TERA

NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

BOSTON EDISON COMPANY, et al.

Docket No. 50-471

(Pilgrim Nuclear Generating Station, Unit No. 2)

Place - Plymouth, Massachusetts

Date - Friday, July 20, 1979

Pages 11225-11352

POOR ORIGINAL

Telephone:
(202) 347-3700

ACE - FEDERAL REPORTERS, INC.

Official Reporters

444 North Capitol Street
Washington, D.C. 20001

582 258

NATIONWIDE COVERAGE - DAILY

7907300133

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the matter of:

BOSTON EDISON COMPANY, et al

(Pilgrim Nuclear Generating Station, Unit No. 2)

Docket No. 50-471

Plymouth Memorial Hall
Plymouth, Massachusetts

Friday, July 20, 1979

The hearing in the above-entitled matter was reconvened, pursuant to adjournment, at 9:00 a.m.

BEFORE:

ANDREW C. GOODHOPE, Esq., Chairman

DR. RICHARD F. COLE, Member

DR. DIXON CALLIHAN, Member

APPEARANCES:

GERALD H. LEWALD, Esq., Ropes & Gray
225 Franklin Street, Boston, Massachusetts; and
DALE G. STOODLEY, Esq., Boston Edison Company,
Legal Department, 800 Boylston Street, Boston,
Massachusetts; on behalf of the Applicant

MICHAEL B. MEYER, Esq., Assistant Attorney
General, Statehouse, Boston, Massachusetts;
on behalf of the Commonwealth of Massachusetts,
Intervenor

POOR ORIGINAL

 582 259

APPEARANCES: (Continued)

MARCIA MULKEY, Esq., Office of the Executive Legal Director, Nuclear Regulatory Commission, Washington, D. C.; on behalf of the Nuclear Regulatory Staff

EDWARD L. SELGRADE, Esq., Deputy Director, Governor's Office of Energy Resources, Boston, Massachusetts

ALAN R. CLEETON, Pro se

I N D E X

582 261

A1-1
KG/RM

P R O C E E D I N G

(The hearing continued at 9 o'clock a. m.)

MR. GOODHOPE: The hearing will be in order. This is a continuation of a hearing before the Atomic Safety and Licensing Board in the matter of Boston Edison Company, et al, Pilgrim Nuclear Generating Station Unit No. 2, Docket 50-471.

Will counsel please state their appearance?

MR. LEWALD: My name is George H. Lewald, 225 Franklin Street, Ropes & Gray, Boston, Massachusetts, representing the Applicant.

MR. MEYER: Michael B. Meyer, Assistant Attorney General, representing the Commonwealth of Massachusetts with offices at One Ashburton Place, 19th Floor, Boston, Massachusetts.

MS. MULKEY: Marcia A. Mulkey, representing the NRC Staff, Washington, D.C.

DR. CLEETON: Alan R. Cleeton, 22 MacIntosh Street, Franklin, Massachusetts.

MR. GOODHOPE: All right. The first thing we want to take up is your stipulation, and the Board has decided they will accept the stipulation, so I will read it into the record right now.

582 262

A1-2
KG/RM

STIPULATION

Counsel for the Commonwealth of Massachusetts (Commonwealth), Alan R. and Marian W. Cleeton (Cleetons), (Applicants), hereby stipulate and agree to the following contention of the Commonwealth and the Cleetons in this proceeding, subject to the approval of the Licensing Board.

Given the guidelines established in Appendix E to 10 CFR Part 50 and the proposed amendment thereto (43 FR 37433):

(1 An acceptable emergency plan cannot be developed to protect persons within and beyond the LPZ of the proposed site; and

(2 The Applicant's preliminary emergency plans as set forth in its Preliminary Safety Analysis Report are inadequate.

That is the end of the stipulation. It was signed by Stephen M. Leonard, Chief of the Environmental Protection Division, Counsel for the Commonwealth of Massachusetts; signed by William S. Abbott, Counsel for the Cleetons; signed by Barry H. Smith, Esquire, Counsel for the Nuclear Regulatory Commission. It is not signed by George H. Lewald, Counsel for the Applicants.

Well, this is accepted in as the contention

A1-3
KG/RM

on the emergency plan contention.

582 264

A-2-1

WEN S. CHERN, Sworn

DIRECT EXAMINATION

Q (By Ms. Mulkey.) Dr. Chern, I hand you a document entitled "Professional Qualifications of Wen S. Chern" and ask you if that is yours?

A Did I prepare this document? Yes, I did.

Q Do you wish to make any changes to this?

A No.

Q Is it true and correct to the best of your knowledge and belief?

A Yes.

MS. MULKEY: Mr. Chairman, I move that this five page document entitled "Professional Qualifications of Wen S. Chern" be admitted into evidence and bound into the transcript as if read.

MR. GOODHOPE: All right. It is so ordered. It will be bound in at the end of today's transcript.

How about the stipulation itself of the affidavit of Dr. Chern?

MS. MULKEY: Not the affidavit, just the professional qualifications.

MR. GOODHOPE: All right.

MS. MULKEY: I have provided the reporter with 20 copies. Copies were sent to the Board

582 265

and to parties by my letter dated June 29th. I have extra copies, should anyone wish them.

Q Dr. Chern, I show you a document entitled "Regional Econometric Model for Forecasting Electricity Demand by Sector and by State, by W. S. Chern, R. E. Just, B. D. Holcomb, and H. D. Nguyen, NUREG/CR-0250, ORNL/NUREG-49 and ask you to examine it?

A That is it.

Q Are you the principal author of this document?

A Yes.

Q Is it true and correct to the best of your knowledge and belief?

A Yes.

MS. MULKEY: Mr. Chairman, I would like the document marked as Staff Exhibit No. 65, which may be skipping a number. If you have a better memory. I chose 65 because I am sure of the number.

MR. GOODHOPE: We will check this out. We make the record clear some time in the future so that 64 is a blank.

MS. MULKEY: I move that this document be received as an exhibit in this proceeding. Copies of this document were provided to the Board

-2-3

and parties by letter from Mr. Smith dated May 21, 1979.

MR. MEYER: No objection.

MR. LEWALD: I don't believe we have got a green-covered copy. We have a blue covered copy.

MR. GOODHOPE: You have a draft.

MS. MULKEY: You were on the service list to get a copy with an enclosure of a letter of May 21st. Apparently there is some confusion.

MR. LEWALD: Apparently we got a blue copy on that date. Not a green copy.

MS. MULKEY: I don't believe so, Mr. Lewald. The blue copy was admitted as an attachment to the answer to the staff interrogatories which were mailed May 25th, I believe.

MR. LEWALD: Well, I don't raise any objection to the admission of this document as an exhibit. I would just like to be provided with a copy at some time.

582 267

B1-1
pp/em

MR. GOODHOPE: All right. We will receive it as NRC Exhibit No. 60. It will be so entered, and it will be bound into the record.

MS. MULKEY: No. I only have three copies and I do not want to have it bound into the record. I would just introduce it as an exhibit.

MR. GOODHOPE: All right. With this, we will receive it into evidence.

(A document entitled, "Regional Econometric Model for Forecasting Electricity Demand by Sector and by State, was received as NRC Exhibit No. 60.)

Q Mr. Chern, would you briefly summarize for the Board and the parties the Forecasting Model which you have developed, something about its history, its evaluation proceedings, and its acceptance in the community of users of Forecasting Models?

A Just a brief review of the model?

Q Yes.

A We have been developing it by now for about three or four years. I think we started to develop it in May of 1976, and this is the project we are doing for the New England Regulatory Commission.

Now, the model we have developed, what the model contains, at least in this report, is very, really, the second generation of the model we have

582 268

B1-2

developed. This is an econometric model. An econometric model means that we use historical data and establish the demand equations. The demand equations mean that we describe, whatever the demand of electricity to a set of variables were at least suggested by theory, economic theory, and also dependent on the various characteristics of consumption of electricity.

For example, the residential demand for electricity is specified as a function of a set of economic variables such as the price of electricity, price of substitute fuel, oil, gas and coal and personal income. Those are the set of economic variables, and there is another set of demographic variables, such as population, household size and also as a function of a set of chromatic variables.

Now, we use heating degree days and cooling degree days because of the conservation of the effective variables of natural gas on demand for electricity.

We introduce the number of natural gas customers as a proxy to measure the variables of natural gas.

So, that is the kind of demand function, and we estimated, based on historical data, and the

582 269

example I listed was to describe the behavior of residential customers of electricity.

Okay. This is an econometric model. We developed the model, as I indicated, as a sensitive, as being sensitive to economic variables, to demographic variables, to climatic variables. Those are the major factors we believe affect electricity band.

Did this point go back to the other one where I said chromatic and should be climatic also.

Okay. The model we developed is capable of forecasting both demand electricity, demand and electric prices by states and by sectors. By sectors, I mean the residential customers and industrial sectors. Those are the three major customers, the three major form of classes of customers and by the states we are having the 48 states and the New England Region is just one of the eight sensor regions that we're dealing with.

As I say, we have developed this model for about three years by now and the methodology we used is a constant redevelopment and improvement over previous models used by others that means, and let me cite here -- this is not entirely in the methodology, but we, as I say, made the improvements over previous studies done by Houthattar at Harvard University and

582 270

also Professor Carbo and Joskow, for the very similar methodology they used for the developing regional electricity demand models at M.I.T., which are also based on the kind of methodology and on the methodology in specifying demand equation used by Professor Taylor and others.

Professor Taylor is from the University of Arizona, and we have updated and improved, basically, the methodology.

Now, in the course of developing this model, we, myself, have participated in many professional meetings, and have, you know, prepared the shop versions of the papers.

For example, one version of the paper will be presented in the Journal of International Energy and one other one will appear in the Future Managing Sciences, and a paper was also going to be published in ENI proceedings on the conditions of the Pricing Conference.

The Conference was held last year, and there also is a paper which will be published in an Institute of Gas Technology Conference on Energy Modeling and Net Energy Users.

The Conference was held last August in California.

B1-5

So, the model, the methodology has been reviewed very extensively by the various groups of professional Economists and also this model was one the ten models validated at EPPI on Electric Load Forecasting.

It is one of the ten models examined for that energy modeling form study.

Now, we are also in the process of, you know -- As you can see, we have been working on those models for three year, and we currently look at the structure of the model and one very important point I should point out is that we have very carefully validated the model or tested the model for both within the sample period, and by that I mean for the period of which the data we used, and, specifically, it is for the period of 1955 and 1974.

Okay. We validated the model, see how the model works by state, by sectors, and as we show in this report, the forecasting varies generally very low in the neighborhood of 3 percent for electric demand.

We have not just validated the model. We did not sample the period we used to data, and computed it which we used to data, but also go beyond the sample period.

582 272

B1-6

The sample period is the statistical term. We validated our model for 1975 and 1976 to see how the model works beyond the period of estimation and we found the forecasting, this is so-called in econometric terms as exposed forecasting. Forecasting exposed.

These were very, very low, and by that I mean in the neighborhood of, again, about 3 or 4 percent.

So, we did this very carefully, and we examined all possible statistical means to check the validity of the model, to check the significance of the parameters we estimated, and we are continuing to do so.

582 213

B2-1
KG/EM

MS. MULKEY: Dr. Chern is available for cross-examination.

MR. GOODHOPE: Mr. Lewald, any cross examination?

MR. LEWALD: I have no cross-examination of Dr. Chern.

MR. GOODHOPE: Mr. Meyer?

MR. MEYER: Yes, I have a few.

CROSS-EXAMINATION

Q (By Mr. Meyer.) Dr. Chern, could we refer, as a shorthand method, to Staff Exhibit 65 as a final report, that is the one with the green cover?

A That is right, because it's published, yes.

Q And the document which is entitled draft "ORNL/NUREG/TM 157," that is the earlier draft report of this same model; is that correct?

A That is correct. Of the same model. That is the result of our earlier testing of the model.

Q And we could refer this as the draft report for shorthand purposes?

A Okay.

Q Now, could I ask you to turn to page 5-2 and 5-3 as Staff Exhibit 65 the final report?

A Yes.

582 274

c-

rm/pf

Q Yes. Please.

A And five---

A Three. They are facing pages.

A All right.

Q Would you read into the record the sentence that starts at the bottom on that page 5-2 and goes over to the top of 5-3, it starts with the words "For example, we would expect?"

A I am sorry. Where am I supposed to start?

Q Well, actually if you could just read that sentence to yourself. This document is already in evidence.

A "For example."

Q Yes. Just read that to yourself.

A "For example, we do expect the price of natural gas to be insignificant in the residential demand equations in the New England region because natural gas has never been an important fuel used by residential customers in this region, even though data on the prices of residential gas are available."

Q Do you believe that sentence to be correct, sir?

A This is relative thing. Do I agree with the sentence?

Q Yes.

A Well, yes. We prepared this.

582 275

Q Is the sale of natural gas insignificant to residential customers in New England?
A Is insignificant relative to the fuel oil. Yes.
Q Is it insignificant relative to electricity?
A Yes.
Q Do you know how much natural gas is sold in New England to the residential sector as opposed to how much electricity is sold to the residential sector in New England?
A I do not have the figure with me. I couldn't give you a percentage, either, but I do remember it is far less than electricity, and on a BTU equivalent basis, equivalent BTU basis.
Q When you say far less, do you mean a few percentage points less or a different order of magnitude?
A Oh, it has to be quite, not just a few percent difference.
Q Do you think it is a different order of magnitude, sir?
A An order of--?
Q Magnitude, like off by a factor of ten or a hundred?
A I wouldn't say a factor of a hundred, no.
Q How would we convert kilowatt hours into BTU equivalent?
A By the way, that conversion is not relevant for

582 276

my study presented in this report. However, one kilowatt hour is equal to 3,410 BTU.

Q Does 3,414 sound about right?

A What?

Q Does 3,414 BTU's per kilowatt hour sound all right?

A It is roughly 310 or 12 or 14, depending on the school of though. Okay. That is, I mean, the difference is, for those conversion factors very small.

Q What would be the similar BTU conversion for a cubic foot of natural gas?

A I did not use that in this report.

Q Do you know what it is, sir?

A I don't want-- you know. It is something which I don't want to confuse with the fuel oil. I don't intend to answer the question.

DR. COLE: Is it that you don't know the answer, Dr. Chern?

THE WITNESS: Pardon me?

DR. COLE: Don't you know the answer?

THE WITNESS: At this point, I couldn't quite-- I don't want to make a guess.

DR. COLE: All right.

Q Would you accept as a reasonable estimate that

582 277

natural gas sent to pipelines varies somewhat in BTU equivalent and it is between about 980 and 1,050 BTU's per cubic foot?

A It would vary between pipeline?

Q What I am suggesting is that it varies depending upon whether it is all pipeline natural gas or whether some additional synthetics have been injected, but the overall average number is between 980 and 1,050, in that range, BTU's per cubic foot?

A Yes, I think yes.

Q Do you know how much megawatt hours or kilowatt hours were sold in New England say in 1978?

A I don't have the figure of r1978, but I did--

Q Do you have an estimate, sir, or would you like to take another number as a reasonable estimate?

A Well, I can, you know, for 1974, that is a total of 1975 gigawatt hours and it declined in 1975 about four percent. I don't have that part, but you know, from 1974 to 1975 to 1976 is about four point. I don't remember exactly what percent figure, but I just recently examined for the last twelve months, the last twelve months in the New England region, the total electricity sales, which grew at the rate of three, this

 582 278

is the latest figure, 3.7 percent. This is based on Statistical Edison Electric Institute.

C-1-5

582 279

C2-1
KG/RM

Q I am going to show you, sir, Applicant's Exhibit 20-A which is the NEPOOL forecast for New England in this case and internal Exhibit 2 on page 7 of that, and I show you the actual figures contained in that report for 1977 and a preliminary figure for 1978 and ask you if those look to be approximately right in your opinion?
A This is for the region as a whole?
Q Yes. So the two figures of 79,781 gigawatt hours for 1977, and 82,800 gigawatt hours preliminary for 1978 appear to be approximately right, is that right?
A Yes.
Q Thank you. Now, have you ever examined the number of cubic feet or thousand cubic feet sold in New England by gas distribution companies?
A We have examined those. All the data on natural gas sales contained in our data base. We did examine all the relationships between electricity demand and natural gas sales, yes.
Q Was that data in volume of gas sold or in some other units?
A The volume of natural gas sold, yes, and also the revenue for those natural gas sold in the New England states, by states and by sectors.
Q Do you have that data with you, sir?
A Can I point out something? Can I say something about

C2-2
KG/RM

the data?

MR. GOODHOPE: Well, is it part of your answer?

THE WITNESS: Well---

MR. GOODHOPE: You have to answer. Let him ask his next question.

Q Now the question, sir, in that date could you give me from that data base your best estimate of either residential or total natural gas sales in volume in New England?

A By New England I need to make some answer -- the data is by states which used the state data to estimate the amount of -- we do not use the aggregate New England data to estimate the model. So the data contained here by states --

MR. GOODHOPE: (Interrupting.) Well, just answer the question as best you can from whatever information you have in front of you, Dr. Chern.

Q My question is, if you'll let me repeat it, sir, could you give me your best estimate for natural gas sales either for the residential sector or for the economy as a whole in New England?

MS. MULKEY: For what year?

MR. MEYER: For the most recent year you have data.

582 281

C2-3
KG/RM

A That was -- I could, but that would take a lot of, you know, to aggregate it.

Q Can I speed, if that is difficult, can I speed things up by showing you some numbers and see if you will agree with them?

A Yes.

MR. MEYER: Mr. Lewald, do you want to see that?

MR. LEWALD: Go ahead.

Q I show you a document entitled Natural Gas Sales in 1978 on the Five Largest Massachusetts Companies, which is broken down by five companies and by sector, and I ask you first if the numbers on that document appear to be right, given your data base?

A Given my data base, the order of sectors appear to be equal, right. Yes.

d-1-1

m/pf

Q Does the amount appear to be correct from the total?
A This was '78?
Q This is for '78, yes.
A Yes.
Q Then would you read into the record just the total figures in MCF, thousands of cubic feet for residential, small commercial, industrial and large commercial and industrial?
In other words, those three numbers?
A "For the residential sector it is 72 489.6 thousand cubic feet, and for small and commercial and industrial sectors it is 37083.4 thousand cubic feet and for large commercial and industrial sectors it is 23465.0 thousand cubic feet."
Q And the top of that chart, the units there are thousand of MCF; is that correct?
A Yes.
Q Then those numbers you read into the record are millions of cubic feet or thousands of cubic feet; is that right?
A That is right. It is a thousand MCF, according to it.
Q Yes. And so, when you read into the record a residential number of 72,489 that number was in millions of cubic feet or thousand of cubic feet;

582 283

is that right?

A That is correct, I am sorry.

Q And those numbers appear to be right to you; is that right?

A Yes.

MR. LEWALD: Could you tell us what those numbers are for again?

MR. MEYER: Yes. They are natural gas sales in 1978 in Massachusetts of retail gas distribution companies and it therefore excludes bottled gas sales and also includes a few relatively small companies.

MR. LEWALD: Thank you.

Q Now, by using the conversion factor of 980 to 1,050 BTU's per cubic foot of gas, you could convert these figures for Massachusetts into BTU equivalent; is that right?

A Yes.

Q And, similarly, we can convert the Massachusetts kilowatt hour sales into BTU equivalents similarly, is that right, using the 3,410 or 14 figure?

A Sure.

Q Would you be surprised if I told you that this shows that the energy equivalent of natural gas sold in Massachusetts in the residential basis

582 284

was roughly the same as that of electricity?
A The natural gas in terms of BTU equivalent?
Q Yes.
A It is the same as electricity sales?
Q In BTU equivalent, yes.
A For 1978?
Q Yes.
A Well, I would not be--- you are asking whether I would be surprised?
Q Yes.
A I would not be surprised about it. I would not be surprised but do you want to know the reasons?
Q Certainly, sir.
A I would not be surprised by the natural gas-- I mean, you know, I have seen, for example, we know, I know natural gas has provided-- this is for residential usage-- well, the reason I am not surprised is because natural gas is much more in terms of-- it is because natural gas is much more in terms of shares of total energy. It has a greater share than electricity, and this, in general, true.
Q And that is a generalization; is that correct? I mean, across the United States and not just for New England region, sir, is it?

A Well, you know, it is national. It is also regional differences, and, you know, in the Southern states where air-conditioning usage is greater the shares, you know, are smaller.

DR. COLE: Would you just repeat what you just said since I didn't hear your answer?

THE WITNESS: What I said was that for those states where air conditioning usag is greater the shares of electricity is higher, shares of electricity for residential usage of energy tends usually to be higher than the states where air-conditioning is usually small.

Q Okay. Given this discussion we have had, sir, if we go back to the statement on 5-2 and 5-3 of Staff Exhibit 65, the final report, that statement is incorrect, isn't it?

A You see, the statement is used to characterize these substitution patterns for electricity demand. So, the statement is used as a comparison with other regions. It is not just f r the New England region.

We did this, you know, we did this for nine central regions and we tried to explain the results and based on the comparison, not just looking at when the region result, but comparing the results for all nine central regions and to see why and in what relation we did not have, say for example, natural gas availability variables, doesn't have a good co-efficient in regions such as New England as compared with the other regions which we have a really significant estimate of natural gas price co-efficient.

Q Let me ask you, does that complete your answer now, sir?

A Yes.

Q Let me ask you this question, is what happened here that you tested your model for various different specifications of your model and attempted to pick up a gas price variable and the model never selected a gas price variable?

A No. We looked at the model. We examined and tested the model for all variables not just natural gas price variables.

Now, we based, you know, we looked at the pattern of the equations. We compared long price electricity price variables, other price variables, even income, household size and to judge which equation is better than the other according to all statistical majors.

Q I didn't mean to imply that it just looked at gas price variables, sir, but what I meant was, in testing the model, in seeing which group of variables it picked up and how the different equations worked under the different specifications, it isn't a general correct statement that your model never selected a natural gas price variable or never selected one that was of any reasonable significance?

A You mean for the New England region?

d-1-6

D2-1
p[illegible]m

Q For the New England Region, yes, sir.
A That is not, that is -- The model, you know, all the specifications it has, natural gas price variables. The significant variable is always very low, but, you know, sometimes it has the correct time, and, you know, that variable cannot be accepted with statistical confidence.

That is a standard means of econometric statistical testing.

And your comments apply to the model as applied to the New England Region or the model as a whole?
A Oh, we're doing this, you know, continuously for all regions, not just the New England Region.
Q My question was, sir, when you said that gas price variables that has picked up has either a low significance or sometimes even an incorrect sign, those specific results were those for the model applied to the New England Region or the model for the United States as a whole?
A For the United States as a whole, no. No, no. I don't understand why you say the United States as a whole. We developed the model region by region. We also have the model as a whole for the nation.
Q I asked the question purely, sir, but what I'm asking

is, that statement applies, that you made about natural gas price variables being selected, having either low significance or sometimes even an incorrect sign, that statement applies to the model as it works for the New England Region and as it works for the various other regions within the U.S.; is that correct?

Q Yes. And then, given that performance of the model, you wrote this sentence on the bottom of page 5-2 and the top of page 5-3; is that right?

A Well, that sentence was written, as I say, in comparing with other regions.

For example, we did find very significant price, natural gas price elasticity which we call cross price elasticity, with respect to natural gas to be significant in the Southern Atlantic Regions.

Q Do you believe that gas is more important in New England for the industrial sector than it is for the residential sector, sir?

A No. The New England Region, the sales to residential in absolute terms, is more for residential sectors than industrial sectors.

However, in 1970, the curtailment had been much more curtailed for industrial customers than for residential customers.

Q Does the model select a gas customer number as a

D2-3

dummy variable, or attached to a dummy variable for industrial sectors for New England?

A The dummy variable times the number of customers.

Q So, for the industrial sector, your model does pick up substitutions and affects between gas and electricity; is that correct?

A The model picks up the curtailment in the industrial sectors; that is correct.

Q And the model does not pick up any such thing, either through a gas price variable or through a gas customer number variable in the residential sector; is that correct?

A That is correct.

No, by that, I must say that we try, we try to include natural gas price variables as we are asked a number of natural customer variables. In our residential demand equation, but for all the statistical means we have, we just couldn't find a significant result for those two variables.

So, we must not be confused. We try to incorporate all the variables, but we need to reject those based on the statistical criteria.

Q If I could turn to a different subject, now, sir, is it a fair statement that the model as a whole, the Oakridge model as it now stands, is very sensitive

D2-4

to the price specification equation?
A Well, it is more sensitive to the forecast of electricity prices than electricity demand, and that is what we have found.
Q And that was true in the draft model and also in the final model, as it stands now; is that correct?
A That is one of the reasons why we did not use the model presented in the draft, and that was the reason why we did not want to get it published.
Q Now, the model, as it existed at the time the draft report was published, predicted négative profits; is that right?
A The model predicted as in the draft?
Q In the draft, yes?
A Not necessarily. It depends on the assumption of cost. It depends on the states, on the regions, and it just happens in some states and some regions.
Q Let me amend my statement to, the model as it existed at the time of the draft report did produce for several states and for several reasons, profits that went from positive to negative; is that correct?
A Are you still talking about the draft report?
Q Yes, sir.
A Yes, for some states, but that is why, again, that is the basis for not choosing it.

D2-5

Q And that was, if I think characterized it, the major or one of the major problems as it stood in the draft report; is that right?

A That is among, I would not say the, you know, there are the improvements, and when we do the model over a time, you know, you always try to improve some of the weaker aspects of the model, but that is one of the, you know, the not necessarily -- it is one of the problems that we had, yes.

582 293

d-3-1

Q And this was something that was changed between the draft model and the final version of the model; is that right?

A That is correct.

Q Do you have Interrogatory 26 that the Staff responded to the Commonwealth concerning how the model currently forecasts and backcasts profit margins?

A Interrogatory 26, yes.

Q The extreme right hand column table on Interrogatory Respnse Number 26 are the profit margins forecasted by the model for 1990; is that correct?

A That is correct.

Q And the second right hand most column entitled 1974 actual, are those the actual profit margins that existed in these states or is that the back-casted figure produced by the margin?

A Those are the actual.

Q Those are the actual figures in the states?

A Yes.

Q Would you read into the record for the six states the 1974 actual and the 1990 forecast that is a total of twelve numbers, please?

A Yes. "1974, the state of Maine, 33 percent, New Hampshire, 18 percent, Vermont, 31 percent,

2

Massachusetts, 24 percent, Rhode Island 7 percent, Connecticut, 32 percent.

For 1990, Maine, 17 percent, New Hampshire, 10 percent, Vermont 12 percent, Massachusetts 18 percent, Rhode Island, 3 percent and Connecticut, 16 percent."

Q Now, sir, could you explain why the model as it currently stands is producing these decreases in profit margins?

A Well, the profit margin is measured into-- I must point out the model is not designed to determine the profit margins. The model is designed to forecast electricity demand. The re ason the profit enters the model is because, you know, there are quite a few technical points and I wish to point out, you know, this is not demand, this is not the purpose of the model to predict profit margins. The reason for, you know, we had two equations and one is read this is demand and one is electricity price.

The reasons we have electricity price is because based on a previous study, i' -- if one use was able to price in the demand equation, the price electricity is likely to rise upward, that is to say, you know, that elasticity measures

582 295

how people respond to price change but because of the decline in growth rate this negative relationship between-- of how the people, how much the people pay is a function of how much they use.

Even customers face a constant schedule. The schedule is not too, does not change the price change because of a decline in growth rate so there is, you know, the purpose of the price is on the theoretical and statistical growth to deduce the buyers of estimating the price of elasticity in the demand equation. That is the approach used by Robert Halverson from the University of Washington and published a paper in the economic journal.

We, in the first model, kind of adopted his approach, you know, and with the price equations specified as prices depends on how quantity people consumed on the average and also total average-- total electricity cost.

However, the model does not insure the consistency of the projected prices with average cost. That is to say, you know, if the model should maintain one very important consistence, one very important behavior of the utility, you know, that is to say, you know, the weighted average prices for all three sectors should be equal to the various costs kilowatt hour plus some profit margin, plus some profit margins, okay?

That is the background why the profit margin interests the modelers which is for us to maintain the consistency, okay?

So, however, we found the model, the profit margin fluctuated in the historical years, in '74 this happens to be the year the price jumped, it is a year with higher profit margins.

However, the profit margin depended on the assumption, this is the projected profit, depends upon the assumptions we used on electricity costs and also profit margin is the result of all of the model equilibrium, and on different conditions, depend, costs depend on the man, and it depends on all fac tors that we included in the model.

So, I have prepared, for example, I have calculated the profit margins.

582 297

E1-1
KG/RM

I have further calculated the profit margins.

MR. GOODHOPE: Could we get back to the forecasting of electric use?

MR. MEYER: I don't want to cut the witness off.

A (Continuing.) For example, in scale of mass, the profit margin for 1990 is 18 percent for the best case high price. For low price 22 percent.

MR. GOODHOPE: Thank you.

Q All right, sir we have already agreed that the results of the model are quite sensitive to the price specification equation or the price equation, is that true?

A It is sensitive to price forecast, is more sensitive to the price equation, but the demand in forecast are much less sensitive. One reason is that the price equation purposely we did twice. It came into effect only indirectly.

Q Could I ask you to turn to 5-13 of the draft report, not the final report, and ask you to read into the record the industrial sector long run elasticity as was used in the draft model?

A I am sorry, five dash?

Q Five dash 13. I believe it appears on that page, sir?

A Five dash 13?

E1-2
KG/RM

DR. COLE: That is just on the residential sector, isn't it?

DR. CALLIHAN: Only residential. There's only residential on that page.

MR. MEYER: Just one minute, please.

DR. COLE: Industrial is on 5-15.

MR. MEYER: I'm sorry.

Q Five dash 15 of the draft report, industrial for New England, the long run elasticity estimate is minus .19, is that correct?

A That is what is presented here, yes.

Q And you in your testimony here today have cited among other economists Professor Houtahker and Halverson of Washington and Seattle, is that correct?

A I am sorry. Houtahker and Halverson.

Q Could you turn to page 5-9. I'm sorry. Five dash 11 of the final report and tell me what the regional estimate for the industrial sector is?

A What do you want me to say?

Q Page 5-11 of the final report, the long run elasticities used for New England region, for the industrial sector?

A Yes. It is minus .16.

Q I'm sorry, isn't it 0.16?

A Minus .16, yes.

Q How do you explain the difference between minus .19

E1-3
KG/RM

and minus .16?

A Well, that is one of the reasons we did not publish this. It is because, you know, this is present. Other material I tested of the model and this particular difference is a result of the error in our data base. This is my error. This is because the wrong decimal point was corrected. It is the value added data. The value added for manufacturing, and at the time this does not -- even we did not detect those other errors until we prepared these tables. One of them even, okay, the difference is a result of the things, one is our incorrect data base on value added, incorrect data base on value added and underestimated the industrial and overestimate of electric price in the early models, so when we found those errors and we corrected those data base and also as a result of some, but this is significant, as a result of the respecification of price equation, but that immediately this is a result of error on data base, and I was going to point out one fact.

This model we used we developed because upon almost 95 beta base for 48 states and for 20 years so you can see that is an enormous data base, and so we have tried to check all the data in a very careful way, and we feel since we have taken those

582 300

POOR ORIGINAL

E1-4
KG/RM

data, I have 3 whole assistants constantly, you know, wher ,e estimate one model, we now always check all the data used, but that was a result of the error in the data base. It is related to the value eta data base, but, you know, I must point out, you know, after we, this what we do. Things come up with some estimated and we always try to explore it. The elasticity is so low and, you know, it varies from region to region in the industrial demand equation, and I am not just, you know, this is one of the studies I have been doing. I had also engaged in the more intensive study of industrial energy use, industry by industry, and I find, okay, the reason for the variation of elasticities among regions this elasticity depends upon the condition of industry.

For example, for the paper and chemical industries, for those industries using primary process steam, what other energy are used for generating steam? Natural gas? Coal and oil? Not electricity. For those industries there is a direct substitution between electricity and another primary energy source. It is not practical and feasible, therefore, the price when this data really reduced the industry responded to any price change in electric use. You know, for those industries which use process heat, for example, then

E1-5
KG/RM

their potential for substitution is likely to be higher, so the elasticities depend upon the number of additional industries within the particular state, depending upon the age of the factory, and so forth.

MR. GOODHOPE: Have you completed your answer to Mr. Meyer's question as to the discrepancy here?

THE WITNESS: Yes.

582 302

E2-1
KG/RM

Q In any case, sir, you are familiar with the published reports in the literature as to what long industrial sector price elasticity has been calculated for the nation?

A Yes.

Q And as a matter of fact you report 5 of those studies in the lower half of the table on page 5-11 of your report, is that right?

A Yes.

Q And the range of those estimates for the long run elasticities on price is between minus .81 and minus .18, is that right?

A Yes.

Q And your model for the various sectors produces for 5 sectors long run elasticities as low as .04 and .09 and minus .16, is that right?

A That's right.

Q Is it a fair statement that that model as it originally stood produced long run elasticity estimates that were closer to those reported in the literature for the industrial sector than the model as a final as it stands?

A I didn't --?

Q Let me reask it.

A Yes.

582 303

E2-2
KG/RM

Q Is it a fair statement, sir, that the model as it was when it was reported in the draft report more accurately produced long run industrial sector elasticities, and by more accurately I mean came closer to the published estimate elsewhere, than the estimate finally as it stands?

A Of course not. The estimate is derived from the data base and contained some error. Of course I annot believe that. I depend upon the estimate -- I am more comfortable with the estimate which is derived from the correct data base.

By the way, the industrial electric demand is one sector which has relatively fewer studies than the studies on residential electricity demand, and I happen to cite two of my own studies, two of my own studies for the nation as a whole. We should note, you know, most of the studies I cited there, and this is on table 5.3, studies done for the nation as a whole use average prices, and average prices in a so-called single equation model. That is precisely the criticism. People, including Professor Houtahker has criticized the use of average price because it is likely to result in the overestimate of long run price elasticity. The model we did, this is precisely why we corrected it, we were using the average price, so as a result lower

E2-3
KG/RM

estimate of price elasticity is perfectly consistent with what we intended to do and is consistent with those previous estimates using average price in a single equation approach.

Again, you know, I reasoned those results not based on, you know, the statistical criterion as was my understanding of how energy is used in the industrial sector, and the potential for energy conservation in the industrial sector.

Q Now, sir, just one last question on this subject. Given your understanding of the way electricity is used in the industrial sector that you just mentioned, and given your understanding of the possibility for conservation in the industrial sector, do you believe it is conceivable that the long run industrial price elasticities of electricity are as low as minus .04? Do you believe that to be conceivable, let alone likely?

A It is conceivable, yes. I will tell you why. We try, you know, we try to do this very carefully. I personally am a price elasticity advocate, but we try to do this carefully to see whether this elasticity is as good as we try to estimate to make it come out. As I testified, we test the model for 1975-1976. Even this low elasticity the model consistently

582 305

E2-4
KG/RM

underestimated electric sales for all three sectors, residential, commercial and industrial sectors.

If the elasticity is too low, then the model should overestimate, overpredict the electric sales in the industrial sector for 1975 and 1976. Even this evidence, I think, shows that we have tested the model more carefully than anyone else I know.

MR. GOODHOPE: I am sure of that, Dr. Chern. Does that answer your question?

MR. MEYER: Yes, it does.

582 306

E-3-1

MR. GOODHOPE: All right.

Q Okay. You said that it was conceivable. Do you consider it to be plausible that long run industrial price elasticities are as low as minus .04?

MS. MULKEY: Objection. Dr. Chern answered that question.

MR. GOODHOPE: Well, if he did, he is going to answer it one more time.

A It is possible, you know.

MR. GOODHOPE: Is it plausible now?

THE WITNESS: Well, yes. I can answer the question.

MR. GOODHOPE: All right.

THE WITNESS: I think that the reason, you know, I have been watching carefully those proposed conservation measures. What we are currently talking about are more significant conservations for industrial sectors. It is two things; one is coal generation and one is coal conversion. Those are the two major measures which are not too likely in the residential and commercial sector. They are not designed to reduce the use of electricity in the future. Coal generation may be used as a substitute on purchased electricity, but is not desired to reduce the use for electricity. I have also the best and most recent report CONAS, a study done for the Department of Energy and Academy of Science. The CONAS demand conservation and predict industrial use of energy will increase in a higher rate than residential and commercial sectors. This is for total energy and electricity.

These forecast 4.4 percent annual growth rate from now until the year of 2020.

MR. GOODHOPE: Thank you, Doctor.

582 308

F1-1

Q I am going to ask a series of questions, Doctor, that I think can be answered yes or no and I don't mean if something else is necessary please say so, but I think these are relevant questions.

In the draft report, and in the model as it stood at the time of the draft report, is it correct that the model at that point included as variables and customer numbers for each of the various sectors?

A Sales and?

Q Customer numbers in each of the sectors?

MS. MULKEY: Sales and customers of what, Mr. Meyer?

Q To be more specific ---

A In the cost equation or demand equation? You have to be more specific.

Q The demand -- Let me back up a little bit.
The price equation, in all sectors in the model as it stood at the time of the draft report, did it use both price variables and customer number variables in each of the three sectors for the sales?

A Not price variables or the sales in customer variables, yes. That is one of the very versions, one of the two versions of the price equation.

Q Now, and, as a matter of fact, at the time you wrote

582 309

the draft report, I think you indicated that you would expect both sales and customer numbers to be selected; is that right?

A To be?

Q Selected by the model to be used in explaining; is that correct?

A Yes.

Q Does the model, as it stands now, select sales and customer numbers in each of the three sectors?

A When you say select, this is not the standard terminology. I don't know what it means by that.

Q Just a minute. I think the word select was wrong.

In your equations in the model, as it currently stands, does the model currently use sales and customer numbers in each of the three sectors?

A Yes.

MR. GOODHOPE: Are you about through, Mr. Meyer?

MR. MEYER: I have about another ten minutes. This would be a good time to have a recess.

MR. GOODHOPE: We will have our regular recess.

(Whereupon the hearing was recessed for ten minutes at 10:18 a.m.)

MR. GOODHOPE: Back on the record.

F1-3

The Hearing is back in order.

MR. MEYER: One procedural matter before we resume, Mr. Chai:man.

I was informed late last night that there i. a meeting at 2:00 o'clock this afternoon at the request of the Applicant, between the Applicant and Mr. Denton of the Office of the Reactor Regulations considering the subject we were discussing on the record yesterday.

That is the affect of the Three-Mile Island investigation on Emergency Planning.

I know nothing more about it than that, but I would assume that the parties, to the extent the parties are now present at the meeting at two this afternoon and the Board would be informed of what goes on at that meeting, and the results that come out of it, if any.

MR. LEWALD: That is my understanding of what the meeting is going to be today.

MS. MULKEY: Nor mine.

MR. MEYER: Maybe I can be corrected, then.

MR. GOODHOPE: Ms. Mulkey..

MS. MULKEY: Mr. Meyer mentioned ----

MR. GOODHOPE: (Interrupting.) Mr. Lewald.

MR. LEWALD: What was intended today was

to present to the Nuclear Regulatory Commission, through Mr. Denton, some commitments on the part of Boston Edison and joint owners with respect to proposed changes, suggestions and I believe design and I don't quite know how ----

DR. COLE: (Interrupting.) Does that have to do with the intake structure?

MR. LEWALD: What?

DR. COLE: Does it have to do with the intake structure?

MR. LEWALD: No. I don't believe it has to do with the intake structure, but it would stem out of the Three-Mile Island investigation of what Edison is initially proposing as a result of its study of the Three-Mile Island incident.

MR. GOODHOPE: Does it have anything to do with matters in this hearing?

MR. LEWALD: Insofar as I understand it, I know it has nothing to do with the Emergency Planning as such, and the hearing, with the hearing set on our schedule.

MR. GOODHOPE: All right. We will find out about this in the future.

You may continue, Mr. Meyer.

Q Dr. Chern, let me do this in a different way.

582 312

F1-5

Would you agree with the following general proposition that sales and customer numbers should effect the variables you have of total operating cost, which is TOC in your Model?

At Expo stand, yes.

Q Would you turn to page Appendix B-2?

A Yes.

Q Of the final report and tell me if the model, as it stands, has sales and customers number affecting total operating cost?

A B-2?

Q B-2, yes.

A Yes.

Q B-2, do you have it?

A Yes.

Q Does the model currently, as it currently stands, does it operate in such a way so that sales and customer number actually affect total operating costs?

A Okay. In order to answer the question, one has to go back to the model and how the total operating cost comes into the model, okay?

TOC is assumed as an alternate data base, it is a fixed data base in a way, and it is not something which the model will determine.

582 313

F1-6

TOC is brought into the model to reflect the changes in the rate structure, this is what it gauges, okay?

So, at a given point in time, customers face a fixed rate schedule and then try to respond to whatever the rate guage confronts him with and because it is very difficult to weight the rate schedule in a model such as this, so it uses average total cost to reflect the changes in the rate schedule so that in a statistical sense, TOC is treated as the variable, which is not determined in the model and it is extalgenous. This is an econometric terminology.

So, in that sense, TOC is used as a fixed variable in the model.

Q Let me see if I understand that, does that mean that you are assuming that rate structures are constant and they are only affected by TOC, and by that, sir, I understand you to mean that rate structures go up or go down, all in relation to one another in the same relation and they are only affected by TOC?

A TOC -- at a given time, TOC changes over time so rate schedule changes over time as well.

582 314

Q But the only changes is with TCC, is that right?

A TOC, however, the way that utility companies, you know, they have an expected total average cost. How do they formulate this expectation based on previous? What happens in the past? So, TOC is a result of many, many factors, you know. That is expo. That is why I call it expo. TOC is determined by previous cost structure, the previous sales structure.

Q My only question, sir, is, when TOC varies and the rate structure changes as is allowed, does the tail block change more than the first block or do all the blocks move up together when TOC changes?

A Could be. I don't have the figure, pattern for that. When TOC changes it could be the stop of the rate schedule change, and, you know, TOC is a proxy for the rate schedule and we are talking about an aggregation of many, many schedules and we are talking about aggregates of rate schedule among utilities in the states So I don't have an answer for that. It does not represent any single change in the rate schedule.

Q In the model, do the rate schedule change tail

582 310

F-2-2

block vis-a-vis first block when TCC changes?

A The model doesn t say that.

Q The relationship between the various blocks remains constant to the models, is that right?

A No. It doesn't necessarily remain constant in the model.

Q Could you turn to page 3-8 of the model, or the final report, sir?

A 3-8?

Q Yes, and read to yourself the first whole paragraph of the text which concludes with your equation?

A Yes.

(Whereupon the witness read as directed.)

Q Now, does that paragraph on page 3-8 on Staff Exhibit 65 indicate to you that rate structure remains constant in the model not in real life?

A No.

Q What varies rate structures in the model?

A Because average cost varies.

Q And, therefore, TCC varies, is that right?

A Yes. TCC varies, yes.

Q And when TCC varies the rates go up altogether; is that right?

A When TCC varies in the long term, yes.

582 316

f-2-3

Q Could I ask you to turn to page 4-5 of the draft and not the final draft but the draft?

A Yes.

582 317

g-1-1

Q Would you read into the record the first full sentence of the draft on page 4-5 which starts with the words "However, these dummies"?

A "However, these dummies must be used very carefully because they can in estimation reduce the effectiveness of some of the important regional information embodied in the explanatory variables, such as the number of residential customers."

Q In the final model did you use dummies in exactly this fashion?

A Yes. The state dummies, to be specific. There were many, many dummies.

Q On page 4-6 of the draft report of the text, just reading that text, can I conclude from that what you are noting in the text on page 4-6 is that there is a difference between fuel cost and the variable OMC, is that correct?

A Fuel cost and OMC is all others.

Q And they are different, is that right?

A They are different components of the total average cost, yes.

Q In the final model, were you able to include both of these variables?

A No, because of the additional constraints, we cannot separate these two variables.

Q And that is because there was a high multi-colinearity, is that correct?

A Yes

Q One last area, sir. In the final model as it stands now, the price equation, did you place any constraint on profits?

A I do not place any co..straint on the profit. The only constraint, which is a very import'.nt-- and I repeated it several times, is that we try to insure the projected average prices. When we get the over average it has to be equal to the average total cost. Some profit margin. The profit margin is determined by a by-product of models. That is to say that if we insure the model, we do not imply the TDT you are losing money. They have to have some profit. That is the only constraint.

Q So with the exception of what you just said, it is your understanding of the model that profits are not constrained, is that correct?

A Profit is not constrained. Profit varies. Profit varies when there is cost as the model reads, the result I tried to tell you, the model predicts, you know, when there is a higher cost could be lower profit margins, but the profit margins doesn't say that it aids the total profit, by the way. The total profit is always increasing as a result of increases in demand and prices.

MR. MEYER: I have no further questions.

MR. GOODHOPE: Mr. Cleeton?

DR. CLEETON: Yes.

CROSS-EXAMINATION

Q (By Dr. Cleeton.) Dr. Chern, you indicated in your preliminary statement that the model is economic, demographic, and climatic factors?

A Yes.

Q In the demographic analysis, is that totally statistical or is there a behavioral element in it?

A Demographic: That means we include such things as population, household size, to explain the electricity sales.

MR. GOODHOPE: Dr. Chern, we would like to hear, too.

Q Yes. You can answer that question directly.

A Okay.

Q By household size, are you indicating that there are some choices that people exercise in the size of house, the household that they will g-1-4

have particularly a large number of children and so forth?

A Household size is the number of people per household, so the model has that feature captures the household size to determine electricity demand where the household size is an important factor.

Q So essentially it is a statistical model?

A It is a statistical model using historical data of household size, yes. That is correct.

Q Now, in section one, the data is divided into three periods; 1955 to 1970, 1970, '73 and '75, in general? There are three columns in here?

A Oh, oh, yes. In what section?

Q In section one, carrying over into section two, and on the next page, page 1.7, annually by sector and state for '75 to '90 using-- no, that's not the right one.

Well, let's move over to section two where it is clear that these three periods are used. In section two-- well, is there specific reason for the choices of the periods or analysis in section two, table 2.1, to be specific?

A Yes.

582 321

G-2 -1
KG/RM

Q For those 3 segments?

A Yes. Well, the reason we look at this computer is because prior to 1970 there is a period which has, you know, has the electricity requirement in real terms has been declining. For most states, usually after 1970 and since 1970 the real prices of electricity begin to rise. There is a critical point, that is 1973, of energy crisis, so we wanted to see how this pattern of electricity use evolved from declining price to increasing electricity price period, and also specifically to look at what happened since 1973 energy prices.

Q All right. You have answered -- you say energy crisis now. Would you further characterize energy crisis as you have used it just now?

A Oil embargo.

Q Is it an electric generating facility embargo?

A No. Oil embargo. We want to know the general, you know, the way of increasing the energy situation effect anyway, whether that effect in any significant way affects the electricity used.

Q On table 2.1, page 2-2, it shows the historical growth rates. The figure opposite on page 2-3 shows historical sales, and the table on page 2-5, table 2.2, shows the distribution of electrical sales by percentage.

582 322

G2-2
KG/RM

Page 2-5. I think you have gone over a page too far.
A Oh, page 2-5.
Q Yes. Page 2-5, table 2.2.
A 2.2.
Q Now, we have applies, oranges, and peaches here. We have percentage of growth rate. We have sales by sector. We have distribution by percentages. Now, can you explain to me why you have one table that shows one thing, a figure that shows something else, and then a table that shows something else again, with the figure between the two tables implying that it is related to them?
A Well, the table and figures are used in the text to explain the general trend of electric usage, so, you know, I don't -- you know, those are the summary statistics I thought very interesting to readers of the report to get a rough idea of what happened in the past, so I chose, you know, to present --- thought those are interesting statistics. That is all the section is for. The historical point.
Q Then may I ask you, could the table be constructed or a figure constructed from table 2.1? In other words, growth rate bracket?
A I did not provide the statistical computing table 2.1 in the report.

582 323

G2-3--
KG/RM

Q But if it were plotted according to the data year, it would show a dropoff in percentage of growth at the end of the extrapolation of the curve or at the end of the actual data curve?
A Yes. Well, when it has the growth rate has negative growth rate implied to actual sales, it declines.
Q In other words, if there were figures opposite this table, it would show a decline in percentage of growth?
A Yes.
Q Now, is there any reason why there is no table for figure 2 on sales?
A There is no reason. The reason is I have to be selective in presenting most interesting things in the report. You know, that is purely judgment on my part to judge what kind of interesting things readers may be interested in seeing there.
Q All right, then, may I ask one further thing regarding these tables. Were any subtotals calculated or collected or put down by anyone anywhere regarding table 2.1?
A Yes.
Q By region for comparison?
A Yes. Those come from the public sources, the historical year book of Edison Electric Institute. Those are the public sources, so anyone who would like

G2-4
KG/RM

to get an actual picture of the electrical sales per man, he can look at this public source.

Q Where is it, some place later on in the book you made comparison by region. Was any comparison of percentage growth rate by region every tabulated?

A Not in that fashion.

Q All right.

A That is why I thought that it would be an interesting thing to provide to the reader.

Q Well, don't you think it would be interesting to look at a tabulation by region of percentage growth rates?

A Percentage of growth rate I have here by region.

Q I see. Each item. All right.

A Each item.

Q Thank you.

Now, on page 3-1 of the text?

A 3-1.

Q On page 3-2, in the short and long run responses, 3-1, you state that electricity demand is a derived demand and it is derived from demand for specific services such as lighting and cooking. Sir, could you give me your understanding of the distinction between demand and need?

A Demand need? The distinctions?

Q Yes.

582 325

G2-5
KG/RM

A Demand is defined in economics shows under a set of prices how much consumers are actually either purchasing and use, so need may be characterized in a more philosophical term -- this is the way I understand, has to put some social value to it. That is the best on my judgment.. It's the best for society. Maybe we should all use more or less. That is a judgmental term which one has to attach a social value to it.

Q Do you think that the President's suggested conservation measures would be characterized as a demand or need?

A It is characterized in the better realistic term of demand. You know, demand is, you know, the reason is because I don't feel the President will ask people to sacrifice, but he would like to maintain a reasonable growth of the economy.

582 326

2?3
H1-1
...po

Q Now, in the third sentence in the paragraph, in the short-run, electricity consumers can adjust their ra.es and use of existing electric appliance and equipment.

Now, this says they ca adjust their rate of use. Would you feel that they could also decide not to use them at all?

A Yes.

Q Would there be a radical adjustment in their rate of use?

A I'm sure there will be someone which would reduce use very substantially in response to higher prices.

Q All right.

Now, over in section 7 on Forecast?

A Section 7?

Q Yes. There are a series of estimates of forecasts of annual growth rates of electricity by demand by section and state for New England, Middle Atlantic and so forth, and it seems like all the Regions are there, there are a series of these?

A Yes.

Q And page 7-14, Figure 7-1 is for Tennessee?

A Yes.

Q And Figure 7.3, page 721, is also for Tennessee?

A Yes. One is for demand and one is for price, but

H1-2

Tennessee is the example, yes.

Q Tennessee is the example?

A Yes. An example to show some highlights, how to resolve them.

Q On page 7-12, Table 7.7?

A Yes.

Q It would appear that Tennessee is representative of the Region in terms of Regional averages at the bottom of the table?

A It appears so.

Q It appears that it is fairly representative of the Region?

A Somewhat, yes.

Q Now, would a charge for the New England Region, and particularly Massachusetts, be, I mean, a figure for Massachusetts be represented as the case for the New England Region?

A The figure can be provided, yes. I am not -- I mean, the figures could be done, could be provided. Do you mean the figure could be drawn from the data?

Q Yes.

A Yes.

Q All right. Now, if that figure were drawn, would the slope of the curve be similar or different than

H1-3

Tennessee?

A I didn't have the figures to say yes or no, but you know, generally speaking, high prices result in lower demands and lower prices result in higher demands. That is the characteristic of the model.

So, you would have something like, you know, Figure 7.3 in a high-price curve, where the, that's price equation, I'm sorry, Figure 7.1.

For electricity demand, I'm sure you would see lower price has occurred on the top and then the high price, as occurred on the bottom, plus, you know, I have, I'm unable to prepare the precise level of each curve.

Q But if we compare the total growth rate projection figure on page 77?

A Page 77?

Q Table 72.

A Yes.

Q For Massachusetts?

A Page 72.

Q On the righthand column, the total is 2.6, 3.0, and 2.1?

A Yes.

Q With the total for Tennessee ----

A (Interrupting.) For Tennessee?

582 329

H1-4

Q On page 7-12, which is projected here, essentially, 4.2, 5.0 and 3.2 with some variations because of uranium emergency facilities in Tennessee?
A Yes.
Q The figures are significantly different, are they not, as percentages of growth rate?
A Yes.
Q So that ----
A (Interrupting.) Tennessee is higher, the growth rate is higher than Massachusetts.
Q So that we would then expect that growth rate curves would be considerably different than those for Tennessee?
A That is correct.
Q Now, in your high-priced case, using Tennessee as a model, page 7-14, which is the one we have in front of us, and which shows a tendency, at least in the short-run, for a leveling at the high-price case?
A (Not responding.)
Q Do you have any reason to believe that the price of electricity will decrease over the next 25 years?
A Over the next 25 years?
Q Yes, even the next 15 years.
A Over the next 15 years I have reason to believe it --

H1-5

does electricity apply to the plan?

Q Yes, the plan?

A In real terms?

Q Well, in such as to effect the growth rate.

In other words, do you believe that the high priced case is going to be the case for the base rate case?

A I think, you know, they are. It depends on a lot of factors and the price can go either way and they are, there is no hard evidence that real price of electricity will either decline substantially or even, based on my knowledge, I think that real price will increase.

Q All right.

A But it will increase probably at a lower rate than say the prices of oil or gas.

582 331

H2-1

Q I'm speaking of electricity?
A Yes.
Q Now, pages 727, 729 and 731?
A Yes.
Q These are tables 717, 718 and 719?
A Yes.
Q In the first two tables, you use the heading, "Comparison of Average Annual Residential Consumption of Electricity per Customer," and Table 718, "Comparison Average Annual Commercial Assumption of Electricity per Capital," and 719, "Comparison of Average Electricity Intensiveness for the Industrial Sector," and can you describe to me the difference in the use of terms consumption, versus intensiveness?
A Intensiveness is described on a kilowatt hours per value per dollar of production.
Q So, it is a specific difference?
A Well, a denominator, and it is different because in an industrial sector, you should use industrial productivity demand.

Now, the different sectors use different denominators.
Q All right. On Table 733?
A Yes.

H2-2

Q 720, on page 7-33?

A Yes.

Q You have an accurate total of the growth rate 3.2 for New England?

A That is right.

Q Do you have any reason to believe that that number might be more or less in the next fifteen years?

A Yes. Those, you know, this is the base case.

Q Yes.

A Plus the higher prices we have demonstrated growth rate will reduce to the point of 2.7 percent if electricity costs were not increased as much as what we projected for the base case., the growth rate will increase to a 3.9 percent.

So, yes, they are, you know, this is by no means this is going to be the case.

It depends on those assumptions that we used.

Q Are you acquainted with the Applicant's figure of the growth rate of estimated, at 3.8 percent?

A It was mentioned here yesterday, yes.

Q Do you believe that to be the high price or low price or base case for the Applicant?

A The Applicant's figure is between our base low price case.

582 333

H2-3

Q Now, do you believe that 3.8 figure for the Applicant's to be their high price, low price or base case?

A I don't think the Applicant -- The range is not presented here. I only know 3.8 percent was mentioned.

Q Do you believe, then, that we can assume that that's the base case?

A Yes, because that is within the range of our forecast. And, you know, I'm defending only ranges of forecast that I would use, and anything falling within that range's possibility.

Q I hesitate to ask the distinction between the word possibility and probability, but since you are a statistician, I will ask that question, but what is the difference between the word possibility and probability?

A Well, the probability is defined in the statistical sense, as the measure or likelihood of events which will happen.

Q But possibility allows for some variations?

A Yes.

Q So that your range then is a possibility of upper and lower?

A Yes.

Q And your best protection of probability is a base case?

A I would say so.

H2-4

MR. CLEETON: I have nothing further.

I have no furthe questions.

MR. CALLIHAN: At this point in time, I would like to pick up on the latest question that Mr. Cleeton referred to, and you have heard, I believe, you just said, Dr. Chern, reports by the Applicant of the projected growth rate of 3.8 percent per year; is that correct?

THE WITNESS: Yes.

MR. CALLIHAN: And in the table which Mr. Cleeton just referred to and elsewhere, in what has been characterized as the final model, there appears 3.2 percent for New England?

THE WITNESS: Yes.

MR. CALLIHAN: Do you consider those two quantitites, 3.8 and 3.2 to be specifically different and perhaps we should approach this in this way, what bounds do you put on 3.2 to be specifically different and perhaps we should approach this in this way, what bounds do you put on 3.2, do you know what bounds the Applicant has put on 3.8 and that brings us back to my original question, are the 3.2 and 3.8 statistically different?

THE WITNESS: I think so. They are, statistically, different, based on the forecasting data available and which was produced.

So, you know, but real comparing different things here.

3.2 is produced by a set of assumptions, the set of assumptions primarily the price of energy, but the error that we're talking about here is, you know, a statistical error which may conform from the dimension of parameter, you know, which may come from the specifications of the model based on the kind of 3 to 5 percent error for any forecast we produce, saying 3.2 is statistically speaking significantly different from 3.8.

MR. CALLIHAN: As you also know, I'm sure, since the subject has been discussed earlier in these hearings, have you read the testimony or seen the transcript of the sections in, I believe, 1975, and again in 1977, at which there was a discussion of the need for power in this area, are you familiar with the earlier testimony?

THE WITNESS: I am not.

MR. CALLIHAN: Point out to me the results of the validation of the model? I think you said in your opening remarks that considerations had been given to the history of the generation and consumption of electric energy in these parts, and I believe you said

H2-6

you used that information over quite a span of years to validate or calibrate, I think the term has been used, your particular model, and is there a table or a graph in your testimony that shows how well the current model has predicted historical events?

THE WITNESS: Yes.

Section 6 discusses the model validation and Table 6.1 on page 6-6 represents the mean square perecentage errors.

582 337

I-1-1

DR. CALLIHAN: Is there a value given for the New England sector as a whole?

DR. CHERN: Yes. The first region is given on Table 6.1

DR. CALLIHAN: I see, and 6.1 gives the values by states?

DR. CHERN: Oh. I did not calculate that for the region as a whole.

DR. CALLIHAN: All right. Fine. So, looking back at history, I presume that data, existing data, were used to establish the model?

DR. CHERN: Yes.

DR. CALLIHAN: And that, I trust, in some instances the model was then applied to historical events and one obtains actual and calculated. Now, in Table 6.1, if this is truly wh[illegible] addresses my point, where are values for demand, price, and so forth; where are values listed in this table or which values are listed in this table, representing actual data and corresponding values calculated where the actual was not used to establish the model? Are those listed in this table?

DR. CHERN: Not the actual data, the actual data was used in our computer model to estimate the model. But we in this report did not present the historical data on, say, residential sales, but they are all the data for this.

DR. CALLIHAN: Let me ask my question more simply. Can you give to us the comparison between calculated quantities and observed quantities that give you confidence in the propriety of the model?

DR. CHERN: Yes. Those are the computer output lists of the historical and predicted. But we cannot present all the dummies in the report.

DR. CALLIHAN: Is there a summary of them?

DR. CHERN: This is a summary. The mean square area is statistical measure for summarizing how the model performed in terms of a percentage of error, so those are the summary measures I presented in the report. They were calculated from the predicted and actual for the period. Every year, not just one point. Every year from 1955 to 1974. And these numbers were produced by our computer models.

DR. CALLIHAN: And table 6.1

presents the percentage differences between calculated and observed?

DR. CHERN: And observed.

DR. CALLIHAN: Right. Fine. That I think I understand.

Let's address the historical data for a moment. Were the data, historical data, compared in 6.1 as calculated in, were those historical data used to establish the co-efficient and constant, and so forth, in the model?

DR. CHERN: Yes. Correct

DR. CALLIHAN: Well, I guess I am looking for something quite independent. I am looking for a comparison of calculated values with historic values not used in establishing the model.

DR. CHERN: I am sorry. I probably should have explained this.

DR. CALLIHAN: Please do.

DR. CHERN: What the model does is to see whether the price affects electricity, whether income affects electricity demand, whether population affects electricity demand, whether heating degree days as a climatic available affect electricity demands. So what we have stablished is a set of co-efficients which explains when the price increased by one percent how people react. How much people change their consumption, the use of their consumption, by how much. This is the model we estimated, but the model, the purpose of the model, is to predict demand for electricity. So we use the model as we establish an estimated and use the model to predict demand from 1955 to 1974 and then compare with actually the data actually observed.

So thus that is the standard way to see how a model, how well the model performs. So the thing we compare is the actual electricity demand as compared with what the model will generate. We are predicting based on all information, population, prices, income and so forth.

DR. CALLIHAN: And in that comparison, and I am saying this for summary, and in that comparison none of the actual data were used in establishing the model.

DR. CHERN: None of the actual data of electricity demand were used in testing the model for that period, yes.

532 341

1-1-5

DR. CALLIHAN: Do you understand my problem?

DR. CHERN: Yes.

DR. CALLIHAN: I am trying to establish that there is no, what I call, inbreeding.

DR. CHERN: What we are trying to compare we will not use in producing the predictions, and that is to say that the actual demand in the residential sector in our post of testing the model has never been used in producing a prediction for residential demand for electricity, but the historical data we use are those variables, population, income and so forth.

582 342

I2-1
KG/RM

DR. CALLIHAN: Are you familiar with the NEPOOL calculations which led ultimately to the 3.8 percent annual growth?

DR. CHERN: I didn't. I did not review their model carefully. I am aware of the structure, the general structure of the Battelle-Columbus model. Their model and our model represent two well-established methodologies; one is an econometric model which we use. One is the so-called end use model which they use.

DR. CALLIHAN: As I understand their method, an interval of history was selected in NEPOOL's terms to calibrate their model, and then, as I understand, they looked at other historical performance not used in the establishment, and I was seeking a statement of whether such a situation existed here, but I repeat what I understand you to tell me, and you can tell me if I'm incorrect about that, the comparison in table 6.1 are real and are not between model values, calculated values, and data used to established the model?

DR. CHERN: This is the most appropriate comparison which we present here.

DR. CALLIHAN: Well, I think it is in the record. I think that is what you said. The 6.I table gives a true comparison?

I2-2
KG/RM

DR. CHERN: Yes. As a true comparison.

DR. CALLIHAN: Of calculations and observations?

DR. CHERN: That is correct.

DR. CALLIHAN: Thank you. That is all I have.

MR. GOODHOPE: Dr. Cole?

DR. COLE: Dr. Chern, all my questions have to do with elasticities, and tables 5.1, 5.2 and 5.3 in NRC Exhibit 65.

First I want to make sure that I understand what the numbers mean from the tables, and in the columns in any one of these three tables under natural gas price and oil price where we have numbers, those numbers are positive, is that correct?

DR. CHERN: Yes.

DR. COLE: I see one exception. Table 5.2. But, does that mean that as price increases the response of the particular sector, whether it be commercial, industrial, or residential, would be to purchase more of that commodity?

DR. CHERN: Yes.

DR. COLE: Does that strike you as a little strange?

DR. CHERN: No. This is, you know, a standard

582 344

I2-3
KG/Rm

economic term called a cross price elasticity. Those elasticities explain the pattern of interfield substitution; when the price of natural gas increases, say relatively to electric price, it is likely to throw a switch from natural gas to electricity, so that will increase the demand for electricity. Did I make myself clear?

DR. COLE: Yes, sir. Then I stated it incorrectly. I was reading that as the price of natural gas increases they would use more gas.

DR. CHERN: This is electricity demand.

DR. COLE: The demand of the elasticity of electricity demand as regards to those prices. Thank you on that clarification.

Now, in comparing the electricity price elasticity for each of the three sectors in table 5.1 to 5.3, making a comparison of the elasticities for New England and the Middle Atlantic, the regional estimates, and comparing those elasticity values under electricity price with national estimates, is it reasonable to say that in the category of residential as shown on table 5.1 that the New England electricity price elasticity values mentioned compare rather favorably with those of the national estimate, those mentioned as national estimates?

I2-4
KG/RM

DR. CHERN: What happened in---

DR. COLE: (Interrupting.) Looking at table 5.1. Can you tell me that?

DR. CHERN: Right. It is the high elasticity we tested in any given region, even compared with the national, yes. I mean compared favorably.

582 346

j-1-1

DR. COLE: Dr. Chern, is that correct?

THE WITNESS: I mean, all the estimates except for this, yes.

DR. COLE: Looking at table 5.1 you have a form for New England, a short run elasticity of minus .33 and a long term elasticity of minus 1.5.

Now, looking at the national estimate it has a range of from minus .5 of up to minus 1.46 with an average of somewhere around 1.2 for the long range?

THE WITNESS: That is right.

DR. COLE: Is it fair to say that this is so, sir?

THE WITNESS: They are saying, these are the differences among the regions.

DR. COLE: I am just looking at New England, now, sir, and how does New England compare with the national estimate that you have listed in table 5.1?

THE WITNESS: But 1.5 is quite higher. It is really higher than, say, the minus .37 we estimated for the Pacific regions.

DR. COLE: Are you looking at table 5.1?

THE WITNESS: Yes.

DR. COLE: And you are looking at the value of minus 1.50 for New England?

THE WITNESS: Yes.

DR. COLE: And you are now looking at national estimates and then all of those values listed on the long run elasticity price , national estimates?

THE WITNESS: Yes.

DR. COLE: And what would you say would be the average of those values, sir?

THE WITNESS: I think that this is a consensus among energy modelers which is about 1.1.

DR. COLE: Would you say that it is significantly different than the value you have for New England in the same categories?

THE WITNESS: I cannot say, statistically, different, but New England appears to be on the high side.

DR. COLE: And New England appears to be on the high side?

THE WITNESS: Yes.

DR. COLE: All right, sir, but you say that the difference between one and 1.5,

582 343

1.5 is on the high side?

THE WITNESS: That is right.

DR. COLE: Now, would you look at table 5.2 in exhibit, Staff Exhibit 65?

THE WITNESS: Yes.

DR. COLE: And look at the values for electricity demand elasticities regarding electric prices for New England both in the short term and long term, what are those values, sir?

THE WITNESS: Minus .47 for the short term and minus 1.31 for long.

DR. COLE: Now, would you compare those values with the comparable values listed in the category of national estimates in the column electricity price?

THE WITNESS: Yes.

DR. COLE: How would those numbers compare, sir? Would they be approximately the same, high or low?

THE WITNESS: I think it is approximately the same in this particular case.

DR. COLE: Now, could you go and do the same exercise, that was for the commercial sector, and would you do the same exercise for the industrial sector for table 5.3?

THE WITNESS: Yes.

DR. COLE: What is the value for electricity price elasticity in New England?

THE WITNESS: It is minus .06 for the short term and minus 116 for the long run.

DR. COLE: Now, what are the national estimates for the same categories, sir?

THE WITNESS: Well, they range from point .81 to minus 1.98.

DR. COLE: Where do you get the .81, sir?

THE WITNESS: This is the second study.

DR. COLE: All right. You gave the long term first?

THE WITNESS: Yes.

DR. COLE: Continue.

THE WITNESS: And how would those numbers compare?

DR. COLE: Yes, how would those numbers compare?.

THE WITNESS: They would appear to be on the low side.

DR. COLE: Would it be fair to say that they are considerably lower than the national estimate?

582 350

THE WITNESS: Yes, based on those studies available, yes.

DR. COLE: All right, sir.

Now, for the three tables the residential sector was, indicated that the New England, that New England was somewhat higher but not statistically different, for the commercial sector approximately the same and for the industrial sector considerably lower than the national estimate, and could you tell me, sir, what is it about the industrial sector in New England that makes it-- sets it apart from the national estimate when the commercial and residential sectors are, approximately, the same?

THE WITNESS: Well, in one respect, you get good evaluations , you know, they would be expected for the industrial sectors for the reasons, you know, since New Englanders-- that there are many types of customers for the industrial sector.

We are dealing with a number of industries, number of firms, which are so homogeneous. I just pointed out that the pattern of electric consumption for the paper industry

582

is so drastically different from the pattern of electricity used in the steel industries.

So, one would expect a high, you know a good variation of, and here we are talking about the aggregate elasticity which, in a way, this describes how the industry as a group responds to the price changes.

The changes in the electricity price and because of this non-homogenous group of industries it could vary from one area to the other, from city to the other, from one region to the other region.

So, you know, we are in the process, you know, we are very curious about this regional variation and we are now in the process of trying to determine, to learn and to establish some evidence as to why electricity varies from region to another, but those are electricity estimates based on the data for that region.

So, it is supported by our data, and, you know, that is the best answer that I can get and, you know, it has been estimated that elasticity for each industry differs very significantly.

582 352

J2-1
/em

DR. COLE: This value for long-range elasticity, electricity demand elasticity as regards the electricity price in New England, value of minus 0.16, this is your prediction of what it will be in the future?

THE WITNESS: No.

DR. COLE: And the ----

THE WITNESS: (Interrupting.) This is what the data, we estimate the model based on the data from this Region, that is the estimate based on data.

DR. COLE: All right, sir, but isn't that included in your model and now becomes your prediction of what it will be?

THE WITNESS: Yes, sir.

That would become the predictors, yes.

DR. COLE: Now, and it is based on actual observed industrial sector response to the price of electricity?

THE WITNESS: That is right.

DR. COLE: I have no further questions.

MR. GOODHOPE: Ms. Mulkey, any questions?

MS. MULKEY: Yes. Perhaps Dr. Feld can join Dr. Chern at this time, and then I could complete the redirect examination of both of them.

582 353

MR. GOODHOPE: All right.

Now, we will have a short recess.

(Whereupon a recess was taken at 11:30.)

MR. GOODHOPE: The hearing is in order.

REDIRECT EXAMINATION

Q (By Ms. Mulkey.) Dr. Feld, would you clarify for us the way in which the concept, "utilized information to predict cost of Pilgrim 2 and the operating and maintenance costs as used in the Staff's predictions of Pilgrim 2 costs?"

A Yes. The Staff relied on generic tools, essentially computer codes, known as Concept and Omcost, and although these are generic tools, the analyst has the opportunity to input specific data to make them relevant to the plant under consideration.

For example, input into these computer codes includes identifying the region of the country in which the plant is being built, the size of the unit, the type of reactor it is, the number of units at the site, the type of cooling system that they will be using and all of these inputs are an attempt to make the estimate more closely in agreement with the actual proposal that we're looking at, in this case Pilgrim 2.

The other, I think, very important component

J2-3

of these models is that they provide a very scientific and very thorough attempt to review the historical experience with respect to these cost components, and that they look at cost trends that have occurred over as much as ten to fifteen years in the past, and as such, the projections that are made, based on these computer codes, in fact, attempt in a very scientific fashion to capture historical costs, experiences that occurred there.

Then, finally, the codes are continuously updated in terms of cost indexes that are played each year and they are updated to account for the latest increases that have occurred, and with respect to concept, for example, the code itself, was revised every few years in order to update the referenced case that we're looking at.

Now, in other words, the nuclear plant design changes over time, engineering changes due to safety changes, due to technological change, and every few years, this reference plant is revised to reflect the latest design that we're experiencing in the construction of nuclear plants.

Q And operating and maintenance costs?

A The same features would apply to costs, as to concepts. The OMCST looks at historical experience and cost

J2-4

trends in projecting the increase in the salaries, the maintenance, the materials and equipment they use, which are all components of the operation and maintenance cost itself.

Q And, Dr. Feld, what is the Staff's judgment of the potential impact of a time of day pricing practice in New England on the Staff's forecast?

A Yes. During my cross examination I was asked to assume that time of day pricing was imposed on all of the utilities in New England, and what impact that would have on the forecast that the Staff came up with.

At that time, I indicated that the effect on energy requirements or energy sales, I would not wish to change my forecast with respect to the energy requirement components and I provided an explanation as to why I don't think it is necessary to produce that here.

With respect to the peak of forecasts, I think my response was that I didn't know and I would like to change that now.

That is, I would expect the peak load forecast to be lower than what I have presented in my testimony.

However, I think it is important to carry the analysis one step forward and ask what then would

582 356

be the affect on the need for Pilgrim Unit 2, and with respect to the need of Pilgrim Unit 2, in terms of reliability assessment, I don't feel as if I would want to change my testimony.

The reasons for that are two-fold:

First of all, if, in fact, peak load pricing or time of day pricing is imposed on all utilities in New England, and its result in lower peak load forecast and correspondingly higher growth rate in energy cells, it means that there will be a shift in the load duration curve for this New England system.

There will be a flattening of this load duration curve.

The affect of that would be to increase the optimum mix of generating capacity that one would want to see on the system that was characteristic of the higher load factor would be to a greater reliance on base load capacity relative to intermmediate or peaking

So, although there may be a net decline in the total capacity requirements for the system that would also be a shift towards the greater reliance on baseload capacity such as Pilgrim Unit 2.

The second point being that as a load factor improves all other things being equal, we would expect the reserve margin requirements to increase.

That is, there is a reserve margin standard of one day in ten years for reliability. That would remain the same, but the reserve margin as a percentage of peak loads to meet that one day in ten years would increase and, therefore, there would be, this would be the prevailing force in terms of the reduction capacity that would actually be resulting from the lower peak load forecast.

K1-1
KG/RM

Q Would you briefly explain to clarify how the Staff converts the energy forecast computed in the Oak Ridge model into a peak load forecast?

A (By Mr. Feld.) Yes. The Staff utilizes an assumption regarding the system for overall load factor to convert its energy requirements forecast to that peak load forecast.

The Attorney General's office has criticized this and indicated that the more appropriate measure would be to take the energy requirements by major customer class and apply the class load factor to each one of those distinct sectors to ultimately derive its peak load forecast, and they essentially said that our methodology is wrong. Well, I feel personally that the methodologies are basically the same. It is simply a question of whether one wants to work with an overall load factor or one wants to work with individual class load factors.

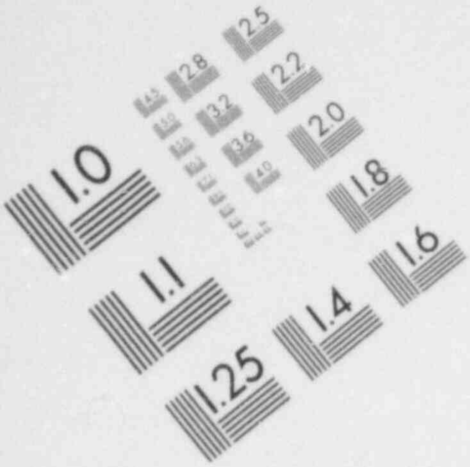
The reason why the Staff avoided using the individual class load factors is twofold: first, the way in which the class load factors were derived. By the way, if we went with the Attorney General's office suggestion, it would mean that we would have to depend on the NEPOOL's class load factors as our input to make this conversion, and, therefore, we would lose some of

K1-2
KG/RM

our independence. But more important than that, the class load factors are derived by NEPOOL based on their forecasting model in which they calculate energy sales as a function of number of customers times average use, and then they must also simultaneously or in conjunction with looking at energy sales or requirements convert it to a peak demand forecast.

In other words, they look at how that load is distributed over time and they develop load profiles for each end use, and then in turn they derive their peak load forecast, so if I were to take NEPOOL's class load factor and apply it to my forecast of energy requirements, it would appear to me to be a very illogical procedure because I would then be taking a load factor that was predicated on certain load profiles which were imbedded in NEPOOL's forecast to derive at a totally different peak demand forecast based on their underlying assumptions. To avoid that, I went went with a class load factor, and I would also like to point out that there was some major differences, or there was a difference indicated in terms of what effect would be on our ultimate peak load forecast between the approach we took and the approach that the Attorney General's office wanted us to take.

I think that they indicated like something



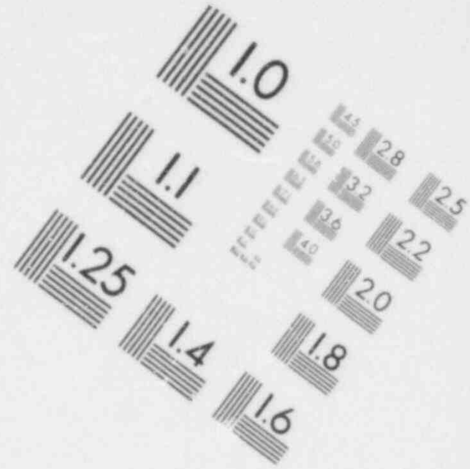
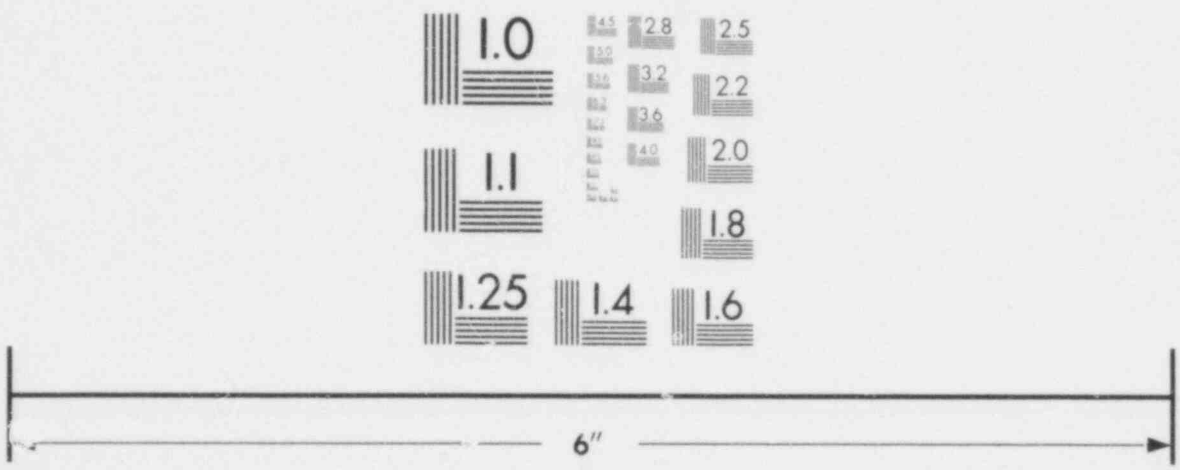
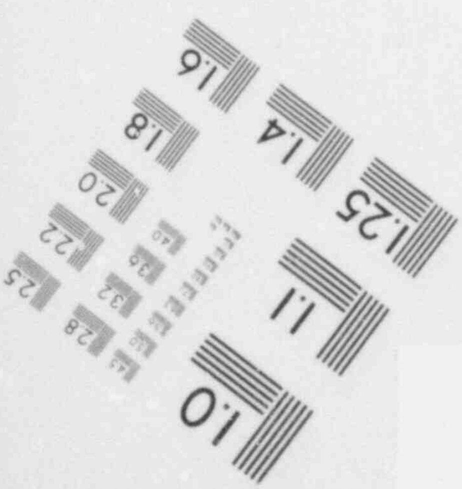


IMAGE EVALUATION TEST TARGET (MT-3)





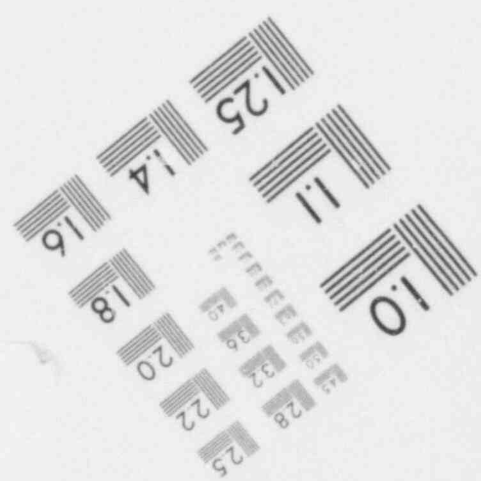
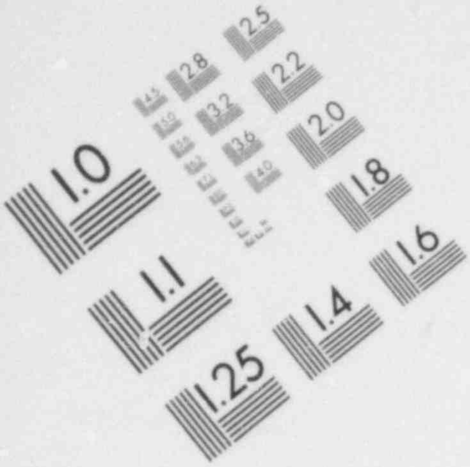


IMAGE EVALUATION
TEST TARGET (MT-3)

6″



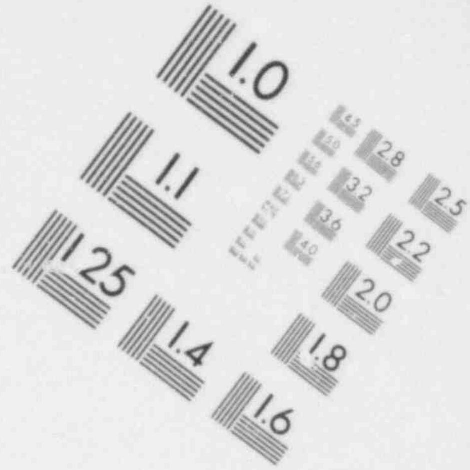
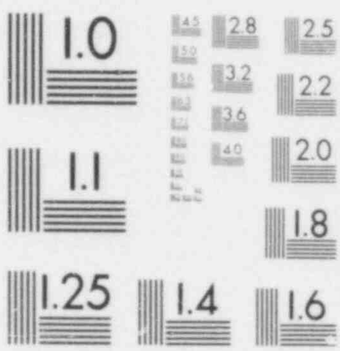
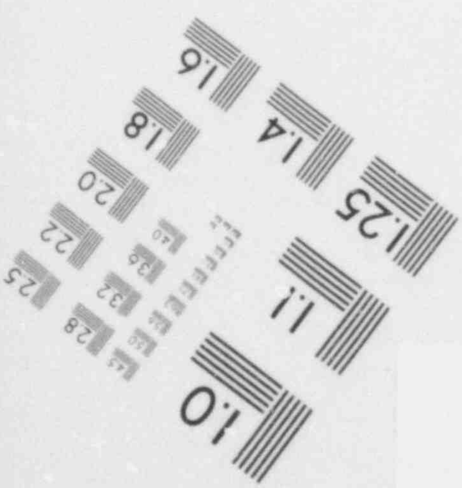
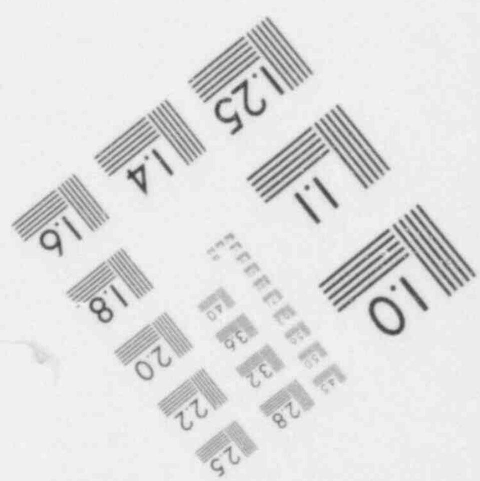


IMAGE EVALUATION TEST TARGET (MT-3)



6″





K1-3
KG/RM

on the order of 2,000 megawatts reduction in peak demand by 1990 would result.

Well, I dispute that. The reason why it is not due to this distinction between a class load factor and an overall load factor is that the Staff's analysis was predicated on an assumed constant load factor of 61 percent over the forecast period. The class load factors were predicated on a weighted average where the overall load factor would improve from 61 to 64 percent over the forecast period.

The major difference attributing -- the major difference that occurred between the Attorney General's office conclusion and ours can be attributed to the fact, to the difference in the assumption regarding the overall load factors, and as I have indicated in my initial cross-examination, I had looked at the effect of assuming an improving load factor over the forecast period of 61 to 64 percent. The conclusion I reached was that under our base case the need would be shifted from one year into the future, and our low price scenario, the need would be shifted to two years into the future.

Q Would you explain how you feel the recent OPEC price action affects the Staff oil substitution discussion?

A Yes. It is my belief that the testimony that I offered

K1-4
KG/RM

with respect to savings associated with the oil substitution essentially contains a very strong conservatism on the part of the Staff. By conservatism I mean that we are tending to underestimate the potential savings associated with bringing the nuclear plant on line early.

The reference case that I presented in my testimony based upon Department of Energy latest official forecast of prices of oil, and to be more specific it's the Energy Information Office projections within the Department of Energy. Those projections were made prior to the recent increase in the price of oil that we experienced back in the beginning of JUne, I believe, and to give you an example, the reference case prices that we have assumed are based on an assumed world oil price per barrel of 15 dollars a barrel in 1978 dollars reflecting 1985 deliveries, and I also want to point out that the Department of Energy projections that we are using for the price of oil are for residual oil that is to be delivered to New England for utilities in the 1985 - 95 period. Their analyses actually look at something that is closely related to the problem that we have here.

In my conversation with the Department of

583 002

K1-5
KG/RM

Energy they feel that based on the recent price experience, using the median case, their scenario C which is what I used and is my reference case, would be an understatement of the expected price of oil to New England utilities in 1985 and 1990. They would recommend using the high end of their scenario.

MR. MEYER: Objection. I think at this point we shouldn't be offering opinions of third parties who we have never heard before.

MR. GOODHOPE: I have to agree. It is pure hearsay now.

MS. MULKEY: Mr. Chairman, hearsay is admissible in administrative proceedings.

MR. GOODHOPE: Who are these people that you are talking about?

DR. FELD: The names are Jean Clark and Anthony Reynolds are of the Energy Information Office.

MR. GOODHOPE: Have you related information that they gave you as to what they felt they anticipated in the future?

DR. FELD: Well, I have some printouts here of the forecast that they are providing, and I think an examination of the underlying inputs relating to each of these scenarios would, independent of what they felt, would lead me to believe that a different

K1-6
KG/RM

scenario wo ld be more appropriate, and I could explain why.

583 004

MR. GOODHOPE: Would you make those available to Mr. Meyer when this is over? I will overrule the objection. Go ahead.

DR. FELD: The scenario B that the Department of Energy looked at considers an essentially low supply scenario and it assumes the highest oil import price of all the scenarios being reviewed by the Department of Energy. That price is, again, for deliveries of 1985, \$21.50 in 1978 dollars.

MR. GOODHOPE: That is still a conservative price.

DR. FELD: It would still be conservative relative to the prices that we have experienced in the last month or so. This type of scenario is incorporated in my testimony as the high range oil price escalation scenario, and I guess what I am ultimately leading up to is that based on this information I feel that the staff's high oil escalation assumption is the more probable one to look at as a reference case in that it calculates savings from bringing the nuclear plant on line.

Q Now, Dr. Feld, in your answer to the previous question converting energy to peak load forecast, you stated that if we had used the improving load factor assumption that it would have changed the staff's prediction of need for Pilgrim 2, keeping everything else equal, in its base case by one year and low price case by two years; did you mean to say that just the opposite?

A Well, now, I am confused. I would have to check some papers.

Q I think you had better. I think the record goes both ways.

A What did I do, one year to base case?

Q Yes. I may be wrong on that.

A May I check.

Q While Dr. Feld is checking, I have a question for Dr. Chern.

Dr. Chern, could you estimate for us the number of specifications which were tested in developing your model to its present state

A (By Dr. Chern.) Number of what?

Q Specifications that you tested for the equation, estimated, how?

A Well, in terms of amount of specifications, we report in the early report, the draft report, we present at least two specifications of th k-2-3

price equations. But this is a common practice of model users in order to select an equation, a final equation. You feel reasonable and comfortable. One often runs at least two dozen equations for one equation, so in terms of number of equations we have done, it exceeds an order of maybe a thousand equations for all of the nine census regions, not just one. Not just those for New England.

I can tell you the extensive testing of the numbers.

Q Dr. Chern, you concluded the number of equations run for New England would be about how many?

A All together for that three years?

Q Yes.

A More than two hundred. At least two hundred equations.

Q Dr. Feld, did you check?

A (By Dr. Feld) Yes. It is one year on the base case and two years on the low price scenario.

MR. GOODHOPE: Two years under the low price scenario?

DR. FELD: Yes, which is the high end of our forecast.

Q Would you describe briefly the relationship k-2-4

between the choice of a discount rate for purposes of the type of analysis you have done and the choice of escalation rate to represent general inflation?

A Yes. I will try. The discount rates that are being used essentially being discussed by all of the parties in this proceeding can be characterized as a nominal discount rate. That is, containing two components. There is a real discount rate. One component is a real discount rate which accounts for the real cost of money or the real value of money, and historically that has been fairly stable.

I would estimate something on the order of three to six percent. Usually it varies depending upon the level of risk associated with this particular investment.

The other component i, much more viable. That reflects general inflation, or simply the fact that the value of the dollar is changing over time. That has to be taken into account when we also make our calculations to bring everything into the same years dollars. It brings it back to the same point in time.

Historically, probably five percent

is a good number. Of course, in recent years the rate of general inflation has double digit level and perhaps 12, 13 percent may be a fair characterization of the rate of general inflation.

In the staff's analysis we assumed a ten percent discount rate. The implied assumption there is that five percent real discount rate and five percent rate of general inflation. This discount rate is being applied to the period 1985 to the year 2016.

It is looking at the value of the cost of money over that time period.

We did not feel that the double digit inflation that we are experiencing today is going to continue out over the 1985 year to 2016 period. We felt that it would revert back to the more normal historical rate on the order of five percent.

The important feature, though, of the entire present worth calculation is that once you have a discount rate, your escalation rate, such as the cost that you are escalating, must be consistent with the assumptions that are imbedded in your discount rate.

Therefore, when the staff uses a ten percent discount rate, which assumes five percent general inflation, the costs that we are escalating out into the future, the O&M cost, the nuclear fuel, the capital, and so forth, should relate somewhat to that perception of five percent rate of general inflation. In fact, they do. Most of our costs are escalating at five percent. Some are a little higher to reflect our expectation of real increases.

But they are consistent with our overall philosophy of five percent rate in general inflation.

The Attorney General's Office on the other hand has suggested that something on the order of 20 percent for a discount rate would be appropriate. They have also indicated that they would expect many of the costs associated with the nuclear plant to escalate at very high rates, perhaps on the order of 15 to 20 percent.

I would speculate that the net effect of their assumption relative to the staff's assumption would be essentially negated in the actual calculations of looking at the effect of our present worth savings.

For example, if the staff assumes a ten percent discount rate with five percent general inflation escalation for its cost components, the net effect of that is a real discount rate of five percent. The real cost of money.

Alternatively if the Attorney General's Office proceeded with the 20 percent discount rate but assumes something on the order of 15 percent escalation in the cost, and they in fact were consistent with the general rate of inflation, their calculation would produce the same net effect. Essentially a five percent discount rate, and that would be what would be captured in the calculation itself.

583 01

K3-1
KG/RM

Q Dr. Feld, Dr. Cole asked you to explain why the Staff had elected to present an analysis of the substitution for oil as a reason for the basis for analyzing the need for Pilgrim 2. Would you amplify a little bit about this? The reason the Staff has done so in this session of the hearing that did not do so in previous sessions.

A In previous sessions of the hearing, Staff looked at the need for power based on reliability assessment, and as a result of our forecast at that time, the need for Pilgrim was clearly demonstrated in the time period proposed by the Applicant. It was a very clear cut assessment, and, therefore, we did not feel that it was necessary. In fact we felt that it would be redundant to provide additional criteria to this question.

However, in our present testimony that I filed at this point in time, the reliability assessment is not at all clear cut. Our most likely time of need, based on reliability, is some three years later than the year being proposed by the Applicant. Because of this, because we didn't have this clear cut standard, we felt it desirable to look at additional criteria, and that is what we did in this case.

MS. MULKEY: I have no further questions on

K3-2
KG/RM

redirect examination.

MR. GOODHOPE: Mr. Lewald?

MR. LEWALD: I have nothing.

MR. MEYER: Very briefly.

RECROSS EXAMINATION

Q (By Mr. Meyer.) Dr. Chern, first you indicated that a large number of equations specifications had been tried for New England and the other regions, is that correct?

A (By Dr. Chern.) Yes.

Q As a general matter, if you have to look at more equations before you find one that works well, is that a sign that your model is good or a sign that your model is bad?

A No. That has nothing to do with whether the model is good or bad. The reason is that none of the specifications of the model is perfect so we are testing the different alternative model specifications and trying to determine which model specification is the best to characterize the behavior of the consumer.

Q And despite the number of equations that you tried, you never found a specification which picked up, say, the gas price variable for residential sector, is that right?

A I didn't say that. I said that on a statistical

K3-3
KG/RM

significant label, no. I was looking very carefully that natural gas supplies coefficient, because, you know, I always try to get a perfect model if I could.

Q Would you agree with the following stateme t as a matter of general statistical principle, that if you try enough specifications for any set of data you eventually will hit something that produces a satisfactorily good fit at any level?

A No. I have been doing this econometric modeling for 7 years and if the data are not good, you are never going, if the coefficient is not there, no matter how many you try, you won't get it. But as a general purpose I try very hard to get a perfect model. I very much would love to have it at every price to appear in the model, but I just couldn't do it based on the methods I used and on the data that I had.

Q Dr. Feld, you mentioned that both the CONCEPT and the OMCOST codes are scientific; is that the term that you used?

A (By Dr. Feld.) Yes.

Q If you attempted to back cast either the Pilgrim 2 capital cost estimates or the Pilgrim 1 operating maintenance expenses to find out if those codes would have predicted what in fact has happened?

583 014

KG- 4
KG/RM

A No, I have not.

MR. MEYER: I have no further questions.

MR. GOODHOPE: Dr. Cleeton?

DR. CLEETON: Yes.

RECROSS EXAMINATION

Q (By Dr. Cleeton.) In what seems more like testimony was a long answer you indicated that the need for Pilgrim 2 is based on the optimum mix for base load, is that correct?

A (By Dr. Feld.) No. I don't believe I did. I remember how I used.

Q Well, let me ask you this, then. You indicated that you had extended or indicated that it is quite possible your peak load forecast would flat out more than you had originally testified?

A If in fact time of day pricing were imposed upon all utilities in New England, yes.

342
L1-1

Q And that flattening of the forecast of peak load would also create a more liberal demand on the base load?

A That is correct.

Q Now, if that is the case, then, given the fact that most of the power sources coming on line in the next fifteen years are nuclear, how does the reliability of anticipated or unanticipated outages in nuclear power generation increase the liability for base load?

A I'm not sure I can answer that question.

Q Let me put it another way, if peak load levels out and with the rate adjustment creates a more level base load and Pilgrim 2 is characterized as a base load plant and that all other plants come on line in NEPOOL are essentially nuclear or at least a large percentage of them are, what then is their anticipated or unanticipated outages for refueling or unreliability of equipment?

How does that effect then, the generation of a base load which is now a constant and its more relied on a nuclear power?

A Well, I'm not sure if I really am going to be responsible for answering that question, and I don't know if I understand it fully, but as the load curve flattens, it essentially means that when you do have

583 016

L1-2

a fourth outage, the probabiity that occurs at a relatively peak period increases schedules, maintenance will begin to have to start to occur during relatively peak periods because in the extreme, if it was totally flat, anytime something went out it would impact on your capability to meet peak demand.

The effect of that would be to increase the reserve margin requirement as a percentage of peak demand to maintain the same level of reliability.

Q Could this be done if Boston Edison would return all the oil-fired plants for reserve rather than base?

A They can, but, of course, there would be a cost to be assessed with keeping those units in working conditions and on line.

If, in fact, you had a perfectly flat low duration curve, your need for peaking would be clearly reduced and you would want to function with mostly baseload units.

The economics would become much more favorable for baseload.

Q All right, in regards to the so-called discount and inflation rates, you mentioned here, and you also mentioned the cost of money, is the cost of money relied upon compounded interest rates?

A The cost of money is dependent on what components of the economy are charged to borrow money, and it is usually reflected as a, you know, the percentage.

Q The percentage?

A Yes.

Q But is, and we hear it said on the news all the time about a jump of the prime rate, but that rate is a stated rate, but this is not in essence over time and compounding of interest?

A I guess you would have to distinguish between an effective cost of money and, you know, I guess there there is truth in lending values of the rate of interest and then they tell you what it is going to be based on how you pay it back.

Q But it is conceivable that should there be, say, a level of economy of recession, then the interest rates will go up or down?

A I don't know.

Q All right. One other question.

Now, you indicated that the Staff has represented a case in the previous testimony earlier in the hearing, based essentially on reliability and therefore felt no need to develop the so-called oil substitution case; is that correct?

A Yes.

Q Now, was that reliability based on forecast of needs that were about twice what they are now, dated in this particular set of hearings, namely about 6 or 7 percent versus 3.2 or 3.8?

A I can only speak for -- I can only recall the case that I was involved in in this proceeding, to the proceeding prior to this one.

I think it was in 1977, and at that time I believe the Staff forecast was in the force.

Q Are you?

A 4 percent range, yes.

Q Are you aware of the Applicant's having set forth rates as high as 6 and 7 percent as in the early part of the Proceeding?

A I'm not -- I dont have those figures, but I would not be surprised.

MR. CLEETON: Thank you, I have no further questions.

MR. GOODHOPE: Thank you Dr. Chern, and Dr. Feld. You are excused.

L2-1

MR. GOODHOPE: Has anybody been able to contact any witnesses?

MR. MEYER: No. Mr. Chairman, I still have not been able to.

MS. MULKEY: I'm afraid that we have some very bad news.

MR. GOODHOPE: What is that?

MS. MULKEY: Not only is it not possible for the Staff to be available for the next Monday, it appears that Dr. Soffer, who is eesential to our presenting not only testimony of population on evacuation planning, but also on population, will also not be available for the week of August 6th.

Let me just inform you of a couple of other things.

At the time we thought the evacuation planning testimony was to have been filed, at the beginning of August, we anticipated filing rebuttal testimony which we had mentioned to the Board on the subject of population as it relates to alternate sites.

That testimony we had anticipated would be handled in conjunction with a discussion of alternate sites population.

That testmiony we might be able to file, to hasten it or file it, but we can't have it in

L2-2

early August.

MR. GOODHOPE: That will be rebuttal testimony?

MS. MULKEY: That is correct.

MR. GOODHOPE: Has all the testimony been filed? Do we have any more coming in from anybody else?

MS. MULKEY: Our rebuttal testimony.

MR. GOODHOPE: And the Emergency Planning comes in, when is it, fairly soon?

MR. LEWALD: The date was August 3rd, as it stood against the Hearing date of August 20.

MR. MEYER: Mr. Hearing Officer, Mr. Chairman, I believe that the Commonwealth's witness that was mentioned yesterday, Mr. Wright, is not currently filed and Mr. Wright was indicating that he might have a problem making the August 3 date on that particular testimony itself.

MR. GOODHOPE: Well then you better get in touch with him and let us know. He may get in touch with us if he wants an extension of time on it.

MR. MEYER: Yes.

MR. GOODHOPE: It is not going to be much because we are going to go ahead on the 27th.

Well, if we can't set a hearing on the

L2-3

sixth, who could we get if we had a hearing on the sixth? We could get Mr. Barstow, I think?

MR. LEWALD: Yes.

MR. GOODHOPE: Could we get Mr. Herr?

MR. MEYER: I don't know. Could I suggest that at least, I'm speaking fro only the position of ignorance now, and it appears that the Staff has some uncertainties, the best way to handle this might be to have all parties get into a conference call Monday and inform the Board on Monday because I just can't inform the Board as to what the possibilities are right now.

MR. GOODHOPE: Would Mr. Kennedy be available on the 6th?

MS. MULKEY: He would, but I don't think it is, I just don't think separating him and Mr. Soffer would be advantageous to the Staff.

MR. GOODHOPE: You had a list of rebuttal testimony that you intended to offer, Mr. Lewald?

MR. LEWALD: On this issue, the need for power?

MR. GOODHOPE: Yes.

MR. LEWALD: No, we hadn't intended to file any.

MR. GOODHOPE: All right. Well, the only

thing that we can say for certain is that we will start hearing on the emergency planning an we will try to work in the rest of the witnesses on population and Mr. Barstow, as fast as we can commencing on August 27, and I think we better reserve two weeks for that.

The following Monday is Labor Day, but I think we better reserve those nine days definitely for hearings and I think we ought to go into the week of the 10th.

Now, Dr. Cole just informed me that the week of the 10th is out for both of the other Board members and so let's try to get everything that we can done on the week of the 27th and the day after Labor Day.

So, we'll get an order out and, like I say, we'll try to accomplish all that we can do so that we can get something together on the 6th, which I very much doubt, and the only one who will be available will be Mr. Barstow and it doesn't make much sense to come together only for one witness.

MS. MULKEY: I would agree with that, Mr. Chairman.

MR. GOODHOPE: So, it looks like we're going to have to try to do it all in those two weeks commencing on August 27.

MR. CALLIHAN: I'm referring to the

Conference call, which will be the 23rd, as Mr. Meyer suggested and let's set a time for it.

MR. GOODHOPE: All right.

MR. MEYER: What I would suggest is that the parties talk amongst themselves Monday and maybe either I or the Staff takes the responsibility of informing the Board.

DR. COLE: You will then give us some date as to when the witnesses will be available to testify.

MR. MEYER: Between now and the 23rd of August. That is correct.

MR. GOODHOPE: The 27th of August.

Now, is there anything else at this time?

MR. GOODHOPE: Mr. Meyers, then we will meet at a future time?

MR. MEYERS: Yes, we will.

MR. CALLIHAN: Thank you.

MR. LEWALD: In light of the change of the hearing date on emergency planning I would make the request that they file testimony instead of on the third, file it on the date of August 10th.

MR. GOODHOPE: Any problems with that?

(No verbal response.)

MR. GOODHOPE: All right. If it is agreeable to everybody than it is agreeable to us.

MS. MULKEY: If it is agreeable to the Board itself we will file this rebuttal testimony on evacuation issues on that date unless there is a change on the date.

MR. GOODHOPE: Get everything done on that date.

MR. LEWALD: Mr. Chairman, I have a housekeeping matter in that I would simply like to introduce into the record Amendment 36, 37 and 38 to the Applicant's testimony. These have been previously distributed to these parties. I would just like, unless there is

L-3-2

any objection to them, I would ask that Amendment 36 be marked as Applicant's Exhibit Number 1-PP, 37 Applicant's Exhibit Number 1-QQ, and 38 Applicant's Exhibit 31-RR.

(The above documents were so marked.)

MR. GOODHOPE: Are they offered into evidence?

MR. LEWALD: Yes.

MR. GOODHOPE: Any objections?

(No response.)

MR. GOODHOPE: All right, there being no objections, the documents will be received.

(Whereupon the documents were received in evidence.)

MR. GOODHOPE: Now, is there anything further?

(No response.)

MR. GOODHOPE: All right, there being nothing further this hearing is adjourned until some further date.

(Whereupon the hearing adjourned at 12:35 p.m.)

PROFESSIONAL QUALIFICATIONS OF WEN S. CHERN

NAME: Wen S. Chern

PRESENT POSITION: Group Leader, Energy Demand Analysis Group, Energy Division, Oak Ridge National Laboratory

BUSINESS ADDRESS: Energy Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, TN 37830
(615) 576-7594

HOME ADDRESS: 10421 Pinedale Dr.
Knoxville, TN 37922
(615) 693-7909

BORN: Taiwan (March 19, 1941)

CITIZENSHIP: U.S.

MARITAL STATUS: Married, two children

EDUCATION

Institution	Degree	Year	Field
National Chung-Hsing University	B.S.	1964	Agricultural Economics
University of Florida	M.S.	1969	Agricultural Economics
University of California, Berkeley	M.A.	1971	Statistics
Univeristy of California, Berkeley	Ph.D.	1975	Agricultural Economics

MAJOR FIELDS OF INTEREST

Energy and Resource Economics, Consumer Demand, Quantitative Policy Analysis, and Econometrics

PROFESSIONAL MEMBERSHIPS

American Economic Association
International Association of Energy Economists
Econometric Society
American Agricultural Economic Association
American Statistical Association

PROFESSIONAL EXPERIENCE

1974-Present: Economist and Group Leader, Energy Division, Oak Ridge National Laboratory. (Duties include developing and managing research projects, supervising staff members, and research on electricity demand forecasting, industrial energy use, and energy policy and conservation analysis.)

Co-principal Investigator, Energy Policies and Their Secondary Impacts. (A Grant From the U.S. Energy Research and Development Administration.) July 1975 - January 1976

Student Adviser and Instructor, Great Lakes College Association/ Oak Ridge, Science Semester. September 1975 - December 1975
September 1976 - December 1976

Principal Investigator, Forecasting Electricity Demand by States. (Sponsored by the Nuclear Regulatory Commission.)
May 1976 - Present

Principal Investigator, Comprehensive Economic/Engineering Models of Industrial Energy Use. (Sponsored by the Department of Energy.)
May 1977 - Present

1978-1979: Visiting Associate Professor, Research Institute of Agricultural Economics. National Chung-Hsing University, Taiwan. (Duties included teaching two courses in econometrics and research on econometric analysis of supply and demand for rice in Taiwan.)

1973-1974: Assistant Professor of Food and Resource Economics, University of Florida; and Research Economist, Florida Department of Citrus. (Duties included research on demand and marketing of orange products.)

1972-1973: Associate Research Agricultural Economist, Department of Agricultural Economics, University of California, Berkeley. (Completed Ph.D. Degree under Professor George M. Kuznets.)

1969-1972: Research Assistant, Department of Agricultural Economics, University of California, Berkeley. (Worked for Professor George M. Kuznets.)

1967-1969: Research Assistant, Department of Food and Resource Economics, University of Florida. (Completed M.S. under Professor Leo Polopolus.)

1965-1967: Analyst, Department of Foreign Exchange, Bank of Taiwan, Taipei, Taiwan. (Foreign exchange services)

PUBLICATIONS

I. Books

G.S. Maddala, Wen S. Chern, and Gurmukh S. Gill, *Econometric Studies in Energy Demand and Supply*, Praeger Publishers, Inc., 1978.

Wen S. Chern and Richard E. Just, *Econometric Analysis of Supply Response and Demand for Processing Tomatoes in California*, Giannini Foundation Monograph No. 37 (Berkeley, 1978).

II. Journal Articles

Wen-Shyong Chern and Leo Polopolus, "Discontinuous Plant Cost Function and a Modification of Stollsteimer Location Model," *American Journal of Agricultural Economics*, November 1970.

Wen S. Chern, "Demand Substitution Between Natural, Flavored, and Synthetic Citrus Juices," *Southern Journal of Agricultural Economics*, December 1974.

Wen S. Chern, "Acreage Response and Demand for Processing Tomatoes in California," *American Journal of Agricultural Economics*, May 1976.

Wen S. Chern, "Demand and Conservation of End-Use and Primary Energy in the Residential and Commercial Sectors," *Energy Systems and Policy*, Vol. 2, No. 3, 1978.

Wen S. Chern and Richard E. Just, "Regional Analysis of Electricity Demand Growth," *Energy*, (accepted and forthcoming).

Richard E. Just and Wen S. Chern, "Tomatoes, Technology, and Oligopsony," *The Bell Journal of Economics*, (accepted subject to revision).

III. Journal Articles Under Review

Wen S. Chern and Richard E. Just, "A Generalized Model for Fuel Choices With Application to the Paper Industry," submitted to *The Bell Journal of Economics*.

Hui S. Chang and Wen S. Chern, "A Study on Electricity Demand and Variation in the Price Elasticity of Demand for Manufacturing Industries," submitted to *Journal of Energy and Development*.

Hoang Nguyen, Wen Chern, and David Reister, "Modeling Energy by the Paper Industry: An Economic/Engineering Approach," submitted to *Resource and Energy*.

Wen S. Chern and Richard E. Just, "An Econometric Study of Electric Power Demand in the Pacific States," submitted to *Management Science*.

IV. Technical Reports

Wen S. Chern, *Econometric Analysis of the Consumer Demand for Orange Juices in Canada*. ERD Report 73-2, Florida Department of Citrus and University of Florida, November 1973.

Wen S. Chern, *Electricity Demand by Manufacturing Industries in the United States*. Oak Ridge National Laboratory Report ORNL-NSF-EP-87, November 1975.

Wen S. Chern, *Energy Demand and Interfuel Substitution in the Combined Residential and Commercial Sector.* Oak Ridge National Laboratory Report ORNL-TM-5557, September 1976.

W. S. Chern, R. E. Just, B. D. Holcomb, and H. D. Nguyen, *Regional Econometric Model for Forecasting Electricity Demand by Sector and by State*, Oak Ridge National Laboratory Report ORNL/NUREG-49, October 1978.

Wen S. Chern, Richard E. Just, and Steven B. Caudill, *Energy Demand and Fuel Choices in the Pulp and Paper Industry*, Oak Ridge National Laboratory Report ORNL/CON-33, October 1978.

D. B. Reister, W. S. Chern, and H. D. Nguyen, *An Econometric-Engineering Energy Demand Model for the Pulp and Paper Industry*, Oak Ridge National Laboratory Report ORNL/CON-29, 1979.

V. Papers in Proceedings of Conferences and Symposiums

Wen S. Chern, "Estimating Industrial Demand for Electricity: Methodology and Empirical Evidence," in Fred Roberts ed. *Energy: Mathematics and Models*, SIAM Institute for Mathematics and Society, 1975.

T. J. Tyrrell and W. S. Chern, "Forecasting Electricity Demand: A Range of Alternative Futures," *Systems Thinking and the Quality of Life*, Proceedings of the 1975 Annual Meeting of the Society for General Systems Research, 1975.

W. S. Chern and William Lin, "Energy Demand for Space Heating: An Econometric Analysis," *The 1976 Proceedings of the Business and Economic Statistics Section*, American Statistical Association, 1976.

W. S. Chern, G. S. Gill, R. S. Carlsmith, and S. M. Cohn, "Electricity Demand Analysis and Forecasts for the United States," *Proceedings of the Summer Computer Simulation Conference*, Washington, D.C., July 12-14, 1976.

W. S. Chern, S. B. Caudill, and B. D. Holcomb, "Future Growth of Electric Power Demand in the South Atlantic Region," *Proceedings of the Third Annual UMR-MEC Conference on Energy*, University of Missouri-Rolla, October 12-14, 1976.

Wen S. Chern and Richard E. Just, "Analysis of Aggregate Electricity Demand Elasticities With Implications for Time-of-Day Pricing," *Proceedings of the EPRI Workshop on Modeling and Analysis of Electricity Demand by Time-of-Day*, ed. D. J. Aigner, (forthcoming).

Wen S. Chern and Richard E. Just, "Regional Analysis of Electricity Demand Growth," *Proceedings of the IGT Symposium on Energy Modeling and Net Energy Analysis*, ed. Fred Roberts (forthcoming).

Hui S. Chang and Wen S. Chern, "A Study on Electricity Demand and Variation in the Price Elasticity of Demand for Manufacturing Industries," *The 1978 Proceedings of the Business and Economic Statistics Section*, American Statistical Association, 1978.

PRESENTATIONS

Wen S. Chern, "Impact of Generic Advertising on the Import Demand for U.S. Frozen Concentrated Orange Juice in Canada," American Agricultural Economics Association Annual Meeting, College Station, Texas, August 18-21, 1974.

T. J. Tyrrell and W. S. Chern, "Forecasting Electricity Demand: A Range of Alternative Futures," The Society for General Systems Research - AAAS Annual Meeting, New York City, January 27-30, 1975.

Wen S. Chern, "A Dynamic Model for Estimating Electricity Demand by Manufacturing Industries in the United States," Western Economic Association Annual Conference, San Diego, California, June 25-28, 1975.

Wen S. Chern, "Estimating Electricity Demand and Coal Supply: Methodology and Empirical Evidence," SIMS Research Application Conference on Energy, Alta, Utah, July 7-11, 1975.

W. S. Chern and G. S. Gill, "Implications of Natural Gas Shortage for Industrial Demand and the Environment," American Agricultural Economics Association Annual Meeting, Columbus, Ohio, August 10-13, 1975.

W. S. Chern, G. S. Gill, R. S. Carlsmith, and S. M. Cohn, "Estimating Future Electricity Demand in An Era of Increasing Energy Scarcity," American Nuclear Society Winter Meeting, San Francisco, November 16-21, 1975.

Wen S. Chern, "A Market Shares Approach to Modeling Energy Demand," Western Economic Association Annual Conference, San Francisco, June 23-27, 1976.

Wen S. Chern, "Forecasting Electricity Demand in the East North Central Region," Western Economic Association Annual Conference, Anaheim, California, June 20-23, 1977.

W. S. Chern and R. E. Just, "Analysis of Aggregate Demand Elasticities With Implications for Time-of-Day Pricing," the EPRI Workshop on Modeling and Analysis of Electricity Demand by Time-of-Day, San Diego, California, June 11-14, 1978.

W. S. Chern and R. E. Just, "State-Level Forecasts of Electrical Energy Demand," Western Economic Association Annual Conference, Honolulu, Hawaii, June 21-26, 1978.

H. S. Chang and W. S. Chern, "A Study on Electricity Demand and Variation in the Price Elasticity of Demand for Manufacturing Industries," American Statistical Association Annual Meetings, San Diego, California, August 14-17, 1978.

W. S. Chern and R. E. Just, "Regional Analysis of Electricity Demand Growth: 1976-1990," The Institute of Gas Technology Symposium on Energy Modeling and Net Energy Analysis, Colorado Springs, Colorado, August 21-25, 1978.

583 031