STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

IN THE MATTER OF CASE 9420 BEING REOPENED PURSUANT TO THE PROVISIONS OF DIVISION ORDER NO. R-8768, WHICH ORDER CREATED THE BASIN-FRUITLAND COAL GAS POOL IN SAN JUAN COUNTY AND PROMULGATED TEMPORARY SPECIAL RULES AND REGULATIONS THEREFORE.	CASE NO. 9420 (Reopened)

REPORTER'S TRANSCRIPT OF PROCEEDINGS
PART I
EXAMINER HEARING
BEFORE: DAVID R. CATANACH, Hearing Examiner
February 22, 1991
8:47 a.m.
Santa Fe, New Mexico

This matter came for hearing before the Oil Conservation Division on February 22, 1991, at 8:47 a.m. at Morgan Hall, State Land Office Building, 310 Old Santa Fe Trail, Santa Fe, New Mexico, before Maureen R. Hunnicutt, RPR, Certified Court Reporter No. 166, for the State of New Mexico.

FOR: OIL CONSERVATION DIVISION

BY: MAUREEN R. HUNNICUTT, RPR
Certified Court Reporter
CCR No. 166

I N D E X

February 22, 1991
Examiner Hearing
CASE NO. 9420

A P P E A R A N C E S

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EXAMINER CATANACH: Call the hearing to order at this time. At this time I'm going to call Case No. 9420 in the matter of the Case No. 9420 being reopened pursuant to the provision of Division Order No. R-8768, which order created the Basin-Fruitland Coal Gas Pool in San Juan County and promulgated temporary special rules and regulations therefore.

This is the first part of, hopefully, a two-part hearing. This hearing is going to be -- GRI and ICF are going to present the results of the study in the Basin-Fruitland Coal Gas Pool, and at this time I'll call for appearances in this case.

MR. STOVALL: Mr. Examiner, Robert G. Stovall of Santa Fe, General Counsel, for the Oil Conservation Division; although I'm in this hearing, for the purpose of this hearing I'll be actually presenting the witness of the Coalbed Methane Committee, presenting the results of the study they had performed by GRI and ICF Resources. I have four witnesses to testify today.

Mr. Examiner, I would like to suggest a procedure, because of the -- we don't have exhibits for everybody here. They're fairly expensive bound volumes. I am going to request that as attorneys enter appearances, that the attorneys entering the appearance come forward, and we will give them a copy, one copy for each company which they represent. And if we can do that, then we can make sure that the parties to the case have a copy of the exhibits; and then if there are additional copies for other interested parties -- BLM, we'll see that you get a copy -- then we can make that distribution, but I would like to ensure that each company who is a party to this case has a copy first, and I think that's the best way to control it.

EXAMINER CATANACH: Okay, we'll do that then.

Other appearances?

MR. DEAN: John Dean for Dugan Production Company.

MR. STOVALL: John.

I apologize for the slowness of the process, but it actually, probably, is faster in the end.

MR. HALL: Mr. Examiner, Scott Hall from the Miller, Stratvert, Torgerson & Schlenker law firm of Santa Fe on behalf of Mesa Operating Limited Partnership.

MR. KELLAHIN: Mr. Examiner, I'm Tom Kellahin of the Santa Fe law firm of Kellahin, Kellahin & Aubrey, appearing on behalf of Meridian Oil, Inc., Phillips Petroleum Oil Company, Marathon Oil Company, Conoco, Inc. With regard to Conoco, Inc., I'm appearing in association with Mr. Tom Burton.

MR. STOVALL: That's four companies altogether, Tom?

MR. KELLAHIN: Yes.

MR. CARR: May it please the Examiner, my name is William F. Carr with the law firm, Campbell & Black, P.A., of Santa Fe. I'm entering my appearance on behalf of Arco Oil & Gas Company, Texaco, Inc., Blackwood & Nichols Company, a limited partnership, and Amoco Production Company. I'm appearing in association with Mr. Eric Nitcher, who is also an attorney for Amoco Production Company.

MR. STOVALL: How many companies is that altogether, Bill?

MR. CARR: Four.

MR. STOVALL: Four.

EXAMINER CATANACH: Are there other appearances in the case?

MR. COOTER: Paul Cooter with the Rodey law firm in Santa Fe. I'll enter an appearance for Northwest Pipeline.

MR. BRUCE: Jim Bruce from the Hinkle law firm, representing Union Oil Company of California.

MR. VIRTUE: Richard Virtue of the Sutin law firm of Santa Fe on behalf of Nassau Resources.

MR. STOVALL: Do the BLM people want to enter an appearance on the record or do you just want to observe?

BLM REPRESENTATIVE: Just observing.

MR. STOVALL: Are there any other government agencies here besides the BLM? The Forest Service? Anybody from the Forest Service here?

(No response.)

MR. STOVALL: Any other appearances?

EXAMINER CATANACH: I think that's all.

MR. STOVALL: Are there any other interested companies or parties? We do have some.

Okay. You're with Giant? Let's see how many hands, how many other interested companies whose names have not yet been entered, companies or parties. This can be off the record too, Maureen.

(Discussion off the record.)

MR. STOVALL: Thank you, Mr. Examiner. Hopefully that helped speed up the process.

EXAMINER CATANACH: Okay. You may proceed, Mr. Stovall.

MR. STOVALL: I'd like to have my witnesses sworn, if I may. Ernie, Rich, Genevieve and John, would you stand up and face the Examiner?

(The witnesses, Ernest Busch, Richard McBane, John McElhiney and Genevieve B.C. Young were first duly sworn.)

MR. STOVALL: Mr. Examiner, before I actually call my first witness and start, I would just like to explain what the exhibits are and the layout of the exhibits. The two big books that you've received are labeled -- should be labeled as Exhibit A. You can mark those Exhibit A, Coalbed Methane Committee Exhibit A. That is in fact the report. We'll get into more details specifically about how that is organized in the course of the testimony.

In addition you should have a stapled packet labeled, I believe, B -- excuse me -- C through F. It looks like that (indicating). The top sheet should say "Data Normalization for Sensitivity Analysis." That will be part of the testimony of the technical witness.

And you'll have an exhibit labeled G, which starts out, the top sheet should be "Intent," and that's going to be for the testimony of Mr. Busch, who will be the first witness.

I will at this time call Mr. Busch.

ERNEST BUSCH,

the Witness herein, having been previously duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. STOVALL:

Q. Would you please state your name and place of residence?

A. Yes. My name is Ernest Busch, and I'm the district geologist for New Mexico Oil Conservation Division, Division 3.

Q. That's in Aztec, New Mexico; is that correct?

A. That's correct.

Q. Have you previously testified before the division and had your qualifications accepted?

A. I have.

Q. In what discipline or field of study have you been qualified?

A. Geology.

Q. Now, Mr. Busch, you're not here actually testifying as a geologist today, is that correct, or as a representative of the Oil Conservation Division?

A. That's correct, Mr. Stovall. I'm here in the capacity of the co-chairman of the Coalbed Methane Committee and as an advisor, regulatory advisor, to the study committee.

Q. Would you just describe for the Examiner, give the Examiner a brief history and description of what the Coalbed Methane Committee is and what its purpose was and why we're here today?

A. Yes. Mr. Catanach, this is an unusual and rare opportunity for you and for us in the industry to be on the cutting edge of this type of study and this type of technology. It started, of course, many years ago, but officially with the New Mexico Oil Conservation Division in 1986.

The New Mexico Oil Conservation Division and the Colorado Oil and Gas Conservation Commission recognized the importance and value of the Fruitland coalbed source, and with that formed a committee consisting of operators, pipelines, the Southern Ute Indian Tribe and regulatory agencies, including the BLM.

I started out as chairman of the committee, and a year later the New Mexico Oil Conservation Division and the Colorado Oil Conservation Commission co-chaired the committee with Katy Templeton-Buell as co-chairman and later Mark Weems, who is still serving.

The purpose of the Coalbed Methane Committee, or the CMC, is to recommend rules whereby the two states can prudently regulate the giant and valuable coal/gas resource. In 1988 the Colorado Oil and Gas Conservation Commission created permanent pool rules. The New Mexico Oil Conservation Division created temporary pool rules from Case No. 9420, resulting in Division Order R-8768.

After the promulgation of the temporary rules and regulations for the Basin-Fruitland coal, the CMC was charged with the responsibility of conducting a study of the reservoir. The study was to be of a technical nature and designed to answer the questions of spacing and sensitivity to shut-in.

The target date for completion of this study was October 1990 when Division Order R-8768 was scheduled to expire. The study was accomplished by creating another committee called the study spacing -- excuse me. the "Spacing Study Committee."

Q. Now, Mr. Busch, if I understand correctly, the spacing study committee really is a subgroup of the Coalbed Methane Committee; is that correct?

A. That's correct, Mr. Stovall.

Q. And what was the focus or the purpose of the study committee?

A. The need to create -- First of all, let me tell you that there was a need to create another committee separate from the Coalbed Methane Committee because of the question of funding, as it turned out, and I'll take you through those events.

After the CMC was charged with the task of conducting the study, we created a subcommittee to determine how to conduct such a study, and I'd like to refer to my exhibits at this time.

Q. That's Exhibit G; is that correct?

A. Exhibit G, Part 1. Our first task was to define the scope -- excuse me -- define the intent of the work to be performed. And if you have Exhibit G, Part 1, in front of you, that is to define, obtain and interpret Fruitland formation coalbed methane data and provide to New Mexico and Colorado's regulatory agencies for their use in determining appropriate rules and regulations governing Colorado methane development in the San Juan Basin.

So the essential elements were spacing and sensitivity to shut-in, as I've indicated before; and that brings us to Exhibit G, Part 2, the scope of work. We came up with a grocery shopping list of things underneath the headings of "Spacing" and sensitivity to shut-in for coal reservoirs.

"Spacing," subparagraphs: Review traditional methodology determining gas well spacing. Number two, review traditional gas well methodology versus coal seam gas. Three, develop and recommend a Fruitland coal seam methodology, and a subparagraphs under that: the fracture/cleating, geologic/geophysical, petrologic characteristics, reservoir pressure work, hydrologic characteristics, tie to actual performance/simulation, evaluate sensitivities: recovery versus spacing, unique versus maximum recovery, economic recovery. And fourth, identify necessary data requirements. Fifth, present proposed timing/manpower. Sixth, generate the output into report format, and then as we are here today, expert witnesses testifying.

The second category, B, "Determine the Effect of Ultimate Recovery and Reservoir Performance of Shut-in

Time on Coal Reservoirs." We did not have the proper data that we needed to evaluate this question, and I believe Mr. McBane is going to discuss that a little bit later this morning. But we were to look at if the effects were adverse, to recommend mitigating procedures and determine the sensitivity parameters, again generate output, the timing and so forth.

Q. Mr. Busch, what did you do -- from that point what did you determine what the scope of the work was to be and the purpose of the study? What was the next step in accomplishing what the committee set out to do?

A. The subcommittee decided that none of the companies within the CMC had the time or resources, although there was plenty of data available, to undertake such a monstrous task, so it was decided that we would get a third-party relationship built that could handle the task. So the second task of the subcommittee was to find the third party to undertake the task.

Exhibit G, Part 3, is a list of organizations that we approached; namely, the University of Texas, specifically the Texas Bureau of Economic Geology; Southern Illinois University; the University of Arizona; Gas Research Institute of Chicago; New Mexico Institute of Mining and Technology; and finally the United States Geological Survey.

Q. Out of those six, which was finally selected and why?

A. We decided on the selection the Gas Research Institute for a number of reasons. Number one, they not only could help with our funding problems, but they were also well-acquainted with our work and working on some of the same problems we were, and they were on the ground and running with existing contracts with other entities, such as ICF here today.

It was the consensus of the subcommittee that GRI's approach was the most logical and sensible, considering the allotted timeframe that we had to work within.

Q. Now, Mr. Busch, you have mentioned in the statement there that one of the reasons GRI was selected was because they could help with the funding. Would you go into just a little more detail about how the study was actually funded?

A. Yes, just briefly though, because Mr. McBane is going to -- in that he is the chairman of the spacing study committee, that should be his --

Q. Well, we can pass that question to him, if you'd prefer.

A. But let me just kind of touch on some details of it that will bring it up to that point. GRI informed us that the study would cost approximately $343,000 to conduct and that they could come up with $199,000 of that, so it was up to the committee, the CMC members, to come up with the difference; and it was decided that if each member came up with $10,000 each that the study could indeed be funded. So the study was funded by GRI, some of the operators and the Southern Ute Indian Tribe.

Q. Mr. Busch, in your capacity as co-chairman of the CMC, what was your responsibility in terms of the study? I mean what did you -- what role did you play as far as getting the study done?

A. Well, as co-chairman of the CMC with Katy Templeton-Buell and Mark Weems, my responsibility was creating agendas, arranging and conducting meetings, controlling order, voting, timetables, creating subcommittees, delegating responsibilities and making assignments.

Q. Can you just explain to the Examiner briefly what the purpose of reopening Case 9420 is today?

A. Yes. Mr. Examiner, to establish permanent pool rules for the Basin-Fruitland Coal Pool.

Q. One last question, Mr. Busch: Has the spacing study committee, which you've described, formed any recommendations to the division for the spacing question?

A. Mr. Examiner, the spacing study committee has not -- will not make any recommendations for spacing today; however, there are certain conclusions that can be used as general guidelines. I won't attempt to get into those conclusions at this time, but again, Mr. McBane, the chairman of the spacing study committee, will do so.

Suffice it to say that the spacing study committee voted and decided that the results of the study would be provided to the NMOCD and COGCC as a guide and a tool in reviewing operators' applications for spacing.

Testimony will be heard at a later date from members of the spacing study committee on behalf of their individual companies.

Q. Do you have anything further to add to your testimony, Mr. Busch?

A. I do not.

Q. And were Exhibit G, Parts 1, 2 and 3, prepared by you under your supervision?

A. Yes, they were.

MR. STOVALL: I would move the admission of the Exhibit G, Parts 1, 2 and 3, and I have no further questions of this witness.

EXAMINER CATANACH: Exhibit G, Parts 1, 2 and 3 will be admitted as evidence in this case.

(CMC Exhibit G, Parts 1, 2 and 3, were admitted into evidence.)

Are there any questions of this witness?

(No response.)

EXAMINER CATANACH: If not, you may be excused.

MR. STOVALL: I would next like to call Mr. McBane.

RICHARD McBANE,

the Witness herein, having been previously duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. STOVALL:

Q. Would you please state your name and place of residence?

A. My name is Richard McBane, and I live in Chicago, Illinois.

Q. And how are you employed, Mr. McBane?

A. I work for the Gas Research Institute, and I'm the manager of coal and shales resources -- research in coal and shales resources.

Q. Have you ever previously testified before the New Mexico Oil Conservation Division?

A. No, I haven't.

Q. Will you tell the Examiner about your educational background?

A. I have a bachelor of science degree and a master of science degree from Purdue University in geology and a master of business administration from Case Western

Reserve University.

Q. What is your work experience related to the field of gas production?

A. I've worked for the last eight years for the Gas Research Institute on research projects related to natural gas supply.

Q. Have those research projects been studies similar to the one that we performed on the Basin-Fruitland Coal Pool?

A. Yes, the research projects have involved all aspects of reservoir engineering, formation, evaluation and geology.

Q. Do you have any experience prior to GRI?

A. Prior to GRI I worked for an engineering consulting firm named Dames & Moore; and in that role I was working primarily in engineering geology in soils and ground water hydrology. Ground water hydrology specifically would have application to coalbed methane.

Q. And have you been directly involved in the coalbed methane study which Mr. Busch described?

A. I've been involved in the coalbed methane study, been directly managing ICF Resources to conduct the study and have been chairman of the steering committee for the study, working with the producers cooperating in the study.

Q. Let me ask you: What is Gas Research Institute? Would you give me a brief description of what that organization is?

A. Gas Research Institute is a not-for-profit research organization, an industry group with member companies, coming from pipeline companies, local distribution companies and gas producers and we are funded through a surcharge on interstate pipeline sales.

Q. Who owns Gas Research, or how is it -- is it a private, for-profit company?

A. It's not --

Q. You said it was nonprofit.

A. Yes, the Gas Research Institute is a private, not-for-profit company, and it's a membership organization, as I said, with members coming from the full industry, gas industry, from the gas producers, the pipeline and the local distribution companies.

Q. Would you just describe for the Examiner the background? How did GRI get involved in participating in the Coalbed Methane Committee and the study?

A. GRI had plans to conduct a reservoir engineering study on the Fruitland coal, using funding available to us through our member companies. And over the course of getting started on that study, I became aware through working with contractors that there was a

Coalbed Methane Committee that was looking to conduct a similar study; and virtually at the same time, one of the members of that organization, Coalbed Methane Committee, and myself met and talked together about the possibility of working on a joint study.

We then visited with the full subcommittee, presented an approach for how we might work together on a joint study. I went back and I had ICF Resources, which was our reservoir engineering contractor already on board, help prepare a proposal to present to the subcommittee.

The subcommittee reviewed that proposal, later notified me that they would accept it, and then we later met to discuss how we would fund the whole proposal, but as Ernie Busch had indicated, we had GRI's portion that we had planned to spend which was roughly on the order of about $200,000. The overall scope of the study was much larger than we had originally intended, and therefore, in order to fully fund it, it was necessary for the members of the Coalbed Methane Committee to come up with the incremental amount of money.

Q. Mr. McBane, you indicated that Mr. Busch briefly touched on that, and he passed the buck to you to explain in more detail the structure and funding of the research project. Can you go into a little more detail about how that was put together and who was offered the opportunity to participate?

A. Right. All members of the Coalbed Methane Committee were offered the opportunity to participate in this study. We held a review meeting where the majority of the members of the Coalbed Methane Committee were in attendance and passed out the proposal and contracts for conducting the work.

In response to that, 13 members chose to participate and contribute the $10,000 per company, which was based on the decision of the Coalbed Methane Committee as to how they would choose to fund it.

Q. In other words, the Coalbed Methane Committee set the participation costs, if you will, at $10,000, and then --

A. That's correct.

Q. -- offered that to the companies; is that correct?

A. That's correct.

Q. And the 13 companies who were members of the committee who contributed, can you identify those companies?

A. Yes, I can. Those companies are Amoco Production Company, Arco Oil & Gas, Bowen Edwards & Associates, Marathon Oil Company, Meridian Oil, Incorporated, Nassau Resources, Incorporated, Devon Energy

Company, Mesa Limited Partnership, Phillips Petroleum Company, the Southern Ute Indian Tribe, Texaco, Incorporated, and Union Oil Company of California, and Mobil Exploration & Production.

Q. In addition to financial contributions from the company -- from these companies to support the studies, did any of the member companies of the Coalbed Methane Committee or the study committee make any other contributions, as far as the studies?

A. Yes, they did. The members of the committee also provided access to a considerable amount of data for review to be incorporated into the study, and they also helped provide an oversight role in examining the work and helping to provide a basis of the work to make sure it stayed within proper scientific -- that it was a properly conducted scientific study.

Q. Now, did I hear you correctly that once this study committee was formed, and the money was put in, and GRI was retained, and it actually looked like something was going to happen, then you stated that you acted as the chairman of this study group, study committee; is that correct?

A. There was a steering committee formed from the full committee of members that consisted of six companies, six producing companies and GRI. The steering committee was Amoco, Arco, Bowen Edwards, Marathon Oil Company, Meridian and Nassau Resources, and of course the Gas Research Institute.

The steering committee elected myself as the Gas Research Institute in part because the Gas Research Institute was sort of an independent party with no specific interest in the San Juan Basin to be the chairman of the steering committee.

Over the course of the study for a short period George Dunn of Meridian acted as chairman of the steering committee, and then as the study was completed, I again became the chairman of the overall committee.

MR. STOVALL: Mr. Examiner, at this time I would like to offer Mr. McBane as an expert geologist and research consultant for purposes of this hearing.

EXAMINER CATANACH: He is so qualified.

Q. (By Mr. Stovall) Mr. McBane, would you now give an overview -- when you talk about how the study committee was structured -- and let's clarify this. Make sure we're all talking the same terminology here in this hearing. When I use the term "study committee," I'll refer to the 13 companies which you have identified who contributed $10,000 each to fund the study and were actively involved and had some input into -- some more direct input into the conduct of the study itself. Is that a safe way to describe the study committee?

A. Yes, that's correct.

Q. And you referred to a steering committee as being the six companies whom you've also identified, and that group, that steering committee, is the group that directly supervised the efforts by ICF Resources, voted on procedures and various other activities to ensure that the research was doing what the group wanted done; is that correct?

A. That's correct.

Q. Would you now just give the Examiner and those present an overview of how the study itself was actually structured once this committee structure was in place?

A. The proposal, the plan, for the study was to examine a number of different areas of the San Juan Basin which were believed to have differing reservoir properties and to conduct a history match on existing producing fields in those areas to provide a better understanding of the overall reservoir properties, and then to use that knowledge and information to conduct a series of sensitivity studies to give a wider or better understanding of how the range of expected properties might affect production from the Fruitland formation.

Q. Now, in terms of actual procedures, as you've pretty much described -- and perhaps it would help if you went into a little more detail, but is that information contained in what's been marked as the CMC Exhibit A, being the --

A. Yes.

Q. -- large book that's -- let me just read the title here so everybody knows we're talking about the same thing, "Presentation and Exhibits for the San Juan Basin Coalbed Methane Spacing Study, Presented at the New Mexico Oil Conservation Division Examiner Hearing," is Exhibit A; is that correct?

A. That is correct.

Q. And we're looking behind the first tab, which is entitled "Overview and Conclusions." Does that contain a summary of what we're talking about right now?

A. Yes, it does.

Q. One thing I would like to spend -- have you spend just a minute on and discuss is the manner in which the steering committee guided ICF in the course of the study. You mentioned something about voting procedures. Would you just briefly expand on that?

A. Over the course of the study, we met with the full steering committee essentially about once a month to once every six weeks to review the progress of the study with the subcommittee. Often we had other members of the full committee in observance at these meetings, and we reviewed the work, looked at the direction it was going, and the full committee would provide inputs on directions of the research and would review the quality of the data that was being used. They would look at the procedures being used, and would help to direct the overall approach of the research to try to provide a general direction that they felt was going to provide the appropriate level of results that the commission would be looking for.

Q. Would it be safe to say that one of the intents of that kind of organization and oversight, if you will, was to ensure that the study was a valid scientific study that recognized the practical world of gas production and didn't become a theoretical -- totally theoretical approach to analyzing this pool?

A. Yes, that's correct. One of the main functions of the subcommittee was to help provide a scientific check on the inputs and the outputs of the study.

Q. Mr. McBane

A. The Basin-Fruitland coal pool is actually a rather large geographic area, is it not?

A. Yes, it is.

Q. Was it studied as a single area? Did they just take a whole pool and make an analysis, or was there any breakdown?

A. No. At the beginning of the study we

recognized that there were some significant differences in the Fruitland pool, and to initiate the study, if we could put up Exhibit 1 from the handout, from the -- I guess it's Exhibit A, Exhibit 1.

Q. Now, that would be found in the book, would be found behind the exhibit tab, for everybody's information.

Now, we've lost the Examiner, so we can go on and have a party.

Behind the "Exhibit" tab there's several pages of index to the exhibits, and then there are pages, each of which has a number at the top; and the first one is Exhibit 1, and so that we may refer to exhibit numbers. These will be the exhibits. There are some hundred-and-some-odd exhibits throughout these two booklets, and this is the very first of those.

Mr. McBane, would you identify the areas on Exhibit 1?

A. Exhibit 1 is a map that was prepared under my direction by the Texas Bureau of Economic Geology, who was working on geologic assessment of the San Juan Basin for Gas Research Institute under my direction at the time.

This is a map which shows three areas, Areas 1, 2 and 3, where they have looked at the geology and the hydrologic characteristics of the basin, and tried to distinguish areas which had fairly consistent, but distinct differences, essentially to try to draw general boundaries on differences.

Area 1 is an area which is considered overpressured. It has high pressures in the area. Area 2 is underpressured. And Area 3 is also underpressured, but tends to be more -- would assume to be more gas saturated based on their geological studies.

The general boundaries between areas, while shown as fairly solid, rough lines here or very solid lines here, are very indistinct. It was based on a scatter of data available through the basin, and those lines should not be perceived as being as falling on very precise boundaries. They really should be more -- several inches wide -- not several inches, but wider on the map and probably several tens of miles wide out in the field.

Q. In other words, they'd be like transition zones --

A. Yes.

Q. -- rather than boundaries, really; is that correct?

A. Well, they may be transition zones, but more so is the data necessary to find the precise location of those lines not readily available; and then also in addition to that, there are very likely to be areas in Area 1, which have property similar to Areas 2 or 3, and there are possibilities of areas in Areas 2 or 3 that may have properties somewhat similar to Area 1. So the exact location and exact properties one would find may vary, and you really need to look at the exact location you're working in to know that; but this provided us with a general overall guideline for some of the differences through the basin.

Q. Remembering that the purpose of this hearing here is to establish regulatory framework and regulatory operating rules, if you will, for the Basin-Fruitland coal pool, are these boundaries or establishment of these different areas and the criteria used, do they have any real direct, specific usefulness in the context of trying to write rules for an area, for example?

A. No. These areas are not well enough defined that they could be used for setting specific rules within the basin.

Q. Let's move on now. And would you please describe for the Examiner -- and I think we can go ahead and take the screen down for now, so we'll bring the Examiner back into the hearing. Describe for the Examiner how the consultant was selected, what process was used to pick ICF Resources as the consultant.

A. ICF Resources was selected by the Gas Research Institute for work in reservoir engineering through a request for proposal process that was conducted sometime before this overall study was planned and put together. They had been -- we had sent out a request for proposals to a number of organizations to conduct reservoir engineering studies, and through that process, being evaluated by member companies who were advisors to GRI, plus GRI staff, ICF was selected to conduct that reservoir engineering study.

When the overall study was put together with the Coalbed Methane Committee, GRI already had ICF on board and proposed to the steering committee that we use ICF because we already had existing contracts in place, and that would allow us to get the study underway in a much more timely fashion than if we had to go out and contract with a new organization.

Q. In other words, ICF had some familiarity with what was going on here in the first place; is that correct?

A. That's correct.

Q. Now, we've talked a little bit about the study structure. Let me again ask you to go into a little more detail as to the role GRI played in its kind of multientity structure. What was GRI's role in that?

A. GRI's role was primarily to try to provide direction, direct contact with the contractor as the study was being conducted, and also to operate within the group of producers who had widely diverging interests and try to provide a balance to make sure all those interests were addressed within this study.

Q. GRI has no specific economic interest in this type of activity, does it? Production, for example?

A. No. GRI has no production activity in the San Juan Basin at all. Our only interests were to try to provide a better scientific understanding of what the controlling production mechanisms are for coalbed methane reservoirs.

Q. Would you just briefly discuss what the role of Ernie Busch from the OCD and Mark Weems from the Colorado Oil and Gas Conservation Commission was in context of the study?

A. Mr. Busch and Mr. Weems provided an important role in that they were the two individuals who had the best understanding of what kinds of information would be useful to the commissions for evaluating spacing issues, and they were providing that kind of direct input to the committee so that we could focus the problem and come up with the right types of information that would be useful to the commission.

Q. And those guidelines are in fact what Mr. Busch presented, I think, as part of his Exhibit G, Part 2; is that correct?

A. That's correct.

Q. Now, obviously one of the major concerns in evaluating some of the questions involved is economics. How were they considered in this study?

A. Economics were not used in this study. Initially, as the study progressed, we took a brief look at economics, and we recognized that each company involved in this work had their own separate set of economics that varied considerably from company to company, and that it was not appropriate for the study committee to try to address economics directly, but rather to provide the -- what this study should do is provide technical data which then individual companies could take and examine and apply their own economic framework to.

Q. So by bringing GRI in the picture and by having the state commissions involved in kind of oversight, would it be fair to say that that provided some guidance to ensure that the research work that ICF performed was scientifically sound and objective and directed towards the task, the charge of the Coalbed Methane Committee?

A. That's correct.

Q. Now, we can get to the fun part of this, Mr. McBane. Would you please describe or tell the Examiner very briefly what conclusions were reached as a result of the study?

A. The conclusions reached as a result of this study --

Q. Where can they be found first? Are they in the report?

A. -- can be found in the report on page 2 of the introduction, starting where it says, "Summary and Conclusions" on page 2, and then going on to page 3.

Q. And I don't believe it is necessary to actually read those conclusions into the record, but can you just, again, bearing in mind that the purpose of this hearing is to establish rules for operations of the pool in New Mexico, can you just summarize those conclusions as they are relevant to that issue?

A. Right. The first was that the current temporary spacing rules provide an appropriate basis for evaluating the Fruitland coal, but that there are probably locations in the pool where reservoir conditions may require different spacing and that the commission should provide every opportunity for a producer to provide data and information to request reduced spacing or other spacing; and this study has identified the key parameters which are listed under that Part A.

Secondly, this study has identified how the gas recovery changes as several of the different parameters either increase or decrease. Thirdly, there are some suggestions that well interference may play a different role in a coalbed methane reservoir than it does a conventional reservoir, and that on an individual case basis, you may wish to consider interference in a different light than it what it might be considered in a conventional reservoir.

Then finally, the selection of the spacing is a function of both reservoir performance and economic considerations; and while this has not dealt with the economic considerations, those also must be considered when considering spacing issues.

Q. Now, Mr. McBane, is it safe to say that these conclusions as contained on pages 2 and 3 of Exhibit A are, in fact, the conclusions of the study committee based upon the research done by ICF, that ICF actually did not make the conclusions, but rather presented the information to the committee, adopted these conclusions through the procedures established?

A. That is correct. This is a set of conclusions which represent the consensus of the committee involved in the study.

Q. Now, does the Coalbed Methane Committee have witnesses who will actually testify as to that information that in fact went into the process -- the process and the information that was provided to the committee and how it got there so that -- in order to determine for the committee to make these conclusions?

A. Ah --

Q. Would you like me to rephrase that?

A. Yeah, actually. I think I would.

Q. I'm asking you if -- you have testified as to the conclusions adopted by the committee. What I'm asking you is now, is there another witness or witnesses who will testify as to the actual report itself and the analysis done upon which these conclusions are based?

A. Yes, there are two other witnesses who will respond to the information that is contained in the report.

MR. STOVALL: I have no further questions of Mr. McBane.

EXAMINER CATANACH: Are there any questions of this witness?

(No response.)

MR. STOVALL: Next, now I would like to call Mr. John McElhiney.

JOHN EDWARD McELHINEY,

the Witness herein, having been previously duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. STOVALL:

Q. Would you please state your name and place of residence?

A. Yes, John Edward McElhiney, and I live in Denver, Colorado.

Q. Where are you employed and in what capacity?

A. I work for ICF Resources, Incorporated, and I am vice president of the Denver office.

Q. Have you ever testified here before the OCD?

A. No.

Q. Before we go any further, Mr. McElhiney, I would suggest, Mr. Examiner, that we are now going to be making greater use of the overhead and exhibits, and you are likely to be able to hear a lot more if you'd like to move down with us. Perhaps you could see what's going on.

EXAMINER CATANACH: Let's take a short break.

(At 9:40 a.m. a recess was taken.)

Q. (By Mr. Stovall) Mr. McElhiney, I think before we took the break and everything, I think we found out who you were, where you lived and where you worked, and that you've never testified here before.

Would you please tell the Examiner and those gathered here your educational background?

A. Yes. I have a bachelor's and a master's degree in chemical engineering from the University of Kansas and a Ph.D. in chemical engineering from the University of Missouri.

Q. And would you describe your relevant work experience that qualifies you to perform this type of study since college?

A. In the reservoir simulation area, the relevant work experience includes a stint with Marathon Oil Company's research labs in Denver between 1969 and 1977, and then consulting experience with Intercomp Research Development and engineering which later become Scientific Software Intercomp.

From 1977 until 1988 and the current work experience that I have with ICF since August of 1988, I have been actively involved in reservoir simulation. During that period and my first exposure to coalbed methane was in the late 1970s in a study that Intercomp performed for Jim Walters Resources at the Brookwood Mine In Alabama.

Q. Now, what has been the role that ICF Resources has had in relation to the coalbed methane committee?

A. ICF Resources served as contractor to the Gas Research Institute as their reservoir engineering consultant in coalbed methane, and as such served the Coalbed Methane Committee in much the same way. We had relevant reservoir engineering and geological experience in coalbed methane from our prior associations with the Gas Research Institute, which we were ready to apply to the San Juan Basin. We also had a reservoir simulation model which was available for use in this study, so we were prepared to accept this charge.

Q. Then specifically how did ICF become involved in the project?

A. I believe Rich McBane called after he had discussions with the Coalbed Methane Committee and asked us if we could prepare some kind of proposal that the Coalbed Methane Committee could examine and see if it contained the elements of the study that seemed to make sense to them, and we prepared that proposal and sent it along to Rich, and he transmitted it to the committee itself.

Q. Then did you actually meet with the committee itself before you were retained to perform this particular contract?

A. Yes. I think we had either one or two meetings with the committee itself before we were actually retained. There was a period of time when the money was being raised from the participants that we were discussing the matter with the committee, and at that time it wasn't an absolute surety that the study would go ahead, but once enough companies responded, we commenced the work.

Q. I heard Mr. Busch and Mr. McBane testify that, in fact, the study was funded -- the majority of the funds actually came from GRI with about $130,000, $140,000 provided by individual companies. ICF is -- Who has ICF actually got a contract with? Who writes the checks to ICF?

A. The Gas Research Institute.

Q. And does ICF have any contract with any individual companies involved with respect to the coalbed methane study?

A. No.

Q. As a consultant, was ICF hired to do -- to advocate any position? Were you asked to support any particular position?

A. No. We were obtained or retained to do the best, objective, scientific piece of work that we could do.

Q. More specifically, what was ICF hired to do?

A. Well, the Gas Research Institute had an agenda of trying to determine, kind of an ongoing agenda, I guess you'd say, over the years, to try to determine those reservoir parameters that best characterized coalbeds; and the committee wanted to investigate, basically, how those parameters affected the performance of coalbed methane wells, and so the two kind of seemed to be a fit, and we were retained to perform that investigation.

Q. What was your individual participation in the actual research and study itself?

A. Well, I'm, I guess, the person at ICF that is responsible for ICF's performance. I participated at different levels and different segments of the study, but it's basically my responsibility to see that the work got proportioned among our staff members properly and that the work got done on time.

Q. And who else -- who were the other researchers mainly involved in the study? Can you tell us who else worked on it?

A. Yes, there were a number of other people on our staff that participated in one way or another. However, the other -- the two other individuals who had the main impact on this study from ICF Resources staff were George Paul and Genevieve Young in our Denver office.

Q. You were all in the office, and you all worked together to accomplish this?

A. That's correct, sharing duties, you know, on various aspects of the study.

Q. And did you meet with the committee from time to time. Have we talked about the study committee or the steering committee? What was your relationship with either of those committees?

A. Our methodology was basically to perform a segment of the study and then report results to the steering committee, if you will. And I would say, we must have had over a 16-month period, probably eight or ten different meetings, so about every six to eight weeks, maybe a little less, in some cases, maybe a little more in others, was about the frequency on which we met.

Q. Now, has ICF actually prepared for the Coalbed Methane Committee an exhibit to be presented to the Oil Conservation Division as part of this case?

A. Yes. I think you identified it earlier as Exhibit A. It's this report, its associated map packet and a few of the looseleaf pages that were handed out this morning.

MR. STOVALL: At this time Mr. Examiner, I would like to offer Mr. McElhiney as an expert in the reservoir modeling, reservoir performance research.

EXAMINER CATANACH: He is so qualified.

Q. (By Mr. Stovall) Now, it's correct that you and the following witness will be referring more extensively to Exhibit A than we've used it up to this point; is that correct?

A. Yes.

Q. Would you just describe how this Exhibit A --

and what we're calling Exhibit A is both booklets -- how that's laid out and the organization of it so as the people are following the testimony, they can understand the answers?

A. Yes. If you'd turn to the introduction or the outline for the presentation, which is on the screen before you, it's listed on page I of your report, it's basically organized in three sections: Kind of a study overview and conclusions section, which Rich McBane has already referred to in his testimony; a technical approach section, which includes the study methodology, the model validation, the reservoir characterization and the sensitivity analyses. In other words, a description of how we went about the study, which I will be testifying to.

And finally a discussion of the study results, which includes history matches of the Cedar Hill and Tiffany field areas and the sensitivity analysis work that we did for the Areas 1, 2 and 3, which Mr. McBane referred to earlier. Those will be testified to by Ms. Young.

Q. And when we refer -- I think I noted before that when we refer to exhibit numbers, those are actually the numbers labeled at the top of the page behind the tab call "Exhibits"?

A. Yes, there is, that's correct. Right behind the tab called "Exhibits," there is a list of the exhibits basically that break down into these various sections that I just described, and they're listed there in appropriate order from the introduction and technical approach to the sensitivity analysis for Area 3.

Q. And then behind those pages are -- following that outline and breakdown of the actual identification of the individual exhibits within each of those?

A. Yes. That's correct. For instance, the Exhibits 1 through 15 for the introduction and technical approach are shown individually by their titles on a separate page, the description of the exhibits with a history match on another set of pages and so on.

Q. Was Exhibit A, this packet, prepared by you or under your supervision as the person responsible at ICF?

A. Yes, it was.

MR. STOVALL: Mr. Examiner, I'm going to offer Exhibit A at this time as an exhibit in this case and get that detail out of the way.

EXAMINER CATANACH: Exhibit A will be admitted as evidence in the case.

(CMC Exhibit A was admitted into evidence.)

Q. (By Mr. Stovall) Mr. McElhiney, are you prepared at this time as representing ICF to make a recommendation of the proper spacing for the pool?

A. No.

Q. Now, you've heard Mr. McBane's testimony about the conclusions which are included in this volume, which we have just discussed. How can this report be useful to the Oil Conservation Division and Colorado Oil and Gas Conservation Commission to establish operating rules for the pool?

A. Well, I think the broad scope of the conclusion that we would like to leave the commission with is the fact that production of coalbed methane wells is highly dependent upon the reservoir characterization of each specific site in the San Juan Basin, and whether we choose to speak of the areas as 1, 2 and 3, or however we choose to categorize them today, there is enough variation in the key parameters that control the performance of coalbed methane wells, that one really has to look at the site-specific reservoir parameters which have an effect on this production.

We have studied them, subsets 2 and subsets 3 previously characterized by the Bureau of Economic Geology for the Gas Research Institute in that fashion, and it made logical sense to proceed that way. However, as Mr. McBane testified earlier, there are some similarities between Areas 1, 2 and 3. There are some dissimilarities between Areas 1, 2 and 3.

It may be that different spacings might be appropriate, depending upon the reservoir parameters at any specific site in any particular area that would require a different spacing within one of these areas.

And within that broad backdrop, what we tried to do, and we took a reservoir simulation approach, was to first validate the simulator by various means; and then having it validated and calibrated to field history performance, we performed sensitivity studies for these three areas which we hope will be helpful to the commission in providing an umbrella of the various combinations of parameters which could be at play in any one of the three areas in the San Juan Basin with the performance or production of wells associated with those parameters in such a way that the commission could look back later on and determine if an applicant brought certain site-specific reservoir parameters to a hearing, whether or not there is some guidance here as to what a well might perform like on a 160 or a 320 in one of those three sensitivity analysis results.

Q. In other words, while the report doesn't make recommendations, if an operator comes with a specific recommendation, this report gives the OCD some way to test the premises on which the operator had made that recommendation; is that correct?

A. That is correct. And what's very important, and Mr. McBane touched on this, is that each operator is going to have different set of economics than probably every other operator, and the economics in and of themselves, combined with these results in this report, you know, will suggest on a site specific basis what the appropriate spacing is, and economics was not included in this report, so that is a detail left to the operator within the structure of this methodology and his own economics to come before the commission and present his own case.

Q. Now, Mr. McElhiney, I mean what -- why make this kind of analysis in the coalbed methane? Is coalbed methane production significantly different from other forms of gas production?

A. Yes. There are two or three things that are different about the physics of reservoir behavior and coalbed methane that are somewhat different from conventional reservoirs.

Q. Can you describe those, please?

A. Yes. If I could have Exhibit 2, please, I would like to contrast the performance of a conventional gas well, the gas rate and what we would term the conventional curve for gas rate.

Q. Let me stop you right here before we go on to the details. When you refer to Exhibit 2, the Exhibit 2 which is actually bound in the volume is not correct; is that right? Is that a replacement Exhibit 2, which was handed out?

A. That's right. We handed out a separate page. You should discard the one that's bound in the book, and when you have an opportunity, to rebind the page which we passed out.

Q. And the actual Exhibit 2, the difference is in the conventional decline, that it doesn't have the little hump at the top, so you can know which one is correct.

A. Right. Normally, for a conventional gas system, the floor space is filled with gas with very little mobile water present, so the initial rate that one experiences in a conventional gas reservoir is demonstrated by the top figure is usually the highest rate seen during the course of production for a conventional gas well; but in coalbed methane, at least in the classical case, the coal cleats are saturated with water and there is no free gas saturation, and we must pump some of the water from the cleats in order to get desorption of the gas from the coal, so we have what's referred to in coalbed business as the sort of negative decline period here on the inclining portion of the curve.

Now, I should point out that there's a little hump on this lower graph which comes very early in time and in many cases is not seen. It represents, basically, early de-gasing of coal in the near wellbore vicinity for coalbeds that are on pump, or for very fast sorption times, one may or may not see that initial spot. They may just see a smooth curve rising from zero to some maximum peak, and finally falling off in a decline that looks more like the conventional gas well.

Now, if we could have Exhibit 3. The gas is held only in place on the coal by a process called "sorption," sorption being both the processes of absorption and desorption; and what's depicted here is what we accept in the coalbed business as being a Langmuir isotherm.

You'll notice that the gas content of the coal in standard cubic feet per ton is presented on the vertical axis, and the reservoir pressure in psia is presented on the horizontal access.

So if we took a reservoir in the neighborhood of 1900 pounds on this slide, we might calculate that Coal A, which is shown here on the curve, we would refer to it as a coal which is completely saturated. In other words, that's the total capacity of gas that Coal A could hold at 1900 pounds, and it is right on the desorption isotherm.

Now, as pressure is reduced in their wellbore vicinity, we work our way down the isotherm from right to left, releasing gas between the high point of about 600 standard cubic feet per ton here to lower values. It is possible in some coals to have them be undersaturated. In other words, at their initial pressure of 1900 pounds, Coal B might not be found on the sorption isotherm, and we'd refer to it as an under-saturated coal.

If we could look at Exhibit 4, then, we might see the implications of a saturated coal versus an under-saturated coal. You can now see that at 1900 pounds, Coal A having an initial gas content of 600 standard cubic feet per ton begins at that point, releasing gas, while Coal B at some lesser gas content of about 450 standard cubic feet per ton, that particular coalbed well would have to be pumped down to 900 pounds per square inch pressure before the desorption pressure was reached on the isotherm.

And so you might pump water for a period without seeing very much or any gas. There might be some solution gas in the water at that point, but the gas would not be truly released from the isotherm until you reached 900 pounds, and the implications of this, of course, are both important for reserve calculations and how much gas

-- or research calculations, excuse me, of how much gas is in place, and coupled together with the physics this kind of desorption isotherm would help one calculate the actual reserves of the well.

Q. Let me just ask you at this point, what's the significance of that in terms of spacing, production, et cetera? How does that distinguish methane production from coalbed methane production from conventional gas production?

A. Well, the major mechanism here, of course, is pressure lowering, and it works in a different way, as you can see, for coalbeds than it does for conventional resources. And the well really starts out in the classic sense as a water well, and later becomes a gas well; whereas, in a conventional sense, it's always a gas well from beginning to end.

If we could turn, then, to Exhibit 5, we can see possibly some of the implications of spacing, which is part of the subject we're trying to discuss today, and you'll notice that what we have plotted here on the top is a gas rate on the vertical axis versus time on the horizontal in the top figure, and on the bottom figure a water rate versus time, and you can see that for this well, the water rates are represented as a pump-down schedule.

In other words, as we begin to remove the water head from the well, the water rate rises to a certain point and turns over, and the gas rate follows a corresponding path; and you can see the associated behaviors between a 160-, a 320- and a 640-acre well in sort of schematic kind of way, both for the gas production and the water production.

So we see that the gas production peaks as the water production is being lowered, and it's due to this relative permeability effect on different well spacings that causes the peaking effects of a gas production curve to occur at separate times.

You'll notice here that the 160 peaks first, the 320 peaks second, and the 640-acre spaced well peaks third. This is because the way these wells are behaving on confined spacings, it takes a while for the pressure transient to reach the boundary condition in the well to respond.

Q. What does that have to do with spacing? How do you use that information to approach a spacing question?

A. Well, you have to have some kind of a mechanical way of calculating all this, and we used a reservoir simulator to help us understand how all this data worked together and complimented itself so that we had a consistent method for making the calculations, so we input all the data into a reservoir simulator and let it help make those decisions for us.

Q. Let me back you up and make sure I understand what you're saying here. I as a lawyer who really doesn't have any idea about natural gas except to turn on my stove, what I do understand is that when you produce gas in a conventional sense, what you want, your objective in setting spacing is to try to get wells where the pressure influence, if you will, one doesn't cross over to the other; is that correct?

A. Yes. You're referring to an effect called "interference effect." I think maybe if we could look at Exhibit 6, we might be able to see how that works. Now, the top part of Exhibit 6 shows two wells side by side; more appropriately this figure might show a single well with four neighbors, one on each side of it, so that it's a totally confined well.

Now, in the cross section below we've attempted to show pressure as a function of the cross section across these two well spacings, and we've showed a top figure where the gas rate is zero. You'll notice that the dotted line across the top of the figure is at its maximum level.

Referring back to the previous slide, during the gas rate increase or the negative incline period in the second cross section down, you'll see that when gas rate is increasing, the two pressure profiles from the wells may have actually interfered with one another because right at the drainage boundary of the two wells there's a slight depression in the pressure contour.

And looking even further down at the third cross section, you'll notice that there is more interference. Now, the reason interference can be useful in coalbed methane is that this interaction helps to lower the pressure in the inner well distance, which would be the damages halfway between these two wells.

And if you never -- if the well never experiences any pressure reduction at its radius of drainage, there will never be any gas released from the desorption isotherm near its radius of drainage. So in this particular case, we want to make sure that we get the pressure lowered to capture as much of the resource as possible.

So these four pictures with gas rate increase and gas rate peaking and gas rate declining may be exaggerated a little bit, but we're trying to get across the idea that while interference has normally and historically experienced kind of a negative connotation with regard to conventional gas wells, there might be some beneficial effects from interference in coalbed wells, and we just at this point don't know how much that might be.

Some people think that this effect is merely an acceleration effect. In other words, you would still recover the same gas on a larger spacing, but it would come later in time than it would come at a smaller spacing, but it wouldn't affect the recovery as much. Other people believe that the best way to guarantee that recovery will be high and truly believe that recovery, at least in the practical time limits of 25 or 30 years, is to have, perhaps, some interference.

And I must, you know, caution you that this testimony is based on the theoretical aspects of reservoir simulation. It's not combined with any economics. While interference here could have some small, beneficial effects, it might be that when you combine economics with those effects, it might not justify drilling on a closer spacing.

So there are a number of things that have to be looked at, but what we'd like to have the commission understand is that interference, as you've previously thought of it in conventional gas production and interference as you think of it in coalbed methane may have slightly different connotations.

Q. I think you mentioned earlier something having to do with reservoir modeling in the context of this information. What is the significance of this in deciding upon the methodology that ICF used to do this evaluation in this specific circumstance?

A. Well, the first thing we had to do, of course, was to verify that the model was a valid tool to use for this study, and toward that end we did two things: One --

Q. Let me back you up first. Let me ask you and make sure I understand correctly what the purpose of modeling is. Can you just tell me what it hopes to accomplish, in general, the purpose of modeling?

A. Sure. In general the purpose of modeling is to run the "what if" scenarios before one really has to invest a lot money in drilling up a whole field. So if you have some initial production that you can calibrate a model with, and you can make some extrapolations using the model. You put your data in. You make those extrapolations. You calibrate it to the historical data, which is a very important step because running a model in the absence of any actual performance data may not give you the result that you're looking for; but then you can use this model to run several performance scenarios at different spacings, perhaps with different variations in your reservoir parameters to see how they affect the resulting production of gas and water from the model, and you do this very quickly in advance of development of the whole field, and you can guide your development all the while, returning to recalibrate as more and more historical information becomes available.

Q. Now, if I understand what you've said correctly, what you're telling me is that what you try to do is create the reservoir in the computer, if you will?

A. That's correct.

Q. And as you adjust various inputs of data, parameters, whatever you want to call it, it causes different things to happen in the computer which would indicate that's what would happen if those same variables vary in the field; is that correct?

A. That's correct.

Q. So what the usefulness of modeling -- you know, I'm trying to paraphrase what you're saying here to make sure I understand it. The usefulness of modeling is that after -- is that you could run different combinations of variables and see how they work.

A. That's correct. See what the interactions between all those variables are, which is, you know, a real mindful when you're trying to do it without -- you know, absent some tool which makes all those appropriate interactions for you in the correct mathematical sense.

Q. And when you take that model to the field and you actually get real information from the rock itself, you can go back and say: Okay, this information -- I'll look for this combination of information in my model, and based upon what the model suggested, this is the kind of performance I can expect for this particular location in the field? I mean, is that a fair summation?

A. Yeah, it's pretty fair. You normally have some parameters that you know better than others, and so there's a process. I call it calibration. It's often referred to as history matching in which there's some variables that you don't know very well.

You try to arrive at a reasonable engineering and geological approximation of what those variables are, and within some reasonable band width of those variables, you try to make the model emulate or mimic the actual well performance in a way that you can believe it, and you have to apply engineering and geological judgment in this calibration, in this history matching exercise; but once that's done, and you can feel comfortable with the tool that you have, then you can place some reliance on it to forecast at least for short periods into the future.

Q. What are the limitations on the usefulness of modeling in predicting those local patterns?

A. Well, the care with which you collect the reservoir data, the number of variables that you can actually measure in the laboratory or collect from the logs or get from the transient tests, anything you can do to eliminate an uncertainty by some other means, you should definitely do, so the number of unknowns that are left in the model, you want to be minimum at the time you're trying to do this calibration exercise because the more variables that you have to estimate from your judgment, the more likely you are to, you know, have some difficulties in the future in relying upon the performance forecast of the model.

Q. Would you please describe how you establish the model? How did you pick the model that you wanted to use, that ICF wanted to use, in this particular study?

A. Well, we had been working with a coalbed model that the Gas Research Institute offered funding to us to develop as early as about 1985 or '86, and we had expanded the capabilities of this model to handle multiple wells, multiple coal seams, variations in coal geology and structure in isopach thickness and structure tops and so on; and we felt that this model was at a mature enough state to offer aid in this particular study.

It had been used many times for single well studies. It had not been really tested in a large way on multiple well, real case history, but we felt it was ready to do that.

Q. Is there a name for this model? Can you identify it in any way so we know what you're talking about?

A. The name of this model is the "COMETPC 3-D," standing for "coalbed methane on a personal computer in three dimensions," so that's the name of the model.

Q. Now, you've indicated that you had this model, that it worked on a limited, one-well basis, that you felt that it would be useful for this study. Now, it seems to me that if you're trying to recreate the real world in a computer, that you've got to do something to make sure that what's in the computer is fairly accurate. What did you use to try to make that determination that this model really was a good starting point, a good tool?

A. We did this in two steps. One was kind of a theoretical step, and easy to accomplish very, very quickly at the outset of the study. We asked for volunteers from the committee because we knew a number of the companies on the committee had their own coalbed methane reservoir simulators; and what we wanted to do was run some common problems between someone else's simulator in an oil company, oil and gas company that had been used for a number of years for this, and our own simulator. That was step number one.

And Arco Oil & Gas said that they were willing to perform this comparison, so our people and Arco's staff selected three common problems to run on their simulator and on our simulator just to test the mathematical veracity, if you will, of the simulations; and those tests can be found in Exhibits 7 through 14, I believe it's -- yes.

And in fact, in Exhibit 14, there is a complete description of the cases run. I won't describe for you this morning those cases because I think it's largely -- it's largely not necessary, and I think it's perfectly explained here.

But basically what we did is run a three-well problem with various wells turned on, with different barriers of sand and so on between the coal seams, and tested our model for gas rate and water rate versus their model's production rates for both gas and water, and examination of these exhibits, I think, would convince any reader that both models behaved mathematically, at least, in a very, very similar way. The precision of the results is quite close.

Q. Let's look for a moment. As you indicated, it's not really necessary to go into detail. The first thing I'm going to ask you: Is the Arco model that you used to compare against, I mean, it was an established, proven, if you will, model, one that had a track record of accurate performance; is that true?

A. Yes. Arco had used it for some time and published several technical papers on this model, and we were completely convinced, as they were, that, you know, this is a very valid simulator against which to test ours.

Q. Now, if anybody wanted to actually go out and make their own evaluation of whether or not this truly was a true validation of your model against another model, the article, let's see, Exhibit 14 appears to be an extract of an article from SPE, the Society of Petroleum Engineers; is that correct?

A. Yes.

Q. And who actually prepared this article?

A. George Paul in conjunction with our software engineer, Walt Sawyer, who is a consultant to ICF, prepared it from ICF's point of view, and Dr. Rick Dean, from Arco Oil & Gas in their research center near Dallas was the participant for Arco.

Q. Mr. Paul actually participated in the study itself, too; is that correct?

A. That's correct.

Q. So he is familiar with the whole --

A. That's correct.

Q. Now, if somebody again -- back to my original question -- if somebody wanted to check out your work, does this article contain sufficient information on that comparison that it would be useful to them to review what you did?

A. I believe it does. If there is any reason why it does not, we'd be happy to supply any of the data that might be missing.

Q. Now, essentially if I understood what you're saying, is you're saying, "Is my tool as good as your tool in terms of the way it's manufactured?" I mean, "Does my post-hole digger do the same job as your post-hole digger? Does it look the same sitting on the shelf? Is it made of the same material?" that sort of thing.

A. Yes. I know the basic test here is to be sure that the mathematics internal to the two simulators work in the same way, that the boundary conditions for desorption and all the stuff that was specific to the coal behaved in same way, and I think we concluded that it did.

Q. All right. Now, and then again, as a lawyer who doesn't really know what you're talking about anyway, that sounds really neat to me, but how do I know that you've taken this tool and that you can actually use it to simulate a real life reservoir?

A. Okay. Well, the calibration against Arco's simulator or the test problems that were run common between them was step one. As I mentioned earlier, it was a step that we could do fairly quickly at the outset of the study.

The second step which is probably more important than anything else is the calibration against field data, so what you need there are a couple of field examples that have enough history of production and enough availability of reservoir data that one can actually put the real information from the field situation, the number of wells, their specific locations, the actual structure map of the coal developed from the logs and the isopach thickness maps from the coal, can all be inserted into the model and run, and the model unknowns or the missing reservoir parameters suggested in such a way that each and every well in the reservoir model mimics to a reasonable degree the same water and the same gas production, simultaneously that the actual production illustrates.

And if there are any monitoring wells that one has measured pressure from or any bottomhole pressures that might be available that have been measured on producing wells, any and all of that data must be included and must be matched simultaneously with the gas and water production rates; and one has to be convinced at the end of the exercise that the parameters that one adjusts that are unknowns at the beginning are in a reasonable range of values for those parameters, in other words, knowing what the geologists and engineers believe, would that set of unknown parameters -- and these are normally permeabilities, porosities and relative permeabilities, are three of the factors that normally end up in this unknown category or in this history match category -- these must come out in such a way that they pass the test of reasonable judgment of the engineers and geologists involved in the study.

Q. In other words, let's bring this back to the Basin-Fruitland coal pool. What you would like to do is validate this model. If I understand you correctly, you go out and you find a place where you've got a history, as you've called it, where there has actually been data taken out in the field, and there's been a period of time over which events have occurred in the field --

A. Uh-huh.

Q. -- and you go back and you re-create that history in the model --

A. Yes.

Q. -- try to re-create what actually has happened?

A. Yes, that's correct.

Q. And then once you've done that, if I understand what you're telling me correctly, then you have some confidence that the model is capable of re-creating field production, field conditions, field events?

A. That's one thing that you gain some comfort in its reliability. The other thing that you gain is that if there's a field area in the area of interest that you want to study, you also get back some parameters that you might not have known about permeability, porosity and relative permeability, and so that in preparation for the later part of this study, the sensitivity study, you're gaining reservoir characterization information which would be useful in specifying the range of parameters for the sensitivity study, and you're sure that they're connected to real life experiences in the field in the basin, and is -- was this reservoir characterization, you recall, that GRI was very interested in.

Q. And then once you've done that -- I mean, assuming you've got a field where you've actually got enough information that you can come relatively close to re-creating the reservoirs in the computer, am I correct in saying that what you can do then is take that model to an area where you have less information, where you don't have the development activity? Play with some of these parameters, adjust them, modify them, vary them in some scientific way? And then based upon that you can say, "If you find this in this new area, this is what you can expect to happen if you find this combination"?

A. That's a very good description of what we did here between the history matches at Cedar Hill and Tiffany and the approach to the sensitivity analysis we did in each of the three areas.

Q. Now, let me ask you: Is there another witness from ICF who is prepared to testify in more detail about the actual process you've described, the history match and sensitivity analysis?

A. Yes. Genevieve Young is here today, and she performed much of the work directly, and she is prepared to testify about it.

Q. Now, let me ask you kind of in that area just final questions on validating this model: Did you have sufficient -- an area within the field that you could find sufficient information to really test the validity of the model. Did you find an area that you could do that?

A. Yes. There were two areas that we thought we had an adequate amount of information for model validation and calibration. One, as I mentioned, was Cedar Hill. That was done mostly from the publicly available data. And then the Tiffany area, which Amoco Production Company volunteered much of their private data files for our input to the models.

Q. Are you satisfied as an expert in the field of reservoir modeling that, in fact, the model that you used was capable of accurately re-creating, simulating reservoir performance for any given set of parameters within a reasonable range?

A. Yes, I'm confident that it does that correctly.

Q. Now, I think you talked about in terms of doing a history match to kind of test the model and then identify a few of the missing parameters in an area where there is some existing knowledge, and then you said something about a sensitivity study. Would you kind of explain in more detail what you mean? Is that kind of the next logical step in the process?

A. Yes. We were hoping that since we can't history each and every area in the basin, the idea is to create a kind of a methodology or a process, having it grounded in a couple of history match areas that kind of test one very good producing field in this case, which is Cedar Hill, vis-a-vis the Tiffany area, which is not as good a producing area, and to help us describe the band width or the range of parameters that are really key in coalbed reservoir engineering, and to set those parameters in such a way that we ran multiple simulations to see what various combinations of these parameters would produce; and I think those parameters are listed in one of the conclusions to the study; and if I could, I'll refer to those now.

They're under summary and conclusions on page 2, part A, and the data that we thought were key are the well performance data; namely, the gas and water production data and possibly bottomhole pressures if they're available; permeability, meaning both absolute permeability of the coal cleat and relative permeability; the porosity of the cleat system; the coal thickness or isopach maps, if you will; the pressure of the reservoir, meaning both initial pressure and desorption pressure of the sorption isotherm; the gas content at initial pressure and as a function of pressure; the sorption isotherm itself, which gives you that relationship of gas content versus pressure, and initial water and/or gas saturations. And those were felt to be the key parameters that we used in sensitivity analyses in Areas 1, 2 and 3.

Q. And again, is Ms. Young prepared to testify in more specific detail about that, the process and the results that you obtain through that modeling?

A. Yes, she is.

Q. And in just kind of summing it up, having now done this, what you're able to do and what this report hopefully does is provide the division with a basis upon which they can evaluate any specific application which would affect spacing or other operating regulations for any specific area of the pool. I mean, just look and say, "Okay. Does it make sense compared to what this study did?"

A. Yes. That's correct.

Q. And I don't mean to imply, and is it also correct to say that you're not suggesting that this report tells us what the spacing should be in any area, but rather gives us a tool to review specific cases?

A. Yes. What's meant by the report is a methodology by which to reach that decision; and when it's combined with the operators' economics and so on to be useful to them, and second, for the commissions in providing a kind of an umbrella of sensitivity results over each of the three areas that the commissions can refer to to see if everything seems to be logical when an applicant appears before them.

Q. Now, you talk about the results over the three areas, and we have the -- in fact, we might put up Exhibit 1 again -- do we have that available -- which is the map of the three areas, and I think we've had some discussion. Mr. McBane testified that these are kind of broad areas based upon some major geological considerations.

Is it correct to say that based upon -- from your understanding of the results of the sensitivity study that you can point to some broad results in a given area, but that doesn't indicate that that area is necessarily appropriate for one spacing or another, based upon those results; is that correct?

A. Well, I think that's a correct statement. There is quite a bit of variation in the reservoir properties, even within these areas, so one might expect to see differences even within these general areas.

Q. So they could be what you'd call an Area 1 characteristic in Area 3?

A. It's possible.

Q. Is there anything else you would like to add about the method of study and how this study was performed, without going into the details that Ms. Young is prepared to testify about?

A. No, I don't think I have anything else that needs to be said about the methodology. I did notice one housekeeping thing which I would like to correct. I noticed in the list of participants, somehow Mobil Exploration & Production was left out, and we don't know why that was. Our word processor ignored them. We will provide an erratum for that.

Q. Now, let me ask you: As far as the report itself, there is a tab labeled "Technical Approach." Does the information behind that tab essentially describe what you've talked about here as a written narrative of the process?

A. Yes. What I've tried to go through here is basically listed on pages 4 and 5. You'll notice on 5 the major headings are: Model Validation, Reservoir Characterization and Sensitivity Analyses. Those are basically the subjects we've been discussing here, and this verbiage goes directly along with my testimony in that area.

Q. Okay. Is there anything further you'd like to add, then?

A. No.

MR. STOVALL: I have no further questions of Mr. McElhiney.

EXAMINATION

BY EXAMINER CATANACH:

Q. Besides the reservoir simulation approach, are there other methods that can be utilized to determine how much a gas well in this reservoir can drain or how the drainage if we --

(Discussion off the record with the reporter.)

Besides the reservoir simulation approach, are there other methods that can be used to determine the area of drainage for a specific well in this pool?

A. The normal procedures that would be in parallel with a conventional gas well would be methods of analogy; in other words, if my neighbor has got a certain performance in his well and has some history, can I assume that, you know, if my reservoir properties are like his, then I could assume that maybe my performance is going to be pretty close to his. That might be one way that it could be done. Although, I must caution you that the parameters change over short distance sometimes, so you have to be careful how you apply analogy. I'm not prepared to say how far is too far, but only to say that, you know, there are some possibilities there.

The normal approaches of decline-curve analyses and that sort of thing are difficult because of this inclining rate curve that you see for the gas production rate. And so far as we know, no one has yet developed, you know, a decline-curve-type analysis that would apply to the declining portion.

It appears to be, you know, some kind of hyperbolic behavior, but it's not entirely clear at this point whether that kind of a method would work or not. I have not seen any technical articles on that. Volumetrics work in the sense that you can calculate from the tons of coal and the gas contents, you know, what's in place; but then you have to figure out how to distribute this rate curve over time; again maybe some combination of volumetrics with peak gas rates and so on, you might be able to, you know, construct some kind of a rough approximation of a rate curve.

But there are not, you know, the wealth of information and background that we normally fall back on in conventional gas resource evaluation, and it's because of this peculiar desorption physics and this negative incline curve and the fact that it starts out as a water well and ends up as a gas well, because, you see, it's a multiphase behavior that's going on in the reservoir, and those are difficult to estimate by any simplified means.

Q. If a given operator were to come in with his own application for specific spacing in his own area, what would you anticipate his needing to bring in in terms of data to support his position?

A. Well, I think any of the data that he can bring in that conclusion item that I quoted from, the more of that that he can demonstrate, I would say the better off his chances are of being able to make, you know, the right spacing request.

Q. Assuming he does bring in this data, how would the division utilize the data and your reservoir simulation model to determine that this spacing might be appropriate for this area?

A. Well, hopefully from the data that he brings you and the umbrella or spread of reservoir parameters that we've given you here in the sensitivity analysis section, you'd be able to find a place where we had pretty closely bracketed that set of parameters so that you could get to these tables and maybe these figures and find a similar kind of performance.

MR. STOVALL: Mr. Examiner, if I might --

Would it be fair to say, Mr. McElhiney, that as Ms. Young gets into the testimony more specifically talking about this, that that would become -- what you've said will make more sense?

THE WITNESS: Hopefully that's true, yes.

EXAMINER CATANACH: I believe that's all I have at this time.

Are there any other questions of the witness?

MR. KELLAHIN: Mr. Catanach, might we have a moment of recess standing in place, and let me ask my clients if there's any questions they want to approach?

(At 11 a.m. a recess was taken.)

MR. STOVALL: Mr. Examiner, on the record now, I'd like to kind of review the discussion that we've had off the record. The first question has to do with the issue of cross-examination. I've advised all the parties appearing in this case that it is the committee's intention to have Mr. McElhiney, and Ms. Young and Mr. McBane and Mr. Busch available at the second phase of this hearing for cross-examination, if they'd like the opportunity to review the information which is being presented today, and then ask questions about it at that time. And that may affect whether people, in fact, want to ask questions today.

And the other discussion which we had off the record related the date of the hearing and it was generally agreed that the parties would prefer to have the hearing on April 4th, with that hearing dedicated to this case without other cases being docketed for that regular hearing day. There was also some discussion about the location, but that issue there was not a clear consensus one way or the other on that issue.

So with that in mind, I would again make Mr. McElhiney available for cross-examination, if anybody wishes to ask any questions at this time.

EXAMINER CATANACH: Are there any other questions of this witness at the time? There being none -- Oh, I'm sorry. Mr. Chavez.

(Discussion off the record with the reporter.)

MR. CHAVEZ: Frank Chavez, OCD, Aztec.

CROSS-EXAMINATION

BY MR. CHAVEZ:

Q. Mr. McElhiney, on Exhibit No. 5, just to clarify my understanding of what that shows, do I read that correctly in this way, that the more acreage that a well would drain, the longer would be the time before it would reach peak production?

A. If one had a well -- this is for the same permeability, and it's meant to be a schematic on how the well would respond on different spacings and a constant permeability. Yes, the confined well would respond later for a 640-acre-spaced well than a 320, than 160.

Q. So this representation is more of drainage area or area drained by a well rather than density of well spaces?

MR. STOVALL: Let's clarify that, Mr. Chavez. I believe what -- if I understand the way you've done this, Mr. McElhiney, is it correct to say that you're assuming that the well that's illustrative in this case is surrounded by other wells, because you're talking about the interference effect; isn't that correct?

THE WITNESS; Yes, that's correct.

Q. (By Mr. Chavez) Okay, then, so the difference in time to reach the peak is relative to interference from other wells --

A. Yes.

Q. -- on the spacing?

MR. CHAVEZ: Okay. Thank you. That's all I had on a clarification.

MR. STOVALL: Mr. Examiner, I do have one more question of Mr. McElhiney on the issue of the interference.

FURTHER DIRECT EXAMINATION

BY MR. STOVALL:

Q. Mr. McElhiney, the conventional well situation, you try to avoid interference because if there is any significant interference, it creates a wait. You've got too many wells draining a single area; is that correct?

A. Yes, that's correct.

Q. Is there a waste concern with respect to the interference issue in coalbed methane production?

A. Yes. I said earlier there were similarities and dissimilarities, and one of the similarities is that, of course, you can be too close, even in coalbed wells, even though some interference might be desirable, certainly there is some space in which wasteful, unnecessary drilling would occur; and of course, the other issue which doesn't go away is the issue of correlative rights, and that issue still remains an issue in coalbed wells as well as conventional gas wells.

Q. So if I could, again, just if I may summarize it in my own words to make sure I'm correct, what you're saying is that in the case of coalbed methane, interference may have some beneficial effect in that it reduces the pressure and gets rid of the water sooner and allows the recovery of the gas in a more timely manner and, in your opinion, may also affect ultimate recovery in a reasonable time; but that it also -- there is an issue of -- some of the more conventional issues about drainage and wasteful, excessive wells.

A. Yes.

Q. Those are the kinds of issues that a conservation commission is concerned about; is that correct?

A. That's correct. And it's a very -- it's still an issue that, in my opinion, is in its infancy. It's a very controversial issue. Certain people on our Coalbed Methane Committee believe that, you know, it operates in one fashion and other people believe that it operates in another. So we're trying to fairly present the fact that it may or may not have these attributes.

Q. Let me just ask you: To explain what you're saying, is if we look at -- we're relying on two things: rate of production and total recovery; would that be correct?

A. That's correct.

Q. And am I correct in saying that it's your opinion, and speaking for yourself as a reservoir engineer who understands what's going on, that interference up to a certain point -- and you're not specifying that point, will improve the rate of recovery; is that correct?

A. Yes, I believe.

Q. You'll get more gas out sooner if you can get the water and the pressure out of the rock, out of the coal and allow the gas to come off --

A. That's correct.

Q. -- the formation; is that correct?

A. Yes.

Q. Is it correct to say also that it is your opinion that there may be some benefit to overall recovery, total accumulative production; but again you're not willing to quantify that; is that correct?

A. Well, at this point I think, you know, some quantification is given in the sensitivity analysis in the back of this report. I think Ms. Young is willing to cover those areas. I'm saying in the term of 25 or 30 years, which in my opinion might be a realistic well life in this basin for a coalbed well, that there could be some incremental, recovery improvement due to shorter spacing. Whether or not that recovery improvement is enough when economic criteria are also applied to it to justify closer spacing or not, I cannot testify to that.

MR. STOVALL: I have no further questions.

MR. NITCHER: Mr. Examiner, if I may ask a few questions of Mr. McElhiney.

(Discussion off the record with the reporter.)

MR. NITCHER: Eric Nitcher with Amoco Production

Company.

CROSS-EXAMINATION

BY MR. NITCHER:

Q. Getting back to the modeling, you do feel that it's important to have modeling in determining spacing of the time parameters?

A. I think it's a very useful tool to apply, yes.

Q. And it's my understanding that the testimony is that at this point in time there is not enough information and data available to determine spacing on site specific areas; is that correct?

A. I'm sorry, Eric. Could you clarify?

Q. Yes, I'll clarify. At this time there is not enough specific, measured data available in order to determine spacing on site-specific areas, to go to look to just a little portion of the reservoir?

A. I think there might be enough data in some areas. Some operators may have it in their private possession. I don't know that I have it in mine.

Q. But it's your recommendation that an operator should come in at a later date and present that specific data if he has it in his possession?

A. It seems to me that that would be the most expeditious way to accomplish that, yes.

Q. Would modeling be an important tool for that operator to have in coming into the commission?

A. I think it would be, and I think it ought to be calibrated to some actual production as well.

Q. Are there other models, you know, besides the ICF model which would be a valid tool?

A. Yes, there are a number of models available, either within private oil companies. As you know, Amoco has their own. Arco has their own. There are a couple of models available in the consulting business besides ICF Resources. S.A. Holditch has a gas model, coalbed model; and I believe that Jim Nolen has a modification of his black-oil simulator which can be used for coalbed simulations.

Q. So there are numerous models, then?

A. There are certainly more models than just the one we're describing here, and I presume that they're all adequate in describing the process, yes.

MR. NITCHER: I appreciate it. Thank you.

MR. DEAN: John Dean for Dugan Production Company.

CROSS-EXAMINATION

BY MR. DEAN:

Q. Certainly, those computer models or simulators are not the only method by which you might come up with this additional information. There are other ways to come up with that information?

A. Well, Mr. Catanach and I had that discussion a minute ago, and other than analogy of a producing well on a very nearby property, the standard methods of material balance, ARPS decline curve analysis --

(Discussion off the record with the reporter.)

A. "ARPS," A-R-P-S, "decline-curve analysis," and to a limited extent, volumetrics are not as applicable in coalbed methane as they are in conventional reservoirs, simply because the coalbed well behaves under a different set of reservoir physics than conventional reservoirs do; and as you probably know, those methods were developed specifically for analysis of more conventional gas production reservoirs.

Q. It was your testimony earlier that private individuals might have information within their possession, though, that would make site-specific --

A. Certainly --

Q. -- spacing available.

A. Certainly possible.

Q. What type of information would that be?

A. Well, I think, you know, probably the strongest indicator of that would be, you know, historical well production on a couple different spaces, for whatever reason it might have gotten that way, might be a very strong indication of what one ought to expect.

MR. DEAN: Thank you.
EXAMINER CATANACH: The witness may be excused.
MR. STOVALL: One more question.
MR. NITCHER: Sorry. Thank you.

RECROSS-EXAMINATION

BY MR. NITCHER:
Q. Historical production, there are other important factors that need to be looked at; is that correct? I've looked at your conclusions. You talked about low performance data, permeability, porosity, coal thickness, pressure, gas content, sorption isotherm, and initial water/gas saturation. Are those also important factors?
A. Yes, of course they are.
MR. NITCHER: Thank you.
MR. STOVALL: One followup question, then I'm through with this witness.

REDIRECT EXAMINATION

BY MR. STOVALL:
Q. Those items that Mr. Nitcher just named that are in the conclusions, is it fair to say that in coalbed methane production, they don't necessarily relate to each other the same way they would in a conventional sand --
A. That's correct.
Q. -- situation?

A. That's correct.

Q. And that will be discussed further with Ms. Young; is that correct?

A. That's correct.

MR. STOVALL: I have no further questions.

EXAMINER CATANACH: Anything further?

(No response.)

EXAMINER CATANACH: This witness may be excused.

MR. STOVALL: Mr. Examiner, my next witness is really going to be the heavy-duty one. We've now had the introductory material. We're really getting into the meat of this report. Given the lunchtime crowds in Santa Fe, I'm going to recommend that we go ahead and break for lunch early so people can get to the restaurants before the crowds and come back at a reasonable hour. I anticipate because it appears that cross-examination may be saved until the next round, that it won't take as long this afternoon as we might have thought because of that.

EXAMINER CATANACH: Mr. Stovall, how long do you have on direct for the next witness?

MR. STOVALL: I anticipate that this witness could be as long as two hours on direct. And there really aren't any logical breaking points early on; there are later in the testimony, but it would be very difficult to start now and break. As I say, I think we gain efficiency by beating the lunch crowd if we break.

EXAMINER CATANACH: Okay. Why don't we do that? We'll break now until about 1 o'clock.

Q. Rest 1 o'clock. He is.

(From 11:35 a.m. until 1 p.m. a recess was taken.)

EXAMINER CATANACH: Call the hearing back to order at this point.

MR. STOVALL: Mr. Examiner, I did indicate before lunch that Mr. McElhiney could not be available if we had the hearing on the 21st of March; however, he has said that if we would like to have the hearing that day, he would arrange a space for us in Maui where he's going to be vacationing. If that affects anybody's decision on which date . . .

Well, now I sort of feel like one of those nightclub acts where, you know, you get the kind of "no name" folks come on first and do the entertainment part, and now we're at the headliner. We're now going to call the witness who is really the true crux of this presentation. I would like to call Ms. Young to the stand. She's there already.

GENEVIEVE B.C. YOUNG,

the Witness herein, having been previously duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. STOVALL:

Q. So then I'll ask you to state your name and where you live.

A. My name is Genevieve Young, and I live in Denver, Colorado.

Q. How are you employed?

A. I'm employed by ICF Resources as a senior associate.

Q. And I'm going to suggest that we move the microphone over this way so everybody can hear.

A. Oh, all right.

Q. Have you previously testified before the New Mexico Oil Conservation Division and had your qualifications accepted?

A. No.

Q. Will you tell the examiner what your educational background is?

A. I have a bachelor's degree and a master's degree in geological engineering from the Colorado School of Mines in Golden, Colorado.

Q. What is your employment history relevant to your qualifications to present the testimony you're about to present today?

A. My initial exposure to reservoir simulation work began in 1974 when I went to work for Intercomp in Houston, Texas. Later in the fall of 1976 I was granted an educational leave of absence where I went to the School of Mines to complete my degree. In 1976 -- or that was in 1976.

In 1979 Intercomp asked me to return upon the completion of my degree, and I remained with Intercomp until 1983 when they were purchased by Scientific Software Corporation. Upon that merger, I remained with the company as the senior project engineer.

I resigned my position in 1984 to return to graduate school, and I actually had a dual enrollment. I completed a master's degree at the Colorado School of Mines concurrently with entering a Ph.D. program at the University of Colorado. That program only got about halfway along before I ran out of money.

I left the University of Colorado, went into business for myself as a consultant in reservoir simulation work, and in 1989 I joined the ICF Resources staff.

Q. So much of this work has been in reservoir simulation and work in --

A. Almost exclusively.
Q. What has been your role as far as the studies or actually in connection with this project for ICF?
A. Well, I performed the history match work for Cedar Hill and Tiffany, and I did the sensitivity analysis for Areas 1, 2 and 3 of the basin under the supervision of the guidance of Dr. McElhiney and Dr. Paul.
I also have played a large role in communicating the results of the work to the committee on a rather informal basis in terms of presentations on a monthly basis and writing memos, reports and that sort of thing.
Q. In connection with that work or as a result of that work, have you actually prepared written materials to convey the results of your studies to the commission or to the committee?
A. Yes, yes, I have.
Q. Are those results of your work contained in Exhibit A, which has already been admitted to the record?
A. Yes.
Q. Now, the history match; you mentioned the history match. Is that part of this validation process which Dr. McElhiney described earlier?
A. Yes, it is.
Q. What is the objective of the history match

studies that you've talked about?

A. Well, in addition to the model validation role that the history matches fulfilled, we also were looking to obtain information about the reservoir properties at site-specific areas in Cedar Hill and Tiffany, provided information in those area.

Q. Why were the Cedar Hill and Tiffany areas selected?

A. Well, primarily the two areas have a long production history which lends itself well to history-matching work. Cedar Hill, specifically, there was an abundance of information available in the public domain which was part of our charge, was to complete that history match from data available in the public domain.

Tiffany was very generously provided to us by Amoco. They provided us their private data so that we could construct a reasonable model and do that history match result.

Q. As a result of -- Let me back up and try that one again. In other words, what you're saying is these two areas, one of the criteria that resulted in their selection was the availability of data; is that correct?

A. Yes.

Q. What about, if you will, their producing characteristics? Are they different?

A. Yes.
Q. Does that help in making --
A. Yes. Cedar Hill is an extremely good -- a very highly productive area. Tiffany, on the other hand, has a lower level of production, and it was anticipated that they would provide information across a band width of coal properties, Cedar Hill giving you maybe the higher end, and Tiffany giving you something towards the bottom end --
Q. That is to --
A. -- in terms of level of production that may be indicative of the type of the coal properties that you might expect.
Q. In other words, now taking from Dr. McElhiney's testimony this morning, talking about what modeling is all about, and looking at it from your actual implementation of the model study, what you're telling me is that we talked about putting variables into the system and then adjusting those variables. I assume that has to be done within some sort of reasonable range; is that correct?
A. Yes, yes.
Q. Were you able to, using the Tiffany and Cedar Hill areas in the history matching, establish a range?
A. Yes, a range that the committee was quite comfortable with for characterizing Area 1 at the basin.
Q. Now, let's actually start to get into what you

really did out here. Would you please explain -- or what is the geologic work? How did you identify the areas? What information did you get in order to define the areas that you studied? Would you explain the process?

A. Okay. The process can probably be -- a slide that might help me has been labeled CMC Exhibit B, and it's entitled the "History Match Procedure for Cedar Hill and Tiffany Field Areas." This sort of --

Q. Excuse me, just a minute. Just so everybody knows where we are -- I think, actually, it's in that packet that actually has Exhibit C on the top of it, and Exhibit B should be in there, a copy of it on the screen.

Would it be helpful to turn off the lights, or would you rather make notes?

(Response from the audience.)

Q. Okay. Now, we've got this Exhibit B on the screen and in front of you. Can you now explain what you did, what the procedure was?

A. Okay. The procedure was quite similar for both Cedar Hill and the Tiffany field areas. The first step in the process was to define the fixed reservoir parameters. Those parameters that the committee felt very comfortable in defining those two areas, variables that we would not use or adjust in the history matching process, and that involved constructing a geological model and a reservoir model.

And then from there we defined well operation, and in both cases, cleat porosity, cleat permeability and the relative permeability curves were not very well defined. They were used as our calibration parameters, those parameters that we would adjust during the course of the history match.

Then there's the verification process, just comparing the simulated result with the observed rate data on these wells, and that is a way that we can tell whether or not we're getting close to what we called a "satisfactory history match."

Q. Now, before we get into more detail with respect to this procedure and how you're able to implement it, did you do any geologic work to define the area that we're talking about?

A. Yes.

Q. Would you, please, explain -- would it be easier, perhaps, to use one area?

A. Yes.

Q. Did you do a similar analysis of both Tiffany and Cedar Hill?

A. Yes. It might be easiest to use Cedar Hill.

Q. Okay.

A. Just to illustrate the process and the specific details.

Q. Okay. Now, I believe we have some exhibits on the wall which are also contained in the second volume; is that correct, the second volume of the report study?

A. Yes.

Q. And let's see.

Dr. McElhiney, perhaps, you can go to the wall and point to those exhibits. They are a little bit big to spread out over these chairs, but I think they're -- Essentially, is it correct to say there are similar sets of exhibits for the Cedar Hill and the Tiffany area?

A. Yes, there are.

Q. Okay. Now, we're going to look at the Cedar Hill area and describe those exhibits. Would you start right through the process?

A. Oh, okay. Dr. McElhiney is standing next to Cedar Hill material. Those are, just for reference, Exhibits 48 through 53, and that's Plates 1 through 6. The map that John is standing the closest to is an index map showing the wells that were chosen for well control in the Cedar Hill area.

The orange border is the outline of the simulation grid, and then there's some dark lines there that show the two cross sections that were constructed through the area, A - A' and B - B'. And the long cross sections are hung there. That would be Plates 2 and 3.

And what you can see is these are log cross sections where what we did is, is we tried to pick -- the "Basal" Fruitland Coal is the zone of interest. It's the main Upper "Basal" Coal which is colored in green there and has been correlated across the area. There's a thinner rider coal which is the second -- or the Lower "Basal" Fruitland Coal is the terminology we've used, and it's been colored, I believe, in pink or some color like that.

Now, the cross sections A and B are at right angles to one another as indicated in the cross section, and from that we were able to use the other logs in the area to pick the tops or the top of these two coal layers and to map the thicknesses.

One of those plates over there -- okay, is that the structure map? And again, just for reference, we have included that orange border on all the maps to show approximately where the model area was located.

We've also highlighted the wells that were chosen for the study area, the Cahn being central to model, the grid area, and then essentially there are seven coalbed methane wells within the model area and three pressure monitor wells.

Q. Let's back up and make sure we're clear on this. We're back to the structure map, and that is identified as Plate 4?

A. Uh-huh.

Q. I'm not sure what the exhibit number on that is. Is that correct?

A. The exhibit number on that is 51, Exhibit 51, and that's the top of structure for the Main Upper Basal Fruitland Coal, coal seam.

Q. Which interval -- just -- okay.

A. That's the green one there that you see in the two cross sections.

Q. Then you say -- you talk about the orange block being the grid block, is that the modeling grid block? Is that what you're talking about?

A. Well, it's the grid area itself. The details of the grid we can show in a minute.

Q. Okay. Now, you referred to the Cahn well. Is that the --

A. The Cahn #1 well is the central well in the grid area.

Q. And is that also, do I see correctly, that that's the well through which both cross sections and which the cross sections intersect? Is that correct or not?

A. Well, they're --

Q. I'm trying to figure out from where he's pointing there.

A. Yeah.

Q. Okay. Now, it's gone -- you start here, you've got your next map and the structure map. What are the other two?

A. Okay. The other two plates are Plate 5 and Plate 6, which are Exhibits 52 and 53. Exhibit 52 is the isopach map for the "Upper" Basal Fruitland Coal seam, and that was mapped on the basis of a 1.75 grams per cc cutoff on the bulk density log. In a similar way Exhibit 53, or Plate No. 6, is the isopach map for the lower member of the Basal Fruitland Coal.

Q. Now, looking again at the orange block, your model area or model grid, why is that oriented in the direction that it is oriented?

A. Okay. The reason that it's been rotated off of due north was, as we had information on the Mesa Hamilton well, oriented for analysis work, that was part of a resource program funded by GRI; and that well is approximately two miles due west of the Cahn well, and it suggested that the face cleat orientation was between 40 and 50 degrees west -- I'm sorry -- east of due north.

So what we did is we rotated the grid so that we'd have the ability to model a preferential flow direction in the grid, so that just -- we can go through the details once another exhibit is up here, but it turns out that the Y-direction in our grid then parallels the face cleat direction and the X-direction in the grid parallels the butt cleat direction.

Q. Okay. One more quick question before we get further into the grid thing. Now, we talked about the isopach layers 1 and 2. Would you tell us which layers those are as represented on that cross section for Cedar Hill?

A. Okay. I was going to say they're colored up here, but in terms of labeling on the cross section, one says the "Upper" Basal Fruitland and one says the "Lower" Basal Fruitland. Those are the two model layers that we used, or the two coal seams that we used as model layers.

Q. On the cross section, then, what is the area that I see, an area marked in orange or something on the upper --

A. That was an additional correlation that was made to assist in developing a geological model through the area.

Q. Okay, but that's not something that's relevant to the balance of the study; is that correct?

A. No, not specifically, no.

Q. Now, you indicated that you have another exhibit that indicates in more detail how the grid blocks are oriented.

A. Yes, I think it would be appropriate to put up Exhibit No. 22, and it shows the actual model grid that was used to do the work, and for convenience the section lines have been placed on the grid so that it's easy to see where due north is and provides a scale for what we're looking at.

And as you can see, the Cahn #1 well sits in the central part of the area. The seven coalbed methane producing wells that were included in this area are: the State BX, State BW, Schneider 1S, the Ealum, the Keys and the Wood wells. The three pressure monitor wells are: the Leeper, the Schneider B1 and the Cahn #2.

Q. Now, just for reference, just to make sure we're all looking at the same thing, the production wells are the hexagonal gas well symbols?

A. Yes.

Q. And the monitor wells are the square blocks around the wells; is that correct?

A. Right.

Q. And to make sure that I know this, what we've got on Exhibit 22 is you've got the blocks going up and down. If we took one of those, one of your plates over there and just simply turned it so the blocks are going up and down, that would be comparable orientation; is that correct?

A. Exactly. And it might be a good time to clarify, since it wasn't on the screen when I was mentioning it: the face cleat direction here, then, is this Y-direction in the model, and the butt cleat direction is the X-direction in the model as shown on this Exhibit 22.

Q. Now, over to the right of that set of exhibits that we just looked at on the wall, is that a similar set of exhibits for the Tiffany area?

A. Yes, it is. There's also a cross section A - A' and a B - B' for the Tiffany area, and they're located on that index map that John is pointing to; and again the orange square there represents the area that was modeled, and we also have a structure map and an isopach map constructed in a similar fashion as the process we used at Cedar Hill.

The other plate up there -- let me tell you which exhibit that is. That's Exhibit 75. What it does is it shows where the grid area is located. Now, John, down, diagonally. No, right there. There you go. It shows the character of the coal across the area that was modeled. And what we chose to do, this was a simplification that Amoco suggested that would be appropriate as to handle Tiffany as a single-layer coal, although there is some separation of the Basal Fruitland coal as you get towards the southeast edge of the grid.

Q. Okay. And then you've got the -- and then in this case, you actually have the two cross sections on the same piece of paper; is that correct?

A. Yes.

Q. Now, let's go back to Cedar Hill, and starting with some detail about the analysis, perhaps we can get the history match procedure slide back up as well and keep Paul busy here, jumping back and forth between overheads as we look at the plates.

You kind of gave us an overview of the procedure as you've described it. Why don't we start at the top and go through the process here? You talked first about defining fixed reservoir parameters. Do you want to start with that?

A. Yes. Essentially, the geologic model, what was done -- just to finish that off, is this Exhibit 22, this grid drawn on the exact same scale as the maps, is -- in case anybody is not familiar with it -- is on a transparency, and it's laid on the top of the structure in the isopach maps; and for the center of each of the grid blocks, a value for the elevation of the coal seam is digitized off and a thickness value for the two coal seams that were modeled are digitized so that when the geologic model is incorporated into the simulator, it represents the geology as mapped in the plate.

Then the next phase is -- probably an appropriate slide for this would be Exhibit 16, and it provides a summary of the reservoir parameters, the fixed reservoir parameters, that were used in the model.

Q. Let's stop and take a look at that now. We're looking at Plate 16, and I see -- just describe how they -- excuse me -- Exhibit 16. Let's discuss the layout and the items of information, what they are so that we know how to use this table.

A. When I say "fixed parameters" on the left-hand side, I'm listing those parameters that some value was assigned or multiple values were assigned. They weren't varied during the course of the history match. Then the center column is the actual value that was used for that parameter, and then the source of the information is summarized on the right-hand side of the table; and where it says "measured" or "estimated," and there's a small number superscript on that, that refers to a reference which is provided on pages 27 and 28 of Exhibit A, where that information was obtained from.

Q. Okay. So if I look, for example, I'm looking at that exhibit and I go down. "Coal Depth" and "Net Pay"

come from actually the plates that are on the wall; is that correct?
A. Yes.
Q. And you've assigned a value for each of the cells in the model or cellblocks --
A. Right.
Q. -- or whatever you want to call those?
A. Yes.
Q. Now the initial pressure I see that that's measured, and I can go to item No. 5 on page 27 and that tells the source of information; is that correct?
A. Exactly.
Q. Now, these fixed parameters, the ones you've described as not being varied, those are known parameters. I mean, you didn't just arbitrarily come in and fix them and say, "We're not going to move these"; is that right?
A. No, that's information we were able to glean from the public record, and they were not varied during the course of the history match.
Q. All right. Now, once you've got those fixed parameters, what do you need next to start building this model testing, doing the history testing?
A. Well, the next thing we need to do is we need to be able to define how the wells will be operated and how the wells will be brought on or shut in, and the best

way to summarize or discuss that would be looking at Exhibit 17 and Exhibit 21.

Exhibit 17 is just a table that lists the wells that were included in the model area, and one of the columns here is called "Perforated Layers." That says which one of these wells was open to the Upper Basal Fruitland Coal seam only and which one of those wells were open to both layers; and as you can see from the table, there were three wells that were dual layer completions.

I also have a column called "Well Control," and all that means is it says what the classification of the well is or how I operated the well. For example, Cahn Gas Com 2 and Schneider Gas Com B-1 are both pressure monitor wells, which means that they were completed -- or used in the model as nonproducing wells, and they were there just to monitor reservoir pressures.

Q. Now, let me stop you right there and make sure I understand. In the field these were actually pressure monitor wells too; is that correct?

A. Yes, these are re-completed Fruitland wells and they were re-completed for the purpose of monitoring pressures, formation pressures, in the Basal Fruitland coal in the Cedar Hill area.

Q. Now, each of these wells that you've got listed on this Exhibit No. 17, those are actual wells that have a performance history of some sort, something against which you can test the model; is that correct?

A. Yes.

Q. Why don't you just briefly explain what Exhibit 22 -- or 21 is, I guess, in comparison to 17?

A. 21. Well, in a way, the way you would view it is the column off -- the two columns off of Exhibit 17 entitled "Simulation (Days)" and "Calendar Date," it has to do with when the wells -- when we first had production data reported on the wells.

And if you look at Exhibit 21, it's sort of a graphical or a schematic showing when these wells came on, and the simulation period that we looked at is from May of 1977 through December of 1985. That corresponds to a simulated production time of zero days being made of '77, and through the end of December 1985 represents 3,167 days of simulation time.

And then it shows -- the wells are listed, the well names are listed down the right-hand side of Exhibit 21. The pressure monitor wells have a slightly different shading in the bars, and it shows when they started monitoring pressures -- well, respective to which well we're talking about. For example, Cahn 2 and Schneider, both started monitoring pressures in July of 1979 or 822 days of simulation time.

Q. So what this really is is just a graphic depiction of the overlap -- time overlap of the operation of these wells?

A. This is sort of an important thing to keep in mind when you're modeling because you want to make sure that you bring your wells on at the appropriate time, and operate -- operate those wells at the appropriate periods of time.

Q. Now, perhaps, we could have Exhibit B back up again for the moment, and what you're talking about here is the defined well operation and scheduled aspect of that procedure?

A. Yes, right. The second component to that is that when you're doing the simulation work, you can specify -- there's a variety of ways you can operate these wells, and what we've done at Cedar Hill is a combination of two things. Where we could, where the water rate data was as complete as -- where it was complete in the public record, we actually specified the water rates that were reported to the state of New Mexico for those wells.

Where the water rate data was questionable or incomplete, we placed the well on a bottomhole pressure schedule, and that is indicated for the Cahn and the Wood well as FBHP on Exhibit 17. That is the information that we used to operate the wells during the simulated period.

Q. Now, it says here actually, it says "Gas/Water Rate." Is that either/or, or is that a --

A. Yes, either/or. As an example at Tiffany, instead of using water rates, we used gas rates primarily, so it's just one or the other.

Q. Why would you use water rates in this? I mean we're talking about gas wells, aren't we? Why would you use a water rate?

A. Well, in this particular case, we just opted to use water rates. We could have used gas rates.

Q. As an optional thing? There's no --

A. The water rates initially were high, and we opted to use water rates, but there's no reason why gas rates couldn't have been used.

Q. Now, once you've divined these fixed parameters and established your well operation and schedule, again, as I understand what you're saying, is you're repeating history in the simulator, in the model, is that right, in these first two steps? You're reconstructing history that you already have?

A. Yes, yes.

Q. What's the next step in that? What do you do? That next appears to be adjust variables?

A. To refer back to Exhibit 16 or the Exhibit B that I believe is up on the screen. The particular variables that were not well defined in the literature for Cedar Hill were the cleat porosity and permeability and the relative permeability curves, so those were the variables that we used to -- We adjusted those.

We'd make a run, making some estimate of what we thought those properties were, and then we would compare the simulated results, production volumes, with the observed volumes; and as we got closer, we became, you know -- that's how you improve on this adjustment.

Ultimately when you get what you would call a "satisfactory match" between the observed production volumes and the simulated production volumes, it indicates that you are nearing a reasonable description of these three parameters that are being adjusted.

Q. Were you able to get a satisfactory match?

A. Yes, one that we were quite comfortable with.

Q. That would be illustrated in a series of exhibits. The first two that I would like to look at or would like to talk about are Exhibits 28 and 29. What these two exhibits show is water production rate and gas production rate for the Cahn well, Cahn #1 well, where the solid lines are the simulator results and the open circles are the observed rate data that was reported to the state.

Now, this particular well, if you recall, has been operated on a bottomhole pressure, so neither one of the observed rate data was not input into the simulator; a bottomhole pressure was used. Therefore, as the simulator, as the solid line gets closer to open -- to the shape and the general shape and level of production as indicated by the open circles -- it tells us that we're getting closer in terms of the reservoir properties used around the Cahn well.

To move on to Exhibits 31 and 32, in a similar way, these are gas and water production rates for the Schneider B-1S well. Now, in this particular case, this well was a single-layer completion. It was only being produced from the Upper Basal Fruitland Coal seam; and we digitized the water rates in this case, that's why the solid line tracks the open circles so well. And then what we did is the comparison that you see between -- on the gas rate between the solid line and the open circles indicates what we considered to be a satisfactory match.

Again, the final well I would like to use to illustrate that process is the State BW-1 well with Exhibits 34 and 35. Now, in this case this is a dual layer completion. This well was producing from both the upper and the lower coal seams.

Again we used the water rates. We digitized off the water rates, and the solid line tracks those open circles very well, and the simulator -- the solid line on the gas rate curve indicates what the simulator is doing relative to the open circles which are the observed data; and on the basis of working our way through all seven of these wells in the same way I've just talked about here, we decided that we were -- we had what we call a "satisfactory match."

Q. What about the -- you say you had three pressure observation wells in there. Were they useful in this process?

A. Oh, definitely. They were sort of the checks and balances on the system, because they're not sitting -- they're sitting in very -- well, let me go back to Exhibit No. 22; and we can see where these three pressure monitor wells are sitting relative to the coalbed methane production wells in the area, and you can see that the Cahn #2 is offset from the Cahn #1 well by something over 900 feet or so.

Now, if you look at Exhibit 37, this shows -- the solid line indicates what the simulator was seeing for pressure at that Cahn #2 location as compared to what the open circles or the observed data that was reported to the state; and as you can see, it's an extremely good match.

In a similar way, Exhibit 38 shows the same simulated versus observed data on the Schneider B1 pressure monitor well, which is shown in Exhibit 22, and it's -- only it's less than 400 feet offset from the Schneider 1S well. And again, the pressure -- what the simulator is showing relative to what was observed for that pressure monitor well is extremely good.

Now, last --

Q. Let me ask you, just to make sure we understand that. What you're saying is that all these things are interacting in the simulator, supposedly, as they should in the field, and you didn't adjust the simulator with respect to these wells except as you adjusted those variable parameters; is that correct? These pressures are all what happened in the simulator to the well?

A. Right.

Q. Okay. And you had the third well; is that correct?

A. The third well is the Leeper Gas Com B-1 well. That's Exhibit 39. It shows the simulated result versus the observed pressures. As you can see, the pressures were not -- they didn't start measuring pressures in this well until rather late in our historical period. And that well on Exhibit 22 is setting between the Keys and the Ealum well slightly off to the east there.

Q. Now, as I go back to Exhibit 16 and look, I see you're talking about your source for porosity and permeability; is that where I go to find out the results, what characteristics that you identify for the wells in those variable parameters?

A. Well, that's the result of the final history match on the range of parameters -- the range of values that were determined for porosity, permeability and relative permeability curves. Since they are the results of the history match, they are shown in the exhibits where the information is summarized, is tabulated in the far right-hand side under the "Source" column.

Q. Why don't you just summarize, then, using those exhibits what you did learn about those reservoir properties about which you did not have a lot of information starting out?

A. The tabular results are shown in Exhibit 18, and I'd like to also direct your attention to Exhibit 25. As indicated in Exhibit 18, what we've done is, is for each model layer, we've tabulated the porosity and the geometric mean in the permeability, for the cleat permeability, just for the locations, for the individual well locations.

Now, Exhibit 25 is a little bit more complete in that it shows the distribution and the modifications that were being made to the grid blocks. So that as an example, the Cahn #1 well, which sits in the central part -- it's on Exhibit 18 -- it indicates that a quarter of a percent of porosity was assumed and that the geometric mean and the permeability was 6.9 millidarcies with 4 millidarcies in the X-direction, or the butt cleat direction, and 12 millidarcies in the face cleat direction.

Now, looking at Exhibit 25, you see that that patch, the area that's affected by those values, is larger than the one grid block that the Cahn well is completed in.

So to put the whole story together you need to look at not only the results summarized on Exhibit 18, but also we have for Model Layer 1 the face and butt permeabilities. The distribution of those permeabilities are summarized on Exhibit 25. Exhibit 26 are the face and butt cleat permeabilities for Model Layer 2, and Exhibit No. 27 summarizes the distribution in cleat porosities for Model Layer 1.

Now, I'd like to emphasize that this is the result of the history matching process. These are not measured values. They're simulated values.

Q. But do you have confidence in those simulations because of the matches you were able to get that you talked about before?

A. Because of the match on the production data and the three pressure monitor wells, we had a -- there was a strong level of -- I mean a very high level of confidence in the results.

It's also, bear in mind, that when the results were presented to the CMC, they also expressed a comfort level with the values that we were coming up with for coal properties in the area based on their actual field experience.

Q. Okay. I think that's an important point, that as you ran these simulations and got results, you then presented it back to the steering committee or the study committee --

A. Yes.

Q. -- and they looked at it and said, "That makes sense in the real world"?

A. Well, based on their experience and what they're seeing in the field, their own independent studies, too, they were able to come back to us and say "That's consistent with what we're seeing. That gives us confidence in the model to performance."

Q. In other words, the rock is -- the rock is looking like what the model says it should; is that what you mean?

A. That's a good way of saying it, yes.

Q. Now, in addition to those rock properties and reservoir properties, were you able to learn anything about reservoir performance as a result of this history matching?

A. Yes.

Q. Did you have exhibits that can discuss that?

A. Yes. I'd like to start off with Exhibit 40 and Exhibit 42. During the course of the history match, we were able to look at what was happening in terms of -- aerially within the area that was being modeled. And what we saw, what these two slides summarize here, is the Cahn well had been producing for about -- on and off for about a four-and-a-half-year period before the Schneider and the State BW wells were produced on line.

Exhibit No. 40 shows the Cahn producing as an unconfined well without any kind of interaction with the State BW or the Schneider well. Alternatively, Exhibit 42 shows about 60 days of production from the BW and the Schneider wells, and it shows what the simulated gas pressure was looking like in the reservoir at the time.

Now, as we -- we have the ability with the simulator to look at these types of maps, every single time step that is taken every day throughout the simulated period, and what we saw was, is we saw the potential for an interaction between the Cahn well and the BW and the Schneider wells.

Now, looking at Exhibits 41 and 43, as a result of the pressure drawdown that we were seeing in the central part of the field from this cluster of wells that I've identified here, the BW, the Schneider and the Cahn well, these simulated maps or these maps show the simulated gas saturation that resulted from the pressure drawdown.

And looking at Exhibit 41, what you see is, is you see approximately somewhere between 7-1/2 to 9 percent gas saturation developed around the Cahn well.

In Exhibit 43 with approximately 60 days of production from the State BW and the Schneider well, you see that that gas saturation has increased fairly rapidly towards and is now involved in the BW well and is very close to the Schneider well. So you have fairly good -- very good development of the free gas saturation in the cleats as a result of this interaction.

Q. Now, again, as I was careful to point out this morning to this morning's witnesses, I'm not an engineer. I don't understand this stuff, but when I look at this, particularly when I look at, say, Exhibits 40 and 42, and I also see a similar type of pattern in 41 and 43, it appears that there is -- the effect seems to be going towards the top of the grid block which would be towards the northeast, I guess, the northwest; is that right?

A. Yes. There is a grid boundary effect here, and it's most readily seen in Exhibits 41 and 43; and what this is, is the gas saturation that is developing as a result of pressure drawdown, these high gas saturations in -- if you would look to where it says, "Y 1," "X 1," up in the northwest corner of the grid -- part of that gas saturation development is because it doesn't have the ability to move on up depth beyond the limits of the grid. So the involvement up there around the BX well is, to a certain degree, a grid boundary effect.

Q. Would I be correct or incorrect in interpreting that that would indicate the kind of orientation of the -- confirm the orientation of the cleats and that the permeability effects would be working in that direction?

A. Well, the elongate nature of the gas saturation is a combined effect of the preferential face cleat direction, which if you're looking at Exhibit 41, that's parallel to the Y-direction. It's also got a structural component to it in that the structure is elongated that way as well, so there is some structural control over the development of the free gas, or where it's distributed.

Q. Now, we heard Dr. McElhiney talk this morning about the interference effect and his belief that it has some beneficial effect. And do I hear your saying that is some interference effect showing up in this, and can you say more about that?

A. Yes. As a result of what we saw in these pressure and gas saturation distribution plots, we asked ourselves: Is there any way to try to determine whether or not the interaction between these wells was detrimental or beneficial during the 8.7 years of simulated history? And to that end, we made a couple of -- we made a couple of runs, and these are summarized in Exhibit 20 and Exhibit 46.

Now, to briefly explain what those cases were, it may be appropriate -- I don't mean to confuse this too much -- it may be appropriate to have Exhibit 22 along with Exhibit 20 just for the moment. The first thing that we did, Case I, is Cahn #1 well is the only producing well in the entire grid.

In other words, we took and left the reservoir description exactly as it resulted from the history match. We ran what we called "Case I" with only the Cahn well producing. Then we ran what called "Case II," which is also in the footnote of Exhibit 20, where the Cahn well is left shut in and the Schneider and State BW and State BX would -- all the other wells are allowed to produce just as they were produced during the course of the history match.

We made those two runs, and what we wanted to try to examine was whether or not if you took -- if you took Cahn out of the problem, and then ran it by itself as an unconfined well, and then if you ran the Schneider and the State also without benefit of Cahn, would they individually show the same level and performance as they had during the course of the history match?

So to go back to a comparison of Exhibits 20 and 46, what we see here is a comparison of the gas rate production resulting from the history match which is the top curve, and what we see also here, the bottom curve is the sum of this Case I with the Cahn only and Case II without the Cahn.

Now, I would like to point out that in Case II, the State BW well and the Schneider were allowed to produce by being controlled by this observed water rate production that we've seen on the two wells. When we presented this result to the committee, it was suggested that that might not be the most appropriate way to view it; so they asked that we reconsider and run the State and the Schneider wells on a bottomhole pressure schedule, which is Case III.

We went back and we made that run, and we summed the results of Case III with Case I, which is the Cahn only, and that is the curve that lies between the history match result and the sum of Cases I and II on Exhibit 46.

Q. Based upon this analysis, are you able to draw any conclusions?

A. The only thing that -- I think what we learned from this is for the 8.7 years of simulated history that we did do is that it appears that there was some beneficial effect from the interaction between the Cahn and the State BW and the Schneider B-1S wells.

Q. Based on that, can you make any conclusions about optimum well spacing?

A. No, absolutely no.

Q. Now, is there anything else that you would like to add about the history match in the Cedar Hill area? Have we pretty well covered it, or is there some additional information that would be useful for understanding -- mostly for understanding the process rather than the details of the results?

A. Well, I think it was an invaluable exercise in terms of demonstrating the ability of the model to satisfactorily match actual field production, and it also gave us a very good insight into the coal properties for that specific area which was later used as input into the sensitivity analyses.

Q. Did you run through the same sort of history match procedure in the Tiffany area?

A. Yes.

Q. Did you have the same sort of data points and data information as far as doing that?

A. Similar. The big distinction here was that Tiffany was provided to us as part of Amoco's private data set so we were provided information, you know, directly from Amoco that they had measured, and that was provided during the course of the study.

And secondly, the other -- the other important difference between Tiffany and Cedar Hill would be that we didn't have any pressure monitor wells in the Tiffany area, but we did have -- most of the wells that were included in that history match had measured bottomhole pressure history on them, once Amoco took over operation of the wells.

Q. Now, I'm looking at the list of exhibits, the summary of the list of exhibits in -- directly behind the exhibit tab in Exhibit A. If I looked at Exhibits 54 through 77, I find comparable exhibits to what we just looked at for the Cedar Hill area?

A. Yes.

Q. So I'd see similar labels, and to go through and do the same evaluation?

A. Yes.

Q. Would you summarize the results of your study in the Tiffany area? Just give us a brief summary. What did you find in the Tiffany area, and perhaps --

A. Well, Exhibit 56 and Exhibit 62 -- Exhibit 56 is again like we talked about in Cedar Hill, the summary of the cleat porosities and cleat permeabilities that resulted from the history matching work, and Exhibit 63 shows, again, the distribution in those -- I'm sorry -- 62 shows the distribution in the face and butt cleat permeabilities that resulted from the history match, and Exhibit 63 shows the distribution in cleat porosities.

Q. Now, if I look at 56, for example, and compare it to 18, they're the comparable exhibits, right?

A. Just a minute. 18. Yes, yes.

Q. All right. Now, did you not tell me at the beginning that Tiffany was actually not as good a productive area, that the production history there has indicated it's less?

A. Less productive.

Q. Less productive, okay.

Did I see, it appears to me that the porosities in Tiffany are higher.

A. They are. They are. They're higher than Cedar Hill in some cases by as much as a factor of 4. Now, cleat porosity, being the water storage term, just essentially what that says is that with more porosity you have more water stored in the coal.

Q. What are some of the other comparisons between Tiffany and Cedar Hill from the study? What did you find?

A. Well, to compare Exhibits 18 and 56, you can see that the cleat porosities at Tiffany are higher than the cleat porosities at Cedar Hill, and the permeability is lower, and in some cases by a factor of 10, at Tiffany than at Cedar Hill.

In other words, if we look at Exhibit 18 we can see that a large section of Cedar Hill was history matched with approximately a quarter of a percent cleat porosity, and a large portion of Cedar Hill's permeability, simulated permeability, is in the 7-to-10-millidarcy range; whereas, at Tiffany, which is summarized on Exhibit 56, the cleat porosities, a large portion of it are 1/2 to 1 percent for porosity, and the permeability, a large portion of it is 1 to 2 millidarcies; and that particular combination of properties just is the -- you know, is why you see a difference in the level of production, gas production, at Tiffany versus Cedar Hill.

Q. As I go look at your isopach map, too, will I find -- I mean, what kind of coal thicknesses are we talking about of the two areas?

A. Well, at Cedar Hill what we saw was, approximately, on the average of about 20 feet of net pay for coal, and at Tiffany we saw on the average of about

40 feet, so we have twice the thickness, approximately; but your level of production at Tiffany is in the range of about one to two hundred MCF per day; whereas, at Cedar Hill you see something closer to a thousand MCF per day for the better wells.

Q. Now, is this where Dr. McElhiney was saying this morning, that those things which -- or that coal production is different from conventional gas production? I mean, there appear to be properties which should lead to better gas production in a conventional sense; is that correct?

A. Well, yeah, that is correct; and then really what we've learned here by doing these two history matches, even though the coal thickness was twice that at Tiffany than Cedar Hill, and the porosity was greater, the permeability -- the combination of factors, you know, more porosity. There was more water present. There was thicker coal. So the way to look at it is the water tank was bigger at Tiffany than it was at Cedar Hill. Okay. There was more volume of water at Tiffany, and it takes longer to dewater it and to get the gas off the coal and start production. It's just these reservoir properties can be tied back to performance of the two areas in contrasting them.

Q. Does that pretty well complete your history matching portion of your study?

A. Yes, for Area 1.

Q. Well, you're not only talking about Area 1, are you? You're talking about more like the Cedar Hill?

A. Well, Cedar Hill and Tiffany field areas are both Area 1.

Q. Oh, they're both in Area 1.

A. Yes, they're both located in Area 1 of the basin.

Q. Having completed that history matching, is the sensitivity study that's in this book, then, go into our having, "We've done this now. Let's see what happens when we start adjusting things," to determine reservoir, to start predicting reservoir in a sense? Is that correct? Is that where we're going, the next phase of what you'd like to testify about?

A. Yes.

MR. STOVALL: Mr. Examiner, we've got about as long on that as we do this. I'm amenable to break or keep on moving.

(At 2:15 p.m. a recess was taken.)

EXAMINER CATANACH: I will call the hearing back to order at this time.

MR. STOVALL: Can I have your attention?

EXAMINER CATANACH: I call the hearing back to order at this time, Mr. Stovall.

Q. (By Mr. Stovall) All right. Ms. Young, we've now talked about the history match, and you've indicated that the next phase of the study was the sensitivity analyses. Would you -- Now, am I correct when we look at the area map, we're now looking at the sensitivity analyses within those three areas that were defined very early in this history; is that correct?

A. Yes, on Exhibit 1, yes. Just to refresh our memories as to how the sensitivities analyses were set up or why we ran them the way we did.

Q. Okay.

A. On Exhibit 1 --

Q. What was the purpose of performing the sensitivity analyses?

A. The purpose was to identify some key parameters and evaluate variations in those parameters and the impact on performance, gas and water production.

Q. And what were those key parameters?

A. The key parameters, the best way to -- I think I'll refer to -- Just a moment. The key parameters were: the well spacing, fracture half-length, cleat permeability, cleat porosity, initial free gas saturation and initial reservoir pressure. Those were the parameters identified by the committee that were the primary parameters that they wanted to look at relative to their impact on performance.

Q. How did ICF approach this analysis?

A. Well, through a multi -- sort of a three-step process. There were three things that we relied very heavily on. Exhibit 15 summarizes the results of some GRI-funded research in Area 1 at the basin.

Q. You've got your partners here puzzled. They're still looking for Exhibit 15.

A. Okay.

Q. But it is in the book, so I think we can go ahead and proceed even without having it on the overhead.

A. Okay. Exhibit 15 summarized GRI-funded research in Area 1 of the basin; and this data was used to help establish the types of parameters that we wanted to look at and a reasonable range in values that we could expect.

In addition to that, we had the results of the history matches which characterize cleat porosity and cleat permeability and relative permeability behavior, so we had that additional input; and then finally, we had the collective experience and the knowledge of the CMC members to provide a reasonable check on what values could be expected in all three areas of the basin.

Q. Okay. Then once you -- having decided that, can you be more specific as to what you really did in terms of the sensitivity analyses? Do you have an exhibit demonstrating that?

A. Yes. The best way to begin probably is with Exhibit No. 82, and that provides an overview of the -- sort of the design of sensitivity analyses. As you can see at the top, Areas 1, 2 and 3 were separated, although to emphasize that the boundaries are complex and not well-defined, we still use this broad subdivision for the basin.

Area 1 was evaluated on the basis of variations in cleat porosity, well spacing and fracture half-length and cleat permeability. Whereas, Areas 2 and 3 we took a slightly different approach. In addition to the well spacing, fracture half-length and cleat permeability, we also evaluated variations in initial reservoir pressure and initial free gas saturation.

Area 1 was the first area that we did the sensitivity analyses on; and as result of that work and the presentation of that result, the committee came back and asked for what came to be called "limited variations"; and on this Exhibit 82 there's a box at the bottom of the column labeled "Area 1" called "Variation Cases."

And what we did in that, in those runs, to a very limited degree -- I mean, they weren't large matrix runs -- we looked at variations in the gas, initial gas content in terms of Langmuir volume and desorption pressure. We also evaluated a second set of relative permeability curves, and we evaluated a third value of cleat porosity.

Q. How did you establish the range of parameters for each area?

A. Well, as I said, primarily we used the results of GRI-funded research that's been conducted in the basin, the results of the history match work and the experience of the CMC members themselves.

Q. Okay. Now, let's go -- Would it be appropriate, then, to, say, go through Area 1 and use that to describe the process and show the results and then --

A. Yes.

Q. -- compare 2 and 3 with that?

A. Yes, that would be appropriate.

Q. Now, in looking at Exhibit 82, I see that you have for each of these blocks on here, you have multiple variables within the blocks; is that correct?

A. Right.

Q. And then you go and adjust those variables in a systematic way; is that a --

A. Yes. Probably an appropriate time now would be to put this Exhibit 83 up, and it shows just for Area 1 how those variables were laid out in terms of the matrix; and you can see across the top that there's two cleat porosities evaluated in the matrix. There's a quarter of a percent, and there's a 3 percent.

Then under each of those cleat porosities, there were three well spacings selected for variations. That was 160, 320 and 640 acres. Also fracture half-lengths of 100, 300 and 500 were selected, and cleat permeabilities ranging from 1 to 50 millidarcies were simulated.

Now, I'll point out before we leave this slide that these boxes that have shadowing in them are the cases that were selected to show as figures.

Q. You mean figures in the report?

A. Right. And we can get into that a little later, but just to point out that on the slide.

Q. And the other boxes, although they may not be shaded, you still did the analysis on them.

A. We did the analysis, and it is summarized in tabular form, but just not included as a figure.

Q. Now, can you show us something which talks about, let's see, some of the input, input variables that you used in the simulator?

A. Yes. Starting with Exhibit 78, is an exhibit for Area 1 only; and just to reiterate, each one of the areas -- area sensitivity analyses are organized in a similar fashion. So although we're -- this summary of the reservoir parameters represent Area 1, there's a comparable table for Areas 2 and 3 also included in this document.

But at the top of Exhibit 78, you can see what the fixed parameters were. The description of the parameters is on the left-hand side of the table. The value that was assumed and held constant is listed in the center column, and then the source of that information is listed in the right-hand column.

Q. And again the superscript numbers refer to that list of sources?

A. Yes, yes. Then the variable parameters, the ones that were selected by the CMC to vary in a systematic fashion are shown at the bottom of the table: cleat porosity, cleat permeability, fracture half-length and well spacing, just as we saw in Exhibit 83.

Q. Would it be appropriate now to go look at the results of that study and see what this sensitivity analyses -- what you came up with?

A. Yes. I think Exhibit 80, there are two pages to Exhibit 80.

Q. Let me just ask you to look at Exhibit 80 here. We've got both pages on the screen. Would you just, initially so we know what we're looking at, describe how Exhibit 80 is organized?

A. All right. At the top of the table, page 1 -- I'm looking at page 1 of Exhibit 80 -- "Sensitivity Parameters" are listed down the left-hand side of the table and across the top of the table; and just to be more specific, down the left-hand side of the column, the first column is the permeability that was varied, the fracture half-length, and then the well spacing.

Now across the top is a cleat permeability -- cleat porosity of 3 percent appears in the central part of the table and a cleat porosity of a quarter percent shows up on the right-hand side.

Now, page 2 is organized exactly the same way. Page 1 is permeabilities of 1 and 5, page 2 is the permeabilities of 10 and 50.

Q. Now, if I understand this correctly, then, what you've done is you've just gone through and just varied one of these variables throughout, and you've gotten this matrix of seeing every combination of changing variables; is that correct?

A. That's correct. The way to view that is, is if we looked at the top half of Exhibit 80, page 1, you can see down the far left-hand column the permeability of 1. You can look in the first three lines, you see that for a permeability of 1 millidarcy and a hundred-foot fracture half-length, well spacings of 160, 320 and 640 were analyzed, and as you move from left to right on the table, you see those results summarized for both cleat porosities that were evaluated.

Q. Now, let's just take it one step at a time so that I can understand this thing. Let's start with the first line. Let's just take the first row across there.

A. Okay.

Q. Now, if I read this correctly, you've got a permeability of 1 millidarcy; is that correct?

A. Yes.

Q. You've entered a fracture half-length of hundred feet?

A. Uh-huh.

Q. And 160 acres spacing?

A. Right.

Q. Now, the next three columns, I see under the heading of "Cleat Porosity = 3 percent."

A. Right.

Q. What do those numbers in those three columns mean? How do you explain those results?

A. The committee felt very strongly -- there's two points of view on how you would represent the results of these runs, and so to provide a balance of the summary of results, they've asked for two types of presentation.

One presentation is on a time cutoff. That's the column entitled "25 Year Cutoff," and under that is a "Gas Recovery," and that value is percent of the initial gas in place recovered at 25 years of time.

Now, next to that there is a column entitled "50 mcf per day Cutoff." This is an abandonment rate cutoff. And what you see is a gas recovery, again as a percent of initial gas in place summarized, and a point in time at which that abandonment rate is reached.

So that literally what you're doing is, is you're saying that once the gas rate falls below some rate on an MCF per day, which has been selected, the committee selected 50 MCF per day as being a reasonable cutoff, rate cutoff. Then what you would do is you'd say, "What are the -- what is the cumulative production at that point in time as a percentage of what was originally in place and what point in time did that occur?" And so that's why both time and recovery are tabulated under the rate cutoff columns.

Q. So in other words, going across there, it would take .3 years before the production reaches that cutoff of 50 standard cubic feet per day, and you only recovered .2 percent of the initial gas in place? Am I reading that correctly?

A. Yes, that's correct.
Q. If you use a 25-year cutoff, obviously you're producing at something less than 50 --
A. Right.
Q. -- and at the end of 25 years, you're only going to produce 8.7 percent of the initial gas in place, right?
A. For this case.
Q. Okay. Now, if I just move to the right, to the next three columns, the only thing that you changed is the porosity from 3 percent to .25 percent?
A. Yes.
Q. And it appears that has a rather substantial impact on the recovery; is that correct?
A. Yes, a significant impact.
Q. Now, if I go down -- if I go down the next line on the parameters, what we've done there is now changed the spacing from 160 to 320?
A. Yes.
Q. And we're talking the spacing. We're assuming again, as Mr. McElhiney did this morning, that there is a well surrounding on each side; is that correct?
A. Yes. All of these cases assume a totally confined well for whatever spacing has been designated. So if you have a 320-acre well spacing, it assumes that

all four offset locations have been drilled and the well is confined.

Q. So now if I go to 320-acre well spacing, again at my 50-MCF-a-day cutoff, it only takes me a third of a year, but I only get half as much. I get .1 percent of the gas, correct?

A. That's correct in this case.

Q. And if I go over to the 25-year cutoff, I only get 3.3 percent of the gas?

A. Right, at 25 years.

Q. At 25 years.

A. And at a rate of less than 50 MCF per day.

Q. Now, again, if I put less hole in the rock, if you will, if I go to a .25 percent porosity, I get some increase there, a substantial increase over the 3 percent porosity, right?

A. Yes.

Q. And there's really -- I mean, these aren't very good wells. What's wrong here?

A. At 1 millidarcy, and only a 100-foot fracture half-length, it would suggest that spacing is not your only problem. You'd better do something to help your well out. Maybe --

Q. Such as?

A. Such as increase the fracture, the size of the

stimulation job. I mean, at a low range of --
(Discussion off the record with the reporter.)
A. Improve the -- increase the size of the stimulation job, s-t-i. Such as if we move down -- assuming again 1 millidarcy and looking at the same two spacings we've just been talking about, the 160 and the 320, and a 500-foot fracture half-length, we can come across; and even at a 3 percent porosity, you see that the recovery now for 25 years has increased to 22.1 percent, and for a 50-MCF-per-day abandonment rate, it's up to 31.4 percent under the 3 percent cleat porosity column.
So the size of the stimulation job for this permeability and for this well spacing, you realize an improvement in your recovery.
Q. Now, that's something that an operator would have some control over --
A. Yes.
Q. -- that would affect it, right?
A. Yes.
Q. Now, say, if we move down to the bottom half of the page, it means we've got a 5 percent -- excuse me, 5 millidarcy permeability. Now, that's more what's in the rock there when you get started, right?
A. A permeability is a characteristic of the coal, and the fracture half-length, of course, helps the near

wellbore condition, but the permeability of 5 millidarcies, you see an improvement in performance over 1-millidarcy coal.

Q. So it appears to be a fairly substantial improvement. As you find more permeable coal, you get substantially more gas out of -- more total recovery and a better recovery at your cutoff points; is that correct?

A. Yes. And to sort of refer back to something that Dr. McElhiney referred to earlier, you can see from this chart, as an example here, 5 millidarcies, a 300-foot fracture half-length, evaluating all three spacings here, 160, 320 and 640, you can see that your gas recovery at 25 years decreases with increasing well spacing, assuming that all these other conditions hold, whether you're at a 3 percent or a quarter percent cleat porosity, although you can see an improvement in recovery in the quarter of a percent cleat porosity over the 3 percent.

The other thing I would like to point out about the way this table is presented is that at a 50-MCF-per-day abandonment rate, you see a convergence in your recoveries under, let's say, a 3 percent cleat porosity.

Your values range at 160-acre well spacing from 54.2 down to 49.4 at 640-acre well spacing; but there is approximately a factor of 2 difference in the length of time required to achieve that recovery where the shorter length of time is 34.3 years at 160-acre well spacing, and increases to 151 years at 640-acre well spacing.

So that's one way in which, you know, the way this information has been presented, you can look at things like that.

Q. It appears, also that if you get to a higher permeability, the greater well spacing, the wider well spacing, actually has less of an impact than it did at the --

A. Yes.

Q. -- early areas; is that correct?

A. That's absolutely correct. As you get up to the higher ranges -- on page 2 of Exhibit 80, you can see up at the 50-millidarcy range for all fracture half-length, 100, 300 and 500, and for all spacings, when you look at it in terms of an abandonment rate, your percent recovery is very close. There's a very narrow range in the data. Although this factor of 2 on the time -- the time in which that recovery is achieved still applies as a general rule; and again, your recoveries in terms of a fixed point in time, still you see the decrease in gas recovery as well spacing increases, but that variation in recovery is being -- is reduced when you compare 50 millidarcies, for instance, with a 1-millidarcy coal.

Q. Now, in this table on Exhibit 80, what you've talked about is the result of a specific cutoff point; is that not correct?

A. Yes.

Q. What if I want to look at, say, look at a range and look over a period of different cutoffs? Is there information in here that would --

A. Well, as I indicated earlier, and just to refresh our memories, on Exhibit 83, the boxes that are shown in shadow are included -- those cases were included as figures. Now, all -- in this case Area 1 had 72 simulation cases run in the matrix. And all 72 runs have been summarized on Exhibit 80 at a fixed abandonment rate or a fixed point in time. But for a few selected cases, we showed production volumes as a function of time. In other words, from the beginning of a simulation through the 25-year period; and I'd like to illustrate there kind of what their format is by looking at Exhibit 88 first and 89 and 90.

Exhibit 88 -- again, this is just for Area 1, but there are similar plots provided for Area 2 and Area 3, and this plot is the gas production for a 320-acre well spacing with the gas production rate plot shown in the top half of the exhibit, and the cumulative gas

production shown in the bottom half of the exhibit.

Exhibit 89 shows the gas recovery for the same 320-acre well spacing.

Now, I should point out that these exhibits reflect certain assumptions, you know, in terms of underlying conditions. In other words, these plots reflect a 300-foot fracture half-length, a cleat porosity of a quarter of a percent; so, I mean, that needs to be kept in mind when you look at them.

Q. Now, the curves that you see are for all four permeabilities that were evaluated in the matrix. The 1, 5, 10, 15 cleat permeabilities, and they're shown as different line types here in the top half of the exhibit.

A. The second thing I would like to point out is Exhibit 90, is the water production rate and the cumulative water production for these same cases for the same range of permeabilities with the same assumptions.

Q. What is that telling you, then? What are you seeing when you look at Exhibit 90 and look at those figures or those lines?

A. Exhibit 90? On Exhibit --

Q. You're talking about the water production, right?

A. On the water production. This is the water production that the simulator predicted would be associated with the gas production shown on Exhibit 88, given the assumptions that we used in the sensitivity analyses.

Q. So if I read, just looking at the top diagram on Exhibit 90 --

A. Uh-huh.

Q. -- the water production rate falls off more quickly at 50 millidarcies than at, say, 1 millidarcy; is that correct?

A. Yes. And you can see how the 50-millidarcy curve, it starts higher early in time, falls off more rapidly. Your 1-millidarcy case starts lower, but doesn't fall off as rapidly.

Now, in accumulative production shown in the bottom part of this Exhibit 90, you can see that on a cumulative basis for this 25-year period shown, that the 1-millidarcy coal will produce less water than the 50-millidarcy coal, given the assumptions intrinsic to the plots or to the cases that were simulated here.

Q. If I understand what you mean, does that mean that because you get more water out sooner, that you get to the gas quicker? Is that what that means, bottom line?

A. Well, when you pull the water out, it provides you the opportunity of getting the gas off the coal.

Q. I assume, then, in this group that we're looking at, you've also got similar exhibits for 320- and 640-acre spacing; is that correct?

A. Actually, yes and no. For a 160 acres, a similar set of plots were provided. For 640 acres those plots weren't provided.

Q. Okay.

A. Not as figures.

Q. Okay.

A. Not as figures.

Q. Now, when I look at this, you've got -- I notice when you talk, for example, the gas production rate, you've gotten a formula there for determining that. How did you arrive at that? How did you arrive at that number?

A. To help explain this, I'd like to refer to CMC Exhibit C entitled "Data Normalization for Sensitivity Analyses Simulation Results." It's one of the additional handouts.

Q. It should be the loose packet that was stapled together and was handed out as part of the exhibit.

A. One of the things that we did with this is the simulator provides us with a gas production rate as a function of well spacing and the assumptions that we made. To attempt to compare performance on a consistent basis, the data was normalized.

And in this particular case, if you look at the top of this data normalization slide, you'll see that the production volumes for wells that were simulated on 160-acre well spacing, all those volumes were multiplied by 4. Whereas, the production volumes for a 320-acre well spacing were multiplied by 2, so that all performance was normalized to 640-acre section basis.

In other words, when you look at these curves, they represent the production from a 640-acre section, and the labels here, like Exhibit 88 being on a 320-acre well spacing, that means there's two wells for that 640 acres that's contributing to this performance data.

The second process in the data normalization was to divide out the number of feet of coal that was used in the simulation work, because average coal thicknesses for the various areas of the basin do vary, so we put this on a per foot of coal basis, and that is the feet of coal section of this Exhibit C for the production volume per 640 acres, was then divided by the coal thickness.

Then a final step in the data normalization was only applied to gas production volumes. And what we did is, is we divided the production volume or the gas production volume per 640 acres per foot of coal by the initial gas content. And in this way, it provided a basis for making the curves more applicable to variations in coal thickness and gas content if somebody were trying to use these curves for part of their own set of circumstances.

Q. So in other words, if I understand what you're saying, in data normalization what you've done is try to get everything so it all fits on the same scale, and when you're looking at two different lines, they have some relevant meaning because --

A. Right.

Q. -- you don't have to --

A. Apples to apples instead of apples to oranges.

Q. Okay. Now, as we look at this, now we know that now these are all normalized, what these represent. How do you use these performance curves? What do you --

A. Well, I'd like to refer to Exhibit CMC D, which is again part of the handout, and use a hypothetical coal problem; and I'd first like to refer to, in addition to Exhibit D, to Exhibit 88.

Now, the assumptions that we'll make, I'm looking at this hypothetical problem, is that again we have an Area 1 coal, and we have 5-millidarcy cleat permeability. We have a quarter of a percent cleat porosity. We're going to assume that the coal is 10 feet in thickness, and that we have an initial gas content of 345 standard cubic feet per ton, and that the well, of course, is drilled on 320 acres. That's why we're going to be looking at Exhibit 88. And we're going to assume that we're looking at this well after its first three years of production.

From the top half of Exhibit 88, you can pick off a gas rate from that curve, assuming it -- using these assumptions at three years of 180 standard cubic feet per day per 640 acres per foot of coal for standard cubic feet per time. Now, the way that can be related to the specific problem we're looking at is we can multiply by our ten feet of coal that we're assuming, and we can multiply by our initial gas content, and we can convert that gas rate reading from Exhibit 88 to 621 MCF per day for a 640-acre section.

Now, the assumption is that we've drilled this on a 320-acre well spacing, so dividing that by 2, we know that we have at three years 5 millidarcies of coal, 10 feet thick, 310.5 MCF per day per well in this per 320-acre well.

Now, in a similar fashion, we can look at the bottom half of Exhibit 88, and we can go through the same exercise on the cumulative production for our hypothetical problem. And if you were to read directly from the curves for the 5-millidarcy curve, that is, it would give you a 160 MCF per 640 acres per foot of coal per standard cubic feet per ton.

When that's converted on the basis of our coal thickness and our initial gas content, it comes out to 552 MMCF per 640 acres.

Now, we can also look at Exhibit 89, and we can get a gas recovery, in other words, a percentage of initial gas in place can be picked off in this particular case at three years and 5 millidarcies. This comes out to be about 14 percent.

Now, I don't mean to make it too complicated, but another way of looking at this would be to pull up Exhibit 79 and look at 79. You can take that same 14 percent recovery, and you can apply it towards the initial "Gas-in-Place" column under the initial conditions, and you can arrive at, again, for the 20 -- for the quarter of percent cleat porosity. There is a 1.15 MMSCF per 640 acres per foot of coal per standard cubic feet per ton.

By taking that number, 1.15, multiplying by the initial gas content, and the thickness we've assumed for our problem, we can arrive at the same cumulative production value that we got directly from the figures.

Q. Well, I guess sort of what you're telling me is by taking these graphs that we have, this information, you can plug it in, you can actually say, "How much gas is there and how much should you get out of that particular well spacing, given the other variables and conditions?" is that correct?

A. That is correct.

Now to sort of continue with the sample problem, Exhibit CMC E sort of answers or addresses the use of Exhibits 94 and 95. I'd like to look at 94 specifically. If you take the same assumptions for our problem, the question might arise: What type of incremental production could I reasonably expect from taking this same set of assumptions and infill drilling my acreage to 160 acres?"

And Exhibit 94 is -- the curves presented here are how you would accomplish that, or how you would answer the question based on the sensitivity analyses. The top half of this figure is a difference in cumulative gas production resulting from having four wells for a 640-acre section, minus the performance of two 320-acre wells on that same section of land. And the data is presented with a parametric permeability; in other words, the curves here, there's a curve for 1 millidarcy, 5, 10 and 50.

Now, in the bottom plot the same difference in gas production is presented, but it's presented versus permeability where the curves are for fixed points in time, being 1 year, 3 years, 10 years and 25 years.

Now, the way you would use a plot like this, referring back to Exhibit E, is at three years of time you could go into the 5-millidarcy curve on the top half of Exhibit 94, and you would read a difference in cumulative gas production of 150 MCF per 640 acres per foot of coal for standard cubic feet per ton.

Now, when this is converted to -- but when you translate this value with your ten feet of coal and your 345 standard cubic feet per ton for your initial gas content, that works out to a difference for the section of land of 517.5 MMSCF for the full 640 acres.

Now, I might point out that the same value can be determined from either the top half of Exhibit 94 or the bottom half of Exhibit 94. Since I've used three years and 5 millidarcies, those curves appear -- both curves appear on this same exhibit.

Now, what that works out to, back on Exhibit E, is 129.4 million standard cubic feet per 160-acre well drilled on this 640-acre section.

To complete the analyses, though, you would have to go to Exhibit 94 and come up with your corresponding water production from this infill drilling question, and then you would have to apply your economic criteria to the problem and then make some decision as to whether or not it was prudent to drill the additional two wells.

Q. Now, you said Exhibit 94 for water. Actually Exhibit 95 is the water production; is that correct?

A. I'm sorry. Yes, you're right.

Q. Would you take the same kind of analysis and say, "All right. How much water am I going to get out of there, and how much does it cost me to get the gas out and dispose of the water?"

A. Right.

Q. That's simple economics?

A. You have the cost side and the revenue side, and all those things would have to be considered before you would proceed with the request or the problem.

Q. Well, if I look at this, looking back at Exhibit E, and using the Exhibit 94 as you've described it, by doubling the number of wells on this particular 640-acre tract, I've increased the cumulative gas production from that 640 acres by almost half a billion cubic feet; is that correct?

A. For the full section, yes.

Q. For the full section?

A. Yes.

Q. But whether it's worth drilling for that half billion cubic feet is something I've got to decide based on --

A. Right.

Q. -- factors which you have not evaluated in this report because, I think, Mr. McElhiney and Mr. McBane said there was no economics considered; is that correct?

A. Well, it's quite specific to the individual operators; but there is one thing I would like to point out before we leave Exhibit 94, or actually two things that I'd like to point out. You can see that this difference that results from infill drilling between the 320s and the 160s, you see that this difference comes up quite high here.

There's a maximum value that appears between -- Well, 4, 5 and 10 -- 5 and 10 millidarcies, it appears somewhere in the first ten years; whereas at 1 millidarcy, you're just starting to hit it out here at about 25 years. Alternatively for a 50-millidarcy coal, you're dropping off here from approximately one year, and you're on a steady decline. So permeability has a great deal to do with this difference and how these volumes are achieved as a function of time.

Q. All right. Again, looking at this from the standpoint of the Oil Conservation Division, it appears to me from this and all the other things that have been said today that one of the critical things that has to be looked at in a spacing consideration is the permeability.

A. That is a very important factor.

Q. Now, important in use of this analysis, if I understand what you're saying, is that for any given specific location, you can find fill-in-the-blanks, find the right exhibit, put in the numbers in terms of gas content, coal thickness, et cetera; and then you can use this as a tool to evaluate specific locations and areas?

A. Yes. And that really, I'd like to emphasize the importance of normalizing the data. It was an attempt to present the results in such a way that it became more readily applicable to other situations. It's your coal thickness, your gas content. These kinds of things can be dropped in which are specific to some area that you're looking at, and then the curves become more readily used in other areas where things did differ from the assumptions fundamental to the sensitivity analyses.

Q. Now, we've basically talked in terms of parameters. The parameters you've really played with have been porosity, permeability, fracture length and spacing.

A. For Area 1.

Q. For Area 1, correct?

A. That's correct.

Q. Are there any other parameters or variables which you've used in Area 1 that you'd like to just --

A. Well, briefly I'd like to touch on -- As I indicated in Exhibit 82, there were some limited variations cases selected by the committee. There were some specific questions that were raised: What would be the impact on performance if we -- you know, if we run into some other values for some of the fixed parameters? We've made certain assumptions. They seem reasonable to us. But if something were to vary, how would that affect performance?

Now, Exhibit 84 sort of breaks apart those variations cases as they were evaluated, and the approach that was taken to the variation cases is this that, well spacing, fracture half-length and cleat permeability were fixed. The values that were fixed, the 320 acres, the 300-foot fracture half-length and 10 millidarcies were selected. That was a case that could be used to vary certain parameters around. So those assumptions are common to all these variation cases.

Now, there's nothing -- it should be pointed out, there's nothing specific. In other words, it was not assumed that this represented an average case for Area 1. It was just a way in which we could vary other parameters, so it was selected.

Then below that you can see that the quarter of a percent and the 3 percent cleat porosities were involved in the larger matrix, and the committee wanted to also see a run done at 2 percent cleat porosity. With Langmuir volume, all the matrix runs were done at 427 standard cubic feet per ton for a Langmuir volume.

We also looked at varying decreasing Langmuir volume to 350 and increasing it to 500 with desorption pressure, which is the pressure at which the gas starts coming off the coal. That's the significance in that, and I should also point out the desorption pressure was assumed to be equal to the initial reservoir pressure as well. So that would be the fully saturated coal condition that was referred to earlier by Dr. McElhiney.

Now all the matrix runs for Area 1 assumed a 1320 psia desorption and initial reservoir pressure. We also evaluated 932 in 1960 variations on desorption pressure.

The last thing that was evaluated in the variation cases was relative permeability. We assumed for Areas 1, 2 and 3 a set of relative permeability curves that were developed by ICF on a prior San Juan Basin study, and they were presented in a Colorado Cause 1-12-73, and this was something that the committee had voted on as being a reasonable looking set of relative perm curve.

Now, what we did is also in the literature. There's a publication by Kamal and Six, and that's listed in the list of references. We digitized the curves that were presented in that publication. They were presented as typical of the San Juan Basin. They were different, and it gave us a sense of how the variations in the relative perm curves would affect performance.

As indicated here, all of these simulation cases are included as figures, and these variations only resulted in six additional simulation cases. The exhibits that summarize the results, without going into the detail, Exhibit 96 through Exhibit 106 of the documents summarized the results of the variation cases for Area 1.

Q. Now, does that pretty well describe your sensitivity analyses study in Area 1?

A. Yes.

Q. And did you perform a similar analysis in Areas 2 and 3?

A. Similar with some variations in it. Specifically, I would like to return to Exhibit 82 and point those differences out without going into the details of it.

Area 1, as you can see here, did not include variations in initial free gas saturation or initial reservoir pressure as part of the matrix, and these are things that were added to the Area 2 and 3 sensitivity analyses design, and this was based on the experience, field experience, laboratory experience, et cetera, from the committee. Those particularly involved in these two areas of the basin.

You'll also notice that the parameters that were selected by the committee don't look exactly like what we did in Area 1. For example, 640-acre well spacings were not evaluated in Areas 2 and 3. 500-foot fracture half-lengths were dropped out of Areas 2 and 3.

The permeability range in Area 2 looks quite similar to that in Area 1. 1, 5 and 10 millidarcies are the same. We lowered the upper range to 30 millidarcies. In Area 3 the range in permeability is .1, 1 and 5. The initial gas saturations and the initial reservoir pressures I would like to briefly touch on.

I said a little bit ago that the initial reservoir pressure in Area 1 was assumed to be 1,320. In Area 2 we looked at initial reservoir pressures of 200 and 300 psi, and in Area 3 we looked at 400 and 650 psia.

On initial free gas saturation, we looked at zero, which would mean that the coal is a hundred percent water saturated. That is exactly the assumption that we made in Area 1. We also -- There's some indication from the GRI-funded work through BEG that there may be free gas saturation in Area 2, so we looked at a free gas saturation of 10 percent.

Now, in Area 3, again, we looked at the coal as though it were a hundred percent water saturated. That would be the zero initial free gas saturation, and we looked at what we call a "dry gas coal," which is the 23 percent free gas.

The 23 percent was arrived at because that is the difference between a hundred percent water saturation and connate water saturation. In other words, what we did was, all mobile water -- I mean there was only connate water in the cleat system, and the rest of the cleat was filled with free gas, so it sort of brackets the two extremes in Area 3.

And fundamentally those are the differences, you know, the comparisons and the contrasts between the three areas in terms of what we looked at in the sensitivity analyses. I'd like to say that the format for presenting the result is similar for all three areas.

Q. Well, let's look at that for a moment, to go back to the list of exhibits, the first sheet after the exhibit tab in the book.

A. Okay.

Q. Again what --

A. Well, you can see that we've gone through many of the exhibits, 78 through 106, for Area 1, and Exhibits 107 through 126 represent tabular results and figures for the Area 2 sensitivity analyses, and Exhibits 127 through 146 represent tables and figures for the Area 3 sensitivity analyses.

Q. Now, based on the sensitivity analyses, what conclusions have you drawn?

A. Well, I'd like to summarize that with Exhibit CMC F. This is something of a simplified form of the conclusions that are discussed in a much greater detail.

Q. Let me --

A. On pages 25 and 26 of the document, there's a section under the sensitivity analyses called "Conclusions," and the conclusions go into a fair amount of detail as to what the figures and tables are, what we were able to learn about performance.

And the slide, Exhibit F, shows that in a simplified way gas recovery increases with increasing initial free gas saturation, increasing initial reservoir pressure, increasing cleat permeability, increasing fracture half-length and increasing initial gas content.

We also saw that gas recovery increases with decreasing well spacing and coal cleat porosity.

Q. Now, you've talked about the conclusions as contained on pages 25 and 26 of Exhibit A. That is behind a tab which is called "Discussion of Results."

A. Uh-huh.

Q. Is the information contained in all of those pages behind that tab, does that summarize, essentially, your testimony that you've given today?

A. Yes.

Q. So having force-fed us quite a bit of information, we do have resource to go to, to come back and try to figure out what we've heard today, if that's desirable?

A. Yes, if it's desirable.

Q. Now, how, again, we started out this whole hearing this morning talking in terms of this study, at least the purposes of everybody's testimony today being for the purpose of giving the division guidance in terms of establishing spacing and operating rules for the pool.

How is this analysis that we've just finished talking about here in terms of the sensitivity analyses, can you just summarize briefly how that is helpful to the division?

A. Well, first of all -- excuse me. I'm getting a scratchy voice. First of all, we've identified certain key parameters which have already been listed or discussed by Rich McBane and are included in the summary and conclusions A on page 2 behind "Overview and Conclusions" of the document.

Those key parameters that were identified were, you know, well performance data, permeability, porosity, coal thickness, pressure, gas content, sorption isotherm, and the initial water or gas saturation. Those are key parameters. When we were able to evaluate the impact those various parameters have on performance by systematically varying over a range of values for these parameters, in that way you can look at, you know, whether you were just -- you had a particular set of properties and you wanted to evaluate what the performance would be, and then to ask yourself what might be the appropriate spacing to develop a coal with those properties on? What that appropriate spacing would be.

Q. Perhaps, restated another way, if an operator were to come to the division with a specific spacing recommendation, are you suggesting, then, that we would -- that it would be best supported if that operator could bring specifically data -- specific data on those parameters, and then this would be a tool by which the division could look and see if the operator's interpretation or its request was reasonable, based upon the parameters?

A. Yes, precisely.

Q. Now, one of the things that I indicated, or at one point we talked about early on, I think it was

Dr. McElhiney, is the fact that what you're doing with modeling is you're attempting to simulate the performance of any given reservoir under certain sets of conditions; is that not correct?

A. Yes.

Q. Now, it seems to me as a paid skeptic, which I think all we attorneys are, that there have got to be certain weaknesses in this. Can you identify what the weaknesses are, specifically in the modeling exercise that was done with this reservoir? In other words, we're looking at it, and somebody tries to use it, what are the weaknesses that we should be aware of?

A. Well, in terms of the sensitivity analyses, I think the only thing that could be regarded as a weakness would be the fact that some of the assumptions that we used in Area 1, the committee felt would be more appropriate to extend to Areas 2 and 3 to maintain consistency.

But the alternative -- the counterbalance using assumptions from Area 1 and Areas 2 and 3, to counterbalance that we normalize the performance data, so that assumptions, like using the same isotherm for all three areas, are -- by normalizing it, now you can bring your own adsorption isotherm information to these curves, apply them. Again, thickness, we may have by choosing an average thickness, we've now normalized that thickness out so that if, in fact, you're in Area 2 and your thickness, coal thickness is half that, we assume it's been taken out of the performance data. So that's -- there's a balance there between making sure that we were consistent in how we approached all three areas and still providing enough flexibility that it had applicability to other problems and other sets of data.

Q. And the decision to transfer the Area 1 parameters to Areas 2 and 3 was made by the steering committee or the studying committee that we identified before; is that correct?

A. Yes, in their view, that was an appropriate thing to do.

Q. Now as I understand, I think at some point earlier it was said there was substantially more information available in Area 1 than there is in Areas 2 and 3; is that correct?

A. Yes, that's true.

Q. Is there any advantage gained? I mean, it would seem to me that if you tried to go in and get specific parameters in Areas 2 or 3, where there was data lacking that that could actually --

A. More harmful.

Q. -- more harmful than good?

A. The committee was very mindful, a[illegible]here were some very long discussions about a concern for making the wrong assumption and then having the results being more misleading than helpful so that at least in part using some information in Area 1 and then the data normalization process -- just don't put something out there prematurely that would mislead.

Q. Mislead in the sense that --

A. That the result --

Q. -- you think you've got more accuracy than you really do?

A. Right. If the input data isn't any good, then the results would be misleading.

Q. Now, when we talk about the cross sections and the geology early on this afternoon, you indicated that there were actually a couple of different layers in there. Did you analyze it in terms of the different layers, or how did you deal with that?

A. Well, specifically when we did the Cedar Hill history match, we used two modeling layers to model the coal. Now, in the sensitivity analyses, very early on it was decided that there really wasn't enough data, and it would have really complicated the problem immensely to use more than one layer, so we used a single layer model to do all the sensitivity analyses.

Q. Given these limitations that you've identified in recognizing that they, in fact -- what you're really saying is that the model is only as good as the information that's available.

A. Uh-huh.

Q. Do you have an opinion as to whether this model is a reliable tool to use in trying to make some reasonable predictions as to appropriate spacing and other well operating -- particularly spacing regulations with respect to the Basin-Fruitland coal pool?

A. When you say "model," I have a comfort level with the simulator itself. Are you referring to the results?

Q. I'm referring to the results, I'm sorry, yes.

A. Results, okay. The results -- yes, I think there is definitely some good information here, and it can be very useful.

Q. And just a question, almost a speculative question, actually, but as more information were to become available could you then plug that in, using the model, and then refine those results?

A. Oh, certainly, certainly.

Q. Did you actually prepare Exhibits B through F that we've seen this afternoon?

A. Yes, I did.

MR. STOVALL: Move the admission of Exhibits B through F

EXAMINER CATANACH: Exhibits B through F will be admitted as evidence.

(CMC Exhibits B through F were admitted into evidence.)

Q. (By Mr. Stovall) Is there anything further you'd like to add to your testimony this afternoon?

A. No, I don't believe so.

MR. STOVALL: In that case, I have nothing further; and you're on your own.

EXAMINER CATANACH: Why don't we take a very short break so people can line out any questions they may have?

MR. STOVALL: Ms. Young will be available for the next round, too, so . . .

(At 3:40 p.m. a recess was taken.)

EXAMINER CATANACH: We'll call the hearing back to order at this time, and I believe Mr. Stovall had a couple of additional questions.

MR. STOVALL: Well, it's not an additional question, Mr. Examiner, but it was pointed out to me -- and I'm not sure whether or not I, in fact, qualified Ms. Young as an expert in reservoir simulation modeling. I would like to offer her at this time.

EXAMINER CATANACH: She is so qualified.

MR. STOVALL: I have no further questions.

EXAMINER CATANACH: Questions of the witness?

Mr. Kellahin.

MR. KELLAHIN: Thank you, Mr. Examiner.

CROSS-EXAMINATION

BY MR. KELLAHIN:

Q. Ms. Young, lead me through, if you will again, the summary of the validation of the model concerning the Cedar Hill history, particularly when you're attempting to validate your model with the history match performance from Cedar Hill, summarize for me the key variable parameters that were adjusted in order to make the history match.

A. The three key variable parameters were cleat porosity, cleat permeability and the relative permeability curves.

Q. It's becoming more frequent that in examiner hearings we deal with reservoir simulation by modeling the performance or the projected performance of reservoirs. Are we subject to criticism if we use your report in Areas 2 and 3 where, in fact, we do not have the ability to history match and therefore validate the model?

A. We have the ability to history match in Areas 2 and 3, but the data was not made available for this particular study. That's not to say it couldn't be done, and it's not to say that there wasn't some quality data available in those areas that provided the guidelines for the committee to set the range and parameters for the sensitivity analyses in those areas.

Q. Let me make sure I understand. If you have a history match with actual performance data in Areas 2 and 3 -- We didn't do that, right?

A. Yes, we did that.

Q. I heard the discussion about Cedar Hill and the Tiffany area being used to validate the model.

A. Yes.

Q. Was there data used in Areas 2 and 3 to history match the model?

A. Yes.

Q. Is that reference somewhere in the materials so that we will know?

A. No.

Q. Are you able to tell us now from memory the information utilized to history match the Areas 2 and 3?

A. Some of the operators active in Areas 2 and 3 of the basin made some of their proprietary data available to us for history matching work. They were not comfortable with our presenting the results of that information. It was of a proprietary nature. They felt that it would be better at the appropriate time to bring that before the examiner, so they asked us not to report on that result.

Q. Let me go back to my first question, then. If we are dealing in a subsequent hearing with a specific portion of Area 2, and were you using as a benchmark to judge that case, your sensitivity run for Area 2 in trying to compare the current case with that information, are we going to be in a lengthy discussion about the fact that your model has not been sufficiently history matched for Area 2?

A. I'm not sure I understand your question. I'm sorry.

Q. Okay. Let me try it a different way. In Area 1 we have got substantial production history from Cedar Hill.

A. Yes.

Q. You've used that performance to fine-tune your model.

A. Yes.

Q. From them you have run sensitivity runs for Area 1?

A. Yes.

Q. It would appear to me that there is little likelihood that we can be materially attacked on using your model because we've got a good history match for

Area 1 --

A. That's --

Q. -- is that a correct statement?

A. That would be my opinion.

Q. Is that correct?

A. That would be my opinion.

Q. What happens if we're in Area 2, and someone says, "Well, you history matched against Cedar Hill, but you're not history matching against my area; and therefore, you cannot use the sensitivity run for Area 2?

A. I would have to disagree with that assumption, because you have to remember the committee was comprised of a large number of operators active throughout the basin, and they brought to bear on this study their experience in field operations and their knowledge of laboratory experiments that they conduct.

In addition to that, GRI has researched -- has funded a great deal of research in this basin, and Rich McBane could bring to this project his experience and guidance. So if some information is not reported that was of a proprietary nature, that has to be respected; and I don't think it invalidates the results.

Q. Would your answer be the same if we were dealing in Area 3?

A. Yes, it would.

Q. When we go back to the dividing of the areas, it was my understanding from earlier today that the division into areas was simply done based upon hydrogeology in that there was a water saturation component and a pressure component by which the basin was loosely divided into three areas; is that a correct recollection?

A. Yes.

Q. Based upon that criteria then, you have individualized the performance within each area using very selective and precise reservoir parameters from which to run the models?

A. Yes.

Q. What happens if I'm in that transition area between Area 1 and 2? What am I going to do?

A. You'll have to look at the individual properties for your specific case that you're referring to and find the appropriate set of combination of parameters in the performance data reported for the specific area.

In other words, I believe Rich McBane made this point that your -- it is quite possible that you could see an area Area 1-type coal in either Areas 2 or 3 and vice versa. You could find areas in 2 -- you could find specific sites within Areas 2 and 3 of the basin that look like Area 1 type coal. So it's been made very clear, these are not well-defined boundaries, and the boundaries between the areas, it's very complex. It was just a convenient basis to subdivide the basin for this analysis.

Q. One final point of inquiry: It appears to me that we simply can't take field data on permeability or fracking, go directly to the sensitivity tables and somehow very simply find what the appropriate spacing is for that particular well.

It appears to me that we're going to have to take an area and model the performance for that specific area and use that modeling result and compare it against your sensitivity runs.

Am I correct in understanding that the typical case that comes up in the future is not going to be so simple that we can go to your sensitivity tables, pick out a conclusion, present that to the Examiner and have the spacing resolved?

A. I'm not sure I track the question.

Q. Okay. When we look at the sensitivity profiles, it's simply a type case, is it not?

A. It's the performance as a function of certain assumptions in reservoir parameters.

Q. Unless I have the unusual, unique example where I can take my 640 and determine that those parameters from my wells fit the parameters you utilize for your Area 2 sensitivity, then I would probably be incorrect to go straight to your table and determine spacing from the sensitivity run on one of the tables we saw earlier. It can't be that simple, can it?

A. Well, yes, and no. I mean, it depends on the variation in the assumptions. I mean, we have attempted to normalize the data so that such efforts could be completed, but there are assumptions that might vary enough. I mean, there might be something there that would mean that your case didn't fall within one of the selected, simulated cases.

Q. When I look at the selected, simulated cases, where are the points of greatest sensitivity in the reservoir parameters?

A. You mean what variables impact the results?

Q. What variables make the greatest difference?

A. That's really very difficult to answer. I'm not sure I can answer it. All the variables that were looked at played a key role in performance, and I would be reluctant to weight one more heavily than the other.

Q. If I'm to present a case for a specific area, may I use your results as a comparison to results I could generate off of my own engineer's reservoir simulation, using his site-specific data for his 640-acre area? Can I do that?

A. You can use it as a compare -- you can compare simulation work done on actual field data with the results in the sensitivity analyses, but nothing is better than actual field data.

Q. Does your book contain enough detailed information that my reservoir engineer that's experienced in reservoir simulation can use the information from that book to run his model from his own data from his wells?

A. I didn't follow the whole question; I'm sorry.

Q. Do you have enough reference information in your book and of details as to reservoir parameters that we can use that as a guidebook, if you will, for the simulation of a more specific area?

A. There's probably enough information here, yes.

MR. KELLAHIN: Thank you.

EXAMINER CATANACH: Further questions of this witness?

(No response.)

EXAMINER CATANACH: Nothing further. I'm going to reserve my questions probably until the next hearing.

You may be excused.

THE WITNESS: Thank you.

MR. STOVALL: Mr. Examiner, I think at this point it would be appropriate to address some procedural questions involved. I'll come up here and see if I can kick the reporter's cord loose.

One question I would like to address, Mr. Examiner, and I'd take some input from other counsel in this case, is I'm concerned because this proceeding is now in the nature of a split hearing. And these witnesses, while they've worked for the committee in the past and have had contacts with individual operators, I have a certain amount of concern about the individual operators, who may be advocating a position in the subsequent phase of this hearing, contact the ICF technical people directly.

And I would request that any contacts or requests for information, if there need be any, should go through Mr. McBane of Gas Research Institute, and that no direct contact be made with these witnesses; and I've instructed them not to discuss in detail information that is not within the record of this hearing, because I think that creates a real problem.

They are not an advocate for any group. They are representing the committee as a whole and presenting some -- what's supposed to be objective, scientific data; and I would like to not have them in the position of being asked to support any position.

So, you know, unless there is some objection to counsel, I'm going to request that you direct that all --

any request for contact with these witnesses until the hearing is concluded go through Mr. McBane at GRI and avoid ex parte; and if information is made available, that we'll work out a procedure to make sure everybody has access to information, should that become the case.

EXAMINER CATANACH: Is there any objection to that from anyone here?

(No response.)

EXAMINER CATANACH: Then we'll go ahead and do it that way, Mr. Stovall.

MR. STOVALL: I guess the next question is establishing the procedure for the second phase of this hearing. I think we've decided unless there is any strong indication that our companies will send us to Maui, that we'll probably meet on April 4th.

In the initial memorandum, which was sent out over Mr. LeMay's signature, what was requested was that parties submit any proposed rule changes to the division by, I think the date was, February 14th.

For everybody's information, the division received from Richard Virtue -- Mr. Virtue, where are you? -- on behalf of Nassau Resources a proposal in a prehearing statement. I think if you see Mr. Virtue, I'm sure he'll be glad to make a copy available to anyone who did not receive it.

I believe Meridian through Mr. Kellahin has also submitted a specific proposal. I'm sure Mr. Kellahin would likewise make that available. To the best of my knowledge, is it fair to say that both -- Mr. Virtue, your proposal just simply recognized what we've said is true, which you wanted incorporated in the hearing or in the rules that an operator could apply through the hearing process for something other than 320-acre spacing if that were the spacing adopted by the commission?

MR. VIRTUE: That's correct, Mr. Stovall. We're simply asking that the rules be changed to reflect, I believe, it's conclusion D in the report. So we're not asking, really, for anything new and different than what has already been recommended through the report. We are just proposing that the rule reflect the conclusions of the report.

MR. STOVALL: Mr. Bruce, I believe you have on behalf of Unical also indicated that they have an interest in areas where they think some sort of denser well spacing, either on infill or otherwise, would be appropriate. Had you actually made a recommendation as far as the rule change?

MR. BRUCE: No, I haven't. I attached something to the letter, but it was just more or less recognizing that infill drilling may be appropriate in certain areas; and that was made available to all the parties who had entered an appearance.

MR. STOVALL: Have you had the opportunity to review the Nassau proposal?

MR. BRUCE: Just briefly.

MR. STOVALL: I would be curious whether it's consistent with what you're asking.

MR. BRUCE: I'll look at that.

MR. STOVALL: Okay. Mr. Kellahin, I believe Meridian's proposals were on the basis of recognizing some nonstandard -- administrative process for recognizing nonstandard proration units in the areas where there are strange surveys and you've got a Basin Dakota, Blanco Mesa Verde rule in place; is that correct?

MR. KELLAHIN: There were a couple minor administrative suggestions to the current rules, none of which we believe were substantive in nature. They were done in an effort to reduce the paperwork. Some of them were administrative. One was the certification with regards to the affirmation that production from coal seam gas is that coal seam gas production model forms. I'll be happy to get extra copies of it, but we did not think that there was substantive change proposed with any of our suggestions.

MR. STOVALL: Mr. Nitcher, did you have a comment?

MR. NITCHER: Yes. Concerning the Nassau change, I recognize that the proposed language speaks to changing spacing and as units and not infill drilling. Looking at Unical, I can't tell which -- whether they're requesting an infill drilling option or a space and change. I think that spacing changes would have another ramification. You have royalty. And I would like some clarification on what exactly Nassau is wanting to put in and whether they really intended to request change in spacing.

MR. STOVALL: Let me -- what you're getting to, the next step of what you're getting to -- and I don't think this is the way we've structured this hearing, I don't think this is the time or place to do it.

One of the discussions we had at the prehearing conference, and I think most of the attorneys were here, was you would like to know what other parties are going to do, particularly if they're going to recommend any significant changes to the rules, because that will affect the way in which you will respond and the testimony will be presented. Is that a fair --

I think, Mr. Kellahin, I think you made that point specifically; is that correct?

MR. KELLAHIN: Well, and perhaps there's a predicate to that statement. We're comfortable with the presentation today and would suggest that that might form the base of making the rules permanent. I guess we need clarification from the Examiner if after today all 14 or 15 companies are supposed to scurry home and then come back with some kind of technical presentation in six weeks to again tell you that we want the rules made permanent.

I do not understand it to be that way, that we were only going to come back and deal with any company's concerns about rule changes. So we need to have that figured out so that we all don't waste our energies doing something that is not required.

MR. STOVALL: Let me clear it up. I think for the record, the testimony -- the conclusions which Mr. McBane entered into the record this morning are not really in the form of a specific spacing recommendation. They are conclusions which the committee drew on the basis of a report which you've seen. So perhaps it would take some at least minimal recommendation that the rules be made permanent. And I think perhaps that could be done on the basis of the testimony which is already of record in the case.

And then, again, the second phase of it, if anybody proposes any changes, I understand everybody else would like to know what those changes are so they can respond to them effectively if they feel they need to; is that correct? Does that summarize what you're asking?

MR. KELLAHIN: I guess I'm still confused. I think the language about reserving the opportunity for individual companies to come back in with a specific case is something we might be able to resolve among ourselves before the next hearing and come in here with a non-issue for you to put in the order.

MR. STOVALL: Exactly.

MR. KELLAHIN: There may not be any dispute at all. I guess what I'm asking you is there's no point in us going out and generating a lot of information for you if the whole purpose of the exercise in this work study committee effort through the consultants is to give you what you have now. I don't know what else to do except to move that they be made permanent.

EXAMINER CATANACH: Mr. Virtue.

MR. VIRTUE: Mr. Stovall, I think we're comfortable with the record as it stands that's implicit in terms of the proposal we've made and what it's based upon. It's based upon the conclusions in the report, and we haven't heard anything here today that would serve to change that conclusion in any way, shape or form.

I think I agree with Mr. Kellahin. We've got a proposal that Nassau has made for a change. We've got some proposals that he has made on behalf of his clients. I'm not aware that there's any specific problems with the proposals that have been made.

I would just suggest that maybe the way to proceed would be to ask anybody who has a problem with or objection to what's been proposed, to file a statement of objection within, say, a week or ten days of today's date; and that way we will know what the problems are and maybe we can get them worked out before April the 4th.

MR. STOVALL: Well, that's exactly what I'm leading to, is what mechanism. If there, in fact, are some issues that would need to be resolved, what mechanism can be used so that you know whether you need to come back and present a substantial technical case or whether you simply come back and make a recommendation based upon the evidence which was presented today.

Mr. Dean, knowing that you represent a client that perhaps has a different point of view in this case, do you have any comment that you'd like to make with respect to the procedural mechanism for dealing --

MR. DEAN: Well, we've just seen the report and hear it like everybody else, and we have just seen -- we may have seen the Nassau recommendations before. I haven't seen them until day. I think if we had a week to ten days, we might be able to either put up or not saying anything at all.

MR. STOVALL: Would it be appropriate in terms of defining this procedure as we're talking about it so we can accomplish exactly what you want to do, to, say, require each party to file, in effect, a statement of position within seven days from today, saying you either recommend the rules be made permanent, recommend the rules be made permanent with these changes.

Recommended changes, for example, Nassau, would ask you to restate yours just so it all comes out the same time. If Unical has any, if Dugan has any, to make any recommended changes that they would want to make at that time. And then perhaps, say, a week to ten days after that date, ask each party to file something in the form of a prehearing statement, which we already use. You now know where everybody is. All right. Now, what are you going to do in response to it? Are you going to present a case, or are you just going to come in and say "We recommend," period.

Does that make sense as a procedure?

MR. CARR: Would that give us an opportunity for Amoco to state at that time in that context that we prefer to go to infill drilling instead of a spacing change so that that issue is properly before you when we come to hearing? I don't think we have a quarrel with a denser development pattern. There is a difference between infilling and coming in with a spacing change; and that's what -- we want to be certain when we come in that we haven't waived our right to come in and say, "Yes, we think you should have an opportunity to go to a denser spacing pattern on a proper showing, but we don't think you should do that by changing the spacing by authorizing infill drilling."

MR. STOVALL: Well, I guess my recommendation would be, procedurally the way to handle that would be that Amoco would submit in its first round of statements the proposal or statement to that effect. At that point everybody in the case would know what Amoco's position was. If somebody disagreed with you, they could contact you and --

MR. CARR: But we could do that short of proposing a rule to do that. We may not be in the position where we want to come in and say, "Yes, we want to propose a rule to go to a denser spacing." We think those that want to do it are probably correct; we just think that perhaps we should go infill instead of spacing changes because --

MR. STOVALL: You might make a conditional proposal.

MR. CARR: Okay.

MR. STOVALL: If the answer, the drilling --

MR. CARR: But we don't want to waive that and be here with one thing before you and then on April the 4th be confronted with, you know, some procedural problem.

MR. STOVALL: My response to you in that would be that you submit that as a statement of position, that if denser drilling is going to be allowed in any area or whatever, that it would be on an infill basis.

MR. NITCHER: One thing more I would request, I didn't receive a prehearing statement from Dugan. I don't know if one has been filed or not.

MR. CARR: No, I'm sorry. Dugan. I was thinking that --

MR. NITCHER: Dugan.

MR. STOVALL: No, I think, as a matter of fact, you know, Mr. Dean only recently got in the case, and it's going to require something. That's what we're setting up. Are you really going to need -- Dugan has not filed anything.

MR. NITCHER: That's right. And we do not know what their position is, and that will impact how Amoco proceeds.

MR. STOVALL: They have not officially stated their position. I think a lot of us know how they feel about specific issues. That's what I'm trying to address, is, yeah, obviously if that's the case, we're going to ask Mr. Dean to express that position within this -- Is this procedure I've outlined a proper framework to do that? A statement of position and recommendations for any changes to be filed within seven days of today's hearing, and then give -- if we're going to meet on April 4th, then 14 days from that date to file a prehearing statement indicating your evidence, the case you intend to present so that we now know whether we've got a day-long hearing with lots more technical stuff or a one-hour hearing with some agreed-upon recommendations? Does that make sense procedurally?

MR. KELLAHIN: I think it's exactly what we need to do.

MR. STOVALL: Mr. Bruce?

MR. BRUCE: That's fine with me.

MR. STOVALL: Mr. Dean?

MR. DEAN: Fine with me.

MR. STOVALL: Anybody else? Mr. Virtue?

MR. VIRTUE: That sounds like a reasonable way to proceed to me.

MR. STOVALL: Mr. Carr? Mr. Nitcher?

MR. CARR: Yes, that sounds like a reasonable way.

MR. STOVALL: Is there anybody else I've missed in the process here that needs to --

MR. DEAN: My only quarrel might be with the seven days. I'm trying to think. It really only gives a weekend and five working days. How about the Monday after that?

MR. STOVALL: Oh, I think that you can make a decision whether you want to recommend any rule changes or changes between now and then. It doesn't mean you've got to have your case prepared. You've got to decide whether you're going to present a case or not. My inclination is to make that early on. This has been -- the Basin-Fruitland coal pool -- coal field has been around since '86. I don't think that's too short a time to decide whether you've got a position or not.

MR. DEAN: That is the only thing. That shouldn't be a problem. I think that can be done.

MR. STOVALL: That's my recommendation procedurally; and I guess part of that, you know, the question is whether we meet in Farmington or here has not been actually been resolved, but if we're only going to have a one- or two-hour hearing, we don't have to clear the docket, and going to Farmington seems impractical, so it seems to me that maybe that will solve some of those other problems, so I think we need to keep that timeframe short for that purpose as well.

(Discussion off the record.)

MR. STOVALL: As the Examiner pointed out, the 7-day/14-day timeframe, that really cuts us pretty close on making the determination how long and where the April 4th hearing will be. He's recommended changing that second timeframe to ten days. Seven days to file -- Everybody file a position statement within seven days, and then ten days after that file your prehearing statement indicating what evidence you intend to present, if any, at the subsequent hearing; and then that gives us time to meet the advertising requirements to get out notice as to what that hearing docket is going to look like.

I know that doesn't concern Mr. Carr, but the rest of you may have some concerns about that.

Does that sound reasonable? Does anybody have any objections to that?

EXAMINER CATANACH: On the prehearing statements you might indicate whether or not you're going to have any cross-examination for any of the witnesses that were presented today also. That will help us to determine the length.

MR. STOVALL: And as I've indicate, if anybody is going to want a transcript of today's hearing, let Maureen know. We've asked her to put it ahead of the list; and I'm sure she'll be glad to sell you a transcript if that would be useful to you.

EXAMINER CATANACH: That's it. We'll call this hearing adjourned for the time being, and we'll meet again.

(The hearing was adjourned at 4:25 p.m.)

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

REPORTER'S CERTIFICATE

I, MAUREEN R. HUNNICUTT, RPR, a Certified Court Reporter and Notary Public, DO HEREBY CERTIFY that I stenographically reported these proceedings before the Oil Conservation Division; and that the foregoing is a true, complete and accurate transcript of the proceedings of said hearing as appears from my stenographic notes so taken and transcribed under my personal supervision.

I FURTHER CERTIFY that I am not related to nor employed by any of the parties hereto, and have no interest in the outcome hereof.

DATED at Santa Fe, New Mexico, this 15th day of March, 1991.

Maureen R. Hunnicutt

MAUREEN R. HUNNICUTT, RPR
Certified Court Reporter
CCR No. 166, Notary Public

My Commission Expires:
April 25, 1993

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 9/20, heard by me on February 21 1991.

David R. Catanach, Examiner
Oil Conservation Division