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Transcript of Proceedings

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

DEPOSITION OF LYMAN WAGNER HELLER

50-329

Bethesda, Maryland

Thursday, 4 December 1980

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the matter of:	
CONSUMERS POWER COMPANY	Docket Nos. 50-329-OM, 50-330-OM, 50-329-OL, 50-330-OL
(Midland Units 1 and 2)	

DEPOSITION OF LYMAN WAGNER HELLER

Bethesda, Maryland

Thursday, 4 December 1980

Deposition of LYMAN WAGNER HELLER was resumed, pursuant to agreement of counsel, at 11:15 a.m., in Room P-114, Phillips Building, 7920 Norfolk Avenue, Bethesda, Maryland, before William R. Bloom, a notary public in and for the District of Columbia, when were present on behalf of the respective parties:

On behalf of the Applicant:

RONALD ZAMARIN, Esq. and ALAN FARNELL, Esq., Isham, Lincoln and Beale, One First National Plaza, Chicago, Illinois

JAMES E. BRUNNER, Esq., Consumers Power Company, 212 W. Michigan Avenue, Jackson, Michigan

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On behalf of the Regulatory Staff:

WILLIAM D. PATON, Esq. and BRADLEY JONES, Esq.,
Office of Executive Legal Director,
United States Nuclear Regulatory Commission,
Washington, D. C.

eb

C O N T E N T S

Witness	Direct	Cross	Redirect	Recross
Lyman Wagner Heller		142		

Exhibits	For Identification
7	217
8	218

eb1

PROCEEDINGS

Whereupon,

LYMAN WAGNER HELLER

resumed the stand and, having been previously duly sworn, was examined and testified further as follows:

MR. ZAMARIN: This is the continuation of the deposition of Lyman Heller, continued from October 9th, 1980, to this date by agreement of the parties.

CROSS-EXAMINATION (Continued)

BY MR. ZAMARIN:

Q Mr. Heller, do you refer to yourself as Mr. Heller or Dr. Heller?

A It's your option.

Q All right.

I don't even call my doctor Doctor, so I'll refer to you as Mr. Heller, and I don't intend any disrespect by that, if you refer to yourself as Dr. Heller.

You understand you are still under oath from the first session of the deposition, sir?

A Yes.

Q Do you know whether it is intended that you will provide testimony at the OM hearing?

eb2

A I guess I'm not sure what an OM hearing is.

MR. PATON: Now you know they've been consolidated. It's OM/OL.

MR. ZAMARIN: Well, he may provide-- I assume he may be provided at the OL on some other issue.

BY MR. ZAMARIN:

Q The soils settlement hearing. Do you know if there is any intention of you providing testimony at the soils settlement hearing?

A I honestly don't know.

Q Okay.

MR. ZAMARIN: Do you know? This may have some effect on how wide our inquiry is. You don't know?

MR. PATON: Off the record.

(Discussion off the record.)

MR. ZAMARIN: Back on the record.

BY MR. ZAMARIN:

Q What is your primary role or responsibility in the Midland soil review issue?

A I think it has changed over the last year and a half. I'm not sure whether you mean now, or at some other point in time. Would you clarify that?

eb3

Q Yes.

If we can start with what your present role is with regard to the Midland soil settlement issue.

A I think my present role is to attempt to meet the schedules that have been set up for the hearings, attempt to get a reasonable degree of resources people time available to go through all the information that has apparently become available.

Q Okay.

Do you have any active role in reviewing and analyzing technical data with regard to the soils issue?

A Not the active, calculational type of activity. I do suggest items that appear to need to be checked and suggest that somebody either carry out a rough check of those items or refer them to someone else for their consideration.

Q Can you give me some idea of the type of things you're referring to when you say you might suggest an item that needs to be checked?

A Well, there's a number of review areas involved in this including mechanical and electrical, the piping people and our people, and I suggested that we keep these other esoteric areas informed of what we are doing and try to

eb4

get a unified review of the different topics.

I guess that's the best answer I can give you.

Q I see.

So when you say "items that need to be checked" you're referring more to like checking with these other areas to see what information they have on that area and to see that the efforts are coordinated as opposed to suggesting that someone check their computations or check the basis for an assumption that he's made?

A I would think it would be both.

Q Do you have any role or responsibility with regard to deciding whether the geotechnical input would either be favorable or not favorable to a fix or a certain aspect of a fix proposed by Consumers or Bechtel?

A May I ask that that question be repeated? I think I missed the first part.

MR. ZAMARIN: Will you read back the question, please?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: Now that you've repeated the question I guess I would ask if it would be possible for you to

eb5

either rephrase or to break that question into more bite-sized items that I can answer.

MR. ZAMARIN: Okay.

BY MR. ZAMARIN:

Q Let me explain really what I'm looking for.

We've taken a substantial deposition from Joe Kane and are aware of his involvement in what I call the hands-on technical aspects of reviewing information and interfacing with the Corps of Engineers to understand the work the Corps of Engineers is doing.

Really what I'm trying to find out is in light of all the things that they're doing, just what you do with regard to the soils. In other words if someone submits something for Consumers or Bechtel with regard to a dewatering scheme, for example, is it your role or your responsibility to review the aspects of that and say either that's acceptable or that's not acceptable?

A I would not do the actual review of the information that came in. I would probably ask the reviewer or the person who is responsible for the review the basis for either excluding certain items from consideration that might occur to me or the basis for acceptance of what was submitted,

eb6

provided that's not adequately described in their SER or questions or whatever.

Q Okay.

And then what would you do after you had asked the reviewer those questions? Satisfy yourself as to whether he was correct in either excluding them or accepting them?

A Yes.

Q And if you disagreed or determined that the reviewer was not correct, for example on excluding a certain item, would you then direct the reviewer to reanalyze or reconsider the problem?

A I might or I might not, depending on how serious I thought the oversight might be. It may be of negligible import and I'd forget it. It may be that it would be necessary to go back and look for more information and perhaps ask a question to get it answered.

Q Other than with respect to the completeness of an analysis or consideration, do you chiefly rely on the technical judgment of your reviewers then with regard to the soils issues at Midland?

A Yes.

Q Do you exercise independent technical judgment on

eb7

major decisions, for example with regard to the dewatering example, or do you simply see that the analysis and review done by the reviewer was complete and comprehensive?

A I guess I would have to answer "both" in this case. It's kind of a cooperative thing, an iterative review where we try to consider important aspects of it and ignore the less important aspects so it's an iterative process.

I feel that I contribute to the review but don't actually do the review.

Q Have you examined boring logs with regard to the Midland soils?

A Some of the early logs I did look at. Yes, sir.

Q When you say "early logs" you are talking about logs prior to what time?

A Prior to about the first of January, 1980, roughly 11 months ago.

Q You had some change in responsibility I believe with regard to the soils issue, did you not, at one time?

A Yes.

Q And can you tell me what your responsibility was prior to that change, and then the time that it changed?

A I believe this was covered in my earlier testimony

eb8

but I'd be glad to refresh your memory.

Q If you would.

A I became knowledgeable of the settlement problem I believe it was in September or October, somewhere in that range, of 1978. At the time Mr. Dan Gillen was doing the review and I was his immediate supervisor and I relied on his expertise for the -- what we call Q-1's acceptance review or Q-2's for the plant in the review process.

We visited the plant together in I believe it was December of '78, along with others from NRC. Some time in the spring or early summer of that year Mr. Gillen transferred to another division of NRC, another office of NRC rather, and at that point I was the only person acquainted with the Midland site and the Midland review, and I attempted to do what I could to fill that void until we were able to get the Corps on board and find time for Mr. Kane to become involved in the review.

And at that point I was able to relinquish my contribution to Mr. Kane and the Corps.

Q I take it then that from some time around the spring of 1979 until just about the end of 1979, your responsibilities with regard to the Midland soils would be

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somewhat analogous to what Mr. Kane and the Corps are doing now?

A My responsibilities were roughly the same. My activities were much less.

Q Since January of 1980, have you reviewed any piezometer data with regard to the diesel generator building and its surcharge program?

A Not in enough detail to formulate any opinions. I have gone over some of the plots with Mr. Kane but have not attempted to look at the physical basis for those plots.

Q Some of the plots that you went over with Mr. Kane, do you recall the reason for going over them with Mr. Kane?

A Well, as I recall he asked me to look at a number of plots so I did. And he discussed some of the reasons for his interpretation and I offered some opinions as to perhaps alternate interpretations that might be made, strictly in a non-detailed but philosophical vein.

Q Do you recall what Mr. Kane stated as his reasons for his interpretations of the piezometric data?

A Not to any great extent. I do recall one discussion of the conditions at the point of the piezometer, what his interpretation was of the soil conditions, whether the

eb10 .

piezometers were sealed, whether they were open piezometers or whether they were closed piezometers, trying to get a feel of the volume change that would be necessary to get those readings in the piezometers; things of that kind.

Q And do you recall what alternative reasons or interpretations that you suggested to him during those conversations?

A The only item I recall was the rebound-- Let me use another word; whether or not there should be some expected drop in the piezometer due to taking the preload off of the fill, how long that drop might be expected to continue before it regained usual groundwater levels.

Q And in your opinion should there be some expected drop in piezometer level upon removal of the surcharge?

A Yes, there would be.

Q And in your opinion would the length of time before regaining what appeared to be the usual groundwater level as exhibited on the piezometer plots that you saw for the diesel generator building comport with what you would have considered to be expected or normal?

A I don't believe I have an opinion on that. It was not clear what the conditions were -- to me. I haven't

eb11

looked at the boring logs recently. I really did not have an opinion on that. I knew it would be expected to happen but I couldn't express an opinion as to whether they were reasonable or not.

Q I see.

Did Joe Kane tell you whether he thought that the piezometric data demonstrated either secondary consolidation or lack of secondary consolidation or nothing at all to him, or something of that nature?

A No, that wasn't the item that was under discussion.

Q Do you know whether Joe Kane ever found out the type of piezometer that was used and which had its data represented on those plots, that is whether it was an open or closed tube?

A Well, we discussed that just the other day, and I don't believe that he has yet a clear understanding or a clear description of the actual physical specifications for those piezometers.

Q Do you know whether he ever asked anybody for that kind of information?

A I don't know whether he has or not. I think somewhere along the line we asked whether they were rapidly

eb12

responding piezometers or whether they were open type piezometers.

Q Do you know whether they were rapidly responding or open type?

A It was my impression over the review period that they were closed piezometers and that they should respond reasonably quickly to changes in pore pressures.

Q Is it your understanding then that Mr. Kane's analysis of the piezometer data is based upon an understanding or a belief that they were rapidly responding, closed system piezometers?

A I don't know that.

Q Did you ever discuss the piezometer behavior in the diesel generator building with anyone other than Mr. Kane?

A Not to my recollection, no.

Q Have you reviewed, since January 1980, any laboratory records of consolidation tests, shear strength tests, or Dutch cone tests for the Midland site?

A I have not reviewed it in detail. I think I'm aware of the existence of those items.

Q Have you had any discussion about either laboratory records of consolidation tests or shear strength tests

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or Dutch cone tests with Joe Kane since January 1980?

A Yes.

Q Do you recall the substance of those conversations that you had with Mr. Kane?

A The substance, as I recall, was simply to indicate to him that cone penetrometer data I believe was gathered quite early in the review, quite early in the exploration by Bechtel in the diesel generator area, and I suppose that additional cone penetration data was obtained later. So I just wanted him to be aware that there was earlier data that had been shown to us or had been available at some time previous to what had been recently submitted.

Q And is that the substance then of your conversations with Mr. Kane about consolidation test, shear strength test and Dutch cone test data? Does that about cover it, in other words?

A That's all I can recall in terms of submitted information.

Q Since January 1980, have you reviewed any Boris anchor measurements with regard to the diesel generator building?

A No, sir.

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Q Have you reviewed a document titled "Applicant's Position on Need for Borings" that was submitted by the licensee?

A I have leafed through it with interest but I have not reviewed it in detail.

Q Did you discuss it with anyone?

A Yes, I did.

Q Do you recall with whom you discussed it?

A I discussed only one small aspect of it with another reviewer on another plant.

Q Can you tell me what you discussed, and with whom?

A I discussed bearing capacity evaluations with Mr. John Greeves.

Q Will you spell "Greeves" for me, please?

A G-r-e-e-v-e-s.

Q And what was the substance of your discussion of bearing capacity with John Greeves as it related to that document, "Applicant's Position on Need for Borings"?

A We were involved in the review of another plant in which bearing capacity calculations had been performed and we were-- I mentioned to him that bearing capacity evaluations had been made for the Midland application as well

eb15

as for this other application.

Q And did you actually discuss the calculations that had been made, the presentation that was made by Consumers in that regard with him, or just mention the fact that it had been made?

A I mentioned the fact that it had been made and the values that had been obtained.

Q And do you recall what he said?

A No, I do not.

Q Was the purpose of your discussion with him in this regard to find out whether he thought the presentation by Consumers with regard to its bearing capacity was accurate or appropriate?

A Could you repeat that question, the first part?

Q I'm just really trying to find out why you talked to him about it.

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: The answer is No.

BY MR. ZAMARIN:

Q Why did you talk to him about that bearing capacity data?

eb16

A I considered it was an interesting coincidence that the bearing capacity value computed for Midland was not too different than the bearing capacity values that were computed for the plant that he was reviewing.

Q What was the plant that he was reviewing, if you can recall?

A I can recall. It was the General Electric Test Reactor.

Q Is Bechtel the A-E on that?

A I don't know.

Q Is there any significance to your mind to this coincidence between the similarity of bearing capacity values?

A May I ask that the question be repeated again, please?

MR. ZAMARIN: Yes.

Please.

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: Yes.

BY MR. ZAMARIN:

Q What is that significance?

A The foundation conditions were rather markedly

eb17

different between those beneath the diesel generator building and those beneath the General Electric Test Reactor.

Q And from this did you draw any conclusions?

A I did not attempt to draw any conclusions. I left that to my reviewers.

Q And do you know if your reviewers have drawn any conclusions with regard to this?

A No, sir, I do not.

Q Did this suggest to you that there was something wrong with the analysis that Consumers had presented with regard to the bearing capacity?

A It suggested that one or the other could not be correct, or both were incorrect.

Q Do you know whether it has been determined whether the G. E. Test Reactor bearing capacity has been found to be incorrect or not?

A That matter is still under review.

Q And you say that you gave this information to your reviewer. Are you referring to Mr. Kane?

A I was referring to Mr. Greeves.

Q Okay.

Did you give this information to anyone connected

e-18

with the Midland soils review? And by "this information" I mean the fact that there was this coincidence between the bearing capacity calculation for the Test Reactor and for the diesel generator building.

A Not to my knowledge, no, sir.

Q Have you, since January of 1980, reviewed the application amendments that have been filed?

A No, sir, I have not.

Q Prior to January of 1980, did you review the piezometer data for the diesel generator building surcharge?

A No, sir, not what you could call a review.

Q Prior to January of 1980 did you review the application amendments submitted by the licensee?

A I should have, but I probably didn't.

Q Prior to January of 1980 did you review laboratory records of consolidation tests, shear strength tests, and Dutch cone tests with regard to the soils at Midland?

A I did review the Dutch cone results in a cursory manner.

Q Did that review lead you to any conclusion?

A Well, it indicated that there were some materials with fairly low penetration resistances beneath the diesel

eb19

generator building.

Q Was this data obtained before or after the preload?

A I believe it was before the preload.

Q Have you reviewed, prior to January 1980, any settlement records with regard to the diesel generator building or other structures founded in whole or in part on plant fill at Midland?

A Yes, sir.

Q And from that review did you draw any conclusions?

A No conclusions that had not been drawn by the applicant.

Q Can you tell me generally what those conclusions were, though?

A That the settlement and the differential settlement of the building were more than had been expected.

Q Prior to January of 1980 did you review any settlement data with regard to the diesel generator building surcharge?

A I don't recall.

Q Prior to January of 1980 did you review any Boris anchor measurements with regard to the diesel generator

eb20

building?

A No, sir.

Q You have indicated that prior to January 1980, you had at least looked at or reviewed some boring logs. Is that correct?

A Yes, sir.

Q And did you draw any conclusions based upon the review of those boring logs?

A No, other than the interpretations that had been made by the applicant that they were sands, clays, fill concrete under the various structures.

Q What other projects besides Midland have you worked on since September of 1978?

A I can give you a list to the best of my memory. I'm sure that there are plants that I have missed. The ones that I recall are Bailly, G. E. Test Reactor, LaSalle, Vogtle, South Texas, Allens Creek, Sequoyah, LaCrosse, a number of tailings dams including Church Rock and Split Rock, a lost plutonium source, and the Low Level Waste Disposal Plant at Sheffield, Illinois.

Q What percentage of your time do you currently spend with regard to Midland?

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A Obviously right now a hundred percent, but in an average week, no more than four hours.

Q When you say "right now" are you referring to the time when you're in deposition?

A Yes.

Q Prior to January of 1980 and after some time in the spring of 1979, approximately what percentage of your time during that period did you spend with regard to Midland?

I've tried to indicate the period after Dan Gillen left the review.

A I understand.

Considering the arrangements for contracts, probably eight hours a week.

Q Excluding the arrangements for contracts, about how many hours a week would it have been during that period? Closer to four?

A Probably around four or less.

Q In your opinion is settlement a decelerating process? -- I guess we would have to say under constant load?

A I had never thought of it in those terms but yes, I guess you can say it's a decelerating process with a global coordinate reference system.

eb22 .

Q With a what coordinate reference system?

A Settlement could be considered a decelerating process with reference to global coordinate reference system.

Q A global coordinate reference system? In other words going in toward the center of the earth?

A Yes.

Q You've indicated previously that preloading is an accepted procedure in some applications. Can you tell me to what applications you refer when you say that it's an accepted procedure?

A Well, it's used quite often for consolidating waste materials, for reclaiming coastal areas, for garbage disposal areas I guess you would call them, sanitary landfills. It's used for those purposes so that you can reclaim them and use them for something useful. It's used for consolidating fill material such as dredge disposal. It's used for reclaiming, you know, coastal areas, swampy areas, sanitary landfills, old sanitary landfills.

It's used in a number of applications of this kind where you're primarily concerned with improving the soil conditions before you construct some kind of engineering facility.

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Q Is it also an accepted application to use it simply to consolidate soil or preconsolidate soil so as to minimize or be able to predict future settlement?

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A Well, the purpose of it generally is to consolidate the soil so that future movements are not beyond those expected, yes.

Q Do you consider the Midland diesel generator building to be an accepted application of a preload concept?

MR. PATON: You say "accepted." Do you mean by him?

MR. ZAMARIN: Yes, does he consider it to be.

MR. PATON: You say "accepted." Do you mean "acceptable"?

MR. ZAMARIN: Accepted, generally accepted.

THE WITNESS: If I measure acceptance by what I would expect ten practicing engineers to accept and I said that if 50 percent of them accept it I would accept it, if less than 50 percent accepted it I would not accept it, I would have to classify the use here as not acceptable.

BY MR. ZAMARIN:

Q Your opinion, however, is would it be generally acceptable insofar as it is based on sound engineering

eb24

principles?

MR. PATON: I'm sorry, would it be acceptable if it were based on--

MR. ZAMARIN: As far as it is, or if it is, to the extent that it is.

MR. PATON: I'm not trying to-- Are you saying is it acceptable if it's acceptable?

MR. ZAMRIN: I understood his last answer to say it is really not a common function. It he asked ten engineers if they would do it, perhaps more than five of them would say they wouldn't and therefore, he would say that it's not generally acceptable; it's not the preferred way to go.

Obviously there are a lot of reasons for that and I'll get into those. But really what I'm asking about is if, in his opinion, it is generally acceptable on the basis of sound engineering principles that it might involve.

MR. PATON: Okay. I did not understand the question but if the witness understands it, obviously he can answer it.

MR. ZAMARIN: And there are other factors. There are costs. Normally you would preload before you have a structure. You know, there are methods of choice for other

eb25

reasons an engineer might choose. And that's really all--
I'm trying to bring him along--

MR. PATON: Do you understand the question?

THE WITNESS: I will answer it and see if it's the answer to the question you asked.

In those applications where engineers would agree that it is an acceptable practice, then I would say that it is acceptable because it does rely on accepted engineering principles as to the behaviors of soils.

BY MR. ZAMARIN:

Q In the diesel generator preload then is there some lack of basic or sound engineering principles with regard to the preload that would cause it in your opinion to be not a generally accepted application?

A Let me distinguish again before I attempt to answer the question:

In situations where most engineers would accept the preload procedure as an option for providing acceptable

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foundation behavior, the engineering principles there of course would be acceptable.

In the case of a building already constructed in which a preload was applied post-construction, I think most

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engineers would not favor or would not consider that acceptable practice.

The relationship between the engineering principles involved in either case would be the same.

Q Okay.

Why is it that most engineers, in your opinion, would not favor it or would not consider it an acceptable practice with regard to a preconstructed structure?

A I think most of them would hesitate to use it in a preconstructed situation because of the difficulties in predicting the consequences to the structure involved.

For example, if you have a coastal area where you wish to reclaim the unconsolidated settlements or consolidated sediments in those areas, you can add more and more fill until you bring your grade up to whatever is necessary to protect from floods and whether you get two feet of settlement is of consequence you just add more fill whereas if the structure is already in place you're going to give that structure a rather indeterminate settlement or stress before in fact you do that.

So I think most engineers would look on it with disfavor because of the difficulty in assessing the stress

eb27

to the building.

Q By that do I understand you to say that it would be looked upon with disfavor because you really don't know when the building is going to stop settling until it in fact does stop settling?

A That would be a large part of it, yes.

Q You say that would be a large part of it. Could you again tell me what the other part of it would be?

A Well, in the case where the structure is already there the differential would be the difficult part, so it would be both total settlement and differential settlement.

Q In your opinion, was the total settlement of the diesel generator building that would occur during surcharge of concern to you?

A Yes.

Q Why?

A Total settlement of the diesel generator building indicates a consolidation process of the soils beneath the generator building and it's my understanding there are facilities, pipes, lines, conduits, things of this nature, that would be influenced by the settlement of that building and by the settlement of the fill.

eb28

So although-- If the settlement had been uniform it may not have affected the building as such, but it would indicate distress to those portions that serve that building.

Q And can you describe the mechanism of how it would indicate distress to those portions of structures that would serve that building? And by that I take it you're referring to conduits, pipes, things of that nature.

A Well, you're going to induce shearing stresses, tension. You're going to cause ovalation of conduits, pipes, all items that are not expected to occur when the plant or these conduits were put into place.

Q In referring to these structures that you just talked about that would service the building, are you referring to those which are buried underneath the diesel generator building?

A They're in the areas of the preloading, yes, sir.

Q You wouldn't be referring to any connections because you're aware that the structures that were buried underneath the diesel generator building were cut loose prior to the preload?

A I'm aware of that.

Q With regard to the building itself, however, and

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leaving aside for a moment the stressing of structures buried beneath the diesel generator building, would the amount of settlement during the preload be of concern to you?

A We're referring strictly to settlement, period, without referring to differential settlement?

Q Yes.

A I find it difficult to separate the two phenomena, total settlement and differential settlement, because an averaging process masks the distress that the building is undergoing in order to calculate a total settlement.

So in general the engineers think of total settlement and differential settlement like a factor of one-half, like the differential settlement might be -- the upper bound might be one-half of total settlement. In those cases the greater the total settlement, the greater the differential settlement. And when one has a large total settlement then one also has to consider the likelihood of large differential settlements.

So if in fact a building somewhere settled uniformly six inches or eight inches it may not be of much concern but the likelihood for differential settlements is of concern.

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Q So then the real concern is with differential settlement rather than simply total settlement?

A Yes, I believe that's a correct statement. I believe Bechtel agrees with those items. At least their other applications have indicated a highly rational approach to this.

Q In the situation of a preload of an already constructed building such as the diesel generator building, if analysis after the preload application were to demonstrate that differential settlements had not induced stresses beyond acceptable limits, would that, in your opinion, be an acceptable application?

MR. PATON: Could I inquire, had not exceeded acceptable limits up to this time?

MR. ZAMARIN: What I'm referring to is differential settlment that may have been induced during the surcharge.

MR. PATON: Were at this point within acceptable limits? Is that what you're asking?

MR. ZAMARIN: That's right, and not overstressing the structure. I understand he stated the concern with the preload program is that it may induce differential settlement which introduces stresses into the structure, and I'm assuming

eb31

then there has been an analysis subsequent to the application of the preload and that analysis has demonstrated that there has not been an overstressing of the structure as a result of differential settlement.

MR. PATON: Are you saying you think we have made that conclusion? I don't mean to be interferring. I'll let the witness take care of it.

MR. ZAMARIN: All I asked him was whether that would be an acceptable application of the preload.

THE WITNESS: Would you repeat the question, please?

MR. ZAMARIN: You want to hear the question, I take it, without all the intervening explanation of the question, or do you want to hear all of that?

THE WITNESS: Whichever you desire, either a new question or the old question.

MR. ZAMARIN: Would you just read back the question and then you can eliminate Mr. Paton's and my exchange.

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: In a hypothetical case it would, yes.

BY MR. ZAMARIN:

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Q How about in a real case, based upon those assumed facts?

A In the real case one would have to consider the evidence available and form his conclusions based on all evidence and not on analyses alone.

Q What kind of evidence are you referring to, for example, with respect to structures like the diesel generator building?

A In a structure like the diesel generator building you would have available to you observations such as cracking, such as void spaces beneath foundations, such as tilt of pedestals, such as -- a very complete analyses of the strains induced in the walls of that building. So these factors would need to be considered as well as the computer output from any analysis method that would be used.

And one would expect to base his conclusions upon the compatibility between what is observed in the real case and what the analyses would show.

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Q Assuming that the analysis took into account cracking, void spaces beneath the foundations, tilt pedestals and a complete analysis of the strains in the building and concluded that the building had not been overstressed, in

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your opinion then would that be an acceptable application of preload?

A Providing the analysis agreed with the observations, providing that the observations do in fact meet the prescribed limitations for that particular structure, one would conclude that the preload program was satisfactory.

Q What do you mean when you say "providing the analysis agreed with the observations"?

A If the analysis showed cracking in the building where cracking was observed, and if the analysis showed settlements and voids in certain parts of the history of that building such as to reproduce in the computer the stress that that building saw during its lifetime, and the output from the computer agreed with the zones of cracking in the building, then one would say Yes, you have properly analyzed, Yes, you have properly found the stress and strain conditions in that building, and Yes, you then have quantitative data to compare to your structural acceptance criteria.

And with that you could then say the preloading program had accomplished the purpose for which it was used.

Q Would the cracks and the locations and other observations with regard to the cracks be inputs into this

eb34

stress analysis?

A What I'm trying to describe is that the results of the computer program, the results of the analysis made would indicate that a crack should form in the building at a certain point at a certain time in the history of that building. And if the computer predicts the crack and you observe the crack, I am saying there is compatibility there and therefore, your analysis is correct based on observations of building behavior and based on the calculations you have made.

And if in fact you take the results of your computer output and you then have confidence in them, you can then compare those to whatever acceptance criteria is appropriate for that material and for that building.

So it is not inputting the cracks, it's observing that the calculation agrees with what your eyes behold.

MR. ZAMARIN: Let's break for lunch now.

(Whereupon, at 12:30 p.m., the taking of the deposition was recessed to reconvene at 1:30 p.m. the same day.)

eb35

AFTERNOON SESSION

(2:10 p.m.)

Whereupon,

LYMAN WAGNER HELLER

resumed the stand and, having been previously duly sworn, was examined and testified further as follows:

.280 CROSS-EXAMINATION (Continued)

BY MR. ZAMARIN:

Q What literature have you read upon which you base your experience with regard to preloading?

A Articles that appear in Journals of the American Society of Civil Engineering.

Q I can't tell whether you're finished with your answer or not.

A I have finished.

Q Okay.

Do you recall the number of articles that you've seen in these ASCE Journals with regard to preload?

A No, sir, I don't.

Q Do you have copies of any of those articles at hand -- and by "at hand" I don't mean in front of you but somewhere?

eb36

A No. I think most of them have been discussed before. I think they're in a compendium called "Design for the Control of Settlement," I believe was the name of the particular specialty conference which has been referred to previously in the deposition of Mr. Kane.

Q Have you read the transcript of Mr. Kane's deposition?

A For the most part, yes.

Q Did you notice anything in there with which you disagreed?

MR. PATON: Let me instruct the witness that because the question directs itself to many hundreds of pages of transcript that he can limit his answer in any way he thinks appropriate.

I think that's quite a broad question.

MR. ZAMARIN: I think what Mr. Paton is saying is if you don't recall it's perfectly all right to tell me that. And obviously that's the case with regard to any question. If I ask for information that you don't recall, you don't have to guess or try to make it up for me.

THE WITNESS: I would prefer to answer to a specific page or question if that's possible. I think on an over-all

eb37

basis I did not have too much difficulty with Mr. Kane's responses.

BY MR. ZAMARIN:

Q Is there anything that comes to mind, though, as you sit here now, that you recall disagreement with what Mr. Kane said?

A Nothing that hasn't been pointed out previously in depositions; with respect to bearing capacity primarily.

Q Okay.

As you sit here now, can you recall anything else beside bearing capacity that you might take issue with as you recall Mr. Kane testified to in his deposition?

A That's the only thing that comes to mind at this point.

Q Can you tell me in what way you disagree with Mr. Kane's testimony as to bearing capacity, as you recall him having testified to it?

A No, not anything in addition to what's already been recorded in my deposition, the matter of appropriate shear strengths, the consistency of the soils under the diesel generator building.

Q Do you agree that the drained angle of friction

eb38

depends on the plasticity and not density?

A I really don't know. You'll find of course that's in conflict with my previous testimony.

Q What's in conflict with your previous testimony?

A My last answer.

Q Okay.

Why is it in conflict with your testimony? I think what you have said, in fairness, on page 94 and 95 of the transcript you said:

"I would agree for static tests, those two seem to be the correct correlations."

"Those two" meaning the drained angle of friction of the soil was a function of plasticity and not of density.

Is it now your opinion that that answer was in error?

A Not in error, just I think that probably an answer "I don't know" is a better answer than the one I gave previously.

Q Why don't you know now?

A I think that the surety and the variability of the soils beneath the diesel generator building as a specific topic is different than the generalities that is implied

eb39

by relating plasticity and drained angle of friction regardless of density, origin of soils, and so forth.

So I would have to say for those soils that occupy the highest shear stress areas beneath the diesel generator building, I do not know if the drained angle of friction does in fact correlate as has been reported with the plasticity.

2.440 Q Are you saying that the angle of friction depends on shear stresses that are applied?

A No, sir.

Q What factors, in addition to plasticity then, could the drained angle depend on?

A The drained angle would depend upon-- Well, generally it depends partly on density. It depends on the constituents, the properties of the soil itself.

I guess part of the reason I don't know now reflects back to an answer that I gave you with respect to two different plants, GETR and Midland, that computed roughly the same bearing capacity, grossly different drained angles of friction. And my confidence, if I ever had a lot of confidence, in the relationship between plasticity and the drain angle of friction is somewhat shaken by those particular analyses which are claimed to be legitimate.

eb40

Q So in other words then your opinion with regard to the correlation between drained angle of friction and plasticity has changed since the taking of the first portion of your deposition on October 9th, 1980?

A It had some influence, yes.

Q You say it had some influence. I take it you're saying that it has changed.

A Yes.

Q You said that the drained angle of friction would also depend in part on density, depending on the constituents and the properties of soils.

Can you tell me what those constituents and properties of soils are that would cause or have drained angle of friction depend, at least in part, on density?

A I think we have to remember that the soils, as I understand them, beneath the diesel generator building are quite variable. Some of the opinions have been expressed before by consultants and by sheer rationale in terms of the way the fill was placed that the fill is non-homogeneous, may have had, after compaction, some voids, contains silts, clays, sands and other materials, and that it's difficult to assign a drained angle of friction to materials composed

eb41

of these kinds of constituents.

I'm aware, and I think others are aware that when soils are not compacted in a way that is anticipated in the design, that shear strength values based on drained and undrained tests can be in error. I believe it is fairly well known among the profession that there's a good possibility that Golden Dam failed because of incomplete consideration of shear strength characteristics of less than optimum compacted fill.

And my answer, changing from my previous testimony to this testimony, is influencedby what I thought the question was originally, which means that if you had a nice sample of soil and if you went through a laboratory study relating plasticity to drained angle of friction that you would get a correlation that did relate with plasticity.

But since I don't know the conditions under the Midland diesel generator building specifically, I'm not sure anyone knows, then it's difficult for me to now answer you with any surety that for Midland and the diesel generator building specifically, whether that relationship is an appropriate relationship.

Q I'm not sure that I understand your answer to my

eb42

question, however.

My question was: What properties of the soil bring about drained angle of friction depending on density?

Now is it your testimony that the properties that you've listed, that is, soil being variable--

A The soil is variable. You may have-- Let's imagine, if you would for a minute, that you have a sample of soil in the testing device in the laboratory composed of alternate lenses of silts, sands and clays. If you determined the plasticity of that sample it would likely be based on the silt and clay fraction of that sample. And if you tested that sample and tried to place it on the correlation chart of plasticity versus drained angle strength, one could likely be surprised if he found that correlation to hold for that variable sample.

So to try to answer your question what characteristics affect it, I would say the variability of the soils and the density of the constituents, not only the clay constituents but also the sand constituents would be reflected in that drained angle of friction determination.

gs3

Q Since the source of all of the clay in the fill at Midland is the same, will you agree that therefore the

eb43

plasticity of the clay would be substantially the same?

MR. PATON: May I ask, are you asking him to assume-- You said the source of all the clay in the fill is the same.

MR. ZAMARIN: I don't remember what I said. Did I say it was or did I say did he agree?

MR. PATON: I'm asking you, are you asking him to assume that, or are you assuming that he knows that, or what?

MR. ZAMARIN: I will ask that the question be read.

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: By sources of material I guess you mean it's a glacial material?

BY MR. ZAMARIN:

Q No, the borrow area. It was all scraped off and--

A It's a glacial deposit is my understanding,--

Q Okay.

A -- except for the sands that drifted over the top.

MR. PATON: Are you asking him to assume that or--

THE WITNESS: I'm not finished.

MR. PATON: I'm sorry.

eb44

THE WITNESS: I'm interpreting your question to be by "source" you mean geologic source.

MR. ZAMARIN: That's right.

THE WITNESS: Thank you.

I think it is fairly well understood that materials of geologic origin are not necessarily the same in plasticity or anything else. I believe you have materials classified as CH, MH, CL's; a fairly wide variety of materials. I could be mistaken. I haven't reviewed it in quite some time.

It was my impression that there was a wide variety of materials present and that they're plotted on the Casa Grande diagram and some are above, some are below, and a very wide scatter of plasticity values of those materials.

So I guess I would say I'm not able to conclude that all of these soils have the same degree of plasticity.

BY MR. ZAMARIN:

Q Have you reviewed the plasticity chart that was supplied in response to Question 40?

A I don't recall reviewing it. I think there was some-- I believe there was information of this type back in the construction permit application.

Q Are you aware that the data with regard to

eb45

plasticity shows the plasticities of the clays all within a narrow range?

A No, I'm not aware of that.

Q Okay.

A What do you call "narrow range"?

3.045 Q P.I. is 20 to 30.

A I'm definitely not aware that all samples obtained and tested fall within that band.

Q Were you aware that with some minor exceptions, some isolated cases, that these data with regard to plasticity show the plasticity of the clays all within a narrow range? And by "narrow range" I mean a P.I. of 20 to 30.

A I have not seen a statistical analysis of the P.I. distribution in the borrow areas or in the fill.

Q Have you been responding to these questions with the understanding in mind that we're talking about fill on which these tests have been done, that is in the diesel generator building area, the tank farm area, the diesel fuel tank area, rather than just the entire site including areas which haven't had the plant fill placed in them?

A I don't understand the question. Can you rephrase it or reword it, please?

eb46

Q Okay.

I asked you a question earlier about whether in your opinion the fact that clay had come from the same source, from the same borrow area, would indicate the likelihood of similar plasticity and I was referring to clay that had been taken from a borrow source and used in plant fill, for example in the power block area.

Is that what you were thinking of also when you responded to those questions?

A No, sir. I was confining my response just to those areas beneath the footings of the diesel generator building that now have and will have the highest shear stresses imposed on them.

Q Okay. That's fine. That's as good a narrowing of the area. I just wanted to make sure you weren't considering all of the area of the plant site.

A No, sir.

Q If you look at just the clay in the fill beneath the diesel generator building and assume that the data with regard to plasticity for that clay demonstrates, with a few isolated exceptions, a narrow range of plasticity, say P. I. 20 to 30, would you be of the opinion that the drained angle

eb47

of friction would depend on the plasticity and not density of that clay?

A I would say for idealized conditions that would be the case, yes, sir. And I use that term because when you determine the plastic index you do a number of things to that clay in the laboratory, and for those conditions after manipulations that are done on the clay in the laboratory, yes, I will agree that you do get a relationship with respect to plasticity that does give you the trends that you have suggested.

Q You're referring to an idealized situation, but any time you go outside of the laboratory and try and apply the laboratory results or any kind of a standard from the laboratory to the real world you're getting outside of that idealized situation, aren't you?

A For some kinds of tests you do; for other kinds of tests you attempt to minimize that, yes.

Q Well, of course you'll attempt to minimize it but as soon as you get outside to the real world you are no longer under ideal situations that you can have under laboratory control. Would you agree with that?

A In part.

eb48

Q In what part wouldn't you agree?

A When you attempt to reproduce field conditions in the laboratory, there are a number of precautions that can be taken, a number of corrections that can be taken to minimize the effect of laboratory operations on the results that you obtain.

For the case of relating shear strength -- I should change that -- drained angle of friction, which is a measure of shear strength through the plasticity parameter, you have decided to perform a certain set of laboratory manipulations to that soil sample that can seriously alter the field situation.

I'm agreeing with you that the correlation is there. I'm qualifying it with respect to its complete applicability to the situation we're trying to evaluate, bearing capacity.

Q I take it you're qualifying it to the extent that the laboratory test results may not be reliably representative of field conditions as it relates to the factor of plasticity.

A Rather than "reliably" we could say that the soil constituents have been massaged, physically massaged by the laboratory procedures that are used to establish plasticity.

eb49

Q And are there standard methods used to correct or account for this type of disturbance that occurs in this laboratory testing you refer to?

3.170 A I'm not aware of the corrections, no, sir.

MR. PATON: Off the record.

(Discussion off the record.)

3.190 MR. ZAMARIN: Back on the record.

BY MR. ZAMARIN:

Q Do you know whether the plasticity index is a generally accepted measure in geotechnical engineering?

A I believe it is, yes.

Q Is the correlation between the plasticity index and the drained angle of friction a generally accepted correlation within the geotechnical engineering field?

A I don't know. It could be.

Q Okay.

Do you agree that friction angle for sand is related to the blow count or relative density of the sand?

A It can be related to either.

Q You say that it can be related. And your testimony is that it is related to either blow count or the relative density?

eb50

A It can be related to either blow count or relative density.

Q By that do you also imply that it cannot be related to either blow count or relative density?

A It depends on whether you accept the correlation between the two parameters that you've mentioned, blow count and relative density.

Q I'm sorry, you're going to have to explain that one a little more. I don't understand what you're saying.

A I believe you mentioned three parameters: friction angle, blow count,--

Q Yes.

A -- and relative density.

Q Okay. Let me break them down for you.

Do you agree the friction angle for sand is related to blow count?

A In part.

Q In what part?

A Well, blow count depends on many parameters. One of them can be the friction angle.

Q Could it depend on things that totally exclude friction angle?

eb51

A Yes-- I'm sorry, you were talking about sands only?

Q Yes, just sand.

A Then the answer would be no.

Q Now with regard to just sands you say that friction angle is related only in part to blow count?

A Yes.

Q And what else is it related to?

A It's related to usually the depth of the investigation which is a measure of the confining pressure on the sampler. It can be related to the sampler itself, what kind of sampler you're using. It can be related to the operator who is performing the investigation. It can be related to the types of equipment, the length of the drill stem that's being used, the type of hammer that's being used.

There are many parameters that affect the blow count in a penetration type investigation, and friction angle is only one of those.

Q With regard to the properties, the physical properties and the engineering properties of the sand, will you agree that friction angle is related to blow count

3.250 determinations with regard to that sand?

A Could you repeat that, please?

eb52

MR. ZAMARIN: Will you read it back?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: It's related, yes, sir.

BY MR. ZAMARIN:

Q Do you agree that friction angle for sand is related to relative density of the sand?

A Yes.

Q If you know the relative density of the sand could you then determine the friction angle of the sand?

A If I had a suite of laboratory tests I could relate the relative density of that sand to the friction angle, yes, sir.

Q You said if you had a what?

A A suite of tests on that particular deposit of sands, yes, I could.

Q What do you mean by a "suite" of tests?

A A series of tests conducted at different relative densities so as to establish a relationship between friction angle and relative density for that particular sand gradation, grade size, D_{50}'s, D_{10}'s, angularity of grain and so forth. Once you have that correlation then you can go in with a

eb53

relative density value and pick off a friction angle for that sand.

But you need the test values to establish the correlation.

Q Are you aware of any commonly accepted relationships between relative density of sand and friction angle of sand, in other words such that you don't have to, in each instance, go through and develop your own standards for comparison?

A I believe there are published results of averaged laboratory tests on certain types of sand. I believe that's true.

Q Okay.

Would you think that competent geotechnical engineers use those in estimating friction angle from known relative densities of sand?

A I assume they're used, yes.

Q Before when I asked you about things that had an effect on or were related to blow count determinations you indicated such things as confining pressure on the sampler, the kind of sampler, the operator, the drill stem, the hammer and the types of equipment.

eb54

Are you talking about limitations on obtaining accurate testing results?

A No, I'm talking about correlations -- factors that affect correlations between blow count and friction angle.

Q Okay.

But it seems to me that the things that you have listed were all things that, rather than being properties of the soil, are actually functions of the testing process. Is that right?

A I believe it's necessary to consider those because blow count has no meaning in the laboratory sense. It's a field investigation tool.

Q Oh, I see.

So what you're saying is that all of these things are taken into account or have an impact upon the force that the hammer exerts or the blow the the hammer exerts and therefore it's part of the measure of how far the sampler is driven?

A Yes.

Q I see.

Are there commonly accepted relationships to your knowledge in the engineering field between blow count and

eb55

relative density of sand?

A There have been relationships investigated and published relating blow count to relative density. There is also controversy among the researchers and professionals with respect to the universal applicability of this correlation.

Q Is the relationship between blow count and relative density a generally accepted and commonly used standard within the geotechnical engineering field?

A I think the profession is probably split about 50-50 on that question. I think in certain cases it's useful and may be relatively accurate and in other cases, certain precautions should be taken in interpreting results of such tests.

Q In what types of cases would, in your opinion, the blow count-relative density relationship be accurate?

A It should be fairly accurate where the conditions are similar to those laboratory conditions for which the correlations have been established, and by that I mean the field conditions should be reasonably consistent with the conditions that were established in the laboratory tests.

Q Give me an example of the conditions to which you refer.

eb56

A Well, to my knowledge there are at least two sets of investigations that have been conducted to relate relative density to blow count, those that were done by the Bureau of Reclamation many years ago and those that were performed by the Army Corps of Engineers in the past half a dozen years.

In both cases attempts were made to carefully measure applied pressures and to control the energy that went into the sampling spoon.

Where field samples are taken and where the grain size distributions and saturation conditions are similar, they probably can be used with some degree of confidence. Otherwise some precautions should be taken to assure that judgments are made on the proper side of those averages obtained under other conditions.

Q What precautions are you referring to?

A I think we have to be assured, for example, that all of the energy of the hammer is received by the sampling spoon is one precaution.

Another precaution might be the angularity of the grains, gravel particles that might be present in the materials that would affect the blow count in a non-conservative manner.

eb57

Probably angularity of the grains is also an aspect that has not been investigated but becomes a problem when you're investigating tailings dams, for example.

Q You believe angularity would be a problem in investigating blow counts of sands in the fill at Midland?

A I'm not familiar with the sands that were used. I believe they were all imported, if I'm not mistaken. I believe the sands were all imported for fill at the Midland site and I'm not familiar with those sands. I don't have an opinion on that.

Q Not knowing then what the sands are with regard to the fill at Midland, do you have an opinion as to the relationship or correlation between blow count and relative density of the sands with regard to Midland?

A Could I have the question read, please?

MR. ZAMARIN: Would you read it back, please?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: I have an opinion but it would be subject to substantiation by a more detailed review.

BY MR. ZAMARIN:

Q What is your opinion?

eb58

A Well, I think the sands up there are fairly well rounded. I think they reasonably fit into the kind of correlations that have been made previously, and I personally would not have a problem with using the normal relationships between blow count and relative density at the Midland site.

Q Do you agree that the friction angle for clays from the same borrow source and having a plasticity index between 20 and 30, and there are only a few exceptions in that range, should be about the same for all of those clays?

A I don't have any reason to disagree with that statement. No, sir.

Q I don't either.

In your previous testimony you had stated that in some past cases a preload was unsuccessful. Can you tell me in what past cases, and in what way the preload was unsuccessful?

A I was referring to an article in the ASCE Journal that we had discussed earlier, and I believe the title of it is "Design to Minimize or Prevent Settlements." And there is a paper in there -- I believe it was written by George Sowers -- that described a case for, as I recall, an air field runway in which preloads were applied, monitored not

eb59

unlike the situation at Midland, and the result was not as expected.

Q You say the result was not as expected. However, I believe you also testified previously that you know of no case where settlement after a preload exceeded the predictions, didn't you?

A I believe Professor Sowers' paper does indicate that settlements after the preload was removed were larger than had been anticipated at the time of the preload removal.

Q Could you supply us with some kind of a cite to this compendium of literature?

A. He's got it right there.

Q That was quick.

A I think he's read the entire Journal.

(Document handed to Mr. Zamarin.)

What was the correct title, just for the record?

Q This is Journal of the Soil Mechanics and Foundations Division, "Conference on Design of Foundations for Control of Settlement, Proceedings of the American Society of Civil Engineers, Conference in Evanston, Illinois, June 16 - 19, 1964." And the citation to this is Volume 90, Number SM5, September 1964, Part 1.

eb60

A Thank you.

Q Was the air field preload that Sowers reported applied for the purposes of compacting or consolidating fill material?

A I'm not sure whether it was fill or whether this was a natural soil deposit that he was compacting. I suspect it was a little of each.

Q A little earlier we talked about differential settlement and preload programs, and you had indicated that a major reason for lack of widespread use of preload is the potential for differential settlement.

Does this differential settlement to which you refer occur during or after the preload program?

A Most of it should occur during the preload program. There may be a small part, hopefully a negligible part, that would occur after the preload is removed.

Q And then the preload program, by accelerating settlement, would also accelerate any differential settlement that you would expect, wouldn't it?

A It would occur more rapidly. Yes, sir.

Q And once soils undernearth the structure entered into secondary consolidation, could the maximum future

eb61

differential settlement then be accurately predicted?

A It's possible that it could be accurately predicted.

Q What is the technique or the procedure that one employs in generating an E versus log P diagram or plot?

A The procedure?

Q Yes. In other words how do you go about constructing a plot of E, which I take it is void ratio,--

A Yes.

Q -- versus log pressure plot.

I mean you've got something in the lab -- right -- and you get some kind of data and then do you do something with that data first, or do you put it right on a graph paper and can you just really describe for me the process that you would go through in generating an E versus log P plot?

A Well, first you need a specimen of soil to work with to test, and it is not uncommon to cut that sample from a Shelby tube in the laboratory using a cutoff saw, extrude the resulting sample of soil into a odometer which is a one-dimensional consolidation device, place a stone and a cap on top of the sample with a stone in the bottom to provide a drainage path for the water to be squeezed out of the sample.

eb62

The void ratio, initial void ratio would be determined from generating an adjacent specimen of soil that is considered to be essentially the same as the soil in the sample, perform the drying and so forth, the weighing that is necessary to establish the voids that are present in that soil so as to get an E_0 value -- I'm sorry, not an E_0 value but an initial void ratio value.

At that point, load is applied to the sample and the movement of the top cap downward indicating compression in the sample is recorded.

B4

A given load is held on that sample until the dial indicator indicates essentially no additional settlement. When that's the case the load is increased to a new value and the observations are repeated to obtain another set of data. And this continues progressively until you've reached a reasonable expectation for that sample of soil under the working conditions that it will see in the field.

At that point there is no need for additional application of additional pressure.

The data thus obtained is then plotted relating the dial indicator reading in the odometer to the void ratio that would necessarily be present in that sample versus the

eb63

logarithm, I believe base 10, of the applied pressure. And you have then an E log P curve for increasing loads on that sample.

C3 4.020

Q When you're reading the dial indicator are you reading the displacement of the sample, the change in volume of the sample?

A Yes, you are.

Q And are you saying then that you plot the change in volume of the sample versus the logarithm of pressure?

A No, the change in volume is interpreted as a change in void ratio. There's a relationship between the dial indicator movement which indicates change in volume, total volume, to the change in void ratio so one calculates the change in void ratio from the movement of the dial indicator that indicates the depression of the sample that you're testing.

Q Could that relationship or that conversion to void ratio be obtained by plotting change in volume versus log of time and then the data point for void ratio be taken off that plot?

A I'm sorry. "Lot of time" came from somewhere-- Could you repeat the question, please? I didn't understand

eb64

it.

MR. ZAMARIN: Would you read it back?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: Yes, a series of tests of that type could be used to determine the void ratio at different pressure values.

BY MR. ZAMARIN:

Q You indicated that you apply a load until there is no additional movement of the top cap. Is that correct?

A I think there is some rate of movement allowed in the ATSM specifications but I don't recall what that rate of movement is. It's a very miniscule movement.

Q Is there some kind of a plot that one generally then does in order to determine when there is no longer any movement, or when the rate of movement has become slow enough to stop the test?

A I don't recall what the testing specification calls for. I think it's with respect to the dial movement but I'm not sure.

Q Okay.

Do you have any reason to disagree with that plot

eb65

being displacement versus log of time?

A Displacement of the top cap?

Q Yes.

A Versus log of time?

Q Yes.

A No, I think the specifications for the test give a dial reading, change in dial reading versus time for stopping the test. I believe that's right but I'm not sure.

Q Are you familiar with the document called "NAVFACS DM-7"?

A Yes, sir, I have a copy of that.

Q Could you provide us with a copy of that through Mr. Jones or Mr. Paton? I would have asked Mr. Kane for that since he had referred to it in his deposition but they didn't want me to ask him.

A It's a commonly available document. Would it be out of order-- Let me ask Counsel.

THE WITNESS: Would it be out of order to tell them where to get a copy?

MR. JONES: Yes. Go ahead and tell them where it is.

MR. ZAMARIN: It may be more commonly available

eb66

to you guys than to us.

BY MR. ZAMARIN:

Q Where would we be able to obtain one?

A You can obtain one from the Department of the Navy. I believe it is now called Naval Facilities Command. Their telephone number is in the directory. I'm not at all sure it's not available in book stores in the technical text-book section, perhaps at IIT or the University of Michigan.

MR. JONES: We will provide a copy of NAVFACS DM-7 tomorrow morning for Mr. Zamarin to look at. It's evidently a rather thick document so, rather than copying it, we will provide it tomorrow.

MR. ZAMARIN: Thank you.

BY MR. ZAMARIN:

Q At your previous deposition session you made reference to the possible existence of fat clays beneath the diesel generator building. Do you recall that?

A Yes, sir.

Q And in your opinion do fat clays exist beneath the diesel generator building?

A I don't know. I assumed that there were some clays classified as CH that were discovered in the area. I don't

eb67

know that there were any beneath the diesel generator building. There were some pocket penetrometer tests that would indicate materials as soft as one might expect a fat clay to be.

Q Are you familiar with the reported plasticities of the clays beneath the diesel generator building?

A Evidently not.

Q Okay.

Are you aware of piezometer data which would suggest the presence of fat clays beneath the diesel generator building?

A I don't know that piezometers would indicate the presence of fat clays beneath the diesel generator building.

Q Are you aware of the liquid limits of the clays underneath the diesel generator building?

A I have not reviewed that data, no.

Q Are you aware of the theoretical shape of the settlement versus log time curve for a fat clay lens?

A Could you repeat the question, please?

Q Yes.

Are you aware of the theoretical shape of the settlement versus log time curve for a fat clay lens?

eb68

A I think that that was discussed at the previous deposition. I believe that I attempted to sketch what I thought was the shape of a settlement log time curve that would result. I'm not sure what you mean now by "lens." Layer? Fat clay layer? Was that the question?

Q Yes. I said "lens" but by that I mean a layer. Is a lens the same as a layer in your parlance?

A It's close enough.

Q Okay. It's close enough in mine then, too.

Would you agree that the theoretical settlement log time curve for a lens or a layer of clay or a deposit of clay has a point of inflection at about 75 percent consolidation?

A I'm not sure if it's 75 percent consolidation or 50 percent, or what the number is. There is a change in slope in the time settlement curve. I'm aware of that, yes.

Q Okay.

Assume for a moment then that the theoretical settlement log time curve for a lens or slab of clay has a point of inflection at about 75 percent consolidation. For time shorter than that corresponding to that 75 percent consolidation, would in your opinion the curve bend downward,

eb69

and for times greater than those corresponding to 75 percent consolidation, would the curve bend upward?

Let me withdraw that question for a moment. There may be an easier way and a fairer way to do this with you, rather than to ask you--

A I'm trying to plot what you suggested.

Q Yes. And maybe if I just....

(Discussion off the record.)

MR. ZAMARIN: Will you read the last question back, please?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: No.

BY MR. ZAMARIN:

Q For times shorter than that corresponding to 75 percent consolidation what, if any, behavior would you expect the curve to display? You apparently disagreed that it would bend downward. Do you believe it would bend upward for times shorter than those corresponding to 75 percent consolidation?

A Yes.

Q And for times greater than that corresponding to

eb70

75 percent consolidation, is it your opinion that the curve would bend downward?

A Let me rephrase my previous answers if I may.

Q All right.

A It may improve upon this bending downward, bending upward situation.

It would be my opinion that a curve representing settlement versus log time for consolidation values greater than 75 percent might well be close to a straight line where that straight line would still, in my view, be aimed downward but the derivative of that curve would have a negative slope.

For times greater than 75 percent consolidation, I would expect the curvature of the representation of consolidation to be -- rather, to have a smaller radius and the slope of that curve would have a larger negative value.

With respect to being upward and downward, as the question was phrased, I probably have misinterpreted the geometric figure that you represented in your question. I hope that my answer has included your question. If not, I'll be glad to explain it.

Q What is your understanding of what is meant by

eb71

the point of inflection?

A A point of inflection is usually a term related to structural engineering and it means a point at which the radius of curvature is infinity, and that the slope of a tangent to those two lines changes sign.

4.260 Q If there were a very thick fat clay lens-- Strike that.

In your opinion do there exist lenses of what you have described as fat clays under the diesel generator building in thicknesses of five feet or more?

A I don't recall seeing any boring logs that would give a consistent classification of clays located anywhere, including the diesel generator building, that would be that thick. Those zones that might be lenses layers that might be considered to be soft clays did not appear to have an extent of more than perhaps a few inches, maybe as much as a foot at the maximum.

Q Would you expect the existence of fat clays of thicknesses such as you've just described, and that is perhaps as thick as a foot, to have more than a negligible effect on the linear portion of the settlement log time curve for the diesel generator building?

eb72

A If there was only one layer that was a foot thick, it wouldn't have a lot of influence. Maybe a half an inch of settlement would be all that could be attributed in the future to that particular lens.

Q You're saying with regard to a lens that's no more than a foot thick that you believe that as much as a half inch of future settlement could be attributable to that?

A It's possible. In that range.

Q What is your basis for that estimation of half an inch? And also I might point out that my question was with regard to the settlement versus log time plot for the diesel generator building after surcharge and during surcharge. What we're talking about is future settlement after the surcharge program. I just want to make sure we're talking about the same animal.

A I'm not sure we're still talking about the same animal. I understand two pieces to the question. One, what is the influence -- what would be the influence of a hypothetical one foot thick layer of fat clay during the preload program. I see that as one part of the question.

The other part of the question: What would be the effect if there were a fat clay of thickness one foot after

eb73

the surcharge was removed and during the life of the power plant.

Q Is my understanding correct that if a lens of fat clay of no more than a foot in the fill beneath the diesel generator building would have only a negligible effect on the linear portion of the log time settlement curve then it should have only a negligible effect, if any, on future predicted settlement based upon the log time curve?

A The log time settlement plot that we are talking about I assume is that one that has been determined for the fill of the diesel generator building during the time that the preload was applied.

Q That's correct, during the time that the preload was applied and also subsequent to removal of the surcharge. The plot continues through the period after removal of the surcharge. And yes, that is the plot to which I refer.

A To answer the question requires the assumption that that fat clay lens was a part of and underwent the same settlement log time behavior as the entire mass of fill. That's probably not a proper interpretation of the behavior. For the five months that the load was on the fill it's not likely that the fat clay would have reached the end of its

eb74

primary consolidation and so it would be still available to undergo additional consolidation resulting in additional settlement after the preload had been removed.

And a one-half inch value that I threw out as an example of a possible range of consolidation of a one-foot-thick hypothesized lens is based on an expectation of perhaps a five percent settlement within that one-foot thick lens.

Q If the slope of the settlement log time curve for a fat clay was less negative than the slope of the over-all curve for the fill at some point in time, would that fat clay lens in your opinion affect a prediction based upon the over-all curve, that is, the curve including that fat clay lens, in an unconservative fashion?

Do you want to hear that one back?

A Yes, please.

MR. ZAMARIN: Would you read that back?

(Whereupon, the Reporter read from the record as requested.)

THE WITNESS: It would affect it in an unconservative manner, meaning that the settlements expected in the future would be larger than anticipated by interpreting the settlement log time curve of the entire fill.

eb75

BY MR. ZAMARIN:

Q And upon what do you base that opinion?

A The sketch that I have prepared that I think represents the question that was asked hypothesizes that at some point in time, and I'm taking that as the point where the preload was removed, that the slope of the settlement curve for the curve was less negative than the slope for the fill as a whole which to me, at this point, would mean that the degree of consolidation of the clay layer would be less than the degree of consolidation of the fill as a whole and therefore, at some time in the future -- I'm sorry -- at increasing times the clay would still have the potential for additional consolidation and therefore, the total settlement of the fill would increase beyond that anticipated by an extrapolation of the settlement log time curve for the entire fill.

Q Can I just see that diagram to which you just referred in that answer? I would like to mark that as an exhibit. Since you're referring to something over there it's going to look funny in the record unless we know what it was you were referring to.

A All right.

eb76

May I label it?

Q Sure. Do whatever you want with it while we go off the record for this discussion.

(Discussion off the record.)

B5

MR. ZAMARIN: I have marked as Exhibit Number 7 for identification as of today's date the diagram to which you have just referred in answering my previous question.

(Whereupon, the document referred to was marked as Exhibit Number 7 for identification.)

BY MR. ZAMARIN:

Q Is that correct?

A Yes, sir.

MR. ZAMARIN: I would also like to mark as Exhibit Number 8 the previous diagram that you drew when you were drawing those settlement log time curves.

THE WITNESS: I think we need to confer on that.

(Discussion off the record.)

MR. ZAMARIN: Weren't those settlement log time curves? Let me take a look at it first.

MR. JONES: I don't care if you see them, but I

eb77

don't know that they should be introduced.

THE WITNESS: Those refer to previous questions -- attempts to answer your previous questions.

MR. ZAMARIN: I understand that.

We will mark it as Exhibit Number 8.

(Whereupon, the document referred to was marked as Exhibit Number 8 for identification.)

MR. ZAMARIN: We understand this referred back to previous questions.

BY MR. ZAMARIN:

Q If a piezometer were located in an area of fat clay, would you expect to see a high pore pressure reading in that piezometer under the surcharge conditions?

A It would depend on the type of piezometer that was installed.

Q Okay.

How about a Casa Grande type piezometer?

A With an open piezometer one would expect a very small response because of the need to squeeze a large volume of water out of the clay, and there would be essentially no

eb78

response.

Q And in a closed type piezometer you would expect to see a more sensitive or a greater response?

A Yes, sir.

Q Do you know which type of piezometers were used with regard to the diesel generator building surcharge at Midland?

A No, sir, I do not.

Q Where on the Midland site have you observed, if anywhere, dry-placed fill or apparently dry fill?

A I have observed fill materials in the excavations that were made in the diesel generator building to expose the conduits that had been bonded to the footings of the diesel generator building.

I observed fill in a test pit that was excavated adjacent to the service water pump house and in a test pit excavated I believe to the east of the auxiliary building to investigate the condition of fill related to a compressed air line that had broken and created a bubbling phenomenon in the fill and water in one of the trenches.

To my knowledge, those are the only observations of fill material that I recall at the Midland site.

eb79

Q What did you notice about the fill that was revealed by the excavations inside the diesel generator building?

A Conditions for observation were not ideal. As I recall it was winter and a protective cover had to be put over the working area. Artificial light of course was necessary in the excavations. And about the only thing that could be observed there was the displacement between the bottom of the footings and the top of the fill, a void of some lateral extent between the footing and the fill.

I observed some large-grained material in the clay fill.

Other than that, that's all the observations I recall.

Q What was this large-grained material in the clay fill that you observed?

A It was a -- I would call it a cobble, part of the glacial material that was used to fill that area.

Q You say you saw a cobble?

A One that I noticed [illegible], and a number of others that were observable in the face of the excavation.

Q Can you describe this cobble for me so I would know it if I saw it?

eb80

A I can bring it tomorrow if you would like to see it.

Q Oh, you've got it?

A Yes, sir.

Q All right. Well, why don't you describe it and then tomorrow we'll find out whether I would know it if I saw it.

A It's roughly the size of a Michigan grapefruit and it's grayish-black in color. It's rounded and has some chips in it, indicating that it had been involved in glacial processes many years ago and would be of the kind of material you would expect in the borrow pit areas used to construct dikes and fill and so forth.

Q What's the size of a Michigan grapefruit? I've never heard of that. About the size of a 12-inch softball?

A Approximately the size of a 12-inch softball.

Q And was this hard material like a rock?

A Yes.

Q Did you observe what you would consider to be dry materials or materials that in your opinion had been placed dry while you were looking in this excavation in the diesel generator building?

eb81

A I don't recall seeing anything that would impress me as being placed in a dry condition, no.

Q Have you reviewed any boring data in the diesel generator building area with regard to the moisture content?

A I believe I reviewed information of that kind perhaps a year and a half or two years ago but I don't recall being impressed with any particular aspect of it.

Q Do you recall whether from that data you received any information or impression that any of the fill had been placed dry of optimum?

A From the information presented I would not be able to draw that kind of conclusion. I was looking mainly at water contents with respect to -- like the densities, rather than whether or not it was placed near or above optimum.

Q Do you have an opinion as you sit here now as to whether the fill beneath the diesel generator building was placed near or above optimum wetness?

A I don't have any way of knowing that. I don't have any personal observation of the consistency of the fill at optimum so I would not know whether the fill that I saw or touched was near, above or below the optimum moisture content.

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Q. Have you ever heard anyone claim that the fill in the diesel generator building area was dry of optimum?

A I guess I have heard that judgment made as a possibility or even a likelihood, yes.

Q By whom did you hear a judgment made of that as a likelihood?

A I can't recall. It would have been at one of the early meetings, perhaps the first meeting that we had in December '78.

Q And do you recall whether it was a member of the staff who made that comment?

A It was not a member of the staff I'm sure.

Q Do you recall whether it was someone from Consumers Power Company?

A It could have been someone from Consumers or someone representing Consumers at that meeting.

Q Is it possible that what you recall is someone speculating on what might be the case if soil were placed dry of optimum?

A I think it had more to do with why is this fill settling than whether it was placed dry or wet of optimum.

I suspect that most engineers would come to the

eb83

same judgment, realizing the source of the borrow materials.

MR. ZAMARIN: Could you read that back, please?

(Whereupon, the Reporter read from the record as requested.)

BY MR. ZAMARIN:

Q When you say that most engineers would come to the same judgment, what judgment are you referring to?

A The judgment that Consumers suspected -- I think it was Consumers who suspected that the fill could have been placed dry of optimum and then, as it absorbed the water, groundwater, on lake filling it would soften and allow compression to occur.

I believe that was the hypothesis offered early on in the investigation.

Q And has anyone ever told you at any time subsequent to that that they have moved toward proving that hypothesis?

A Not to my recollection.

Q Have you discussed this question of whether fill had been placed dry of optimum with Joseph Kane?

A I probably have, yes.

Q Do you recall any of your discussions with Joe

eb84

Kane about the possibility of fill having been placed dry of optimum?

A I know we discussed it many times but I'm not certain that I can answer yes, that dry of optimum placement of fill was our major discussion topic. I really can't answer that positively.

Q I'm not asking whether it was a major discussion topic. I'm just asking if you recall the gist or substance of any conversations with Joe Kane with regard to that subject.

A I think we discussed the reasonableness of that hypothesis, yes.

Q And was your discussion about the reasonableness of that hypothesis centered about the fact that it was a possible explanation for the settlement behavior of the fill?

A Yes, sir.

Q You have seen at one time or another, have you not, the settlement log time curve for the diesel generator building?

A Yes, I have.

Q And in your opinion is any portion of that curve due to closing of cracks in clay balls?

A It's likely that a part of it is due to that, but

eb85

I don't know that that's a fact.

Q And if in fact part of the curve is influenced by closing of cracks in clay balls, would that affect the overall reliability of that curve in predicting future settlement in your opinion?

A I don't know the answer to that question and I suspect few others do.

Q You suspect few others do?

A I suspect few others do know the answer.

Q Okay.

In your opinion is it very likely that the settlement log time plot could represent in the first branch of that plot the closing of cracks in clay balls under the diesel generator building and then, in the second branch, that is, after the change in slope in that plot, primary consolidation, and that no secondary consolidation settlement data is reflected on that graph at all?

A That's possible.

Q Is it likely? And when I say "likely," I'm asking would that be a reasonable interpretation of that plot from a geotechnical engineering standpoint?

A Yes, I think that's a reasonable working hypothesis.

eb86

Q When you say that's a reasonable working hypothesis, are you saying that that is a reasonable interpretation of that plot from a geotechnical engineering viewpoint?

A Yes.

Q And what do you base that opinion on?

A That opinion is based on the observation when the settlement began, almost as soon as the loads were applied, which would indicate we're not consolidating anything, we're just squeezing this spring a little tighter and causing it to move downward.

It is also based I think on the rapidity with which -- not rapidity, the speed with which consolidation occurred on initial loading. I think most people would look at that and feel that that was the way a sand would behave or the way a spring would behave, rapid initial consolidation.

The latter part of the curve, one could hypothesize, would be the onset of -- call it secondary consolidation of the cracks or primary consolidation of the clay, or part each would be a reasonable interpretation as well.

Q The Army Corps of Engineers are your consultants with regard to the geotechnical matters on the soils issue, are they not?

eb87

A Yes.

Q Do you have confidence in the competence of their personnel?

A Yes, sir.

Q Are you aware of any calculations that were done by anyone within the Army Corps of Engineers with regard to the number of days that they believed it would take to reach secondary consolidation under the surcharge loading of the diesel generator building?

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A I'm not aware of such calculations, no.

Q If such calculations had been done by one of the Army Corps of Engineers personnel and those calculations showed a figure of 42 days from the time of the loading of the surcharge to secondary consolidation, would your interpretation of the log time settlement plot that you just described to us as a hypothesis change at all?

A I don't know why it would.

Q You don't.

Well, you've hypothesized that what we have perhaps on that plot is the primary branch of the plot being closing of cracks and the secondary branch of the plot being the secondary consolidation of the cracks and the primary

eb88

consolidation of the clay.

It seems to me that would be inconsistent with the calculation by one of your consultants in whom you have confidence that secondary consolidation under the load and the conditions of the diesel generator building would occur at 42 days.

A I'm not aware of that calculation.

Q I asked you to assume that calculation in my previous question.

A All right, I assume that calculation.

Q In other words assume that one of the personnel from the Corps has calculated 42 days as the date of secondary consolidation. And would that factor, if you were aware of that, cause you to change your thinking at all about the hypothesis with regard to the closing of cracks representing the first branch and the primary consolidation of clays being represented by the second branch of that plot?

A I think you have to look at the basis on which the calculations were made and I'm assuming that basis is some kind of laboratory test made on a sample of the fill. And I would interpret the closing of the cracks in the sample in the same way as I would interpret the settlement of the

eb89

building.

In other words if you had a sample and if there were cracks in that sample and if you put it in the consolidometer and if you recorded the settlement -- consolidation behavior time, log time or log pressure or whatever you have to work with, you could measure the closing of those cracks in the laboratory and you could make a calculation

5.360

that showed primary consolidation as a -- I don't want to use the word "mind set" -- as a working hypothesis in the same way that you could use primary consolidation as a working hypothesis.

Whether in fact the cracks are closing or whether in fact primary consolidation is occurring I really don't know, and the calculations would not show the difference. It would be one and the same physical phenomenon. The interpretion and the words used to describe that behavior would be different.

Q Are you aware that there is a means of calculating the predicted time to secondary consclidation in a given soil situation without the use of laboratory sampling and data?

A You can do it based on the physical characteristics, soil parameters and assumptions of drainage paths. You

eb90

certainly can.

Q If that were the procedure that was followed by the Army Corps of Engineers personnel, and based upon those calculations that were done by the Army Corps of Engineers where the time to secondary consolidation was calculated to be 42 days, would you still feel that the primary branch of the log time settlement curve for the diesel generator building representing closing of cracks and the secondary branch representing only primary consolidation is a reasonable hypothesis?

A I would consider the calculational evidence as supporting the fact or supporting the hypothesis that the initial settlement was in fact primary consolidation and not the closing of cracks.

Q Did you see any clay balls in the test pit adjacent to the service water pump house?

A I have not seen what I would call clay balls in the fill anywhere. I think the term "clay balls" is another useful word to describe the possible presence of voids or macro voids, as Dr. Peck calls them, in the fill. Those balls are probably envisioned by different people in different ways. I suspect Professor Peck and others familiar with the

eb91

borrow pit operation-- I suspect the clay ball represents what is peeled from the bottom of that borrow pit and probably went into the grader in a round shape and is not what you would consider to be a homogeneous, small, base-ball sized piece of material.

So I don't expect one would see that representation of a clay ball in the borrow pit.

Q Did you see in the excavation at the diesel generator building anything that looked like the clay things that have cracks in them that are going to be closed under the surcharge load we've been talking about?

A No, I did not see them in that borrow pit. I've imagined them from the results of the pocket penetrometer work that was done in the test pit early in the investigation.

Q And which test pit are you referring to now?

A It's one that was I believe somewhere in the submission, probably before January of 1979.

Q I mean do you know what the location of that test pit was?

A The location was interior to the diesel generator building, and I believe it was in the eastern bay, as I recall, the eastern bay and close to the north wall, one of

eb92

the eastern bays and close to the north wall.

Q So you have never seen any of these cracks that were part of that hypothesis about closing but you imagine those based on that penetrometer data?

A That's right. Those test pits were closed before we were notified.

Q How is it that the data from that pocket penetrometer leads you to imagine these cracks?

A The wall of the test pit was marked off in I believe three-inch squares and a pocket penetrometer was used within these squares and a plot of the results -- not a plot of the results but a plan view of the results was presented. And by looking at these results you see a very wide variation in the unconfined compressive strength attributed to the clays on the wall of the test pit.

And it's difficult to understand how zero compressive strength could be obtained on a fill from a borrow area composed of glacial till unless in fact that penetrometer reached what I would consider to be a crack or a void between the different lifts or between the slabs of material that were laid down in the fill.

Quite satisfactory results, fairly high unconfined

eb93

strengths were obtained at other points on that cross-section. I personally have simply formed that as a model of what I see the fill representing.

Q Would one of those areas of zero compressive strength represent a spot where somebody swiped a cobble?

(Laughter.)

A I feel that would be unlikely, sir.

Q Did you ever discuss this pocket penetrometer result with anyone else within the NRC, to your recollection?

A Not in the manner I have just discussed it with you. I thought that everyone would -- not everyone, but the interpretation of how the fill came to be in such a rather -- or came to give wide values to pocket penetrometer resistance could be interpreted by those who reviewed the data.

Q So your answer is no, you don't recall having discussed it?

A No, I did not discuss that aspect.

Q If none of the penetrometer readings had presented indications of zero compressive strengths, would that then indicate an absence of cracks or voids between the different lifts or slabs of material in that area?

A Not necessarily, but far less likely.

eb94

Q What does the pocket penetrometer measure?

A I believe a pocket penetrometer is calibrated in terms of the unconfined compressive strength in tons per square foot. If it's not that number it's twice or half of that number. Either way, zero comes out zero.

Q Is that compressive strength to which you refer related to shear strength?

A Yes, sir.

Q How?

A Well, the unconfined compressive strength is roughly half the shear strength of that material.

Q Is this penetrometer data-- Strike that.

Would the presence of these imagined cracks or voids between different lifts or slabs of material that we've been talking about tend to increase or decrease, in your opinion, drainage paths available for dissipation of pore water pressure during surcharge -- drainage rates or paths?

A It probably in fact wouldn't make much difference.

Q Why not?

A Well, the cracks become filled with water. The cracks are discontinuous. In order to force the water out from any of these voids it has to have some place to go. If

eb95

the void is discontinuous then it must go through fill at some other point.

Q How do you know the voids would be discontinuous?

A How do I know they'd be discontinuous?

Q Yes.

A The slabs of fill would have finite bending strength and they could only span a given distance before they're supported at some point, just from a mechanic's point of view.

Q What you're saying is if they were continuous then they would just fall together?

A Yes.

Q They've got to be discontinuous so as to have support along their length?

A Yes.

5.680

Q Is it possible that these voids which you imagine could interact or interface with areas of granular soil so as to provide some type of continuous drainage path?

A It's possible.

Q And is it likely under circumstances existing under the diesel generator building that that would happen, at least to some extent, and thereby increase the drainage

eb96

rate during preload?

A To answer that question you need to realize that the clay can drain horizontally or vertically. The shortest path in terms of distance would be vertical, so that the water in the voids wou'd move up above the present water table and be dissipate'd at that point.

The cracks I would anticipate, considering how the fill was laid down, would be primarily in a horizontal plane and considering drainage in the horizontal direction, it would have to move a considerable distance in order to dissipate itself. So that's why I responded that it probably wouldn't make a lot of difference as to whether the cracks

B6 were there continuous, discontinuous, or whatever.

Q In your opinion as a geotechnical engineer is

C4 it possible that effective drainage paths exist underneath the diesel generator building of a shorter distance horizontally than vertically?

A Sure, it's possible.

Q Do you think it's likely?

A It is likely for those parts of the fill adjacent to the diesel generator building in which we have some confidence that sand was placed beneath those, say, footings. In

eb97

those areas they probably did drain to that same boundary.

(Recess.)

BY MR. ZAMARIN:

Q What would you predict the pocket penetrometer value to be for a sand seam near the surface of the fill in the area of the diesel generator building? Would you expect it to be close to zero?

A I would expect, since it's near the surface or at the surface, it would be zero. Since those particular pocket penetrometer values were taken I believe at least at a depth of five feet, even if sand lenses had been present I would expect the pocket penetrometer to give a recording somewhere above zero.

Q Like what above zero?

A Oh, one ton per square foot, perhaps two tons per square foot.

Q And you're talking about pocket penetrometer values for sand seams five feet below the surface you would expect to be one or two tons per square foot?

A Interspersed between the clay layers and loaded by the clay layers, in that vicinity.

6.035

Q I believe you stated in the first portion of your

eb98

deposition that sections of the dike near the service water pump structure were safety-related or necessary for assurance of safety.

Are there other areas or portion of the dike which you believe are necessary to safety or necessary for insurance of safety?

A I believe that I included all of the areas in the previous deposition. But that would include any parts of the dike that could affect the return lines for the service water pond or that could possibly affect the capacity of the pond itself.

Q What do you mean by affect the capacity of the pond?

A The pond has a finite capacity and if soil should move into the pond, it would displace water, reducing the capacity of the pond, the volume of the pond such that greater than expected temperatures would be obtained when that pond was being used.

Q You're talking about the operating cooling pond and not the emergency cooling pond?

A No, I'm talking about the emergency cooling pond.

Q I see.

eb99

Do you believe that there is a likely problem with the dikes at Midland?

A "Likely" implies to me a good possibility, at least a 50 percent chance of a failure affecting the safety-related portion of the pond or the facilities related to the pond. I honestly don't know what that probability would be. I guess it would be less than 50 percent.

But in any case it must be a very low likelihood of failure in order to be acceptable for safety purposes.

Q And do you have any evidence that would lead you to believe that it is higher than that very low level which would be acceptable?

A I have no confidence that the level is very low because I have no basis to evaluate the ability of those slopes to remain stable.

Q That wasn't my question.

A Your question was would I have any information to indicate that there is a safety problem now or likely to be in the future.

Q That's correct.

A And my answer would be no. And I must qualify that:

eb100

I have no information to answer that the dikes are safe, which is my job to do.

Q In your opinion is it customary engineering practice to take borings in dikes or earthern embankments in order to obtain samples for laboratory testing after the embankment or dike is in service for retaining water, or after the pond or whatever it is that it is built adjacent to is filled?

A It is not at all unusual to use borings or test pits to evaluate the quality of the fill that's placed. Generally that operation is done either before the reservoir is filled or in times when the reservoir is at a very low stage.

Q My question was with regard to the time when the reservior is filled.

A It's not uncommon to do it that way, to take borings when the reservoir is filled.

Q And take borings for the purpose of obtaining samples for laboratory testing as opposed to, for example, installing piezometers?

A No, laboratory testing, yes.

Q Can you tell me all of the situations of which you're

eb101 .120

aware where such borings have been taken?

A I'm aware that borings were taken on a Corps of Engineers project in northwestern Mississippi. I'm struggling now with the name of that project. It begins with an "S" but I can't put the rest of it to it.

The purpose of those borings were to investigate the density of the fill material that had been placed in order to make an assessment of the earthquake stability. I believe the project was Sardis Reservoir.

I'm aware of a very small embankment similar to the size that's in place at Midland being bored, sampled, tested and subsequently pressure grouted in order to alleviate an underseepage condition that had developed in that full reservoir. That project was carried out on the grounds of the Waterways Experiment Station in Vicksburg, Mississippi.

I'm aware of, although I did not participate first-hand, an investigation of a large dam I believe in Wyoming or Montana which is a Corps project in which borings were placed in the downstream portion of that embankment for purposes of obtaining samples testing and assessing its resistance to earthquake effects.

So it's not uncommon.

eb102

Q So in your opinion then it is a customary practice to take borings in order to obtain samples for laboratory tests in dams or earthern embankments after their reservoirs are filled?

A If it's necessary, yes.

Q Okay. If it's necessary.

By that do you mean if there has been some kind of a problem demonstrated or evidenced that needs remedial action and that therefore information has to be obtained with regard to the extent and the nature of that remedial action?

A No. By "necessary" I mean if it's desirable for safety to assess the resistance or potential for resisting, say, an earthquake and if the consequences of that earthquake are unknown with respect to that dam, then it becomes necessary to assure the safety of that particular facility and borings then are a necessary part of the assessment of that safety.

Q Had any problem been exhibited with the Sardis Reservoir or Dam prior to the taking of borings?

A No problems that I'm aware of. I recognize it was constructed many, many years ago using construction

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practices that have later been learned to be questionable and with that doubt came the necessity to reassess the stability of the dam.

Q What about the Wyoming dam in which downstream portions had borings taken? Had there been any problem or concern exhibited there which led to or prompted the taking of borings in that embankment after it had been filled?

A The dam did not exhibit any distress, no. Again it was a matter of assuring that it would respond safely in case of an earthquake.

Q What was it that prompted the curiosity with regard to that dam?

A The concern with the safety of people downstream from those dams, people and property downstream of those dams.

Q Was there something that happened between the time that the dam was being constructed and the time the borings were taken that caused someone to become concerned?

A I think the realization that earthern embankments can in fact perform unsatisfactorily, based on experience in Alaska in '64 and San Fernando in '71, that there was a reasonable concern about the ability of those dams to behave properly.

In other words it was a consideration not recognized at the time those dams were initially constructed.

Q You referred to something in Alaska in '64. What was that?

A There was an earthquake in Alaska and soils behaved in a way that had not been observed or recognized or analyzed in the past. I'm speaking now of the slides that occurred at Turnagain Heights in which liquefaction phenomena on apparently thin seams of sand caused a large portion of the area to slide into the sea. And it was that behavior that prompted I believe the profession to look more closely at the behavior of certain types of materials during earthquakes.

Q You also made reference to the San Fernando Valley in February of 1971. What happened there?

A There was an earthern embankment that performed unsatisfactorily to the point where there was some worry that the downstream residents could suffer damage, again the performance of a particular type of material and engineered construction during an earthquake.

Q In your opinion could the taking of borings in a dike, the reservoir of which has already been filled,