by Mr. Wacker?

A. Yes, it does.

Q. Okay. Go on, please.

A. Of those 369 wells, at this time 258 are connected to the gathering system and are on production. 111 are completed as CO_2 wells and are currently shut in or inactive.

Additionally, I've shown with a solid dot with a diagonal slash the permanently plugged and abandoned wells, and there are presently 20

of those in the unit. As you can see from looking at this exhibit, they are scattered throughout the unit, and those have been plugged and abandoned for various reasons.

There also are two open circles with the label "SWD" which sands for salt water disposal. Those are both in the currently active producing area, which is down in the south or east-central part of the unit.

That brings us to a total number of completions, as shown down in the legend, of 391 wells in the unit.

There's also a designation right there in the east-central part of the unit where I've shown the location of our central conditioning facility for compression and dehydration of the gas.

Q. And that's marked "plant"?

A. Correct.

Q. Let's move on to your Exhibit 2, which I think is a schematic or block diagram of the plant facility, then, and ask you to take us through that exhibit.

A. Okay. This is labeled Exhibit C-2. This is simply a schematic showing the layout of

the central conditioning facility. This was constructed in 1984 and added to in 1985. At the time it was located on Highway 65, which is now 420.

Q. The plant didn't move?

A. Correct. The highway used to be State Highway 65, it's now State Highway 420.

Q. Okay.

A. This, essentially, is the same layout as we showed you four years ago, with the exception of over on the east side the schematic block labeled carbonic reserves has been added since that time to provide for a market for carbonic reserves for liquid CO_2 and carbon--dry ice.

Q. So, since the last four-year review, in addition to methods that we've discussed in the past and we'll discuss again, disposition of our production to pipelines, there has been a local takeoff station built here as well by one of the interest owners?

A. That's correct. That's since 1988.

Q. Okay. Anything else that we need to cover on this general layout?

A. No, sir.

Q. I believe the next thing in your book are a series of photographs which are marked Collier's Exhibit 3 and lettered (a) through (g).

Why don't you just go through those and tell us what's shown on those, what we perceive from them.

A. We've labeled all these photographs, as you said, Exhibit 3. There are seven total photographs. The reason for including these is to give you some appreciation for the hardware that's out there that we used to condition this gas with.

The first photograph is simply a front elevation view of the conditioning facility and the entrance to it.

The second photograph, 3(b), shows on the left innerstage cooling. This is a fan-air cooling unit. An inlet scrubber, as shown, is the vessel in the center part of the photograph, and then the glycol tower on the right. This is all for dehydration and cooling of gas. You can see in the background other innerstage cooling units.

Q. So the gas comes into the plant through

that inlet scrubber from the field--

A. That's correct.

Q. --knocks out the water and then it's processed in the plant?

A. That is correct.

Q. Or some of the water?

A. As I mentioned, the plant was constructed in two phases, a Phase I and Phase II, and the next exhibit is Phase II. This shows the header system coming from the compressor building. Again, in the background is another innerstage cooling unit and some innerstage scrubbers. Those are the vessels in the center part of the photograph. And then you can see the base of the glycol tower on the right-hand side of that photograph, and then the small tank or vessel on the left-hand side is a recycled well storage tank.

The next photograph, back to the Phase I plant, again showing innerstage cooling. This is the second and third stage cooling. Between each stage of compression, the gas has to be cooled again, and over to the left are our holding tanks and working tanks for salt water disposal.

Turning to the next photograph, these compressors are very large compressors, driven by electric motors. This is a shot of the inside of the electrical control panel, for the electrical distribution.

The next photograph, this would be subscript (f). This is a shot inside the compressor building itself. The large gray vessels are pulsation dampener bottles. The large one to the right, there's been a change since the last review to give additional control over vibration on these compressors.

Q. Helps with the operating characteristics, reduced maintenance and so forth?

A. Yes, sir. And the final photograph there would be (g), which is a typical well out in the unit. This shows the well site. There's a mast as you can see on the right-hand side of the well site. This small black rectangular shaped thing is a solar collector. And then you see just above that an antenna for data transmission, as well as automation control transmission. The white box in the front contains the remote terminal unit for the

automation system. This is very typical of a well out in Bravo Dome.

Q. All right, sir. The facilities here, while compact in the one location with respect to the plants, are quite extensive, however, are they not, with these two phases?

A. They are.

Q. And all of this activity that you depict, or all of these items that you depict in the pictures, had to come along at some point through the life of this in order to have gas produced, gathered, conditioned and prepared for shipment on down the line to the Permian Basin?

A. Yes. This was a very extensive construction project, and I would like to turn to the next exhibit, if we could, to demonstrate. I've labeled this Bravo Dome CO_2 Gas Unit Commodity Development. This is Exhibit C-4. This is a 3-D columnar chart. There are four colors, and I'll walk you through this and describe each one.

You can see at the front of the exhibit the blue columns. That is number of wells drilled in Bravo Dome. This shows the drilling activity which occurred upon the unitization of

Bravo Dome. As I mentioned earlier, as Mr. Wacker mentioned, it was effective in 1980.

You can see that even though facilities were not in place, that we undertook some extensive drilling in the face of considerable uncertainty. The actual start of production did not start until 1984. That's when production first started, in April of 1984, with the completion of the Phase I facility.

Q. Is that that little yellow plant thing at the back of the 1984 line?

A. Yes. I'll move to the back of the graph. The yellow columns depict, by years, the plant capacity, the total compression capacity of our Phase I and Phase II combined. With the completion of Phase I, you can see in 1984 the first yellow appears, that was the--with the completion of Phase I, we developed a capacity of about 110 million cubic feet per day. And production, which is the green, showed up, again beginning in 84, at about 40 million a day for that year on the average.

Moving along to 85, again referring to the yellow columns, we completed the Phase II plant and increased the total capacity for

compression to 390 million cubic feet per day. And that is the current capacity at the central facility.

Now, the production is shown here in green. That's the second row of columns on this plot. Again, we averaged about 40 million a day that first year of production in 1984, and then with the completion of Phase IV, that increased to 272 million cubic feet per day in 1985.

On an annualized basis, we peaked in 1988 at an average of about 366 million cubic feet per day. Right now, the first quarter average of 1992 has been 288 million cubic feet per day. That's shown on the far right-hand side of the plot.

Q. What are the red bars?

A. What's important to note about the red is, I've labeled that "Active Well Productivity." That's the current total deliverability of all wells that are connected to the gathering system. What's important to show is that that active well productivity has been sufficient to meet our market demand of CO_2 throughout the entire life of this unit.

Q. And, I take it, since we talked about

active wells and inactive wells, that there are a number of other wells that could be connected if some additional market were achieved that required additional productivities of the plant?

A. That's correct, sir.

Q. All right, sir. Now, we see here that we have plenty of wells that have been drilled because we have sufficient productivity with respect to markets that are now available to production from Bravo Dome. I believe we see that from this figure, as well as the fact that we have excess plant capacity in the event more demand were to come about?

A. Yes. We do operate the unit both with excess compression capacity, which is the yellow showing in the back, as well as excess well capacity at this time.

Q. But we haven't done any recent construction? Have we built a new plant or anything like that?

A. No, sir. That has not been necessary.

Q. Well, how do we occupy ourselves during the periods when we're not building new facilities out here?

A. Well, our efforts in the last four

years have been to increase operating efficiency, thereby reducing cost. As I'll show you, cost is a very high percentage component of total investments out here. That's daily operating cost.

So, if we turn to the next exhibit, I've put together a list of representative operational improvements. This is a very condensed list. As such, it's still quite lengthy and I won't read this into the record.

Q. This is your Exhibit C-5, right?

A. This is Exhibit C-5.

Q. Okay.

A. Many of our main efforts in the last four years, since 1988, have been in the area of operating efficiency and environmental controls. You'll see the top four or five items on this list have to do with replacing steel, tubing or casing, flow lines, valves, with more corrosive resistant materials, be it fiberglass or stainless steel. We do this because it increases the life of this equipment, it increases well life, it reduces operating costs, it increases our efficiency overall, which extends well life and therefore makes recoverable reserves, over

the long run, greater. That has been our main focus for the last four years.

We also, the third item, negotiated a new electric power contract which very much helped to control operating costs. This benefits all the owners, the state, as well as Amoco.

Q. All right. You mentioned a while ago that continuing operating costs were important in our current activity and that there have been a number of investments. Have you prepared an exhibit to show where we stand with respect to spending?

A. Yes, sir, I have.

Q. Let's move to that exhibit. That's your C-6?

A. Yes sir. Exhibit C-6 is an area cumulative chart or plot showing millions of dollars spent on the left hand, or Y axis, and time in years on the X axis.

I've broken down the four major components to show the total expenditures in each of those. The total spent is shown at the top as $374 million. That's the total investment in this unit as of the beginning of 1992.

The red area is operating costs, and

you can see, as I mentioned earlier, that's a very important component of total investment, being over half the total expenditures in this unit. That has been about $200 million to date, to the beginning of this year.

As far as drilling, the unit owners have spent just under a hundred million dollars to drill all the wells I showed you earlier, and for maintenance expenditures, maintaining the facilities that are out there, a little under 17 million.

And construction, this is for the gathering facility and the gas conditioning facility, about $60 million, bringing us to the total of $374 million.

Q. Do you have a rough estimate of how much we spent in the last four years?

A. Yes. Since the last four-year review, we've spent about $93 million in that four-year time.

Q. Okay. We've talked then about the kind of spending that has occurred. What kind of benefits, say in royalty, have accrued to the royalty owners in this unit?

A. I show that on the next exhibit, which

is my C-7. Again, this is an area chart showing cumulative royalties paid out from Bravo Dome.

Again, production started in 84 so the first payments were back at that time. The yellow area shows the royalty payments from the unit to the State of New Mexico, and in the blue is the cumulative of all other royalties.

Together, these have come to a grand total of about $47 million as of the beginning of 1992. About 13 million of that has been to the state and 34 million to other entities.

Q. In addition to the royalties that are paid to the state, I know we pay a lot of taxes within the state, both the production taxes and ad valorem taxes in the counties and so on. Will Exhibit 8 give us a picture of that as well?

A. Yes, sir. Exhibit 8 shows again the cumulative taxes from Bravo Dome. First of all, the orange area is cumulative taxes, and again I've repeated in yellow the cumulative royalties and added those together. So this is total taxes and royalty paid by Bravo Dome since first production.

As of the beginning of 92, that has accumulated to slightly over $40 million. 27

million of that has been in taxes paid to the state and other local taxing entities.

Q. I believe that's the last exhibit of yours that we have, Mr. Collier. Could you summarize the things that you've discussed with us today?

A. Yes. I think what I've tried to show is that Amoco has taken obviously a very large area that had a resource that was really nonquantifiable, and in the face of considerable uncertainty as to the size of the market, how many CO_2 projects would be demanding CO_2, I think we've taken this nonquantifiable resource and turned it into a marketable commodity over the last eight years.

We've operated efficiently and we continued to operate efficiently, and we stand , ready to continue to do that. That's our main thrust here; and to be ready, in case the market does increase, to be able to provide that gas from Bravo Dome.

MR. CURRENS: That's all I have of Mr. Collier. I would offer his Exhibits 1 through 8 in all their parts, and would offer Mr. Collier for any questions.

CHAIRMAN LEMAY: Exhibits 1 through 8 will be admitted into the record, without objection.

Any questions of Mr. Collier? Commissioner Carlson?

COMMISSIONER CARLSON: Yes, I had a couple of questions.

EXAMINATION

BY COMMISSIONER CARLSON:

Q. Doesn't Amerada Hess also have a plant there?

A. There is another takeoff. There's a rosebud line that goes to supply the demand for Amerada Hess, but it ties in at the Amoco conditioning facility.

Q. It goes through the Amoco plant?

A. It comes from the Amoco plant and then there's roughly a 20-mile lateral that ties into another major gas transporter out to the west.

Q. Right. Okay, but they don't have their own plant facility?

A. Not to my knowledge.

Q. So your numbers are total unit production and total unit cost, not--

A. Correct.

Q. --not just Amoco's?

A. Yes. That represents the total unit, Bravo Dome Unit.

Q. If I remember correctly, when these facilities became operational, there was some debate over, because of the corrosive nature of CO_2, how long the facilities would last. We've had eight years now.

What is the experience on the expected life of those facilities?

A. There have been corrosion problems mainly related to the field, you know, where you have CO_2 and water produced together. That's the reason for some of the changes we've made, by replacing tubing with fiberglass. We've also drilled a well, and that was in 1988, and equipped it with fiberglass casing. That's the only one like it so far. There have been some line replacements, some line sleeving because of corrosion; so, yes, the corrosion does exist.

I can't comment to whether it's more severe in a non-CO_2 environment or not, but that is part of our ongoing maintenance, is to change metallurgy, to replace steel with fiberglass. We have been producing for eight years, and so far

it's been a problem we've been able to manage successfully.

Q. If I remember correctly, they anticipated a 15-year life for that plant and gathering system. That leaves seven years left. Is that still what Amoco expects, or do you expect more life out of that equipment?

A. Well, I can't speak to that. I'm not a design engineer. I would hope that we could operate longer than that without major modifications. We've spent, in the last four years, major modifications to the plant to reduce pulsation problems. We have done significant rewinding of the electric motors to extend their life.

So, I would have to answer by saying the things we've done, just in the last four years, should extend the life of that facility beyond that 15 years.

Q. You don't anticipate building a whole new plant in seven years?

A. Not as a replacement. We hope we can build another one for increased demand. But expenditures that would have been made at that 15-year point, probably already have been made,

and would extend beyond 15 years.

Q. How much water is removed at the plant?

A. We produce about 500 barrels a day, slightly under 500 barrels.

Q. You talked about scrubbers at that plant. What is scrubbed out in those scrubbers?

A. The free water. The first stage scrubbers take out the free water. There's additional, of course, deliquefication further in the process, but at the inlet, the bulk of the free water is removed.

COMMISSIONER CARLSON: That's all I have.

CHAIRMAN LEMAY: Commissioner Weiss?

COMMISSIONER WEISS: Yes.

EXAMINATION

BY COMMISSION WEISS:

Q. As I recall four or five years ago, density was a big factor in metering. Is it still, the density of CO_2?

A. As far as--?

Q. Metering CO_2?

A. Well, it's a factor. I think I can say that we have made additional expenditures on electronic gas metering. We have a very low

meter factor. Our meter error is very low, somewhere around one percent. So it's a measurable problem. We're happy with our meter.

Q. I guess my question is, as I recall, I've seen some designs where some of the operators weren't concerned about the density of the gas, they merely metered it through a turbine meter or through an orifice plate, something of that nature. Is that how you do it?

A. It's electronic, yes. I believe it's an infrared electronic system, I believe.

Q. Is density needed to make the calculations?

A. I'm not really sure.

Q. You didn't say anything about reservoir pressure. Do you have a comment on it?

A. Reservoir pressure varies across the unit. We have seen some decline reservoir pressure, of course, with production. It varies from, oh, I think originally on the order of 350 or 400 pounds up to, on the western side, up to the range of 550 or 600. That was original pressure; and, of course, we've seen some decline in that.

Q. Has it paid out?

A. I believe it has.

COMMISSIONER WEISS: No more questions.

CHAIRMAN LEMAY: Will your next witness be dealing with sales and issues like that, so this witness will be engineering criteria?

MR. CURRENS: The next witness will cover the marketing activity and the markets and the forecast, not forecasted activity but hopes on the horizon as we see them today.

CHAIRMAN LEMAY: I had one question that was brought up, and maybe you could address it.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. Some of the higher parts of the field, I understand, are producing more waters or a hydrodynamic effect in this reservoir. Do you know, or are there higher water recoveries maybe updip, where you expect them downdip without hydrodynamics?

A. I know there's an area of the field that is more susceptible to high water production. In fact, we've installed a salt water disposal system in that area to handle

production from those wells. Now, whether it's a hydrodynamic effect or a perched water contact, I'm not sure. I can't speak to a hydrodynamic effect, but I do know there's a higher water contact in a part of the active area.

Q. And that area is also higher structurally, is it?

A. Yes, it is.

Q. No explanation, though, as far as you know for that?

A. I can't comment on that today.

CHAIRMAN LEMAY: Any more questions of the witness?

MR. CURRENS: I have a couple for clarification.

FURTHER EXAMINATION

BY MR. CURRENS:

Q. Mr. Collier, in response to questions that you were asked by Commissioner Weiss, I believe you said that the original pressures were perhaps 350 to 400, and pressures on the western side might have been 500 or 600?

A. Correct.

Q. Might the pressures on the western side have been as high as, say, 1200 to even 1600 psi?

A. I believe they were measured that high, yes.

Q. So you might have been a little bit off in your memory there?

A. I was really speaking on a weighted aerial basis, but I think some were measured that high, yes.

Q. And with respect to our measurement out in Bravo Dome, there are two fundamental measuring activities that take place, if I'm correct, is that right? That of the wells, and that at the outlet of the plants, where it goes to the two pipelines?

A. That's correct.

Q. So the kinds of measurements that take place in those two areas are somewhat different because of the pressures involved?

A. Correct.

MR. CURRENS: That's all.

CHAIRMAN LEMAY: Any additional questions of the witness? If not, he may be excused. Let's take a 15-minute break and we'll wind it up when we get back.

[A recess was taken.]

CHAIRMAN LEMAY: Let's continue with

the hearing.

MR. CURRENS: Thank you, Mr. Chairman. My next witness has assumed the chair up there, and I'll ask him to state his name for the record.

RONALD G. KRENEK

Having been first duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. CURRENS:

A. Ronald Glen Krenek.

Q. Mr. Krenek, by whom are you employed?

A. Amoco Production Company in Houston, Texas.

Q. What do you do with Amoco?

A. I'm the manager of CO_2 sales and supply.

Q. How long have you occupied that position?

A. I began as a CO_2 coordinator for Amoco in July of 1989. In May of 1991, I assumed the position of manager of CO_2 sales and supply.

Q. With respect to your duties as manager of CO_2 sales and supply, are you familiar with the, broadly familiar at least, with the

activities of Bravo Dome, with Amoco's marketing efforts, with the general marketing by other marketers of CO_2, and the whole broad spectrum of that kind of activity?

A. Yes, I am.

Q. Have you ever testified before this Commission before?

A. No, sir, I have not.

Q. Tell us briefly of your educational background, then.

A. I graduated from the University of Houston in July of 1980 with a bachelor of science in industrial engineering.

Q. What did you do at that time?

A. Upon graduation I was employed by Amoco Production as a production engineer in Sweeney, Texas.

Q. And in the roughly, what, 10 years since then, what sort of assignments have you had?

A. Yes. Up until the time of July 1989, when I assumed the responsibilities for Bravo Dome, I had a number of various engineering jobs; in operations engineering, production engineering and reservoir engineering. These covered areas

in Texas and Southeastern New Mexico, waterflood primary areas. This was both in staff and supervisory positions.

Q. So, from that engineering background, you moved into the carbon dioxide marketing activity that you've been engaged in for the last three years or so?

A. Yes, sir, I did.

MR. CURRENS: I would ask that Mr. Krenek be accepted to testify as an expert in this matter.

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. Mr. Krenek, I believe you have prepared a number of exhibits to help us understand the production and supply situation in the industry, is that correct?

A. Yes, sir, I have.

Q. Let's turn to the first one of those, and I'll ask you to explain what's on your Exhibit No. 1.

MR. CURRENS: Mr. Krenek's exhibits all start with a "K," K-1 through whatever.

A. My first Exhibit, K-1, is a series of production curves that start with unit sales in

April of 1984.

Q. Could you speak just a little bit louder and perhaps a little more slowly, Mr. Krenek?

A. Yes, sir.

Q. Thank you.

A. I'll start with the green curve. This represents annualized average sales for each year, except for 1992, where I've represented the first quarter average. The scale on the left is in million cubic feet per day.

Since Mr. Collier has previously gone over the producing history, I'll only mention that we reached a peak of 366 million cubic feet a day in 1988, and it declined somewhat since that time.

Q. Now, on this curve, where you say unit sales, you're talking about the output of the unit down to the pipelines out of the area, or any of that carbonic reserve takes from the unit, is that right?

A. Yes, sir. That would be sales to both pipelines and to carbonic reserves.

Q. Now, there was a question earlier having to do with measurement. Perhaps you may

be a little more familiar with some of the details of measurement than Mr. Collier was, is that right?

A. Yes, sir, I am.

Q. Tell us about how we go about measurement.

A. Okay. With reference to the question about density, density is very important to our measurement. In our electrical gas measurement, we have developed an algorithm or correction factor for that density. We don't really have a lot of problems with density at our source field. Of course, density can we affected by temperature and composition.

Where we see a lot of problems are at the CO_2 projects in the Permian Basin. There we see the effects of temperature more readily, and also we see the effects of composition because of the various projects are receiving both pipeline CO_2, which is usually much more pure, and it receives CO_2 from recycled plants which has a lower composition. Thus, this change in composition can cause some problems in control of the CO_2 floods; but at Bravo Dome, we really don't have a lot of problems.

Q. Okay. Let's move on then and talk about the next curve that's depicted on your K-1.

A. This is the red curve. This plots cumulative CO_2 production for each year. The scale is on the left in billions of cubic feet.

The red squares are plotted in the middle of each year, but they represent the production at the end of each year. Through the first quarter of this year, we've produced 872 billion cubic feet.

Q. Through the first quarter?

A. Through the first quarter of 1992, that is correct.

Q. Almost nine-tenths of a trillion?

A. Yes.

Q. And we're approaching a trillion probably at the--well, next year, hopefully?

A. Yes, sir, that's correct.

Q. That's fantastic. What else is shown on this curve?

A. The final thing that we show is at the bottom of the exhibit. That is the blue curve. That represents water production from the unit. The scale is on the left, the values have been divided by 10. You'll note that we reached a

peak of about 500 barrels of water per day in 1988. Since that time, we've declined to about 200 barrels of water per day in 1992.

Q. Okay. Anything else that we need to cover, then, with respect to your Exhibit 1?

A. No, sir, there is not.

Q. Now, the production of carbon dioxide from Bravo Dome has primarily been to serve tertiary recovery units in the Permian Basin, in both New Mexico and West Texas?

A. Yes, sir, that is correct.

Q. That's a moderately recent activity in terms of years, is it not?

A. Yes, sir, since the early 80s.

Q. Have you taken a look at the opportunities that might have been presented to Bravo Dome owners to supply various projects, and made some measurement of the success that those owners have had?

A. Yes, sir, I have. That is Exhibit K-2.

Q. Let's look at that.

A. This exhibit will show the marketing success that Bravo Dome owners have had over time. I've presented that here in bar graph format. Basically, it represents the CO_2 supply

opportunities that have been available to Bravo Dome Unit suppliers; that is, all the working interest owners. I want to point out that it does not include all projects in the Permian Basin.

Q. Why is that?

A. Because it's only those properties where Bravo Dome owners have had a chance to supply. There may be projects where different source fuel owners have a hundred percent of that project and must supply it.

Q. Okay. Go on.

A. Taking a look at the curve, first, the time scale covers the period of 1983 through 1992. On the X axis, we have the years that the actual CO_2 floods began, with the actual years that they needed supply. On the Y axis, we have three bars represented.

First, the blue is a total number of projects that started that year or needed supply. With the yellow, we have the total number of projects that Bravo Dome owners supplied in full. This would be a hundred percent of that CO_2 flood project. In the red we have the projects that Bravo Dome owners supplied

in part, thus, they would not have supplied 100 percent of the project but supplied part of it.

Q. I notice the first one here is 1983 and I remember your production curve saying we didn't start until 1984. How can that be?

A. Yes, sir, let me explain that.

Q. Okay.

A. 1983, what I do is start with the years that the actual CO_2 floods needed supply or started ejection. In that year, there were two projects that started. These were the Denver unit and the Wellman unit. I indicate that the Bravo Dome suppliers supplied part of one project. That was the Wellman unit. It began injection in 1983, but Bravo Dome suppliers did not actually start supplying it until 1985.

Q. So, what you show in blue is when a project started, and then, even if it were a year or two later, if Bravo Dome were the supplier, they get credit there?

A. Yes, sir, that's correct.

Q. How come all these blues are up in the early part of this curve and not in later years?

A. As you can see, through 1986 there was a lot of activity and a lot of projects. And

this, of course, tied to the oil price decline that we're all familiar with, and I'll explain that in detail in the next few exhibits.

Q. All right. Let's move on to those exhibits, then, if it's timely.

A. Yes. I think just to summarize there, I would like to say that if we looked at the total sum of all these projects, we indicate that a total of 19 projects were supplied by Bravo Dome Unit suppliers in whole or part out of the total 29 that I had presented here.

Q. Now, relate that to oil price.

A. Yes. My next plot, Exhibit K-3, is a plot of West Texas sour oil prices. I present West Texas sour prices because that is the crude posting that most projects in New Mexico and Texas receive as their posting.

For comparison purposes, I've used the same time scale as Exhibit 2, 1983 through 1992. I present it here to indicate the correlation between oil price and CO_2 project activity.

As we look at the graph, you can see that oil prices were just under $30 starting in 1983. As we're all familiar with, you see the large decline in prices in 1986. After that, we

see some rebound in price, but again a decline in 1988. If we recall back to the previous exhibit, we'll see that there were no new projects contracting for supply in 1987, and only one in 1988.

Q. I noticed, though, there was a pretty good spurt in 89 and then again in later years. Are those new projects coming on?

A. Yes, sir. We did see some increase in oil price activity. In 1989, we had five new projects contracting for supply. There were two new projects included there, but there were three existing projects that were basically already injecting CO_2 but needed new volumes of CO_2 because their original contract volume obligations had been met. Thus, they wanted to continue with their CO_2 flood, and went out to secure a new supply.

Q. So while in recent years we haven't seen too many new projects, operators of existing projects have been keeping up their CO_2 injection programs?

A. Yes, there has been continued activities with both new projects and securing supplies for existing projects.

Q. So apparently this is proving to be quite a good process by the users?

A. Yes. I think the operators or users have shown that CO_2 floods have worked technically. It has been a technical success. That is, improved oil recovery does result.

Q. I know that various people make forecasts of what usage will be in projects coming on and so on. Have you made some comparison of actual CO_2 injection projects and included some forecasts of others?

A. Yes, sir, I sure have.

Q. Would that be your Exhibit 4?

A. Yes, sir, it is. I'll turn to that now. This exhibit depicts the historical activity of the CO_2 floods in the Permian Basin, and makes a projection of new CO_2 flood activity.

I present it here as the last of the three exhibits to kind of show the relationship between CO_2 flood activity and Bravo Dome CO_2 demand.

The plot starts in 1980, the year that the unit was formed. You'll note that there were five existing projects at that time. If you

follow the black line, you'll note there was increasing activity up through 1986, again related to the oil price decline.

You'll note that we reached about 30 projects up to that time and then flattened out. I think it's important to note that you do not see a decrease. CO_2 floods may cut back on their injection, but they will generally maintain some injection due to the large capital investments that they have made.

Q. Okay. So your black curve goes on out to 92 and shows how many projects, then?

A. We had 36 active projects in 92.

Q. Superimposed on this, though, I also see some red lines. What's their significance?

A. What those are are projections made by the Oil & Gas Journal every two years since 1988. For example, looking at 1988, they made a projection that there would be 34 new projects in 1989. This was right on.

Q. You said 34 new projects. You mean total projects?

A. I mean total projects. Excuse me. You'll note that in 1989, the red square overlays the black line, indicating the forecast was right

on.

If we look at 1990, we'll see a different story, though. There they projected for 1991 that there would be a total number of active projects of 40, but actually they only stayed at 36. They were a little optimistic.

If we looked at their 1992 projection made in 1990, it even grows more optimistic. We continued with only 36 active projects but their forecast was 45. I think this is kind of characteristic of the supply industry. There's still quite a bit of market uncertainty.

Q. Now, on this curve, you're showing that there are 36 total projects in the Permian Basin and on your earlier curve, your Exhibit 2, you were talking about 29 projects where the Bravo Dome people had been successful in supplying 66 percent.

Why do we have a difference between 29 and 36?

A. Okay. The 36 is total active projects. That is all projects in the Permian Basin. The 29 again are the total projects that Bravo Dome owners had a chance to supply, so thus there can be a difference between those. There would be

some CO_2 flood projects where 100 percent of the supply is from another source.

Q. Okay. Do you know, are there going to be new projects coming on in the next several years?

A. Yes. If we looked at the forecast that was made by the Oil & Gas Journal for 1992, it predicts about two new projects in 1993. I think that's very realistic. One of those is the Salt Creek Project, which part of the supply will be from Bravo Dome.

Q. That's not included in your earlier historical information?

A. No, it is not. That only went up through 1992.

Q. Anything else with respect to these curves on supply and demand, before I ask you to kind of summarize the supply and demand picture?

A. Just to summarize the last three exhibits, if I can--

Q. Go ahead and do that, please.

A. All right. I think we will see an increase in CO_2 flood activity in the next few years; that is, barring a total oil price collapse. Operators have shown that the CO_2

floods are a technical success, as I've mentioned previously, but again economics will be significantly effected by oil price as we've seen from the previous plots.

There are some positive tax incentives that will help operators. Some of those are the recent severance tax breaks that the states New Mexico and Texas have enacted. Also there's the 15 percent investment tax credit that the federal government has provided.

Q. Okay. Mr. Krenek, in addition to the supply/demand picture as we see it and that you've talked about, I believe you have prepared two more exhibits that summarize, perhaps, some information that's been discussed before but perhaps some that's not, that sort of is a summary of our unit activity to date?

A. Yes, sir, I have.

Q. Why don't you turn to your next one, K-5, a statistical summary, and tell us what's shown there.

A. Okay. This is the first of the summary slides, Exhibit K-5. First I'll start with production data. You can see we've produced in the first quarter of this year just under 900

Bcf. You can also note that our 1991 average producing rate was about 311 million cubic feet a day. This compares to a peak producing rate of 381 million cubic feet a day which occurred in February of 1987.

Also, you can see that our current deliverability of wells connected to the system, as Mr. Collier pointed out, was 340 million cubic feet a day. That compares to current plant capacity of 390 million cubic feet a day.

Q. I think the next section of that particular chart contains information that's already been written down and detailed by Mr. Collier, so rather than repeat that, why don't you move to the bottom part?

A. Okay. We'll move to that final category. This category summarizes the road work that has been done in the unit, which is quite significant. There is a total of 751 miles of road that are either new construction or resulted from improving county roads. This work has been split between 375 miles of lease roads, which directly benefit individuals, and 376 miles of county roads, which directly benefit the three counties involved.

Q. That's quite impressive. Let's move to your last exhibit, which is a financial summary, and tell us--give us a financial summary.

A. Yes. This is Exhibit K-6. This exhibit summarizes the costs, taxes and royalty that has been paid out by working interest owners since the start of the unit. Starting with cost, at the end of March of 1992, owners had incurred direct costs of over $378 million. Of this, approximately 30 percent, or $157 million, has been spent on drilling and facility investments. Another $17 million has been spent to maintain unit operations, and over 50 percent, $205 million, has been spent to operate the unit.

Q. Those numbers are different in total than Mr. Collier presented?

A. Yes, sir, they are slightly different. Mr. Collier's numbers went through the end of 1991. Mine go through the first quarter of 1992.

Q. Go on please, now.

A. The next category indicates that $26.5 million in direct taxes have been paid to state entities to the end of the first quarter of this year. The final section just summarizes the royalty costs that have been paid out that Mr.

Collier summarized. Those are just under $50 million since the life of the unit.

Q. Anything else with respect to your 5 or 6?

A. No, sir.

Q. Let me ask you, with your familiarity with all of the activity of Amoco and the other working interest owners in the Bravo Dome Unit, do you have an opinion as to whether or not those activities have been such that they have continued to move in the area of prevention of waste and protect correlative rights?

A. Yes, sir, I think they have.

Q. Let me ask you if there's some overall summary that you would like to wind up this hearing with?

A. Yes, sir, I would like to make some points to summarize.

Q. Okay.

A. First, I would like to say we have examined the CO_2 supply history in the Permian Basin and the effect that Bravo Dome suppliers have had. The number of projects that Bravo Dome suppliers have supplied in whole or in part has been very significant. This has been an

environment that has been very competitive and will continue to be so.

We have been on everything that is reasonable and accessible to pursue, and we will continue to have an aggressive marketing approach. We've also gained a better understanding of the effects that oil price has on CO_2 flood activity and the resulting demand from Bravo Dome.

Next I would point out that Bravo Dome owners have invested a significant amount of money to develop and maintain unit sales, the $378 million that I referenced previously.

As Mr. Collier pointed out, some of this spending has been to make us more efficient. This, of course, will make us more competitive in the marketplace.

Through eight years of sales, royalty owners have received just under $50 million as their mineral resources have been monetized.

Finally, although sales have declined this year, we're rapidly approaching one trillion cubic feet, and I think that's a significant milestone. I'm also optimistic about 1993, as we should see increased demand from Bravo Dome due

to the Salt Creek Project which I mentioned previously.

As you have seen, we have gas available to meet those needs. Also, we are prepared to respond to a wide variety of possible demand scenarios. Thank you.

MR. CURRENS: That's all I have of Mr. Krenek. I would offer his Exhibits 1 through 6, and I would offer Mr. Krenek for questions.

CHAIRMAN LEMAY: Without objection, Exhibits 1 through 6 will be admitted into the record. Questions of Mr. Krenek?

Commissioner Carlson?

COMMISSIONER CARLSON: Yes.

EXAMINATION

BY COMMISSIONER CARLSON:

Q. Your second exhibit, that supply is for all the working interest owners? In other words, it's not just Amoco as the supplier, it represents the total unit?

A. That's correct.

Q. How many working interest owners are directly marketing their own share of CO_2?

A. I don't know the total number, but there are quite a few, such as Amoco, Amerada,

Shell and some smaller owners.

Q. There are some smaller owners that do their own marketing?

A. Yes, sir, there are. Some of those are like Markland. There's a company called Rim, and a few other smaller companies that do market their own CO_2.

Q. What percent of the total unit production does Amoco market, do you know?

A. I think it's somewhere in the range of 60 to 70 percent, something like that.

Q. For what percent of production is Amoco the actual working interest owner? Do you understand the question? You market 60 to 70 percent, but I assume some of that is on behalf of other working interest owners, is that correct?

A. No, sir, it is not.

Q. That is Amoco's share of unit production is the 60 to 70 percent?

A. Right. That's correct.

Q. So Amoco does not market on behalf of other working interest owners?

A. No, sir. There's no joint marketing of Bravo Dome. Each working interest owner is

responsible for their own marketing.

Q. Last time we looked into this, Amoco Production Company sold, I believe at the tailgate of the plant, to Amoco Oil Company. Is that still the case?

A. That is still the case, yes.

Q. Are you employed by Amoco Oil or by Amoco Production Company?

A. No, I am employed by Amoco Production Company.

Q. But Amoco Production Company sells all its production to Amoco Oil?

A. That's correct.

Q. Amoco Oil in turn, then, sells this CO_2 to operators of enhanced oil recovery projects in the Permian Basin?

A. Right. They would sell it to operators of the Permian Basin projects, which would include Amoco Production and other parties.

Q. Are you involved in those transactions?

A. I'm involved strictly from the viewpoint of Amoco Production's sales, end at the tailgate. Again, I would be involved when they sell it back to us at the project.

Q. So, you have some knowledge of those

sales that are occurring at the tail end of the pipeline?

A. The projects that came to Amoco Production, I would.

Q. Of the CO_2 that Amoco Production markets out of Bravo Dome, how much does Amoco Production in return buy from Amoco Oil at the tail end of that pipeline?

A. Of the total that we--

Q. Yes. Here again, in percentage.

A. Approximately 70 percent.

Q. So I could say the remaining 30 percent is actually marketed under arm's length contracts?

A. Well, I think it's marketed all under arm's length contracts.

Q. Marketed to nonaffiliates?

A. Yes, sir, that would be correct.

Q. Are you knowledgeable of the pipeline rates that Bravo pipeline charges Amoco Oil?

A. No, sir. I'm familiar with the rates but they can change from time to time, and I'm not familiar with that determination.

Q. Those rates have changed in the last four years?

A. Yes, sir, they have.
Q. I take it they have increased?
A. Yes, they have.
Q. Are those rates negotiated, or are they just posted rates?
A. That's the business of Amoco pipeline, as far as determining those rates. It is a common carrier pipeline that they post, and everyone can have access.
Q. Are those rates subject to approval of any federal or state agency?
A. I'm not familiar with that.
Q. If I remember correctly, not just the state leases but a lot of those private leases had the opportunity to take their royalty in kind from the Bravo Dome. Is any royalty owner taking their production in kind?
A. No, sir, not that I'm aware of.
COMMISSIONER CARLSON: I don't have any further questions.
CHAIRMAN LEMAY: Commissioner Weiss?

EXAMINATION

BY COMMISSIONER WEISS:
Q. You mentioned the Salt Creek Project. Who is the operator of that?

A. That is Mobil.

Q. In your figure K-3, you've got your oil price history. What's the forecast of Amoco?

A. I think there are probably lots of oil price forecasts, and I would hate to hazard a guess on that.

Q. I'm asking for Amoco's. Do you have one?

A. I really can't say. We don't expect a real large increase in price, but I really can't make much of a guess beyond that.

COMMISSIONER WEISS: Thank you. No other questions.

CHAIRMAN LEMAY: I've got a couple.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. Out of the projects you mentioned, the 29 that you're supplying, are any of those in New Mexico?

A. The Dollarhide Unit is on the Texas and New Mexico line. I'm not sure if part of it is in New Mexico.

Q. Are you supplying that?

A. Yes, sir. Beyond that, I don't think there are any New Mexico projects.

Q. Maybe I can back up, and you don't have to answer this if you don't have the figures, but you mentioned getting close to one Tcf. How about reserves in the field? Do you have any figure for reserves under the unit?

A. All I know is that the total reserves were 8 Tcf as outlined in the unit agreement. I really don't have any--

Q. As far as you know, that hasn't changed much?

A. No, sir, I'm not familiar with any changes.

Q. A couple of other questions here. Your average demand per project, the projects, I assume, would vary with the demand, with how much gas they need to put, depending on the size and all.

Is there a profile, where you would take the average life of the CO_2 injection and at some point start recycling that so your demand would fall off? Is that what happens in a CO_2 projects?

A. Yes, sir. A typical demand scenario would be, you know, high initial rates. Those would all be supplied by the pipeline CO_2 as

source field in the early life, but you wouldn't have any breakthrough. As the project goes along and you start to see breakthrough, the recycle will start building and the demand from pipelines will go down.

Q. Do you have an average project life for supplying that field?

A. Each field is unique. I really can't state what the life of those floods are. I think we'll kind of see the history that we see on waterfloods. As they earn more and more, they'll keep operating and injecting more CO_2.

Q. The projects you're supplying to date, when have you seen the dropoff since initial supply? Was there a five years, and then it started dropping off three to years?

A. No, sir. I think you start seeing it within the two or three years.

Q. Two or three years, the dropoff?

A. Right.

Q. Did I hear you say that Amoco is a common carrier pipeline?

A. What I stated was that Amoco pipeline system is, that's correct.

Q. You're sure of that?

A. Yes.

CHAIRMAN LEMAY: Okay. That's all the questions I have. Any additional questions of the witness?

Yes, sir, Roy.

EXAMINATION

BY MR. JOHNSON:

Q. One I get asked an awful lot. What's the price of CO_2 today at the wellhead?

A. As far as the price at the wellhead, let me state that there's no one Bravo Dome price. Of course, each working interest owner markets their own gas; thus, they're all responsible for their own contracts and prices. Thus, there could be a myriad of different prices in contracts. I'm not familiar with all of those, of course, because I don't market everyone's gas.

And that price can change monthly due to the varying demands during the projects. As far as what that price is at the wellhead, I guess if you were a royalty owner, you could look on your check and discover that.

CHAIRMAN LEMAY: Do you have a rough guess for us here, for Amoco-supplied prices at

the wellhead?

THE WITNESS: I really don't because of the change you can see in that.

COMMISSIONER CARLSON: Our oil reports say 31 cents, and I think that's been pretty constant over the last--

MR. STOVALL: Just for the record, let it reflect that the question from the floor was asked by Roy Johnson, petroleum geologist for the NMOCD.

CHAIRMAN LEMAY: Any follow-up, Roy? I'm sorry. Morris Lierz.

EXAMINATION

BY MR. LIERZ:

Q. Director of royalty management, New Mexico State Land Office. Today, or in recent past, in the recovery projects, how much CO_2 is consumed or not recovered from the reservoir to raise up barrels of water? I heard at one point it took 5 Mcfs of CO_2 to raise a barrel of oil, that you probably do not recover 2, it may stay in the reservoir and you'll lose it, but you may recover 3 Mcf of the 5.

In other words, I'm trying to get at, what is the recovery or the consumption of CO_2 in

raising oil?

A. I think that's referred to as a utilization factor in Mcf per barrel. I've heard the same kind of numbers quoted in the 5 to 10 range. Some projects are higher. It just kind of depends on the reservoir. I can't really state any industry average, because I haven't looked at that.

CHAIRMAN LEMAY: 5 to 10 Mcf per barrel?

THE WITNESS: Are numbers that I've seen published.

CHAIRMAN LEMAY: Mcf of CO_2 per barrel?

THE WITNESS: Right. That one concluded a combination of the recycle and pipeline CO_2.

CHAIRMAN LEMAY: Anything else, Mr. Lierz?

Additional questions of the witness? Yes.

MR. JARAMILLO: Arthur Jaramillo. I'm an attorney here in Santa Fe. I was just wondering what steps Amoco has taken, over the last four years, to analyze or consider whether the surface acreage allocation formula on which

royalties are distributed to the royalty interest owners, continues to protect the correlative rights of the royalty interest owners in the unit?

MR. STOVALL: Mr. Jaramillo, are you representing somebody in this hearing?

MR. JARAMILLO: No, I'm not representing anybody in this hearing.

MR. STOVALL: I guess I would have to--Mr. Carr, do you have any problem, or Mr. Currens, with answering questions from the public in general?

MR. CARR: Mr. Stovall, we recognize there is a substantial interest in Bravo Dome, but we really are here to report to you on particular questions and not just have a public forum or questions of that nature. I recognize Mr. Jaramillo's concern, but I'm not even convinced that there's an appropriate witness here who can discuss a matter which really would be a reevaluation of certain matters that were set by the original contract and the unit operating agreement.

I guess we object, partially because I don't think we have an appropriate witness here

to review that kind of inquiry for Mr. Jaramillo.

MR. STOVALL: Mr. Chairman, I would state that the previous questions came from representatives of the state agencies which are specifically involved, and I would have to say this is not a public forum for discussion. If somebody were to enter an appearance on behalf of a party, I would say take the question, but you run the risk of opening this into a discussion forum rather than a procedural hearing by allowing questions from the public on the floor in a proceeding of this nature.

CHAIRMAN LEMAY: Any other comment concerning the objection? Do you have any response to that? We'll rule on it in just a minute.

MR. JARAMILLO: Just that it was published as a public hearing, and it would seem to me that that would be a matter that the Commission ought to consider within the published notice, which is whether or not the operations continue to protect against--prevent waste and protect correlative rights. I'm just curious why the matter had not been addressed by Amoco.

MR. STOVALL: The question is not whether his question is valid, the question is whether he is the proper person to be asking a question.

CHAIRMAN LEMAY: All right. Let's take a couple minutes here.

[Discussion off the record.]

CHAIRMAN LEMAY: I think our question is really directed to you, Mr. Jaramillo, if you want to make an appearance on behalf of a party now? If not, I think we'll uphold the objection and give you an opportunity to make a statement at the end, if you care to.

MR. JARAMILLO: I represent no party here, Mr. Chairman.

CHAIRMAN LEMAY: Thank you. The objection will be upheld, then.

Additional questions of the witness? If not, he may be excused.

Wrap up, Mr. Carr or Mr. Currens??

MR. CARR: I will be brief. May it please the Commission, the original orders that approved this unit agreement recognized the value of the unitized development of carbon dioxide in the Bravo Dome area. This Commission found at

that time that efficient and effective unit operations would prevent waste and would protect correlative rights.

We submit to you that the physical operations of Bravo Dome are both efficient and effective. We employ state-of-the-art equipment, facilities and practices. By doing this, we have maximized recovery, we have enhanced the revenue that is obtained from this development and, at the same time, we have been sensitive to environmental concerns.

The actual extent of the physical development of this resource is tied directly to the price of oil, but our efforts to define this particular reservoir are not so restricted. We have employed the most recent and advanced techniques to define this reservoir in the unit area. We have shown you what we're doing in that regard. We've shown you what efforts we're undertaking in trying to understand the Tubb Formation and to meet our obligations to all interest owners in the unit and, at the same time, comply with all regulatory requirements.

I think in sum we simply believe we're continuing to do today that which we set out to

do in 1980. We submit to you that the operations are efficient, that they are effective, that they do prevent waste, that they do protect correlative rights, and that they're doing these things on a continuing basis.

CHAIRMAN LEMAY: Thank you. Mr. Currens? Anything to add to that?

MR. CURRENS: No. I'll not. Thank you.

CHAIRAN LEMAY: Are there any other statements? Anything else in the case?

If not, we shall take the case under advisement. Thank you all very much.

(And the proceedings concluded.)

CERTIFICATE OF REPORTER

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

I, Carla Diane Rodriguez, Certified Shorthand Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Commission was reported by me; that I caused my notes to be transcribed under my personal supervision; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL July 28, 1992.

Carla Diane Rodriguez

CARLA DIANE RODRIGUEZ, RPR
CSR No. 4