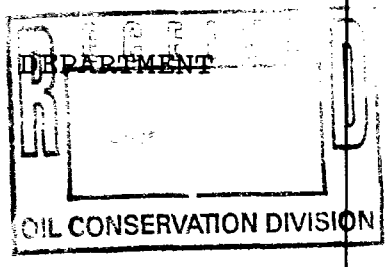
STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION




IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:

APPLICATION OF AMOCO PRODUCTION COMPANY FOR FOURTEEN UNORTHODOX INFILL CARBON DIOXIDE GAS WELL LOCATIONS, UNION COUNTY, NEW MEXICO

CASE NO. 11,497

ORIGINAL

REPORTER'S TRANSCRIPT OF PROCEEDINGS

EXAMINER HEARING

BEFORE: DAVID R. CATANACH, Hearing Examiner

March 21st, 1996

Santa Fe, New Mexico

This matter came on for hearing before the New Mexico Oil Conservation Division, DAVID R. CATANACH, Hearing Examiner, on Thursday, March 21st, 1996, at the New Mexico Energy, Minerals and Natural Resources Department, Porter Hall, 2040 South Pacheco, Santa Fe, New Mexico, Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

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# I N D E X

March 21st, 1996
Examiner Hearing
CASE NO. 11,497



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A P P E A R A N C E S

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ALSO PRESENT:

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* * *

WHEREUPON, the following proceedings were had at 1:05 p.m.:

EXAMINER CATANACH: At this time we'll call the hearing back to order, and I will call Case 11,497.

MR. CARROLL: Application of Amoco Production Company for fourteen unorthodox infill carbon dioxide gas well locations, Union County, New Mexico.

EXAMINER CATANACH: Are there appearances in this case?

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

We represent Amoco Production Company in this matter.

I'm appearing today in association with A. Andrew Gallo, counsel for Amoco, who's a member of both the Texas and Missouri bars, who's going to assist in presentation of the case.

We have three witnesses.

EXAMINER CATANACH: Are there additional appearances?

Can I get the three witnesses to stand and be sworn in at this time?

(Thereupon, the witnesses were sworn.)

MR. CARR: Mr. Catanach, as you're aware, the

Bravo Dome was formed in the late 1970s and became effective in 1980. Since it was originally created, this unit has been developed by and large on a 640-acre spacing pattern. There are two spacing patterns in the unit, but most of the development has occurred within the 640-acre spacing area.

Recently Amoco undertook a study of the reservoir and evaluated the feasibility of further developing the Tubb formation with an infill drilling program, and the Application we bring to you today is the result of that evaluation.

We also determined that certain wells needed to be located at unorthodox well locations if, in fact, we were going to maximize the recovery of carbon dioxide from this unit.

We will present three witnesses today.

We will first call Sam Culpepper, a landman, who's going to generally identify the three areas or clusters of wells that are the subject of this hearing. He will review the general ownership in the area and the current status of Amoco development in the areas that are affected by this case.

Next we will call Herbert J. Wacker, a geologist. He's testified before this Division and Commission before. He will review the geology of the Tubb formation in the

unit as a whole, but especially in each of the areas that are the subject of this Application, and he will review the geologic parameters that have been utilized in our computer modeling of the reservoir.

We will call a petroleum engineering witness, Mr. Bill Gibson. He's going to review the criteria used by Amoco to identify the area selected for infill development. He's going to review the computer models that we have used to simulate flow, both in the reservoir and on the surface. He will show how these have been integrated and used to predict performance of wells at individual specific well sites. And using these tools we will show you that we have selected 13 locations for wells, unorthodox locations, for infill wells within the Bravo Dome unit.

We will then show you that to maximize the ultimate recovery of carbon dioxide from this reservoir, wells must be drilled at these locations.

We will also request, at the end of the presentation, that if future applications for infill wells do not qualify under the provisions of new Rule 104, that the order in this case authorize an administrative procedure whereby future infill wells can be considered for approval without the necessity of hearing.

And with that, we are now ready to call Mr. Culpepper.

EXAMINER CATANACH: Let me introduce Mr. Roy Johnson, who's our guest up here today, who's going to assist us in this case.

SAM CULPEPPER,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. CARR:

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

A. Sam Culpepper.

Q. Where do you reside?

A. Houston, Texas.

Q. By whom are you employed?

A. Amoco Production Company.

Q. And what is your position with Amoco Production Company?

A. I'm senior business analyst, land negotiator in the Permian Basin business unit.

Q. Mr. Culpepper, have you previously testified before the Oil Conservation Division?

A. No, I have not.

Q. Could you briefly review your educational background for Mr. Catanach?

A. Yes, I have a BA from Southern Methodist University and received my law degree from SMU in December

of 1975.

Q. When did you go to work for Amoco?

A. I went to work for Amoco in 1981.

Q. Could you summarize the nature of your work experience with Amoco Production Company?

A. I've worked in both property administration and land negotiations since that time, and I'm currently supporting the Bravo Dome since November of 1995.

Q. Are you familiar with the Application filed in this case on behalf of Amoco and the amended Application?

A. Yes, I am.

Q. Are you aware of the status of the lands in the portion of the Bravo Dome unit on which the proposed infill wells are to be drilled and also on the offsetting tracts?

A. Yes, I am.

Q. And are you familiar with the ownership in those adjoining and diagonal offsetting properties?

A. Yes, I am.

MR. CARR: We tender Mr. Culpepper as an expert witness in petroleum land matters.

EXAMINER CATANACH: Mr. Culpepper is so qualified.

Q. (By Mr. Carr) Could you briefly state what Amoco seeks with this Application?

A. Yes, Amoco is seeking 13 unorthodox carbon

dioxide gas wells in the Bravo Dome unit area.

Q. What are the locations for each of these wells?

A. The exact locations are set out in the amended Application filed in this case.

Q. Now, the Application is styled "seeking approval of fourteen unorthodox locations". Today we're here only seeking 13; is that right?

A. That's correct, one is on an orthodox location.

Q. Is that the Unit Well 1835, Number 72?

A. 72K, yes.

MR. CARR: And Mr. Catanach, that is Well Letter I on the amended Application. That well is 1980 from the south and west lines. It's a standard location, and therefore it can be dismissed from this Application.

Q. (By Mr. Carr) Mr. Culpepper, why was an amended Application filed in this case?

A. Two wells were changed from the original Application, two were deleted, and two were substituted.

Q. What are the new wells? And if you can maybe refer to the --

A. Okay.

Q. -- amended Application.

A. On the amended Application the new wells are listed as H and N, as in Nancy. These are at 2134132P, and 2234172A.

MR. CARR: Mr. Catanach, the legal advertisement provided in this case did not provide specific well locations within Bravo Dome. It generally referred to townships and ranges.

Both of these wells fall within those townships and ranges, so there is nothing that can be changed in the published notice on this matter, and therefore we submit that that notice is appropriate and the case should not have to be continued for readvertisement.

EXAMINER CATANACH: Was there any notice provided to any interest owner, Mr. Carr?

MR. CARR: We'll review that with Mr. Culpepper. We have provided -- There are no individuals to whom notice is required under the rule, but I will review that with this witness.

EXAMINER CATANACH: Well, in terms of -- Was notice provided in terms of exact well locations to those interest owners?

MR. CARR: There are no interest owners to whom we can give notice. We will show that.

EXAMINER CATANACH: Okay, all right.

Q. (By Mr. Carr) Mr. Culpepper, will each well covered by this Application be an infill well on the subject spacing units?

A. Yes, each well will be either a second or third

well on the 640 spacing unit.

Q. And are additional wells, more than one well, authorized on the 640-acre spacing units in this portion of the unit?

A. Yes, under the special rules for the Bravo Dome, 640-acre area Rule 2, it allows up to four wells per -- or doesn't preclude four wells on a 640-spacing unit.

Q. So there's no need to seek additional approval for multiple wells on this unit?

A. Correct.

Q. What are the well-location requirements set forth in the rules for the 640-acre Bravo Dome area?

A. Applicable to this case, it's a setback from the outer boundary of the section, 1650 feet.

Q. So we're actually closer with each of these wells than that 1650-foot setback?

A. That's correct.

Q. Let's go to what has been marked as Amoco Exhibit Number 1. Can you identify that, please?

A. Yes, this is the major carbon dioxide supply and systems in the United States, and it's offered in order to locate Bravo Dome in the northeast corner of the State of New Mexico.

Q. This also shows pipelines from the area?

A. Yes, it also shows the pipelines from which

supply is shipped.

Q. Let's go to Exhibit Number 2. Can you identify that, please?

A. Yes, Exhibit 2 is the -- You notice on the right-hand side, you have the eastern boundary of the Bravo Dome unit, and the largely developed area, if you note that there are three colored squares on it with red dots inside.

The green area at the top is a cluster of wells that are proposed on Leg 9 of the gathering system.

The black square is another cluster of wells on Leg 9 of the gathering system, four wells there.

And then to the south in the yellow square, that's four proposed wells on Legs 6 and 7 of the gathering system.

Q. Mr. Culpepper, later exhibits will show these particular clusters of wells as they are located within the entire unit boundary; is that right?

A. That's correct.

Q. What is the red line around this exhibit? What does that indicate?

A. The red line is, as I understand it, the boundaries of an engineering model.

Q. And that will be reviewed by a later witness?

A. That's correct.

Q. Let's go to Exhibit Number 3. Can you identify

that, please?

A. Okay, Exhibit Number 3 is focusing in on the northern part of Leg 9 that you saw on Exhibit 2, the north end. It indicates the proposed unorthodox well locations, and it also indicates the adjacent and diagonal tracts to those unorthodox locations. It also indicates wells that are on those adjacent and diagonal tracts that are operated by Amoco Production Company.

Q. So what you've done is, you have highlighted with the yellow blocks all adjacent and diagonal spacing units as that term is defined by OCD rules?

A. Correct.

Q. And you've shown the existing development on those tracts, and all tracts are operated by Amoco?

A. Correct.

Q. All right. Let's go to Exhibit Number 4. Can you identify and review that, please?

A. Okay, Exhibit Number 4 is the other cluster of wells that we saw in Exhibit 2, just to the south on Leg 9. Again, I've indicated the unorthodox -- proposed unorthodox locations, the adjacent and diagonal tracts and the wells existing on those tracts, all operated by Amoco Production Company.

Q. And now let's move to Exhibit Number 5. Can you identify and review that, please?

A. Exhibit Number 5 are the proposed well locations that exist between Legs 6 and 7 of the gathering system.

Again, we show the one orthodox location, being 72K, and the three proposed unorthodox locations, all of the adjacent and diagonal tracts, the wells existing on those tracts, all operated by Amoco Production Company.

Q. Now, Mr. Culpepper, are all of the wells that we are proposing to drill located in the 640-acre spacing unit?

A. Yes.

Q. Or a portion of the unit?

A. Yes, they are.

Q. And are all of the diagonal and offsetting spacing units also located in the 640-spacing unit?

A. Yes, they are.

Q. Are all the properties that we're dealing with here today in this hearing operated by Amoco?

A. Yes, they are.

Q. Are there any affected parties who are entitled to actual notice of this Application pursuant to Division Rules either 104 or 1207?

A. No, since we operate all of it, there is no notice.

But public notice was published in the *Union County Leader* March 6th, 1996.

Q. Now, Mr. Culpepper, there are tracts in the adjoining and diagonal spacing units that have not been committed or interests that have not been committed to the Bravo Dome unit agreement; is that right?

A. There are a few tracts where there is unleased mineral interest that's either unknown, unlocatable, and it's very small.

Q. Do all of the interests -- or all of the tracts that are not committed in these particular offsetting or diagonal spacing units -- are the owners of those interests either unknown or unlocatable?

A. That's correct.

Q. Will Amoco call a geological and engineering witness to review the technical portions of this Application?

A. Yes, they will.

Q. Were Exhibits 1 through 5 prepared by you or compiled under your direction and supervision?

A. Yes, they were.

MR. CARR: At this time, Mr. Catanach, we move the admission into evidence of Amoco Exhibits 1 through 5.

EXAMINER CATANACH: Exhibits 1 through 5 will be admitted as evidence.

MR. CARR: And that concludes my direct examination of Mr. Culpepper.

EXAMINATION

BY EXAMINER CATANACH:

Q. Just to clarify that, Mr. Culpepper, the offset tracts to these infill well locations, was it your testimony that the royalty interest owners are all signed up as to participate in the unit, with the exception of those that are not locatable?

A. Other than -- well, we have some unleased mineral interest in some tracts, particularly in the most northern leg. It's small interests in only -- not over the whole 640, but in small tracts of that 640 spacing, there are some small unleased mineral interests, and of course money is being set aside, if they're locatable and can be determined.

Q. The reason they're unleased is because they're not locatable?

A. As I understand it, yes.

EXAMINATION

BY MR. JOHNSON:

Q. Mr. Culpepper, on your Exhibit Number 2, this exhibit has got three green dots --

A. Exhibit 2.

Q. -- on it. What do those signify? Is that something that's going to be talked about?

A. Those three green dots will be discussed by

subsequent testimony.

Q. Okay. And to just clarify Mr. Catanach's question, the offsetting acreage on this one, come as a royalty, all that royalty is in the Bravo Dome unit except for those tracts that you can't find the owners of; is that correct?

A. Yes, as I understand it, through my research, that's what I see.

MR. JOHNSON: Okay, that's all I have, David.

EXAMINER CATANACH: When we say "offsetting tracts", did you -- were those tracts that completely surrounded these infill proration units?

THE WITNESS: Well, the tracts were -- as I understand the definition of what an adjacent and diagonal tract is, it's the tracts either diagonal or adjacent to the encroaching well. So it would be caddy-corner and the two tracts on either side, and that's the way that I did my exhibits and research.

Q. (By Mr. Johnson) You didn't scribe a half-mile radius around one of these wells to see if any other tracts were affected?

A. No, sir, because that was not the definition of adjacent and diagonal as I understood it and was communicated to me.

Q. And yet these wells are capable of draining 640

acres; is that correct?

A. I can't speak to that. I think you'll have subsequent testimony that I think it would probably be -- you'll get a better answer if you ask people who know.

Q. All right. Well, assuming that that is the last testimony on your 640-acre spacing case, then potentially there could be a tract within a half-mile radius around these wells that is not in the unit that could possibly be affected; is that correct?

A. I can't really -- I can't really speak to that. I'm not an engineer.

MR. JOHNSON: Thank you.

FURTHER EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Culpepper, did you personally do the examination of these records?

A. Yes, I did. Yes, I did.

Q. Okay. And as I understand it -- let me just -- one more time. For any given proration unit in which you propose to drill a well, you looked at the eight surrounding proration units?

A. I looked at the -- For each unorthodox well location, I looked at the two adjacent 640s and the diagonal 640.

Q. Now, the two adjacent being --

A. Well, as an example, if you'd like to look at Exhibit Number 3, and you look at the top there and you see the unorthodox location proposed, 172A --

Q. Uh-huh.

A. -- as I understand the definition of "adjacent" and "diagonal", it would be Section 8 to the north, Section 9 diagonally, and Section 16 to the east. And those would be the three applicable proration units, spacing units.

Q. Okay, you looked at the tracts which the unorthodox location was moving towards --

A. Correct.

Q. -- encroaching towards?

A. Correct.

Q. Okay, got it.

A. And I did that in every case.

MR. JOHNSON: And you looked at the entire section?

THE WITNESS: Yes, I did.

MR. JOHNSON: Okay.

Q. (By Examiner Catanach) Mr. Culpepper, you stated that this case was -- or this request was advertised in the Union County newspaper?

A. Yes.

Q. Was that done by Amoco?

A. Yes, it was.

MR. CARR: No, it was done by the OCD.

THE WITNESS: Was it?

MR. CARR: It was the regular notification that appeared March the 6th in the *Union County Leader*. I have copies here if you'd like to see one.

EXAMINER CATANACH: Yeah, could you -- Mr. Carr?

THE WITNESS: I've got one here, I believe. I think I have an original.

(Off the record)

MR. CARR: March the 6th.

EXAMINER CATANACH: I think that's all we have of this witness. He may be excused.

MR. CARR: Thank you, Mr. Catanach.

At this time we would call Mr. Herb Wacker.

(Off the record)

HERBERT J. WACKER,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. CARR:

Q. Mr. Wacker, would you state your full name for the record, please?

A. My name is Herbert J. Wacker.

Q. Where do you reside?

A. I live in Houston, Texas.

Q. And for whom do you work?

A. I work with Amoco, USOG.

Q. And how long have you been employed by Amoco?

A. I've worked with Amoco for 23 years.

Q. Mr. Wacker, you have previously testified before this Division and Commission concerning the Bravo Dome, have you not?

A. Yes, I have.

Q. At the time of that prior testimony, were your credentials as an expert witness in the field of petroleum geology accepted and made a matter of record?

A. They were.

Q. Are you familiar with the Application filed in this case on behalf of Amoco Production Company?

A. Yes, I am.

Q. And are you a member of the team within Amoco that has made a study of the Bravo Dome to determine the feasibility of performing an infill drilling program in portions of the Bravo Dome unit?

A. I'm a member of that team.

Q. And what was your role as a member of that team?

A. My role was to provide the base geologic information on which the modeling relied.

Q. And are you prepared here today to review that geological work with Mr. Catanach and the other

representatives of the Oil Conservation Division?

A. Yes, I am.

MR. CARR: Are the witness's qualifications acceptable?

EXAMINER CATANACH: Yes, they are.

Q. (By Mr. Carr) Mr. Wacker, have you prepared or has there been prepared under your direction certain exhibits for presentation here today?

A. Yes.

Q. I'd like to direct your attention to what has been marked as Amoco Exhibit Number 6, and I'd like you to first simply review for Mr. Catanach what this exhibit is designed to show.

A. This exhibit is a montage, including a regional base map on the left-hand side of the exhibit, that includes all of the Bravo Dome area. It includes on the right-hand side the areas that are particularly important to this hearing involving Leg 9 and also Legs 6 and 7 further to the south.

On the regional structure map of the Bravo Dome the contour interval is 50 feet. The colors that you see on there range from a green in the south where it's structurally low, to a red in the northwest that is structurally high. This helps give us a picture of the general shape and configuration of the Bravo Dome

reservoir.

Outlined in blue are the two key areas that are shown on the right-hand side of the montage. They're labeled "Leg 9 Area" on the regional reference map and "Legs 6 and 7 Area" on the regional reference map.

Q. When we look at your exhibit and we go to the structural top map, the large orientation map you have shown a lot of additional information, have you not?

A. Yes, I have.

Q. What are the red lines that go back and forth across the unit area?

A. The red lines are the geophysical data points that were used to help construct the structural configuration of the dome. Because of the well control and the distribution, it was important to have a good distribution of data points to come up with an accurate structure.

Q. And is the area that is shown as the unitized -- or the unit, is that the boundary following contraction of the unit, or is that the original unit boundary?

A. The actual colored area is the original unit boundary. The contracted area is shown in a black line just inside that, and it's identified back down in the lower left-hand corner of the diagram as the approximate unit outline, and you can see that it's just a dark line.

It shows also some of the windows that are present in the Bravo Dome field, as far as leasing and so forth.

Q. This map also has the zero net pay isopach line shown on it, does it not?

A. Yes, it does. It skirts around the outside and is identified as it was in Case 11,122, where we defined that line.

Q. This exhibit was prepared by you?

A. Yes, it was.

Q. And the information shown on this exhibit reflects the current status of the development and operation of Amoco in the Bravo Dome unit; is that right?

A. It does. It has been reconfigured to include the additional drilling that took place in 1995. We've reflexed the structures and recontoured the maps in the area where we have additional well control, and that way we can accurately represent the reservoir.

Q. All right, Mr. Wacker, let's go to the enlarged map of the Leg 9 area, and I would ask you to review the information contained on that portion of this exhibit for Mr. Catanach.

A. In the Leg 9 area there are ten well locations. they are all unorthodox locations, and they are identified by a red dot and an arrow above them.

There are two provinces that we talk about in Leg

9. One is the northern province outlined in green, and the southern province outlined in brown. Later on, I'll be showing a cross-section that goes across the Leg 9 area -- also known geologically as the Clapham Anticline -- that the cross-section will go generally from north to south and demonstrate the porosity configuration for the Leg 9 area.

Q. Would you like to go to that cross-section now, and then we can come back and look at the wells in Exhibit 6 and 7?

A. That would be great.

Q. Let's move to what has been marked as Amoco Exhibit Number 7, and again I'd ask you to first identify this and then explain the significance of this exhibit to the Examiner.

A. Exhibit 7 is a structural cross-section through Leg 9. It shows the structural latitude of the Cimarron anhydrite, which is important because the base of the Cimarron anhydrite defines the top of the Bravo Dome unit.

It also shows an approximate gas-water contact. The wells that we show on here are the wells that were drilled in 1995. We haven't actually drilled through the gas-water contact in any of those.

The objective in this cross-section is to demonstrate how broadly continuous the porosity is in the Bravo Dome reservoir.

On the right-hand side of each log is a bulk density curve. The vertical line going through the bulk density curve identifies the 12-percent porosity cutoff that we determine to be the porosity cutoff for Bravo Dome reservoir.

To the left of that line is porosity greater than 12 percent, up to 30 percent. And it clearly shows that the reservoir is continuous from well to well. In drilling the thirty wells, we had no dry holes. The production was good in each one, and the tops came in more than -- More than half of them were plus or minus 12 feet of the predicted interval.

So we feel like we have a reservoir that is predictable, continuous and relatively easy to describe geologically.

Q. In this area, what generally or approximately is the gross pay thickness that you're encountering?

A. The maximum gross pay out here is 250 feet. It drops down to 100 to 150 as you move further to the south on the southern part of Leg 9.

Q. Let's go back now to your Exhibit Number 6, and let's look at the enlarged portion of that exhibit that relates to the locations on Leg 6 and 7 of the gathering system.

A. In the lower right is the outline of the 6 and 7.

It's a 1-to-4 base map, pretty much the same as the one above it, which is the Leg 9.

The area in yellow is the area of particular interest to us. It shows four dots. One is an orthodox location. The other three, identified by red arrows, are unorthodox locations.

What you'll see there is also a red line, which defines the Bueyeros Fault. It's a fault that was active fairly recently. Based on information that we've got, it's Quaternary or Ogallala in age, and it has offset the reservoir.

The drilling of these wells up against this fault will help drain the acreage between the fault and the existing wells.

Q. You again have a trace for a subsequent cross-section on this exhibit?

A. Yes, I do.

Q. Let's go to that cross-section, which has been marked Amoco Exhibit Number 8, and would you please review that for Mr. Catanach?

A. Yes. Exhibit 8 shows five wells, two of them on the downthrown side of the Bueyeros Fault and three on the upthrown side. It also shows the position of the unorthodox locations between the Bueyeros Fault and the first well to the south, which would be 1835161M.

What's important to notice here is that there is a variance in the gas-water contact, which helps us identify the Bueyeros Fault as a sealing fault. The fact that it's sealing demonstrates that there won't be any drainage from the south side of the fault by wells that are drilled on the north side.

Again, you can see the massive porosity in the density curve marked on the right-hand side of each of the wellbores identified on the cross-section. The 12-percent porosity line is shown, and the blue identifies the porosity that's characteristic of the wells in those areas.

Q. Basically, what is the thickness in this area we're looking at in terms of gross pay?

A. The gross pay is somewhat thinner here; it's about 50 to 75 feet. But the pressures are slightly higher, and I'm encouraged by the fact that the porosity is excellent.

Q. If we look at where we're proposing unorthodox locations on this cross-section, is it fair to say we're proposing to develop an area that probably cannot be efficiently drained without some additional drilling and development?

A. That's right.

Q. Let's go to what has been marked as Amoco Exhibit Number 9. Will you identify and -- Explain first, what

this is?

A. This includes two pieces of information. The colored photograph on the right-hand side is a photograph of the sediment that is present in the well, on the center well, in the cross-section 1835101K. The blue represents porosity, the white represents the sand grains.

What's important to notice is the fine-grained nature of this particular reservoir. The formation itself is called a loessite. This loessite is broadly distributed throughout the Bravo Dome area and constitutes a good, uniform, continuous, porous interval.

One of the characteristics of this rock is that it has relatively uniform porosity and predictable permeability characteristics, based on the cores that we've taken and the logs that we've evaluated in Bravo Dome. That includes 40 cores and all 500 wells or so that are in the province.

What's important here is the fine-grain nature. The formation is really coarse silt, which identifies it as loess or loessite, and it says that -- it's a little bit different from what we normally think of as coarse sandstones that are regionally productive in the rest of the Permian Basin. It's just a little bit different reservoir. More like a sand-dune concept than what we usually think of.

Q. Mr. Wacker, what geological conclusions can you reach concerning this portion of the Bravo Dome and its suitability for infill development?

A. The summary of the concepts is shown on Exhibit 10, and it does a good job characterizing the reservoir properties of Bravo Dome. The porosity is 12 to 30 percent. It averages 5 to 40 millidarcies. It has a gross pay thickness in this area of 50 to 250 feet, and the water saturations are about 30 percent.

The characteristics of Bravo Dome Reservoir are such that they are almost textbook, as far as modeling. The facies are broadly distributed and easily described geologically. And by taking the facies distribution and the porosity, $\phi h$, maps that we've put together we have been able to develop excellent properties for engineering modeling.

Q. Now, these properties that you have developed through your geological work, they were then in turn taken and input into the modeling effort to select not only areas for infill development but actual well locations --

A. That's right.

Q. -- is that not correct?

A. That is true.

Q. And will Amoco be calling an engineering witness who will review exactly how that modeling took place?

A. Yes, they will.

Q. Were Exhibits 6 through 10 prepared by you or compiled under your direction?

A. They were.

Q. Did you tape them together this morning like this?

A. Yes, I did. And if you would like replacements, I'll get replacements for you later.

MR. CARR: Mr. Catanach, we would move the admission into evidence of Amoco Exhibits 6 through 10.

EXAMINER CATANACH: Exhibits 6 through 10 will be admitted as evidence.

MR. CARR: And that concludes my direct examination of Mr. Wacker.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Wacker, the wells located on the Legs 6 and 7 have geologic considerations as to why infill wells are needed in those -- in that area.

Are there similar geologic considerations in Leg 9, or are those basically --

A. Those are engineering.

Q. -- drainage-type situations?

A. That's right.

Q. So there's no geologic factors up here?

A. The importance to the geology is that the fine-grained nature of the rock and the relatively low pressures of the rock cause the gas to migrate more slowly than we normally think of in a normally pressured reservoir.

The original bottomhole shut-in pressures on these wells was about 390 p.s.i., which is really quite low if you think about it in comparison to other reservoirs we're familiar with. As a result, the combination of that low pressure with the fine-grained nature of the rock makes it slower for the gas to move through.

Q. Does that reduce the ultimate recovery from these wells?

A. The engineering information that you'll hear today will demonstrate that.

Q. Does Amoco plan to drill more wells on the south side of that Bueyeros Fault at later times?

A. We'll take a look at those and see, you know, which ones are best for us and which ones are appropriate.

There's pretty good space between the existing well control in that fault right now, and I think it will help us quite a bit to get some wells against that fault.

EXAMINATION

BY MR. JOHNSON:

Q. Mr. Wacker, your Well Number 182 --

A. Yes, sir.

Q. -- in Township 18 North, from where you have the Bueyeros Fault drawn in, it appears possibly that this will be a standard location, or is that something that you know the fault is there but you can't pinpoint it?

A. If you'll look at the location of the two seismic lines --

Q. Uh-huh.

A. -- those two locations really do kind of -- that location in Leg 8 kind of splits the seismic lines, and I lose control geologically between the well numbered 1835081C and the next point of control, which would be 1835181G. So it's a geologic interpretation as to where that fault goes. Thank you, Mr. Johnson.

Q. So your confidence level on this position --

A. It degrades towards an unorthodox location.

Q. Okay. Do you have an estimate of the size of this pool? Can you give me an estimate in acres, how big is it?

A. The $CO_2$ Bravo Dome reservoir?

Q. Yes, sir.

A. No. No, I don't.

Q. You wouldn't want to hazard a guess?

A. Well, what I know is what we defined for the unit when we had the unit-contraction hearing. I'm not sure how far it goes outside. We know that there is $CO_2$ outside by

west Bravo Dome. I mean, there's another unit abutting ours. I wouldn't want to hazard the guess of the single continuous reservoir.

Q. Well, Bravo Dome is what? Currently a little over 900,000 acres?

A. That's right.

Q. And you would say probably the bulk of that would be inside the unit -- inside the gas --

A. From the information that I have right now, geographically the answer is yes.

Q. Okay. What percentage has Bravo Dome been developed?

A. I haven't taken the time to calculate that number.

Q. Hazard a guess?

A. No.

MR. JOHNSON: That's all, David.

FURTHER EXAMINATION

BY EXAMINER CATANACH:

Q. Just one more. Mr. Wacker, the geologic properties within the zone, permeability, porosity, that kind of thing, do they vary from area to area considerably, or not much?

A. Within all of the areas, the permeability seems to be fairly consistent between 5 and 40 millidarcies as a

gross interval. Occasionally, we'll get a few stringers that are 100 or 200 millidarcies. Some of them are even higher than that, but they're just thin spikes and generally are not good representatives, samples of the reservoir as a whole. But we do have some that are really quite high.

Q. Porosity varies?

A. Porosity varies, but -- that is productive between 12 and 30. Occasionally we'll get it a little higher than that, but for the most part it -- For an average, I would pick something in that range.

Q. Is this Amoco's first attempt at infill drilling the unit?

A. We've drilled interference wells back in the 1970s, but I'm not familiar with any of that work. I wasn't involved with it. That was different from interference -- that was different from infill drilling.

Q. Is it possible at this point to tell how much of the unit may eventually be infill drilled?

A. I wouldn't alone be able to answer that right now. I haven't been part of that kind of estimate.

EXAMINER CATANACH: I believe that's all I have, Mr. Carr.

MR. CARR: Thank you, Mr. Catanach.

At this time, Mr. Gallo will present Mr.

Griffin's testimony.

MR. GALLO: At this time we'll call Mr. Bill Griffin.

BILL GRIFFIN,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. GALLO:

Q. Mr. Griffin, would you please state your name for the record?

A. William Griffin. I go by Bill Griffin.

Q. And where do you reside, sir?

A. Houston, Texas.

Q. And by whom are you employed?

A. I'm employed by Amoco Production Company as a petroleum engineer in the regulatory affairs group.

Q. How long have you been in the regulatory affairs group?

A. Since 1979, or approximately 15 years.

Q. Have you testified before administrative agencies in the past?

A. Yes, sir, I've testified before this board as well as in the states of Texas, Louisiana, Michigan and Pennsylvania.

Q. And are you a registered professional engineer

anywhere?

A. Yes, sir, within the State of Texas in the field of petroleum engineering.

Q. Are you familiar with Amoco's Application in this matter?

A. Yes, sir, I am.

Q. Are you a member of the team that made a study of the Bravo dome unit to determine the feasibility and desirability of performing additional drilling within the Bravo Dome unit?

A. Yes, sir, I was.

Q. What was your role as a member of that team?

A. Well, my part was to examine the very detailed infill drilling evaluation based on our computer programming, and compared what that indicated that we would like to do and what we ultimately decided we would like to do with the rules and regulations that govern our activity in the Bravo Dome area.

And if exceptions were necessary to implement that particular program, I was to digest our complex computer program and the results it was indicating and put it in a form where we could officially present it to the regulatory body to gain approval for the exceptions.

MR. GALLO: At this time we would tender Mr. Griffin as an expert petroleum engineer.

EXAMINER CATANACH: He is so qualified.

MR. GALLO: Thank you.

Q. (By Mr. Gallo) Mr. Griffin, have you prepared or had prepared under your direction and supervision certain exhibits summarizing the results of Amoco's study?

A. Yes, sir, I've prepared 11 exhibits.

Q. Let's go ahead, then, and turn our attention to what has been previously marked as Amoco Exhibit 11, which I believe is the first of your series of exhibits. Would you please tell us what that shows?

A. Okay, Amoco's Exhibit Number 11 is the starting point, the criteria that we use to simultaneously satisfy or call or high-grade the potential drilling opportunities that we might have in the Bravo Dome unit as a result of what our computer program is telling us.

There's three bullet points here.

We want to locate drilling areas where infill drilling can maximize ultimate recovery, of course.

We also want to locate areas where infill drilling will result in wells with relatively high deliverabilities. This first pass, we were looking at wells that generate rates of 2.5 million cubic feet per day or greater. Of course, these areas are closely related to the higher pressure areas.

Then finally, we want to identify areas where our

drilling cost and completion cost would be minimized. These areas correspond directly to those where current gathering lines exist and, in addition to that, where the current gathering lines have additional capacity that could carry additional gas.

Q. What type of study did Amoco perform to determine if infill drilling would increase ultimate recovery and where the best spot was to perform that drilling?

A. We performed pretty well sophisticated computer-model studies, actually two of them, one for representing properties beneath the earth, up through the wellbore, and then the second one was a sophisticated model that modeled the surface flow.

Q. Have you prepared an exhibit that shows the configuration and interrelation of these two models?

A. Yes, sir, that's Amoco's Exhibit Number 12.

Q. Let's turn our attention to what we've previously marked as Amoco Exhibit 12, and if you would, please, tell us what that shows.

A. Okay, Amoco's Exhibit Number 12 is a model or a horizontal cross-section through the Bravo Dome unit.

What it shows up at the top is surface facilities, including a wellhead, flow lines or gathering lines. And over on the right at the top is the central facility, represented with a square with the letter F in

it.

Now, toward the bottom I've shown the reservoir which the $CO_2$ is originating from, and that's labeled the top of the Tubb formation and the base of the Tubb formation.

Now, to explain how our model works, I've identified certain points on this exhibit.

Looking at the lower left, point "A", that's the inter-well area. Gas flows, of course, when the well is placed on production from the inter-well area, point A to point B. And then from point B it flows, of course, up the wellbore to the wellhead at point C.

Now, this is the portion where our reservoir model performs its work. It's a very sophisticated model. It simulates the entire developed area. There's 350 wells out there. The input parameters for this model include the net pay, the porosity, the permeability, as well as the wellbore configuration that represents what we model from point B to C as the gas flows from the reservoir to the surface.

Now, I've also shown here the surface model, and that's the model for flow from point C to point F. Included in that model is -- This flow to our central facility is not entirely radial. It flows into gathering systems. And as this exhibit indicates, the pipe diameters

get larger and larger, and that's what's represented by these headers.

Now, input into that particular model are pipe lengths, pipe diameters, bends, relative roughness and things of that nature to represent pressure drop as one flows from point C to point F.

Now, we merged these models into one composite model. And what we wanted to do, we felt like in order to use these models to predict future performance, we had to calibrate them against some standard. Fortunately, in this case we've had production since 1984, so we have ten years of production that establishes a standard with which to calibrate this model, and that's what we did.

The method that we used to calibrate the model is shown on this verbiage on the right-hand side of the exhibit. We first calibrated the reservoir model. We input the reservoir parameters for the model area and the wellbore configuration for each of the 350 active producers.

For this first pass, we used our best estimate of reservoir parameters, porosity, permeability and effective wellbore diameter that we got from engineering and geologic studies.

Then we allowed the model to run, to simulate production from 1984 through 1995, in monthly increments.

The model predicts the flow rate and flowing tubing pressures at point C for each of the 350 wells.

We then compared these predicted flow rates with actual flow rates from historical data. And we adjusted the effective wellbore radius, since that was the item that we felt the least secure about in our input data, with -- We adjusted effective wellbore radius as necessary to approach a match from our simulator to actual field conditions.

The reason we had to adjust the effective wellbore radius, because we felt like the reservoir was rather uniform from well to well, so we didn't have great permeability variations. However, each one of these wells has received some sort of fracture stimulation. We know the diameter or the radius of each wellbore, and of course that is one of the components in the flow equation.

However, when you fracture-stimulate these wells, it alters the effective wellbore radius somewhat, and in varying matters, and that's what we adjusted to fine-tune this model to calibrate the predicted performance during the historical mode against actual performance.

Q. Now, did the model compare the -- or did you compare the model's predicted pressures with historical pressures as well?

A. Yes, sir, and that was at point C.

Q. And once you got it calibrated on the reservoir, what did you do?

A. Then we calibrated our surface model, and that's also shown in the verbiage on the right-hand side. We went again and input the pipe parameters, the diameters, the lengths, the valves, roughness, et cetera, for the gathering system within the model area and the flow rate at point C for each of the 350 active producers. We input inlet pressure at the central facility each month, which varies from 90 pounds to 175 pounds.

The surface model was allowed to run to simulate flow and pressure drops at the surface, again, from 1984 through 1995 in monthly increments. The model, the surface model, calculates flowing tubing pressures at given rates at point C for each well.

Then we compared that flowing tubing pressure with the actual conditions on a monthly basis and adjusted our parameters within our surface model to match historical performance of the flowing tubing pressures at point C.

The big unknown for our surface facilities is not pipe diameters or length; those are measurable. However, things like the relative roughness of the pipe or the flow efficiency of the pipe itself, that we can adjust to achieve our history match.

And in this particular case at this point C we

would continue our adjusting until our pressures were within one or two pounds of what we actually experienced in the field.

Q. And when you reached that plus-or-minus-two-pound match at point C, you considered the model calibrated; is that right?

A. That's correct, we considered that both models are then calibrated to the real conditions that exist, both beneath the earth and at the surface, in real life out in the field.

And we feel like, then, we have a composite model that's tuned and that is ready for us to use to predict anticipated performance in the area developed of the Bravo Dome unit under various that we might want to pick to examine, such as infill drilling.

Q. Can you describe for Mr. Catanach the size of the computer model?

A. Yes, the computer model is modeling an area that was shown on Mr. Culpepper's Exhibit 2, which is roughly 40 miles in the north-south direction and 24 miles in the east-west direction. The grid size within the model is 1320 feet, so we're modeling each governmental quarter-quarter section.

But when you talk about size of computer models, the modelers usually like to envision how long it takes to

make a single run. And when we flipped the switch on this model -- Well, when you flip the switch on a normal model, if it takes six or eight hours to run, that's considered a fairly sophisticated, large-scale, fine-tuned model.

This particular model for each run takes a little greater than 36 hours per run, which is the biggest model that I'm familiar with. And that's a pretty good size model, take that amount of time to run.

Q. Do you have an exhibit which shows the modeled area as well as the surface facilities?

A. Yes, sir, that's Amoco's Exhibit Number 13.

Q. All right. If you would, please, turn your attention to what we've previously marked as Amoco Exhibit 13 and tell us, please, sir, what that shows.

A. Amoco's Exhibit Number 13 is a map that's similar -- It's almost identical to that that Mr. Culpepper presented as Exhibit Number 2. It's a map of the eastern portion of the Bravo Dome area

The scale of this map is roughly one inch to 16,000 feet. And as you can see, each one of those squares is a section.

And it shows the location of 350 wells within the modeled area of the Bravo Dome unit.

Also, we talk about legs in reference to our gathering system out there, and I'd like to identify those.

Those are color-coded. The legend for the legs is shown on the lower left-hand portion of the exhibit.

Plus there's little numbers. They're a little more difficult to see in there. There is -- The one I'm really looking at is toward the upper portion where our 10 recommended infill drilling wells will be located, and that's Leg 9, and you can see a little "9" there.

Now, Legs 1 through 7 are generally down in the southern portion of this area, and Legs 1 through 7 were developed from 1979 through 1985.

Leg 8, that extends to the northwest from our central facility, was developed in 1993.

Then Leg 9, that just goes due north, was developed basically last year.

Q. Can you see on this exhibit the central facility where all the gathering lines converge?

A. Yes, sir, that's located in the southern portion of the unit, roughly at Township 19 North and Range 34 East.

Q. And as I understand it, the red outline shows the entire modeled area; is that right?

A. That's correct.

Q. Do you have an exhibit which shows the results of the history matching part of your computer model study?

A. Yes, sir, that's Amoco's next exhibit, Exhibit

Number 14.

Q. If you would, please, turn your attention to Exhibit 14 and tell us what that shows.

A. Well, I'm going to preface my discussion of this exhibit by mentioning, as Mr. Wacker already previously mentioned, that this is almost a perfect reservoir for modeling. That is, there's no major changes over relatively short distances in permeability. And that makes modeling much, much easier.

Now, the format of this exhibit on the left side, or the Y axis, is in MCF per day. It goes from zero to roughly 500 million cubic feet per day.

And on the bottom is a chronological scale that starts January 31st, 1984, and goes through January 31st, 1996. It's divided into annual increments. Each one of those little dashed lines there represents a year.

Now, the green line is the actual producing rate. As you can see, production from the unit started in 1984, and the current rate is roughly 400 million cubic feet of gas per day.

The red squares are the results of our history match, our modeling results. And you can see I've represented four per year, so this is the result of a history matching at the end of each quarter. They almost -- It's almost a perfect history match, again, due to the

outstanding pay quality in this reservoir.

Q. And what does the excellent nature of this history match tell you about the quality and reliability of your model?

A. Well, an excellent history match such as this tells us two things.

One, that our reservoir and gathering system parameters that we've input into the model are almost exactly as they appear in nature, in the field, and hence we've got almost a perfect history match here.

The second thing this near-perfect history match tells us is that it will be an excellent tool for predicting future performance under various scenarios.

And that's the key. You want an excellent history match to know that your model is accurately calibrated, so it's an excellent tool to predict performance in the future.

Q. And this history match is for the entire modeled area; is that right?

A. That's correct.

Q. Do you have history matches that you'll show for individual wells, based on the final model run?

A. Yes, sir, and those individual wells, as Mr. Johnson mentioned, are located -- they're shown as green dots on Amoco's Exhibit Number 2.

Q. Okay, but we're not going to get to those just yet?

A. A little later, yes, sir.

Q. Now, did this model resolve any of the questions you originally posed on Exhibit 11 about the criteria for infill drilling?

A. Yes, sir, it did.

Q. And what did the model help you determine?

A. Okay, as I showed on Exhibit Number 1, we wanted to use the model to identify any areas, if they do exist, where we can anticipate an increase in ultimate recovery through infill drilling, and the model did provide that answer.

We also wanted to know within those areas, if we could increase ultimate recovery, could we expect a respectable producing rate to make the economics attractive? And it did tell us that answer.

Q. Do you have an exhibit that shows the increase of ultimate recovery, the model predicted, as we place infill drilling wells at various locations within the unit?

A. Yes, sir.

Q. And that's Exhibit 15?

A. Yes, sir, Exhibit Number 15.

Q. All right, let's turn our attention to what we've previously marked as Exhibit Number 15, then, and if you

would, please tell us what that shows.

A. Okay. Amoco's Exhibit Number 15 is a two-part exhibit. On the left side I've shown a model grid configuration. This is simply just four sections. I've located an existing well in location number G in each one of these sections.

On the right side is the same four-section grid, except that I've added contours that were generated by the model to show the anticipated increase in ultimate recovery as one locates an infill well and as he moves about these existing units with the existing wells.

Intuitively, you feel like that if you locate a well, geometrically, the maximum distance away from existing wells, that that's where you could locate a well and gain or achieve a maximum increase in ultimate recovery.

That may or may not be true. That would only occur if all the characteristics of each of the four wells were identical.

So the model helped us locate where we should drill an infill well, if one was warranted, the area where we would get the maximum increase in ultimate recovery -- in this case, and you can see this, at the exact geometric center of a fivespot.

However, the thing where the model proved the

most benefit was telling us how much incremental recovery we could expect, because intuitively you put your well where there are no wells, at least within the fivespot. But the amount of incremental recovery, that's the key question that the model was used to answer.

Q. And Exhibit 15, as I understand it, the concentric circles radiating areally from the wellbores are percents of increased recovery; is that right?

A. That's correct. And of course, it's zero where existing wells were, and it moves out to a maximum of seven percent incremental increased recovery.

Q. And as to the 13 unorthodox locations involved in this Application, have you determined how much additional $CO_2$ we will recover by drilling wells at unorthodox versus orthodox locations?

A. Yes, sir, on the average. But the incremental increase in recovery moving from an orthodox location -- I mean -- yeah, from an orthodox location to an unorthodox location will exceed one BCF of gas.

Q. So for these 13 proposed wells, no less than 13 BCF of additional reserves will be recovered by drilling at unorthodox locations versus orthodox locations?

A. That's correct.

Q. If you would, now, turning back to your Exhibit 11 -- or our Exhibit 11, explain how you went about high-

grading the drilling opportunities to come up with the location that we've proposed here today.

A. Okay, I took Amoco's Exhibit Number 11 and I used the format from it and expanded it a little bit, and that's included as Amoco's Exhibit Number 16, which shows how we used our high-grading method to select a given number of wells for our initial infill drilling program, 14 wells in this case. Looking at Exhibit Number 16, it also -- it duplicates the criteria that we examine.

We of course wanted to locate an area where infill drilling can maximize ultimate recovery. We first placed wells in every undrilled location between existing wells, so that would be roughly 350 wells. Then we surrounded the existing developed area with a halo of wells to evaluate those at the same time.

After looking at item number 2, after our model was run in the predictive mode, we sorted the wells by the highest predicted producing rate, which also means the cumulative gas production, for the first three years.

The predictive mode, by the way, started January 1st, 1996.

From that group or from that high-grading, we selected the top 35 candidates, based on the highest three-year producing rate or cumulative. With those 35 wells, we further simulated their anticipated performance for a total

of 20 years. Then we sorted those again by the highest cumulative.

At this point we've got a sort of 35 wells, when we move down into our second criteria, which is to locate an area where the infill drilling will result in wells with relatively high deliverabilities. We selected those. As I mentioned, our computer model will tell us how much each well will produce if it were drilled. And we eliminated all of those wells in that 35-well group with a producing capability less than 2.5 million cubic feet per day.

Now, with those wells that we had left, we entered into our third criteria, which was to minimize the cost of drilling, completing and hooking up the wells, by locating them near existing surface facilities. We eliminated the wells which were not located close to the existing gathering lines, as well as those that are located near existing gathering lines but the gathering lines were relatively loaded. This was --

Q. What was the result -- Sorry. What was the result of that analysis?

A. This resulted -- when we started out with -- We started out with 450 potential candidates. Those were high-graded first to 35, and then we ended up under this particular program, 14 potential infill drilling locations.

Q. And are all of those wells located at unorthodox

locations?

A. No, sir, 13 are located at unorthodox locations and one at an orthodox location.

Q. And if you would, please, describe for us why unorthodox versus orthodox locations are necessary here.

A. Well, the rules require that wells be 1650 feet from the unit boundary or the section boundary, as well as 330 feet from any quarter-section boundary.

Of course, all of these wells, as we saw on the previous exhibit, Exhibit Number 15, will be located very close to the corner of each section. Therefore, they will be unorthodox locations, all of them but one of them, anyway.

Q. And so to drill that close to the section boundary, we needed an exception to the spacing rule for the Bravo Dome unit?

A. That's correct.

Q. All right. Then let's turn back to Exhibit 15. Which groups of wells are represented by the recovery profile distribution shown on this exhibit?

A. This -- Amoco's Exhibit 15, the production profile that's indicated on the right-hand side is represented -- It's an average of the 14 proposed development wells we are recommending be drilled.

The range actually was from 6.5 -- In the maximum

increase in ultimate recovery area, was from 6.5 to 7.5 percent. And here I've shown the average as 7 percent.

Q. And as I understand it, our Exhibit 2, again, shows where these 14 wells are located in the areas with the green box, the brown box, and the yellow box; is that right?

A. That's correct.

Q. Okay. And if you would just describe for the Examiner how Exhibit 2 fits into your analysis of the infill drilling program.

A. Okay, I'm looking at Exhibit 2 that was introduced by Mr. Culpepper, and again it shows the three basic areas where we would like to infill drill.

To the north -- and we refer to it as the Leg 9 area -- the northern Leg 9 area, you see six wells outlined in green. The southern Leg 9 area, which is the middle area outlined in dark brown, there's four wells. That's the southern Leg 9 area. Then down in the south is the Leg 6 and 7 area, outlined in yellow. There's four wells down there.

Now, the three green dots Mr. Johnson -- I'm glad he was able to see those. I was worried because the dots were kind of small. But what I wanted also to show was the results of individual well history matching within the vicinity of these three areas.

Now, of course the Leg 9 area was developed in 1995, so I didn't have a whole lot of history versus computer performance to compare, so I moved over here into Leg 9, and that's -- I'm going to be comparing the northwesternmost green dot with that in the upper Leg 9 area wells.

Moving on down is the middle green dot which we consider representative of those in the southern Leg 9 area. Then down in the south you see a green dot just to the north of the yellowed area that I'll be showing the actual performance versus the history match on that individual well.

Q. And as I understand it now, our next three exhibits, which we've labeled 17A, -B and -C, are individual history matches for those three wells represented by those three green dots?

A. That's correct.

Q. Let's go ahead, then, and turn our attention to what's been previously marked as Exhibit 17A, and if you would tell us what that shows.

A. Okay, Amoco's Exhibit 17A, the format is the same as I previously showed for the fieldwide model matching, and that was Exhibit Number 14. This particular exhibit is a lot of Well Number 081G, which is located in Township 21 North, Range 33 East. It was the well located up in the

upper northwest portion of the unit that's offsetting the upper Leg 9 area.

And it shows -- Now, this is in the Leg 8 area, and as I mentioned earlier in my testimony, it first came on production in 1993. And you can see a relatively good history match in this case, so we feel like, of course, in this area our model is calibrated.

I would like to point out, now, that the green is the actual production, and the red diamonds is the model prediction. You can see in the early days -- and this will occur on the next two exhibits also -- that the model predicted flow rates as less than that which actually occurred in the early stages of production from the well. That's because the model grid is quite large in relation to a wellbore.

The model grid size is 1320 feet in each direction, and of course a wellbore may be a foot by a foot. Therefore what's happening in actual production, there's some flush production that's occurring -- that occurs in actual conditions that's not able to be seen by the model with its larger grid. So it takes a little while for the model to catch up, and that's what you see there.

But after that, after the model does catch it, it appears to be an excellent history match.

Now, moving on to Amoco's Exhibit Number 17B,

this is the green dot that was in the middle of the previous exhibit, and this is for Well Number 161G, which is located in Township 20 North, Range 34 East, and this represents a history match in the area of wells in the lower Leg 9 area. Again, the model had to catch up due to flush production when it came on in late 1984, but other than that it's an excellent history match that we saw, even on a fieldwide basis. But this is for the individual well.

Now, moving on down to a well representative of the southern area, the Leg 6, Leg 7 area, I have on Exhibit Number 17C the model versus actual for well Number 041G, which is located in Township 18 North, Range 35 East. And you can see again an excellent history match on an individual basis, as we saw with the fieldwide model.

Q. Now, when you couple the excellent history match you have on a well basis with the match you had on a fieldwide basis, did it lead you to any conclusion about the model?

A. Uh-huh.

Q. And what's that?

A. I mean, yes, sir.

Based on my examination of these individual history matches -- and I looked at several more besides these -- it indicates that again it really confirms that the model is a very good tool to predict performance under

various scenarios.

Q. Now, does your simulator model the reservoir pressures in the inter-well area in both the calibration and predictive mode?

A. Yes.

Q. And does the model allow you to generate isobar maps to show that?

A. Yes, sir, it does. We can generate isobar maps or pressure maps, pressure distribution maps, really anytime in the life cycle, whether I'm in the history mode or the predictive mode.

Q. Do those isobar maps help you in your examination for the reason these 14 wells were selected during the high-grading process?

A. Yes, sir. Again, one can intuitively feel like the best place to locate them is in the geometric center of a fivespot, and we see relatively large incremental recoveries for some of our wells, but we would like to generate pressure isobar maps to help us feel comfortable that the reason these wells are indicated by the computer is that these are located in wells that are of relatively high pressure, and that's where the isobar maps become an essential tool.

Q. And our next two exhibits, 18 and 19, which actually also are our last two exhibits, as I understand

it, show those isobar maps and how they helped you determine locations for these wells?

A. That's correct.

Q. If you would, then, please, turn your attention to Exhibit 18 and tell us what that shows.

A. Amoco's Exhibit Number 18 is also a two-part exhibit. On the left side I've shown the Leg 9 area wells. Those scribed by the green at the top are the six wells located in the upper Leg 9. Those scribed by the brown toward the lower right is the lower Leg 9 area.

Now, over on the right-hand side I've shown the same map, except the green and the brown scribing is removed. However, it's the isobar map.

Now, this isobar map occurs after a particular point in time. It occurs after a year in the predictive mode of our computer run, and it shows pressures after the wells were shut in for 24 hours. And you can see that where there are existing wells, there are pressure sinks.

The exceptions are located down toward the lower right-hand portion. You see Well Number 181K and 191F, and these wells are located in the Leg 9 area, and they are relatively new, and the effects of their withdrawals have not yet been seen, is what the deal is there. The other wells have been on a little longer than these.

You can also see the location of our proposed

infill drilling wells, and they are located exclusively in areas of higher pressure.

Now, this tells us two things. One, that they're located where we can expect to maximize our increase in ultimate recovery, as well as a maximum incremental producing rate, as compared to other areas.

Q. Now, if we turn our attention to what's been previously marked as Exhibit 19, as I understand it, this shows the four wells in the more southern part of the unit. Tell us, please, what that shows.

A. That's correct. Amoco's Exhibit Number 19 is a format similar as our Exhibit Number 18. It shows the four wells in the southern area. Looking at the left, the wells that are located to -- the three wells on the -- to the right in the square are the unorthodox-location wells, with proposed Well Number 072K in the upper left is the well that's at an orthodox location.

Now, on the right-hand side, again, is the isobar map. Now, the isobars terminate at this northwest-southeast trending fault that Mr. Wacker referred to earlier. All of the pressures in all of those wells on the north side -- or on the northeast side of that fault are roughly 200 pounds, so you can see that this fault in this area is definitely sealing.

Now, the drilling opportunities down here in the

south in this particular area are different than those in the north in that there's two reasons these wells will recover incremental reserves.

The first, of course, they're located in the inter-well area, between wells.

The second, as Mr. Wacker pointed out, is, they're in an area between the existing wells and this sealing fault where there's relatively high pressure and there's a lot of reserves out there that are yet to be recovered or could not be recovered with existing wells.

Q. So as to the northern area, there's an engineering basis for the need for the wells at unorthodox locations. As to the southern area there is both an engineering and geologic reason for the wells?

A. That's correct.

Q. To summarize, then, have you made a comparison of whether wells at unorthodox locations will recover more reserves than wells at orthodox locations?

A. Yes, sir, we have.

Q. And what was the result of that analysis?

A. The results are that the wells at unorthodox locations will recover typically at least a BCF of reserves more than if that well were located at an orthodox location.

Q. So the bottom line is, if we don't get permission

to drill these 13 wells in this Application at unorthodox locations, something more than 13 BCF of $CO_2$ will be left in the ground?

A. That's correct.

Q. In your opinion, will the drilling of the proposed wells at the proposed locations increase the ultimate recovery of $CO_2$ from the unit and prevent the waste of $CO_2$?

A. Yes.

Q. Now, on our Exhibit 18, the isobar exhibit, there appear to be other additional areas for possible infill drilling; is that right?

A. That's correct.

Q. At this time do we intend to drill in those areas?

A. We're looking at those. As you recall in my testimony, we initially high-graded our list of 450 candidates down to 35. We selected the top 14 candidates, but that left 21, at least in that group, that we're still looking at. Many of those are located in this Leg 9 area, in these higher-pressure areas not indicated by existing wells.

We were definitely -- We decided on these first 14, and now we're looking at our second grouping and anticipate one or more wells might come out of that

evaluation.

Q. Would the analysis and justification for those wells be the same as what we presented here today?

A. Yes, sir, it would be almost identical.

Q. Does Amoco request that future applications be granted administratively, pursuant to Rule 104 or that an administrative procedure be established by this order?

A. Yes, sir.

MR. GALLO: At this time I have no further questions for Mr. Griffin.

Oh, and I'd move to admit our Exhibits 11 through 19.

EXAMINER CATANACH: Exhibits 11 through 19 will be admitted as evidence.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Griffin, once you have all your isobar data and everything else, how do you specifically go about locating a well at any given location?

A. The computer actually picks it out, down to roughly a quarter section, down to a 40-acre location, because we can move those wells around in that model, we can place them anywhere we want to in each section.

And the computer model tells us, of course -- We output these isobar maps to kind of give us a hint as to

where we ought to place them in our model in the first place, and that's in the area of the highest pressures.

Q. By fine-tuning these locations, will you recover more reserves in the infill well?

A. Yes. Incremental recoverable?

Q. Yes.

A. Yes, sir. Yes, sir.

Q. Do you know what the range of recoveries on these infill wells is?

A. Not exactly. I know they're greater than a BCF though.

MR. GALLO: I would point out, Mr. Catanach, that one of the reasons we didn't give a little bit more specificity is because a lot of proprietary information goes into ultimate recoveries and reservoir -- ultimate production from the reservoir, a lot of things that we don't really want to have in the public record, and so that's why we used just the -- we used a number that we felt could substantiate the wells, and didn't get more specific on that.

Q. (By Examiner Catanach) Basically, you're saying that drilling at these unorthodox locations, you'll recover 1 BCF more than if you had to drill at standard locations?

A. That's correct.

Q. That's what you're using to justify it?

A. Yes, sir.

MR. GALLO: And I hope we were clear in saying that that was the bare minimum, that we were going to be at least one BCF and that it would be something more than that.

EXAMINER CATANACH: Right.

Q. (By Examiner Catanach) Now, as I understand it, these infill wells will recover gas that will not be recovered by the existing wells?

A. That's correct.

Q. It's not just accelerating it, but it's --

A. It's incremental recovery, a BCF, yes, sir.

Q. There's a possible 21 more wells that you might drill eventually?

A. I hate to place a number on it. I just used that as an example to show that there were 35 that passed our original criteria. It could be more than 21. It could be less, of course. It could be more than 21. But we got to this point with this criteria that we set out, 14 of these wells popped out of our analysis. Now, we start looking at the next group in detail.

Q. Is it possible that your criteria could change?

A. Yes, sir.

Q. Is that dependent on, say, economics?

A. Yes, sir.

Q. The model that you guys ran, is it two separate models, or is it one that incorporates surface and downhole?

A. It's two separate models. The downhole model models through the reservoir down to the wellhead --

Q. Uh-huh.

A. -- and then the other one models just surface conditions. But we marry them where they run together, basically, because once those models -- We calibrated them separately, and once they were calibrated they run together, they run predicting the flow from point A to the bottomhole at point B, up to the wellhead at point C, on up through our gathering system and all the junctures and everything, D and E, to the tailgate of that central facility at point F.

Q. So your history match on Exhibit 14, that represents both models combined?

A. Running together, yes, sir. That's one reason why it takes so long, 36 hours plus.

EXAMINATION

BY MR. JOHNSON:

Q. Mr. Griffin, these areas up here on Leg 9 --

A. Yes, sir.

Q. -- the bulk of those wells up there are tubingless completions. Did that have any real big effect

on your modeling when you did that, and especially when you started making these isobar maps?

A. Whether they're tubingless completion or cased and perforated -- I mean, however they're completed, the thing that we adjusted to fine-tune that model was the effective wellbore diameter. And therefore that took into consideration whatever completion technique that we used, regardless of whether that well was -- had a drill diameter of 4 1/2 inches or a drill diameter of 7 5/8.

Q. That's built into your modeling?

A. Yes, sir. Yes, sir.

Q. These 14 wells you're proposing to drill, are they all going to be fiberglass casing, or do you know?

A. I don't know. I don't know that.

Q. Are these 14 locations specifically designed to achieve better recovery in the long run, or is there something going on at the plant, with the demand for gas --

A. There is a demand --

Q. -- justifying these locations?

A. There is a demand for the gas that we anticipate to be incrementally produced from these wells.

The primary driving force was to increase ultimate recovery, but of course we married, you know, both criteria. If we could increase ultimate recovery and had no demand for the gas, you know, then no pay out. So they

have to be -- It has to be a simultaneous circumstance.

(Off the record)

EXAMINER CATANACH: I believe that's all we have.

MR. CARR: That concludes our presentation in this case, Mr. Catanach.

EXAMINER CATANACH: Okay, just -- The amended Application reflects the current correct locations for the 13 wells; is that correct?

MR. CARR: Yes, sir, it does.

EXAMINER CATANACH: Okay. And I think we've agreed that there's no need to readvertise the case or continue it?

MR. CARR: It would be exactly the same as what we've gone out with before.

EXAMINER CATANACH: Yeah. Okay, I think that's all we have in the case.

If there's nothing further, Case Number 11,497 will be taken under advisement.

(Thereupon, these proceedings were concluded at 2:40 p.m.)

I ~~do~~ hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 11497, heard ~~by~~ me on March 21 1996.

David R. Catanach, Examiner
Oil Conservation Division

# CERTIFICATE OF REPORTER

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

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I transcribed my notes; 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 April 2nd, 1996.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1998