EEP02D013

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

June 5, 1982

Dr. Mihailo D. Trifunac
1488 Old House Road
Pasadena, CA 91107

Dear Mike:

Two questions have arisen in connection with the response you gave to my question concerning recurrence frequencies of increasingly severe earthquakes at the Midland site.

1. On Page 336 when you use the term return period, is this per year?
2. Richard Holt mentioned that when they tried to go from your assumptions, as stated in the transcript, they had difficulty getting the results you presented. (They appeared to expect smaller exceedance probabilities). Do you have any comment?

Sincerely,

D. Okrent

David Okrent

Cert: Service EEP-2
Midland
Trifunac CG-2

8508230147 850722
PDR FOIA
BELL85-363 PDR

C/30

MR. OKRENT: I thought some levity might help. I am going to go on to the next part of this seismic discussion in a moment; but let me forewarn the seismic

experts here, meaning from the Applicant and the Staff and the ACRS consultants.

At the end of the discussion on the seismic safety issue, I will be interested in your considered opinions on what you would give as your expected value for the earthquake acceleration tied to REG GUIDE 1.60, so we have a certain spectrum in mind, which has a probability of nonexceedance of 99 or a probability of exceedance of one in a thousand, let's say, a probability of exceedance of one in 10,000 and one in 100,000 per year; okay?

Is the question clear, so you have time to reflect on it?

(Laughter.)

MR. OKRENT: By the way, I will also be interested in what you would say if people asked you to give a number for which you could be 90 percent confident; and I will accept as an answer you have no basis for giving a high confidence level; but, I mean, that tells one something about our problem.

However, I would prefer that you try to play that game, also. It's not a game, really, because it's fairly fundamental to the question that we are trying to get at.

Why don't we go on, then, to the engineering part of the discussion?

I do want before we recess for tonight to come back to the question I posed earlier to the seismologists.

Namely, what is their estimate of that earthquake having a return frequency of a thousand years, 10,000 years, a hundred thousand years?

Will the spokesman for the Applicant start off?

MR. KNIGHT: We had hoped, the seismologists and myself and the others who had thought that, perhaps, the meeting, before it would end tonight -- had hoped to be absent tomorrow. We have to drive to Detroit, which would mean that we would have to leave fairly early.

Is there any way that we could satisfy your requirement, either in writing or to have a member of Staff, which, certainly, would be represented here, to pass their judgments onto the other members of the Staff?

MR. OKRENT: I am not sure what it is you are requesting or proposing.

MR. KNIGHT: I understand you would like us to be here for the opening part of at least the meeting tomorrow.

MR. OKRENT: I was hoping to get the answers --

THE VOICE: Tonight.

MR. OKRENT: -- this evening.

MR. KNIGHT: I am sorry.

MR. OKRENT: I said before we recess. If we can, we will.

So, again, I will give the Applicant first opportunity.

MR. KLIMKIEWICZ: I just happen to have brought some slides.

(Laughter.)

MR. KLIMKIEWICZ: I have a response to your question. I am not so sure that it's an answer.

(Slide.)

Shown up on the screen now is results that we had given in a draft report. These represent a family of seismic hazard curves to be used in a seismic PRA.

Now, I believe what needs to be discussed is how this band of curves is developed.

Several sets of input are used in order to develop these types of curves.

Initially, the seismic hazard curves for modified intensity that I showed earlier I used as a basis for developing these sets of curves.

Also, we had used subjective weighting of models,

the three tectonic models that I had described early. We had favored model one, weighted it as .5, model two at .3 and model three at .2.

The intensity model curves were then transferred into sustained accelerations using the data published by Nutley, 1979.

I believe part of the problem with defining confidence levels is in a type of data that is available -- if I can take a minute to change the slide --

(Slide.)

MR. OKRENT: It's not every subcommittee that has this type of a meeting.

MR. COOK: This one could go down in history.

(Whereupon, there occurred loud volumes of music, generated by the band Radiation.)

MR. OKRENT: I hope the reporter is getting everything.

(Laughter.)

MR. KLIMKIEWICZ: Shown on the slide now are the data of Nutley, 1979.

As you can see, the data are very limited at intensity 8 and higher earthquakes; and for determining probabilities at very low annual frequencies you really need to examine the types of ground motions at intensities

8, 9 and larger.

In order to develop the curves that were shown in the previous slide what we did was fit a model to this type of data, assuming a value of -- while fitting linear models through the median values and the standard deviation values, the standard deviation values are shown as dotted lines.

Also, having fit that type of model through there, it illustrated that maxima for this type of data fell out about two-and-a-half standard deviations. That was used to define sort of an upper range considered in the family of curves shown earlier.

If you can put the other slide back up, please.

(Slide.)

Using the distribution that was fit to the Nutley data, the weights for the three models and also the annual frequencies which were determined in the original hazard assessment, we had to assign weights of probabilities to all of these curves, and their weights were adjusted such that the cumulative distribution was one at the outside curve.

We interpret these as probabilities rather than absolute confidence levels that we are modeling to a reality situation.

From the standpoint of this kind of curve, the 90th

percent confidence is pretty much defined by this solid line, and that intersects the SSE shown as a blue line at about -- at close to ten to the minus four.

So using this type of an approach, it sort of verifies that at fairly high confidence the SSE level is close to ten to the minus four; but, again, we are dealing with limited data in making this type of assessment.

One other aspect of doing probabilistic assessments is that normal assumptions made in calculating probabilities result in curves that generally over-estimate the historical observation, even at low levels of motion that have been observed, well, frequently.

You can see here that the probabilistic results shown on two correlations of peak acceleration to intensity, those of McGuire, 1977, and Trifunac and Brady, 1975, show that the probabilistic results are conservative when compared to the historical estimated ground motion levels at the site.

(Slide.)

This is seen here, plotted against the OBE. Ground motion levels are the estimated ground motions resulting from an intermediate earthquake shown down below and a Parkfield earthquake, which pretty much represents an estimate of ground motion resulting from the 1812 New

Madrid earthquake at the Midland site.

So I guess the answer is that you can extend probabilistic assessment to this degree, but whether it represents absolute confidence has yet to be resolved.

Clearly, you can make many more assumptions about tectonic models and ground motion models.

MR. OKRENT: But this is what you are proposing as an answer, if you have to give one; can I phrase it that way?

MR. KLIMKIEWICZ: Yes.

(Laughter.)

MR. OKRENT: Okay. Thank you.

(Laughter.)

MR. POMEROY: Mr. Chairman, might I just ask, what is the answer? I am sorry.

(Laughter.)

MR. HOLT: What is the question?

(Laughter.)

MR. POMEROY: Can you speak into the mike?

MR. KLIMKIEWICZ: Sure. I believe the answer is that given the assumptions that we used in this analysis, namely, the Nutley data which correlates sustained motions versus intensity, the Cornell McGuire approach for calculating probabilities out of site, also our subjective weighting of tectonic models which is based in part on

eastern seismology as well as seismology in the central U. S. region, also based on geology.

Given that, and assuming all of that information such as that definition of annual frequency of some ground motion is weighted, this is a representation of that, of a synthesis of that seismic hazard analysis.

It represents the distribution in ground motion versus intensity and also the uncertainty in defining seismic recurrence rates for tectonic model and also the effect of variation of upper magnitude, because we assumed the larger upper magnitude for one of the source models.

MR. OKRENT: Again, just so we distinguish between what it is when I talk to my graduate student and I say, "Oh, just do a perimetric study because we are only interested in methodology," here this is your best judgment that you are giving us as well?

MR. KLIMKIEWICZ: That's right.

MR. OKRENT: Thank you. Were you answered, Dr. Pomeroy?

MR. POMEROY: I am not sure. I think your question was what is the earthquake in a thousand years, in 10,000 years, in 100,000 years?

MR. OKRENT: What he did say is you can read that curve and from it have 90 percent confidence the safe shutdown earthquake, which looks to me like .12 G, is a

ten to the minus four earthquake.

Did I read that correctly?

MR. KLIMKIEWICZ: That's right, that's right.

MR. POMEROY: Fine.

MR. OKRENT: Then, of course, you can read it ten to the minus five, ten to the minus three. Okay?

MR. POMEROY: Fine.

MR. OKRENT: Ten to the minus five at 90 percent confidence. As I can eyeball it from here, it's of the order of .17 G.

Is that a fair reading?

MR. KLIMKIEWICZ: I can't see from here but it's probably so.

(Laughter.)

MR. OKRENT: Thank you.

MR. OKRENT: Dr. Trifunac.

MR. TRIFUNAC: First of all, this is sustained acceleration. This is generally not acceptable type of acceleration. Only some people use that; most people don't.

The other thing is that if you look at these curves, they all bend and they all reach a saturation level, which I cannot explain with confidence that is very high, what it means; but I suspect that it is coming from the fact that model attenuation function has a flat cutoff region

for the source; and there is no data for that, either.

So you are really reading numbers from parts of the curves that are highly extrapolated and you don't have the data.

MR. KLIMKIEWICZ: I believe I said earlier that we assumed a truncation at 2.5 standard deviations.

MR. OKRENT: Dr. Trifunac, I am going to suggest that for this part of the meeting, it's fair to ask what is on the viewgraph if someone uses a viewgraph but not why.

(Laughter.)

MR. OKRENT: What I asked was that the that people give their opinions and I didn't say we were going to ask them to justify their subjective judgments.

It would be very interesting but that would go beyond the call of duty, sort 6 of. Thank you.

Let's go to the Staff.

MR. KIMBALL: I also have a viewgraph.

(Slide.)

In the spirit of Dr. Okrent's request, Dr. Reiter and I will both offer our individual professional opinions; and this is not to be taken as a Staff position.

(Laughter.)

MR. KIMBALL: I must say in the review of the Applicant's seismic hazards analysis, we did not make a

definitive enough review to come up with a specific return period for the SSE.

However, we did review it in quite a detail, so we can make some judgment on that alone.

In addition, in my opinion, the most definitive study that has been done on the seismic hazard is that done for the systematic evaluation program.

Quickly, in this viewgraph the slide shows the two closest sites and the sites in Michigan, the Palisades site, which is the closest, and the Big Rock Point.

Even though it looks like an open triangle, that is characterized as the one thousand year uniform hazard spectrum. If I were to approximate that, it's probably somewhere between 5,000 and 10,000, and the Staff says it's on the order of a thousand to 10,000.

Based upon looking at the Applicant's hazard results, looking at relationships such as Murphy and O'Brien and Trifunac and Brady, not looking at sustained, looking at the terra results, I would say I have moderate confidence that it's in the order of a thousand to 10,000, probably closer to 10,000 or ten to the minus four, essentially concurring with what George says there.

Now, to extrapolate into the realm of ten to the minus four to ten to the minus five, I would have low confidence in what I am about to say. No numbers.

Probably somewhere in the order of intensity 7 dash 8, which depending upon which correlation between acceleration and intensity you were going to use, and would probably range somewhere between .16 and .2 G.

MR. OKRENT: Okay. Thank you.

MR. REITER: My name is Leon Reiter from the Staff.

Just a brief comment mentioned before with respect to Parkfield. We can, of course, go into great detail as to why our decision about Parkfield as to exclusion, non-exclusion was taken, but I just want to assure you that we did give this a great deal of consideration.

Our conclusion was not that Parkfield represents the typical record for this particular area but that given the uncertainty and the source conditions for eastern earthquakes and the uncertainty in Parkfield, we think it appropriate to include it within the range of records used to assign a site-specific spectrum. It is not to say we are rejecting the argument.

Right now we are in the middle of funding a research program to examine this item specifically, the effect of surface or near-surface rupture upon records. We hope to have some results within a few months.

With respect to the probabilistic estimates, although we did our results entirely separately, I agree

with Jeff that if I had to make a very good guess, this would be somewhere in the order of ten to the minus three or ten to the minus four, probably a lot closer to ten to the minus four.

With respect to ten to the minus fifth, I would like to paraphrase the response of Jim Devine of the USGA.

The chance of me giving a probability at this probability is very low.

(Laughter.)

MR. OKRENT: Dr. Pomeroy, can we get your opinion?

MR. POMEROY: I don't want to belabor the point. I think that simply I would want to state first that there are great uncertainties in what we are dealing with here, as everybody is now reasonably well aware.

There is no need to go into that much further, but I think there are uncertainties in almost every parameter that goes into a probabilistic analysis.

Those uncertainties are generally orders of magnitude; and as long as they are orders of magnitude -- for example, the slide that was shown earlier that showed you an order of magnitude in standard accelerations.

As long as you have that kind of uncertainty, it's a concept of predicting an exact acceleration or an exact intensity and I think is nothing more than a sort of

scientific gut feeling when you come down to it.

I am really very reluctant to do that; but as long as the Chairman has asked to do that, I will do that.

I would say that if you are talking about ten to the minus third, you are probably talking about an intensity 8, plus or minus one unit.

When you talk about ten to the minus fourth, you are talking about intensity 9, plus or minus two units.

When you are talking with ten to the minus five, you are probably talking about intensity 10 plus or minus three units.

That says that there is no real estimate there. That's all I wanted to say.

MR. OKRENT: Dr. Trifunac, do you want to comment today or tomorrow morning?

MR. TRIFUNAC: I can comment tomorrow.

(Laughter.)

MR. OKRENT: Dr. Trifunac, walked to me during the break and said if I gave him to tomorrow morning, he would work for an hour and come up with an estimate based on some arithmetic.

So I am going to give him that privilege. He is going to tell us before he leaves.

So that you don't miss too much more of the festivities, let me suggest what we might plan for

tomorrow.

Clearly, as I indicated earlier, we cannot complete the original agenda. However, I think it was useful to devote this time on seismic, because I hope we don't really have to do any more on it in detail at the full committee meeting, either, just a summary.

I would suggest that we pick up the item on AC, DC first thing tomorrow morning and then pick up the items G and H.

I wasn't sure whether that was going to be short or long, but possibly Item I and then as much of K and L as we can in the morning. That would be my intent.

After that we would see where we were. You know, that might take us through the agenda time; or if our experience is any indication, it might take more than that.

Are there any comments on that proposed revision of the agenda?

(No response.)

MR. COOK: Would you care to start at 8:00 o'clock perhaps?

We are at your disposal.

MR. OKRENT: Let's see. Are there any comments on starting at 8:00 o'clock?

MR. FISCHER: Just a minute.

MR. OKRENT: I am sorry. It seems we are bound by the Federal Advisory Committee Act both to have open meetings and to begin them at the time published in the Federal Register.

We don't have to end at the time published.

(Laughter.)

MR. OKRENT: So we would be willing; but, unfortunately, in the same way as this evening, for example, were we ready at 5:00 o'clock, we couldn't begin until 6:00, because that was the published time.

Does the proposed revision of the agenda inconvenience anyone, that they desperately wants a topic covered tomorrow morning that is not currently proposed?

(No response.)

MR. OKRENT: Any comments? Going --

MR. SULLIVAN: Dr. Okrent, we may have to ask for a slight re-arrangement of the management, because we are flying some folks in from Big Rock tomorrow morning early.

When they get here, we will discuss it with them.

MR. OKRENT: All right, fine. Well, you can think it over. We are flexible.

Let me know first thing in the morning if you want to do something different than what I proposed.

With that I will recess the meeting until tomorrow

morning at 8:30.

(Whereupon the meeting was recessed until the hour of 8:30 o'clock A. M., May 21, 1982.)

(The meeting was recessed at 10:30 o'clock P. M.)

Before going into the agenda for today's meeting, I am going to call on Dr. Trifunac. He owed us something from last night.

Why don't we deal with that matter first?

Dr. Trifunac?

MR. TRIFUNAC: Yes. I have done some calculations that are preliminary, but here is the summary.

I am going to give a list of ifs, and then if you want to accept that, I will give you the conclusions.

(Laughter.)

MR. TRIFUNAC: Okay. The first if is if we assume in quotation marks Michigan Basin seismicity applies.

If you recall, there was a figure, which I believe was figure No. 5 in one of the presentations yesterday, which showed the recurrence relationships for the area, and Michigan basin is the case which corresponds to a very large area subject with a uniform seismicity rate, and I am assuming that this is a meaningful way to come up with

a preliminary estimate of probabilities.

So this is assumption No. 1.

Assumption No. 2 is that seismicity is uniform in the area around the site, in large areas necessary; and I am going to assume, also, that the largest earthquake can happen in the area as modified by Cal intensity of 8, with a cutoff level recurrence relationship, is going to be 8.

The second assumption is that we want to incur the PSV, the psudo relative velocity spectrum for 5 percent damping. I picked 5 percent. It's sort of a nice number in the middle.

This could be done for any damping.

The third assumption is, then, that the logarhythm of base ten of sub V is equal to 1.1 minus 1.0 M sub B. This is, again, essentially from figure No. 5 which was presented yesterday, per year, per ten to the power kilometers squared.

All of this data is really based on the intensities, and I have used the Nutley-Herman 1978 relationship between MB and I class, which states that M sub V is equal to 0.5 times the max number intensity plus 1.75. With this going back into N sub C relationship, I find that logarhythm base ten, where N is the number of earthquakes, is equal to approximately 0.18 minus 0.5 I, where zero stands for intensity.

This gives me the relationship for the area I want to consider.

The next "if" is that I am using intensity based risk calculations. I don't believe that we have enough statistics and data to use M sub V in this area, even though this is the way calculations were done for the other estimates.

The other "if" is my assumption that the life of the plant is going to be of the order of 50 years, and so this is an input that I needed.

So if you are willing to accept some of these ifs, or at least consider them, the conclusions are tne following.

When the probabilities of exceeding the following figure accelerations are approximately according to the following numbers -- and I will give three numbers in order.

First I will say what is the acceleration I am talking about.

Then I will give approximate probability of exceedance, given the above conditions, and then I will give an estimate of the term period.

I picked up numbers which are in the range that might be of interest.

So the first acceleration is .05, 5 percent G,

probability of exceedance is about 80 percent. Return period is about 30 years.

10 percent G, .10, probability of exceedance is about 40 percent. The return period is close to 100 years.

15 percent G, .15, the probability of exceedance is somewhere in the vicinity of 15 percent. Return period is about 300 years.

The last entry is 20 percent G, .20. Probability of exceedance is on the order of 8, certainly less than 10 percent, and the return period is 600 years.

This concludes my summary.

MR. OKRENT: If I can just ask two questions to understand what you were saying.

When you said you were assuming that there was a certain region in which you were accepting the stated seismicity, is that what was called the -- well, categorized as the smaller region on the map or designated Michigan basin or the central stable region? Which of those two was it?

MR. TRIFUNAC: I believe it is the smaller region; but if you look at the map, you will find that this is really a very large region; and the other things, the others are hot pockets further away, are quite a few kilometers away and, therefore, the effect they produce on

the final result is very small, yes.

MR. OKRENT: Okay. And then, just to make it clear -- I think it is -- that when you are talking about probability of exceedance, that is over the 50-year period?

MR. TRIFUNAC: Yes, that is right.

MR. OKRENT: Thank you. All right.