ORIGINAL

TRANSCRIPT OF PROCEEDINGS

UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of:)
)
FINDINGS FROM THE INTEGRATED DESIGN)
INSPECTION (IDI) AT TVA)

Pages: 1 through 71

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UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of:

FINDINGS FROM THE INTEGRATED DESIGN INSPECTION (IDI) AT TVA

Friday
September 11, 1987

TVA West Tower
400 West Summit Hill Drive
Knoxville, Tennessee

The above-entitled matter came on for hearing, pursuant to notice, at 8:58 a.m.

PRESENT:

JOHN A. ZWOLINSKI
BRYANT M. LOWERY
B.D. LIAW
GARY ZECH
JANE A. AXELRAD
JAMES E. KEPPLER
STEUART E. EBNETER
JAMES LEIVO
ANDRES DUBOUCHET
RONALD PARKHILL
GENE V. IMBRO
ROBERT E. SHEWMAKER
RICHARD MCFADDEN
HAI-BOH WANG
DOUGLAS WILSON
MICHAEL J. RAY
CHARLES H. FOX
STEVEN A. WHITE
CHARLES C. MASON
RICHARD L. GRIDLEY
HERBERT L. ABERCROMBIE
BRIAN K. GRIMES

P R O C E E D I N G S

MR. ZWOLINSKI: My name is John Zwolinski, and I am the Assistant Director for Projects in the Office of Special Projects. The purpose of today's meeting is to have the staff present its findings of the results from the integrated design inspector having been conducted over the past two months. We are passing an attendance list about the room, and we would appreciate you filling it in as it will be part of the meeting minutes. This meeting is being transcribed, and that will also be an attachment to our meeting minutes.

At this point, I would like to have the members of the various staff sitting at the table introduce themselves being perhaps with Mr. Abercrombie.

MR. ABERCROMBIE: Herbert Abercrombie, site director.

MR. GRIDLEY: Dick Gridley, director, nuclear safety and licensing.

MR. MASON: Chuck Mason, deputy manager, Office of Nuclear Power.

MR. WHITE: Steve White, Office of Nuclear Power.

MR. FOX: Charlie Fox, Office of Nuclear Power.

MR. RAY: Mike Ray, IDI team leader.

MR. WILSON: Doug Wilson, nuclear engineering.

MR. MCFADDEN: Dick McFadden, electrical engineering team, inspector leader.

MR. HAI-BOI: Wang Hai-Boi, civil structure team.

MR. SHEWMAKER: Bob Shewmaker, co-IDI team leader.

MR. IMBRO: Gene Imbro, NRC IDI team leader.

MR. PARKHILL: Ron Parkhill, mechanical systems lead.

MR. DUBOUCHET: Andy Dubouchet, mechanical components lead.

MR. LEIVO: Jim Leivo, instrumentation and control systems lead.

MR. GRIMES: Brian Grimes, safety director, Division of Reactor Inspector and Safeguards.

MR. ZWOLINSKI: John Zwolinski.

MR. EBNETER: Stewart Ebneter, director, TVA.

MR. KEPPLER: Jim Keppler, director of the Office of Special Projects.

MS. AXELRAD: Jane Axelrad, deputy director of the Office of Special Projects.

MR. ZECH: Gary Zech, assistant director for inspection programs.

MR. LIAW: B.D. Liaw, assistant director for technical programs.

MR. ZWOLINSKI: Thank you. As I mentioned, meeting minutes will be issued in approximately a week containing the transcription of this particular meeting. As this is an exit meeting, there are a few unique aspects which are taking place today. Normally when we conduct an inspection, we would document our findings and provide an inspection report very quickly.

We are here today to present our findings, and these will be documented in an inspection report scheduled for early November. We are not attempting to resolve questions that may come up today. However should you have questions regarding any specifics that the team members might be presenting, seek clarification as necessary. But we are not attempting to resolve issues that may arise.

At this point, I would like to turn the meeting to Jim Keppler.

MR. KEPPLER: Thank you, John. In the beginning of June, we made the decision that an independent design inspection was needed for the Sequoyah project before we could conclude that the efforts undertaken by TVA were sufficient enough to permit restart of the reactor.

We gave TVA the option of conducting that inspection at that time or to do it with an internal inspection of the NRC. And at the meeting in Washington to discuss this, TVA took the position that they could not commit to an inspection at that time. So we made the decision to move ahead to conduct this inspection.

We laid out a schedule in which this would be conducted, and we set at that time the date of September 11th to brief you on. We have met that schedule, and we are here to share with you the results of that effort today.

This was a controversial decision which TVA did not feel the need for this inspection. But I will say publicly that you supported the inspection fully, and we appreciate that effort. But we have put together a strong team to look at the various engineering disciplines associated with one of the safety systems in the plant.

Now we recognize in carrying out this effort that we need to get to you for you. For you to meet your schedules, we need to get to you information by the early part of October of what work has to be tied to restart of the reactor. So if you have additional information relative to this inspection effort, which I understand you do have, it is important that you get that information to us in a very early time frame. Because otherwise, we are just going to have to push back our dates.

I am somewhat concerned that information will be coming in late, but I realize that this is a complicated inspection effort, and that this will necessitate back and forth flows of information.

But what we are here to do is to share with you our view as we have the information today. We are going to proceed in writing the report that way. And so if you have information which significantly affects the findings that we are talking about today, it is incumbent upon you to get that information to us promptly.

Gene, I will turn it over to you now, or do you want to make some remarks?

MR. EBNETER: Just one comment briefly. The integrated design process consists of two parts for Sequoyah, as you recognize, and one of them was the as built inspection at Sequoyah which we completed, and we held the exit interview at Sequoyah. There are some common threads running between these two, as there should be, because the as built should reflect the actual incorporation of the design features of the plant.

So as you go through this, as Gene goes through his findings, you will find some common threads in electrical separations over pressure protection and design engineering and the operations interface. And both of these areas should be viewed in that light, that they are not completely separate, but they are tied to operations and the plant condition as well as Knoxville.

That report should be out in about two weeks. Frank McCoy has the final draft ready now, and you should get that in about two weeks, and it will identify some deficiencies similar to this.

MR. KEPPLER: What we are going to do is Gene Imbro is going to give you some information related to the conduct of the inspection. And I had a briefing yesterday by my staff, and I thought that I would share with you how I view the results, and then turn it over for the detailed results to the individuals.

Do you have any remarks that you would like to make?

MR. WHITE: Yes. I would like to say one thing. I agree very much that -- of course, the effort, first of all, is kind of unprecedented, to do what we both attempted to do here. And I appreciate your words that we have tried to support you as best we could. We also very clearly understand I think, first of all, that as the process went on, I think the teams worked very closely together, and we were able to furnish information to my understanding fairly rapidly until late in the game where at some point in time and I understand this, that at some point in time your team leader, Mr. Imbro, has to stop and say wait a minute I have got to now write a report.

So at that point in time, which was I guess roughly last week, about a week ago, I clearly understand why he could not accept information from that point on or at least limit it, because he had a job to do to get ready for today, and we understand that. But as a result, we do have much information that we are ready to transmit on a number of these issues very quickly.

So I appreciate your words. I think that they are very appropriate. I think that after this meeting that we need to keep those teams very closely aligned, so that we can have a rapid transmission of the information that we have now accumulated. And of course, we are out getting other information as necessary to answer the various issues.

MR. IMBRO: Before I start, I would like to introduce the rest of our team which are not sitting at the table right now. Let me just go through the first row there. If you would all stand up when I introduce you. Ahmet Unsal.

MR. UNSAL: Ahmet Unsal, specialty.

MR. MALLEN: Owen Mallon, structural team.

MR. MASTERSON: Bob Masterson, mechanical components.

MR. FERRARINI: Vic Ferrarini, mechanical components.

MR. CHEN: S.T. Chen, instrumentation and control.

MR. HOUGHTON: Jim Houghton, mechanical.

MR. HALLER: John Haller, electrical.

MR. IMBRO: Thank you. And I would just like to take a minute here to thank them all for what I consider to be a very professional and thorough job during the inspection. It was a very difficult inspection, and as Mr. White said, unprecedented.

There are a lot of TVA people here. But for the benefit of those who are not TVA and some of the media people, I just wanted to go through a little bit of what I spoke about in the entrance meeting as to what the purpose of the inspection is and a little bit of how we conduct the inspection.

First of all, the primary purpose of the inspection was to get a handle on the adequacy of the original design of the Sequoyah plant. Now what we tried to do was to review the original design calculations of the documentation and purchase specs. But since the system we chose has evolved substantially during the years, it became necessary not only to look at the original design but some of the more current calculations. And we wound up looking at the system as it stands today and give comments relative to the adequacy of that system.

This inspection is termed the integrated design inspection. And the reason that it is called that is in the design of a nuclear power plant there needs to be a lot of interdisciplinary communication. There are a lot of different engineers and different design groups working on the project, and they essentially need to have a coordinated effort to make sure that everything turns out the way that it is supposed to and meets the NRC requirements.

So how we structured our inspection is basically we had a team consisting of five major discipline areas. The first area was mechanical systems. And that essentially was to look at flow calculations and transfer calculations, and that type of thing which we consider as systems.

The second area was a review of mechanical components, and that essentially is piping, pipe supports, and also seismic qualification of equipment.

Now structural design was another area that we looked at. And both of these two areas, mechanical components and structural design in TVA basically are embodied in the civil engineering branch. We also looked at instrumentation and control, and we looked at the electrical power.

Now the types of documents that we reviewed just quickly. Obviously, we looked at calculations, and we looked at TVA drawings, and we looked at TVA procurement documents, and we looked at design change documentation, design change requests, nonconformances, et cetera. We also looked at maintenance requests, and licensee event reports, and TVA design criteria.

The reason that we looked at the maintenance requests and licensee event reports was that we tried to get a sense of how the system was operated and tried to spot in looking at those anything that we perceived maybe to be design problems that came about through repeated maintenance on components or an abnormal number of licensee event reports in the same area.

The standard that we used to judge design adequacy are the licensing commitments that TVA made in their FSAR that were approved by the NRC. And embodied in those licensing commitments are certain codes and standards which TVA has committed to. For example, ACI-318, 1963 and ACI-B-31.1, 1967 for piping, and there are many, many others.

We selected the ERCW as a system for review partially because we felt it was representative of TVA work, design work, during the period of time when Sequoyah was being designed. It is a safety related system, and it is one of the systems that TVA has sole responsibility for design as opposed to other systems which are supplied by the reactor manufacturer.

The investigation was pretty intensive. We had a large team by normal inspection standards, and it is about average for IVI. And as you can see, we had fourteen team people, team members, and essentially about six weeks of effort, four weeks of direct inspection plus the time back in the office where we also continued our inspection reviewing documents that we had taken home with us. So you can see that it is a rather intensive and focused effort on one particular system.

Before we started this inspection, we anticipated that there were going to be problems. And if I could characterize that. Any time you get a team of experts, as my team is, no matter what plant in the country we go into, we find problems. It just goes without saying that you are going to find problems.

And the problems vary depending on the utility and how they approach the design. But we knew that we were going to find things wrong when we went in to look at the design. Some things surprised us and some things we expected to see.

Let me go through quickly what we consider to be the major problem areas. First of all, we feel that there is major programmatic weakness in structural calculations. And structural calculations are those which essentially support the design of the building and support the equipment foundation and those type of things which are done in the civil engineering branch.

Also we feel that there is a programmatic weakness in TVA review of seismic qualification reports provided by the vendors and also in equipment seismic qualification. We also feel that there is a programmatic weakness in the design of pipe supports.

Before I go on, to try to set the tone for the meeting, we are going to try to give a balanced presentation. We are also going to try and say what we saw good about TVA and what we say that we did not think was quite as good. But the focus of this meeting for TVA's benefit is essentially to point out to them the areas where we think that they need to do additional work.

So members of the press, I think that they really should understand that the reason that they are not hearing a lot of good things is not because a lot of good things do not exist, but we are not really focusing on those right now. We are really trying to concentrate on areas where we think that TVA needs to do additional work. But we will try to go into some of the positive things also.

Other problem areas, to continue. We found a problem in equipment qualification placed in a mild environment, and that is not the intent of 450-49. We also found inconsistent application of the code of record for piping systems. And I think that presented some confusion in TVA. We also found problems related to the design pressure of the ERCW system which was again our primary system which we looked at.

So there were a number of things that we found that are indicative certainly that TVA has got a little bit further to go to get the plant design cleaned up. And we also have to acknowledge that in the last few years since I have been involved with TVA that I feel that they really have come a long way in getting well.

On the positive side, TVA has put together again as a part of the design base line and verification program a very comprehensive set of design criteria which from our point of view looking at the different plants in the industry, we think that they are quite superior to a lot of things that we have seen. So I think that the fact that they have a strong basis for design now will certainly go a long way to help them in the future in the plant design in accordance with criteria.

We found that we generated calculations for the most part that were clearly improperly performed. Also I have to go back and say that in our last inspection we did find problems with regenerated calculations, particularly those performed by contractors, and we still have those problems. But things that we saw since this inspection led us to believe that things are getting better.

Electrical calculations. TVA took the initiative I guess about a year or so ago to completely redo the electrical calculations, and we feel that they have done a very complete and comprehensive job. The calc design documents we found to be readily retrievable. In some plants, that kind of document retrieval is very difficult. And that essentially made the inspection a little bit easier for us. And certainly, TVA's cooperation in helping us get the design documents went a long way to help us along also.

Another thing that I view as positive at least is the development of the CCRIS system. And that is a system, I guess that I do not really remember what the acronym stands for right now, but basically it is a system where you can track inputs and outputs of calculations so that you know exactly what calculations support other calculations. So if you make a change in one, you know that you have to change all of the others. That is something else that I have never seen in the industry, and I think that is a very good thing to have.

So I guess with that sort of preamble, I will turn it back to Mr. Keppler now.

MR. KEPPLER: Thank you, Gene. I mentioned yesterday that I received a briefing that you are going to receive today from the team members. I had an opportunity to ask a lot of questions and tried to focus a perspective on each of the issues.

What I came away with was the feeling that in the areas of mechanical, electrical, mechanical components, and instrumentation and control that while we have findings in these areas and there were some surprises to us, I would say that on a big picture look that the plant did not come out too bad. Maybe a little better and a little worse in spots than we would have expected, but not grossly off the mark.

The area that shakes me personally is the civil structural area. Based on the information that we have today, we think that the inspection came up very short in that area in terms of the findings. And it is of some concern to me because what we went looking for in this inspection was to make sure that there was no major area overlooked by TVA in its review programs.

At this stage, and I caution the comment that I am going to make, but at this stage based on the information that I had, it is of concern to me that this can lead to delays in the plant. So if you have information which changes our view, it is very important that we receive this information. We will keep an open mind on out findings and we have instructed the team to do that.

We recognize from discussions between the various organizations that you do have a view that is not similar to ours in this area. But based on the information that I sat with today, I have a concern that this area has the potential to set things back.

So this is the area that you ought to focus very carefully on in the findings. Not to overlook the other areas, but to make sure that the concerns that we have in this area are properly addressed.

MR. WHITE: I think that I understand that, Mr. Keppler. And of course, that is the area where I believe we have the most information available and ready to turn over to you, and I appreciate the fact that you and your team will keep an open mind when you receive this information. I think that is the area where the majority of our information is available.

MR. IMBRO: Thank you. Before I turn it over to the team, maybe just a quick word for some of you people who are not familiar with the Sequoyah design as to what the ERCW is and what it does. Basically, ERCW is an acronym for essential raw cooling water system.

What it does is that it is essentially the primary heat removal system for safety related equipment, and it would reject the plant's heat from that equipment to the river. So essentially, it is a cooling system for heat exchangers interfacing with various other systems and certain components such as air compressors, and seal conversion, and a whole raft of other things.

So it is a safety related system that communicates with the river and provides cooling for quite a large number of essential components.

I guess that I would like to start going through the discipline summaries now. First, I would like to present Ron Parkhill, who will talk about the mechanical systems area.

MR. PARKHILL: Myself and Jim Houghton performed a review of the mechanical systems area. The mechanical systems discipline for the Sequoyah IDI reviewed the ERCW systems for implementation of licensing commitments. The scope included a review of the thermal and fluid design basis of the system, the procurement specifications, compliance with the governing codes, interfaces with other design disciplines. Hazards analysis including monitored energy line break analysis, flooding, seismic two over one considerations, testing procedures, operating and maintenance interfaces, and various FCRs, NCRs, ECNs, CAQRs, and maintenance requests.

In the mechanical systems scope of review, the IDI team noted the following good practices by TVA. The new and recently revised calculations are generally clear and supported the stated objective. Where problems were identified, TVA promptly defined the proposed corrective action. Design criteria documents are generally up-to-date reflecting the current licensing commitments.

An effective ASME Section 11 program is in place. An effective moderate energy line break analysis has been performed. An extensive surveillance program is in place for erosion, corrosion control, and MIC which is microbiologically induced corrosion.

Additionally, system modifications are in place for long-term resolution of these problems. However, the Office of Special Projects has the responsibility for review regarding the MIC issue.

The following problems were identified in the mechanical systems review. The first problem is associated with the design pressure of the ERCW system. TVA's stated design pressure of the ERCW system is 160 psig except for the piping in the ERCW pump house which is 180 psig. TVA's associated design pressure calculation identifies many ERCW components with a design pressure of 150 psig or less, and attempts to justify lowering the system design pressure to 150 psig by using administrative measures to limit the pressure in the pump discharge header and using frictional flow losses in the system.

The code in effect for the design of the ERCW system piping, ANCI-B-31.1, 1967, requires that the design pressure not be less than the maximum sustained operating pressure within the piping, and shall include allowances for pressure surges.

The team believes that the ERCW system's design pressure cannot be established by relying on administrative measures such as switching ERCW pumps on and off and/or throttling system valves. Instead a conservative design pressure needs to be established, and the system needs to be designed and rerated for that design pressure or the leak valves provided.

The IDI team noted the two following nonconservative assumptions in the TVA design pressure calculation. First, the river water levels above plant elevation 683 up to and including the maximum design basis flood at elevation 726.8 feet were not considered. Secondly, the effect of equipment outages was not considered.

Additionally, many of the components in the ERCW system have a design pressure which is at least 10 psi less than the current system design pressure of 160 psig. TVA needs to reconcile these differences.

Finally, the auxiliary air compressor cylinder and after cooler as well as a station air compressor cylinder and air cooler have design pressures less than 75 psig. Throttling of the upstream valves cannot be relied upon for over-pressure protection. And either the equipment must be rerated for the maximum sustained operating pressure or relief valves provided as required by the code in effect. In summary, the system needs to be requalified for the established design pressure or relief valves provided.

With regard to safety related and non-safety related interfaces, TVA does not have an analysis which adequately evaluates the consequences of failure of the ERCW non-seismic piping to the station air compressor coolers. Such an analysis needs to demonstrate that the functionality of the ERCW safety related equipment is not degraded by the failure of the non-safety related portion of the system that is not seismically designed.

Additionally, TVA has no procedure which ensures consistent identification of location of safety class boundaries. Three examples were identified by the TVA team where safety class boundaries were improperly identified, and one such example is provided here. The TVA Class C piping interfacing with the AERCW and old AERCW intake pumping station has lower TVA Class G components within the Class C system.

With regard to qualification of equipment in a mild environment, two problems were identified. The first problem is associated with the mild environmental qualification of the AERCW components. The specifications augmented by contractor data for the AERCW pumps, strainers, screen wash pumps and traveling screens were compared to the drawings entitled environmental data mild. It was noted that none of these specifications had temperature ranges that were compatible with the environmental data drawings.

The inconsistencies noted raised the concern that other equipment may not be qualified for the mild environment in which it has to function.

The second problem under this heading is associated with establishing the maximum and minimum temperature limits for the AERCW pump house at elevation 704 feet. The calculation which established the mild environmental conditions for Sequoyah and Watts Bar was reviewed for the portion that applies to the AERCW pump house.

Review of this calculation identified two problems. First, the maximum temperature limit was not based on technically justified heat gains and losses, but rather on unjustified assumptions. Secondly, the lower temperature limit did not assume the worst case failure of non-1-E equipment, namely room heater off and ventilation fan on. Also, heat losses through the uninsulated concrete walls were incorrectly neglected.

As a result of these concerns, TVA needs to ensure that this entire calculation provides a technically justified basis for establishing the mild environmental temperature limits throuyhout the rest of the plant.

In response to the previously mentioned IDI team's concerns, TVA provided a more rigorous analysis of the AERCW pump house mild environment temperature limits. However, this newer calculation did not adequately establish the lower temperature limit associated with the abnormal condition LOCA due to a number of non-conservative assumptions.

The next finding is associated with TVA not having an approved operating procedure for manual operation of the screen wash pumps. The AERCW screen wash pumps are designed to be operated automatically based on traveling screen high differential pressure. However, a temporary change removed the existing differential pressure automation and recommended procedural control utilizing manual operation of the screen wash pumps.

However, no procedure has been approved for manual operation. This demonstrates a lack of timely implementation of the formal procedure by operations.

With regard to the definition and application of code commitments, TVA has been inconsistent with the safety related ECRW piping components, specification, and in-service testing. For piping design, the TVA has inconsistently used ANCI B-31-1, B-31-7, and ASME Section 3 as the code in effect.

For components, the screen wash pumps were procured to manufacturer's standards rather than the FSAR identified code of ASME-3. For specifications, professional engineering recertification was not obtained for procurement modifications to the original design specs. For testing, the screen wash pumps were not included in the ASME Section 11 pump in-service test plan even though these pumps were safety related TVA Class C per FSAR and performed the safety related function during normal plan operation.

Therefore, TVA needs to clearly define how the various codes in effect are applied and document them consistently in the design basis documents.

The final mechanical system IDI team problem presented here today is associated with breach of containment integrity. In the design criterion title flood protection provisions, TVA indicates that during a design basis flood that it may become necessary to cut a hole in the free standing steel containment to prevent external build-up of water pressure on the steel containment vessel. Cutting a hole in the steel containment vessel under the design basis flood has not been formally identified to the NRC, and therefore cannot be reviewed for acceptability.

A summary for the mechanical systems. As indicated in my introduction of the mechanical systems IDI team review, the majority of the items reviewed are considered to be adequate. However, of the items discussed, the following have potentially significant generic impact. Code compliance in the areas of design pressure and over-pressure protection, assurance that failure of non-safety related portions of the system do not functionally degrade the safety related system and assurance that safety class boundaries have been adequately located, qualification of equipment in a mild environment, and inconsistent application of codes in effect.

When we came here to perform this inspection, we expected to find problems, as Mr. Keppler indicated, much like we would find at other facilities. However, we did not anticipate the problems associated with design pressure and codes in effect would be identified. This concludes my remarks.

MR. IMBRO: Thanks, Ron. Next I would like to turn it over to Andy Dubouchet, who will discuss the area of mechanical components. And again this is piping, pipe support, and seismic qualification of equipment.

MR. DUBOUCHET: In the mechanical components discipline, the IDI team reviewed a selected sample of the equipment, piping, and pipe supports installed in the essential raw water cooling system at the Sequoyah Nuclear Plant, Unit 2. For each of these areas, we reviewed TVA's licensing commitments, the industry codes of record which TVA used, and TVA's technical design criteria. TVA's commitments to the criteria contained in these documents form the basis for our technical review.

Before we summarize the problems identified during our inspection, we would like to emphasize that six weeks were spent inspecting a substantial sample of the equipment, piping, and pipe supports in the essential raw water cooling system at the Sequoyah Nuclear Plant. We found a major portion of the documents that we reviewed to be in accordance with TVA's licensing commitments and design criteria.

The team was impressed with the technical expertise of the TVA engineers with whom we interface. We were also impressed with the quality of TVA's engineering procedures and design criteria and the project's ability in general to retrieve important documents in a timely manner.

A number of the problems that we identified appear to be isolated. However, we identified two areas of concern that will require TVA review in the areas of equipment qualification, seismic qualification, and design of pipe supports.

In the area of equipment seismic qualification, we will review TVA's equipment procurement documents to confirm that these documents incorporated the appropriate technical criteria and specified appropriate levels of design control. We also reviewed the equipment seismic qualification documents which the equipment vendor prepared to confirm that the vendor qualified the equipment to the specified technical and design control criteria.

The deficiencies that the team identified during the course of this review were characterized primarily by vendor equipment qualification documents that did not meet the requirements of TVA's equipment procurement documents.

The following nine examples are provided. For the first example, the vendor seismic qualification calculation for the motor operated valves that regulate the flow of emergency make-up water to the turbine driven auxiliary feedwater pumps uses a design pressure of 50 psig, although the system design pressure is 150 psig. The vendor seismic qualification report combines the valve seismic loads with valve operating loads based on 50 psig to seismically qualify the valve.

The second example involves the vendor's seismic qualification document for the turbine driven auxiliary feedwater pumps which does not address the axial thrust of the pump discharge nozzle due to the 1650 psig pump discharge pressure as required by TVA's pump procurement document. This is a concern for the motor driven as well as the turbine driven pumps at Sequoyah Nuclear Plant.

The third example involves TVA's procurement of flexible hose for safety class application in the essential raw cooling water system. In this instance, TVA took unjustified exceptions to the criteria within its own procurement document to reduce the seismic and quality control requirements that the flex hose vendor was required to satisfy.

The fourth example involves the vendor seismic qualification document for the upper containment air cooler. The calculation contains an error which when corrected yields a unconservative minimum frequency for this equipment. This document was apparently not designed verified by the vendor or by TVA as required by the PSAR and TVA's procurement document for the equipment.

The fifth example involves separate seismic qualification reports for shut-down board room chiller B and its associated control box which is mounted on the chiller unit. The seismic reports violated a key technical provision of the equipment procurement document which requires that no device location on the support structure be permitted to have an acceleration greater than three-quarters of the actual device test acceleration.

The sixth example is similar to the fifth and involves two Westinghouse reports which separately qualify a Westinghouse vertical auxiliary panel and two types of Westinghouse switches. These documents did not meet the same key provision of TVA's procurement document for this equipment which requires that the switches on the panel be limited to seismic acceleration less than three-quarters of the actual switch test accelerations. This provision is also a FSAR requirement for panel supporting electrical and control devices.

The seventh example documents the team's concern with the design changes that permit the field to procure and install electrical and control devices such as relays, timers, and terminal blocks, and previously qualified Class 1-E panels without an apparent engineering review. This review was required to confirm that the original seismic qualifications of the panels and devices remain valid.

For the eighth example, the equipment vendor's calculation for the component cooling water and containment spray heat exchanges were not performed in accordance with technical requirements specified in TVA's procurement document. The vendor's calculations appear to be unconservative with respect to TVA's requirements due to the fact that two nozzle shift forces were not considered for both the equipment and their supports.

In addition, TVA did not install the component cooling water heat exchanger in accordance with the vendor's drawing. TVA installed the heat exchanger using three supports rather than two supports as shown on the vendor's drawing. No calculations were performed by TVA or the vendor to evaluate the effects of this additional support on the heat exchanger shelf.

The last example concerns TVA's inability to demonstrate or TVA design verified the vendor's seismic qualification reports for the upper containment air cooler, lower containment air cooler, and the control rod drive air cooler. Design review and certification of vendor seismic qualification documents was a PSAR and TVA procurement document requirement.

The team notes that failure to perform a design review may result in incorrect or unverified assumptions or calculation errors which may affect the seismic qualification of the equipment. This item therefore has generic implications for equipment requiring seismic qualification.

In the area of piping analysis, the team reviewed a number of safety class piping subsystems within the essential raw cooling water system that TVA either computer analyzed or field routed. The team documented several deficiencies in this area due primarily to inconsistent documentation, calculation errors and omissions, and failure to meet FSAR commitments.

The following four examples are provided. In the first example, TVA did not analyze a piping subsystem for a thermal load which is specified in the FSAR. TVA did not analyze the piping between header 2-B and containment spray heat exchanger 2-B for the cold thermal mode or the thermal range.

A second example concerns TVA's failure to model the flexibility of a valve operator in a piping analysis calculation as required by the FSAR. The FSAR requirements that valve operators with fundamental frequencies less than 25 hertz be modeled in the piping analysis as flexible.

The third example concerns TVA's inability to confirm that temporary piping can be installed in the essential raw cooling water system including the spool piece which connects header 2-B to the component cooling water surge tank without overloading the adjacent piping and supports. TVA may have fabricated some of the spool pieces to nominal rather than to as built dimensions.

As a fourth example, the team noted that in a portion of the piping analysis that TVA elected to reduce the seismic stress at a T connection by incorrectly interpreting and improperly applying a provision of the piping code of record for the Sequoyah Nuclear Plant.

TVA performs pipe stress analysis using the ASME Section 3, Subsection NC-3600 stress equations. The piping code of record for Sequoyah is ANCI-B-31-1, 1967 edition. TVA has justified using the NC-3600 equations because they are essentially the same as the B-31-1 requirements.

However, for a piping subsystem which used the NC-3600 stress equations and was of a stress at a T connection, TVA justified the over-stress condition by using an interpretation of the B-31-1 code which allowed TVA to ignore the stress intensification factor of the T when computing the seismic stresses.

The team disagrees with TVA's interpretation of the B-31-1 code requirements. We also take strong exception to the practice of invoking an isolated portion of a code to reduce an over-stress condition in order to meet allowable code stress levels.

In the area of pipe supports, the team reviewed the pipe support designs and calculations for a number of the pipe supports installed in the essential raw cooling water system.

We first note that TVA cannot currently retrieve the calculations for a number of safety class supports at the Sequoyah Nuclear plant. However, the NRC is separately overviewing TVA's program to regenerate these calculations and the team has confirmed that that TVA has scheduled the missing pipe support calculations which the team identified for regeneration.

For the pipe support calculations that we were able to review, we identified several deficiencies which involved calculation errors and omissions and failure to meet FSAR criteria. Five examples are provided here.

In the first example, TVA used unconservative and incorrect assumptions to analyze three pipe supports in two of the piping subsystems that the team reviewed. These errors may affect both the structural analysis of the support and the anchor bolt qualification due to the support design.

Since the team discovered errors in three of the eight pipe support calculations reviewed, and this was just in one package as we reviewed many more than eight, the team concludes that generic concerns exist with respect to pipe support calculation adequacy.

It should be noted, however, that all three calculations are included in TVA's commitment to regenerate pipe support calculations.

In the second example, TVA has a FSAR commitment to maintain pipe support stresses below a certain percentage of the specified material strength of structural steel. However, the team noted that TVA's use of allowable load factors for the full load condition can result in pipe support stress levels which exceed the FSAR maximum allowable stress level.

As a third example, the base plates and anchor bolts used to attach a pipe support to a concrete wall or slab for some typical TVA pipe support designs were not sized with respect to all of the applied loads.

As a fourth example, TVA developed load ratings for pipe clamps based upon testing in accordance with the load rating rules of AMSE Section 3, Subsection NF. However, the TVA calculation which evaluated the clamp test data contains several errors and omissions. For example, the calculation did not apply a ten percent reduction in the resulting load rating as required by ASME-3, Subsection NF when only one sample is tested.

Also, ASTM-A-307 bolting material is used in a pre-loaded friction connection to resist pipe axial load. However, both AISC and ASME-3, Subsection NF prohibits the use of A-307 bolts in a friction connection due to its uncertain pre-load capacity.

Item 5 is related to the previous item and addresses calculations required to augment corrective action for a nonconformance report. The team reviewed a preoperating license nonconformance report and found that TVA's corrective action to address the nonconforming condition resulted in the incorrect qualification of previously used pipe clamps for TVA's fuel routed piping program.

The corrective action attempted to address the interaction effects of multi-directional loading on pipe clamps which had been previously evaluated for one directional loading. In the evaluation for the corrective action, TVA failed to properly address the effects of interaction of tension and bending on the pipe clamp for all clamp sizes required, and unconservatively interacted sheer and tension for the three loading directions on the clamp bolts.

To put our findings into perspective once again, we know that we reviewed a significant portion of the equipment, piping, and pipe supports in the essential raw cooling water system with respect to a total of 22 separate inspection checks. However, a review for the majority of these checks confirmed with some localized exceptions the adequacy of the documentation which we reviewed.

However, we reiterate that two areas may be areas of potential generic concern at the Sequoyah Nuclear Plant. The first area is vendor seismic qualification reports which were not prepared in accordance with the requirements of TVA's equipment procurement documents and were apparently accepted by TVA without design review.

The second area is pipe support calculations which were not prepared in accordance with TVA's commitments and design criteria.

This concludes the summary of our review of the mechanical components discipline.

MR. EBNETER: Stu Ebneter. Just one comment. You have heard several comments early on in this discussion about the procurement interface. And Mr. Kazzanis, I see you sitting over there. I would like to direct your attention to this. We repeatedly have discussed it. There apparently is some difficulty between the design and the procurament interface. And we recognize that the total procurement function is not under nuclear operations. And do not lose sight of the fact that we are talking about design here primarily, but that procurement interface is important.

MR. IMBRO: Thank you. I would like to next turn the floor over to James Leivo, whose discipline is in instrumentation and control review area.

MR. LEIVO: Dr. Chen and I conducted the instrumentation and control systems review. In the instrumentation and controls discipline, the team reviewed several major areas of the design with emphasis on compliance with FSAR and other TVA commitments and requirements as well as assurance that the systems and equipment would function as required under design basis conditions.

Where problems were reported within the ERCW system, the team identified any design issues that might extend beyond the ERCW system scope, and we will mention these potential generic issues in this discussion.

The major areas reviewed which will be discussed included process instrumentation and control detail design, design features provided for a safe shutdown from outside the control room, environmental and seismic design and qualification, and radiation monitoring.

The selective documentation reviewed and discussed with TVA included FSAR and regulatory requirements, standards, TVA design criteria, engineering procedures, logic and schematic diagrams, instrument installation details, instrument specification and procurement documents, demonstrated accuracy calculations, engineering change notices, work packages, nonconformance reports, and various technical documents.

We will selectively highlight today and report comprehensively later the problems and unresolved issues that we have identified during this review.

In the first review area, that of design detail, the team identified a deficiency in the implementation of the mechanical systems functional requirements. The team observed that TVA did not provide a calculation justifying the use of manual operator action initiated by a high flow alarm to manually isolate a break in the non-seismic portion of the ERCW piping.

Furthermore, we determined that the enunciator system is not seismically qualified. And that in any case, a seismic event would likely result in numerous alarms and indications competing for the operator's attention. The team concludes that timely and sufficient operator action to manually isolate the postulated break has not been assured.

Also in the area of design detail, the team identified problems and unresolved issues regarding circuit separation and isolation. And we will summarize three of the more significant ones.

First, the team determined that fuses used to provide isolation of the non-Class 1-E traveling screen feed switch had not been properly coordinated with the control circuit fuse. Since the control circuit fuse is shared by both the Class 1-E traveling screen control devices and the non-1-E feed switch, a seismic event shorting the switches could render all four traveling screens inoperable.

TVA should assure adequate fuse or other protective device coordination for all instrumentation and control circuits where credit is taken for fuses as isolation devices.

A second item regarding adequate separation of non-Class 1-E from Class 1-E switch gear control wiring remains unresolved until a satisfactory analysis is provided by TVA demonstrating that no credible fault is non-Class 1-E wiring could be propagated into the Class 1-E wiring where that internal wiring is bundled together.

A review of the control wiring within the 6900 volt switch gear indicated that input and output wiring for control relays that are used for isolation devices were bundled together within the switch gear enclosure such that non-Class 1-E wiring is in contact with Class 1-E wiring.

A third item regarding the TVA criteria for separation of instrument sensing lines and instrument air lines remains unresolved in that the criteria permits the use of common instrument line penetrations for redundant channels. TVA must identify any safety related instrument lines which share common penetrations and demonstrate compliance with single failure criteria.

In the second major design area, safe shutdown capability from outside of the control room, the team identified a deficiency in the circuit design for the traveling screen drives and screen back-wash pumps. Control indicating lights for these circuits are directly connected to the control circuits such that a design basis control room fire could render all of the screen wash pumps and traveling screen drives inoperable from many locations. TVA should examine any similar indicating light circuits in the control room for this deficiency.

In the area of environmental and seismic design, the team identified two deficiencies. First, as noted earlier by the mechanical systems IDI discipline, the team observed that no analysis had been performed by TVA adequately justifying the absence of qualified environmental control features in the ERCW pumping station. No heat tracing or qualified space heaters are provided to prevent freezing of safety related instrument sensing lines within the ERCW structure. TVA should also review other safety related instrumentation and its environmental protection where extreme temperature conditions may be encountered.

Second, with assistance from the IDI mechanical components discipline, the team reviewed seismic qualification of the main control board room switch modules. The efficiency in this area was earlier reported by the IDI mechanical components discipline.

TVA could not retrieve the calculation demonstrating that the maximum accelerations at all switch locations satisfied the FSAR criteria that the acceleration at the panel mounting location be less than three-fourths of the actual device test acceleration. This FSAR requirement was not evident in the procurement documentation nor was compliance with the criteria clearly demonstrated by test or analysis. This finding is applicable to all of the main control room panels.

Also as previously reported by the IDI mechanical components discipline, an additional unresolved item was identified regarding assurance that instrumentation and control devices identified as field located on drawings are mounted in locations that do not compromise seismic design and qualification criteria.

Finally in the radiation monitoring area, the team reviewed the specifications and location of the ERCW discharge liquid monitor and determined that the monitor background radiation had been incorrectly specified, since it did not take into account post-accident radiation sources.

The team determined that the existing monitors will probably not function during a design basis accident, since accident background levels were actually at the monitor and will likely mask any measured level. The FSAR states that these monitors are required during an accident to detect leakage of the containment spray or component cooling water heat exchangers into the ERCW system. TVA should review all post-accident radiation monitors for this type of deficiency.

To summarize our review in the I&C discipline, while the team believes that with one exception that the number and significance of deficiencies identified seems comparably low, we would also note that the ERCW system has comparatively simple and straightforward safety related instrumentation requirements, and that the electrical and instrumentation discipline has had prior extensive review.

The deficiency that seems to be an exception to our normal expectations for this type of review is the discrepancy that we identified in the main control board switch module seismic qualification.

This concludes the instrumentation and control systems discipline summary.

MR. IMBRO: Thanks, Jim. While at this point rather than continuing, as I know these things get kind of dry and drawn out maybe, I think that it may be appropriate to take a fifteen minute break here to refresh ourselves.

(Whereupon, a recess was taken.)

MR. IMBRO: I would now like to turn the floor over to Dick McFadden, a leader in the electrical power area.

MR. MC FADDEN: Thank you, Gene.

The electrical engineering inspection team evaluated the design of the electric power subsystem of the Sequoyah ERC EE system and the electrical supply systems which support it with respect to conformance to licensing commitments, internal TVA design criteria and good engineering practice.

Since the ERC EE power supply is an integral part of the plant auxiliary power system, this inspection developed into a broad evaluation of Sequoyah plant electric power system design.

The team examined the following systems, subsystems and components: 6900 volt and 480volt AC auxiliary power systems, 125 volt DC and 120 volt AC vital power systems, stand-by diesel generators, motors driving the various ERC EEE pumps and motor operated valves, ERC EE pump and motor operated valve controllers, switch gear, including protected relays and circuit breaker trip units, and power conductors.

The teams evaluation of the application and operability of electric power equipment and systems included such critical design issues as the following: voltage traps under load, adequacy of emergency power sources to supply the applied loads, capability of circuit breakers to interrupt available short circuit currents, adequacy and coordination of short circuit and overload protection, system grounding and ground fault detection, automatic load transfer from normal to alternate power sources. Separation between Class 1E power divisions and isolation from 1E from non 1E power circuits and environmental qualification ERC EE electrical equipment.

In addition, we evaluated such design control issues as the execution of engineering change orders, resolution of non-conformance reports and interfacing among the various organizations involved in the design process, TVA design engineering and construction branches, Sequoyah plant operations and maintenance, vendors, et cetera.

The major deficiency the electrical team identified is the lack of ground fault detection on the entirely ungrounded low voltage, and that is 480 volts and below, AC power systems. As a result, a line to ground fault can persist undetected indefinitely. This condition is unacceptable for two reasons. First, a permanent ground fault imposes a continuous 173 percent line to ground overvoltage on the unfaulted phases, which tends to accelerate the deterioration of the insulation of conductors and equipment.

MR. MC CORKLE: MEMA standard EEOC 5 1974 to which TVA is committed in the FSAR recognizes this fact by declaring that the cable used in ungrounded power systems must have an insulation rating of 173 percent of the nominal system voltage unless the system is equipped with a ground fault detection feature allowing ground faults to be sensed and interrupted within one hour of their occurrence.

Much if not all of the cable in the ungrounded 480 volt AC systems at Sequoyah is rated for voltages lower than the 830 volts required by this standard. Therefore, complying with the FSAR commitment requires either ground fault detection or extensive cable replacement.

Second, the lack of ground fault sensing is a technical violation of the FSAR commitment to the single failure criterion in IEEE Standard 279 and NRC regulatory guide 1.53, in that a single detectable failure, combined with an undetected ground fault can result in the loss of both trains of safe shutdown equipment.

Furthermore, while there are no explicit regulatory rules or TVA commitments requiring auxiliary power systems to be grounded, ungrounded equipment -- ungrounded systems are susceptible to transient over-voltages which are severe enough to damage equipment and conductor insulation, generated by intermittent line to ground faults.

To avoid the resulting degradation of power availability accepted electric power distribution design handbooks uniformly recommend some form of systems grounding. In the team's opinion, installation of ground fault sensing equipment at each safety-related 480 volt distribution substantiation is a minimum requirement. We further strongly recommend that the ground fault detector circuits be designed to provide effective high resistance system grounding in order to reduce the risk of failures caused by transient over-voltages.

The electrical team's other areas of concern are unresolved design issues, rather than design deficiencies. The major questions are the following: first, TVA has not yet satisfactorily demonstrated that the worse cases were considered in the analysis of auxiliary power system voltage and loading. Additional calculations are needed to confirm that offsite grid power rather than onsite diesel generator power gives the worse voltage conditions, and to establish the effect of unit 1 loads on unit 2 voltages, when unit 1 is restarted.

Second, TVA's calculation of control voltages delivered to the 6900 volt and 480 volt safety related switch gear and celluloid operated valves under accident conditions are based on the assumption of 120 volts at the vital battery switch boards.

Various references in FSAR Chapter 8 indicate that the battery voltage can degrade to 105 volts under worst case conditions. So, a calculation is needed to confirm that the voltage of the loads will still be adequate in this case.

Third, TVA has adopted IEEE Standard 382 1974 as its basis for environmental qualification of electrical equipment. More information is needed on the qualification testing of the motors on the limit torque operators for the ERC EE system motor operated valves to confirm that low level vibration, seismic and degraded voltage operation criteria in this standard have been satisfied.

Finally, the team is concerned about the operability of some motor operated valves at the low terminal voltages potentially prevailing during an accident. While most of the valve motors were purchased under specifications calling for operability at 80 percent of rated voltage, some others had no degraded voltage specification. Calculations or tests are needed to confirm that these latter motors are acceptable.

In summary, the electric power inspection team found the technical and management aspects of those portions of those portions of the electrical design work which we reviewed to be acceptable with only one significant exception, which is the lack of ground fault detection on ungrounded low voltage power systems.

In addition, we discovered a number of open issues whose final resolution will require TVA to provide us with some additional information.

We were generally impressed with TVA's aggressive efforts to recover from the deficiencies in electrical engineering identified during previous NRC and internal evaluations, which have resulted in a set of electrical design calculations of exceptional comprehensiveness and depth.

Now, that concludes the electrical engineering presentation.

MR. IMBRO: Thanks, Dick.

Next, I would like to turn the floor over to Dr. Hai-Boh Wang, who is the discipline leader in the structural design area.

DR. WANG: Thank you, Gene. Mr. Ahmet Unsal and Mr. Owen Mallen and me formed the idea of a structural, civil structural team. During the inspection we reviewed the licensing commitment as stated in the FSAR design criteria, engineering, and QA procedures as well as appropriate NRC regulations. We also reviewed a portion of the following analysis and design packages: The first one was seismic analysis that generates floor response spectra, including the auxiliary building, the ERCW pump house, steel containment vessel, the shield building and the containment internal concrete structures. We also reviewed the reinforced concrete and structural steel design of the auxiliary building and the ERCW pump house.

We reviewed the equipment support, the pipe support, cable tray and the cable tray support, HVAC dock and the support. We reviewed the berry piping analysis, seismic analysis of pipe tunnel, ERCW access cells and dikes, seismic analysis of steel tags.

The concerns I am going to present are all negative. Most of them are major issues and considered to be generic. The first concern is about the seismic analysis. This generates floor response spectra. The team reviewed five seismic analysis calculations and found four of them are not totally checked. Those partially checked calculations are the analysis of the reactor and auxiliary buildings. Floor response spectra are used to design equipment and systems that are supported by the floor, such as tanks, pumps, heat exchangers, pipe and pipe support, cable tray and cable tray support, et cetera.

TVA did find inconsistency of the vertical response spectra for the steel containment vessel in the winter of 1985. Consequently, a new set of vertical response spectra for the steel containment vessel were regenerated earlier this year. At higher elevations, the newly generated response spectra shows significant increase in vertical observations. In some cases, it was several times higher than what was used in the original plant design.

TVA is presently assessing the impact of this set of newly generated spectra.

The team also reviewed the missile protection analysis of the ERCW pump house roof. The design of the ERCW pump house roof consists of structural steel members which are rotated 45 degree to provide for missile protection. The analysis of the roof system conceded only the tactility factors. It did not show that the system would remain stable. The calculation did not evaluate the sheer with -- or flange buckling. It also did not include the potential penetration of small missiles as committed to in FSAR.

The team reviewed equipment support calculations and we have the following four concerns. The first concern is the discrepancies between design calculations and construction drawings. For example, the component cooling heat exchangers hood design requires a 3/4 inch thick imbedded plate. However, the associate TVA drawing shows only 1/2 inch plate is necessary.

The containment spray heat exchanger support has a similar discrepancy in the thickness of the embedment plate. The calculation requires a 3/4 inch and the drawing only shows

1/2 inch.

The calculation for the component cooling surging tanks support required 9 anchor stubs with 3 inch spacing between them. The TVA drawing shows only 8 anchor stubs with spacing varying from 2 to 4 inches.

Design calculations for the containment spray heat exchangers support how that 5/8 inch diameter and 6 3/8 inch long anchors are required, but the TVA drawing shows only 1/2 inch diameter and 5 3/16 inch long anchors are required. Further TVA review in this area is warranted.

The second concern is the possible underestimating the seismic load on tank support. Seismic calculation for the mineral rights water tanks used equations from TID 724 to determine the dynamic load on the tank and its support. Similar approach was used for this component cooling surging tank calculation. TID 724 as well as other TVA design criteria for tanks require that the tank be rigid. However, TVA specifications for tanks require that the tank vendor should develop a lump mass dynamic model of the tank to calculate the natural frequency in order to determine that the tank is rigid.

For the mineral rights water tank, the vendor calculation cannot be located and the TVA calculation did not address the flexibility of the tank.

For the component cooling water surging tank, the vendor calculation did not concede the shield flexibility of the tank. TVA needs to determine the validity of the assumption that the tanks are rigid.

The third concern is that seismic overturn movements are not conceded in equipment support design. The auxiliary building roof, steel design calculations show that there are four tank supports on girders. These tanks weigh from probably from 90 to 130 kips. The design of the roof girder and truss did not consider overturn moment from those tanks during seismic events. TVA needs to evaluate the structural adequacy of those supporting girders, including seismic overturn moments.

The fourth concern is that seismic sheer was not considered in equipment support design. The component cooling water surging tanks support calculations show that the anchor bolts were designed for tension only. The design failed to consider the fact of sheer as required by the ACI code. TVA omission of this item may yield an over stress of anchor bolts during seismic events.

The team has four concerns with the reinforced concrete design which are all related to the auxiliary building. The first one, the base slab of the auxiliary building is anchored to rock to minimize the bending stress due to hydrostatic uplift pressure.

TVA calculations show that the net ups pressure was calculated wrong, since the calculation deducts the total building weight as opposing hydrostatic pressure. Instead, only the weight of the base and field slab should have been subtracted. Also, the number 11 reinforcing bars used to anchor the slab into the rock did not have enough embedment in the lens to develop the full strength of the bar.

The team believes that the detail of anchorage used by TVA does not agree with the ACI 318-63 code requirement. TVA needs to evaluate the structural adequacy of the base slab taking account of those two deficiencies.

The second concern, the team reviewed the calculation for the base slab and the walls poured against rock showed that no reinforcement was provided at the face of the rock. The team is concerned that no consideration was given to determine the effect of cracks that would be introduced by the negative movement due to the lack of this reinforcement.

The third concern, the review of the reinforced concrete walls calculations show that TVA provided a minimum reinforcement area of .2 percent rather than the .25 percent required of ACI 318-63. TVA has not provided a justification for the use of this lower amount of reinforcing steel.

TVA calculations also show that no error -- an error was made in calculating the steel area required in walls. TVA should evaluate the impact of these two items on the structural adequacy of the walls.

The fourth concern, the team reviewed the auxiliary building roof slab at elevation 778 and A15 column lined walls. Both the roof slabs and the walls are designed in accordance with ACI 318-63 building code as committed in the FSAR. However, this calculation show that TVA failed to evaluate the sheer stress at edge of the structural elements as required by the ACI 318-63 code sections 1201 and 1207.

The team is concerned about the lack of evaluation for sheer stress due to the brittle nature of failure in reinforced concrete structures.

The seismic analysis of the ERCW pump house access cells was based on the assumption that the six cells and the interconnecting cells would act as a one single J-shaped unit. The calculations show that shrinkage would occur in the concrete field. The concrete field will therefore not be in contact with the steel sheet pile. The calculation also shows that there will be vertical movement between the cells. The inability of the cells to transfer vertical sheer makes original assumption of the single J-shaped units invalid. Even if the J-shaped unit assumption is valid, then the torsional effect of the J-shaped unit should have been considered in the analysis.

The calculation also states that the cells probably are not stable if they act as single units. Failure or excessive movement of those cells would cause the failure of the ERCW piping and electrical counters embedded in those cells. Therefore, TVA has not substantially demonstrated that the cells will be stable under all loading conditions.

Immediately west of the access cells the ERCW piping and electrical counters are support of a pile support structure embedded in a rock-filled dike. The response of the piles will be the same as the rock-filled dike. The calculations show that the rock-filled dike will not be stable using the material properties stated in the FSAR.

Also, the vertical earthquake was not considered in the rock-filled dike analysis.

Two laboratory tests were performed on the rock-filled dike material. The result of the tests indicate that the material of the dike is more stable than the property listed in FSAR. The original calculation did not incorporate the test result. Therefore, TVA has not adequately demonstrated that the rock-filled dike is stable.

The last concern the team has was with respect to pipe support. We understand TVA is presently reanalyzing 5000 pipe support. Their accepting criteria state that for the self-growing expansion anchor bolts, the factor of safety will be five for long-term operation and the factor of safety of 2.8 for the short term or race start.

The team reviewed pipe support packages and three of them called for RAWL expansion anchors. However, the calculations revealed do not address the low ultimate strengths of the RAWL expansion anchor bolts which is lower than what was used to determine the acceptance criteria in the allowable bolts load.

The analysis also increased the allowable bolt load by taking account of the increase to concrete strengths due to aging. This is not a valid assumption since the self-drilling expansion bolts were qualified in higher strength concrete. TVA should identify where the RAWL expansion anchor are used and qualify them in according with the actual ultimate strengths of the bolts.

This completes my presentation.

MR. IMBRO: Thanks, Hai-Boh.

I would like to take a minute to summarize the structural area. We feel that it is our area of major concern. Just in summary, we in NRC, the RDI team feels that there are a lot of fundamental omissions in civil engineering calculations. For example, there are a lot of unsubstantiated assumptions in calculations. I don't know if this is one that Hai-Boh mentioned before, but one is the analysis of the roof of the aux building. You have an 80 foot steel span and it was assumed to be rigid. And, again, without obviously, at least to our minds, it is not a rigid structure and shouldn't be analyzed as that. But someone should have gone back, at least to verify the assumption that if it is considered rigid, is it really a rigid structure?

In the design of the ERCW access cells, as Hai-Boh pointed out, there are a lot of omissions in the calculations, things that should have been considered that weren't. Also is the assumption that the different access cells act as a single unit. And, again, that is another assumption that was not substantiated and probably turns out it was not a valid assumption.

There is the assumption of rigidity of steel tanks. Again, TVA used it to document TID 70-24 and all the equations in that are based on the fact that tanks are rigid. However, TVA didn't go back and verify that the tanks they installed actually were rigid and that those equations were therefore applicable.

The basic consideration which we feel TVA missed was the failure to evaluate sheer in walls and slabs. I'm not a civil engineer, but from what I understand talking to our team members, that is a basic thing that everyone does in design. Again, this was not considered by TVA.

There are questions of the generation of the floor response spectra, which again TVA in a later analysis performed I guess early this year, identified that at least for the vertical acceleration in the steel containment vessel, you know, you are probably looking at maybe seven times higher acceleration than was used in the original design. You are going to get acceleration levels probably as high as 2.5 to 3 gs which are pretty substantial.

Also, we found that TVA has deviated from the ACI Code 318-1963 which is an AFSAR commitment essentially in regarding the placement of REBAR and reinforced concrete. Now, many codes essentially state, well, they basically give you an out. If you don't use the prescribed method in the code, at least you should be able to justify the design that you do use. However, we did not really see this justification for deviations from the code.

In addition, TVA used a lot of their own internal standards and I guess the team felt that we hadn't had time to assess the validity of the standards. They don't necessarily conform to what people think of as a standard industry practice.

Again, we have a large concern between equipment support calculations and the design details that implement those calculations. As Hai-Boh pointed out, calculations are based on certain thicknesses of steel embed plates, lengths of bolts, certain numbers and thicknesses of bolts. However, when we go to essentially the construction drawings, we find that there are discrepancies: lesser number of bolts, thinner bolts, thinner support steel. So, there is a definite miss match between what was analyzed and what is actually in the plant.

Also, was the failure to consider overturning moments in support designs. Again, basic, what we feel is a basic consideration that was overlooked. And, also, the structural analysis of the Tornado Missile Protection for the ERCW pumping stations. In that area, we feel that there were a lot of design features in that design that TVA didn't consider. So, what does it all mean now that we sit back and look at it?

Well, we think that maybe just to clarify: I guess I saw a statement in the paper this morning that the nuclear expert, TVA nuclear expert said that the NRC was of the opinion that the structures would collapse under an earthquake or they would collapse under a tornado. I think that was a little bit overstated.

What I will say, though, is I think based on the calculations that exist, I don't think that we can determine the structural adequacy of the buildings. Now, that is not to say that they are not going to come out okay once they are reanalyzed. All I think we are saying now at this point is that based on the calculations we have seen and the omissions in the calculations, we don't know until those areas have been addressed whether or not the design is adequate. So, we still need information to review.

What we did suggest to TVA and, actually, more of a request was that we think TVA should conduct a comprehensive review of structural calculations for the five major safety related buildings on a sample basis. And we think -- I will name the five buildings: the reactor building, the auxiliary building, the control building, diesel generator building and the ERCW pump house.

Further, we feel that the review should be conducted by independent engineers. And just to clarify that, by independent, we mean that people that may be employed by TVA now, but however did not participate in the original design, and TVA is free to use contractors that they have available.

We think that the review should include a substantial sample of all major design features, such as structural steel design, the reinforced concrete design, including foundations, floors, walls, columns and roofs. Masonry walls in the buildings, also equipment anchorages and equipment supports. And we also feel that TVA needs to look at the design construction interface, particularly in light of the concern raised regarding the RAWL anchors, the fact that RAWL anchors were specified on the drawings, however, they may not have been installed in the field.

And, also, there is -- again, the inconsistencies between the calculation detail drawings for equipment support. I guess since we have two conflicting pieces of information, we don't really know what is out there. Is the analysis right or are the drawings right? Maybe the drawings are right and the analysis needs to be correct. I think TVA needs to take a look at that.

In addition to this separate program which I will put aside for a minute. I think specifically relating to the IDI concerns, I think TVA needs to do 100 percent review in five areas and I will go through those quickly. I think that you need to take another look at the seismic response spectra generation for all the buildings that contain safety-related equipment. We think that on 100 percent basis the design for sheer in walls and slabs needs to be reviewed.

We also think that in tornado missile protection should go back and reanalyze the roof of the ERCW pump house and we limit it to that because we think the rest of the design is adequate.

We also think that the dikes and access cells and the stability of those needs to be addressed fully. And, also, TVA on a 100 percent basis needs to go back and review the Category I steel tanks to determine whether or not they are flexible or rigid.

I would like to make a couple of general observations regarding the inspection in general apart from civil. It is difficult to do an inspection like this and there is a lot of information that is coming across at us and going back and forth. So, I am trying to take the time and step back and say, "Now that we have all these, are there any common threads?" And the range, what we think could be generic problems with TVA. And we thought about this at great length yesterday and we have come up with a couple of things that we think TVA might be -- that we pass on to TVA for their consideration.

The first area is I think there seems to be in some areas a lack of timely corrective action. Now, for example, seismic analysis in the steel containment vessel and the problems related thereto. This was something that TVA was aware of in 1985. However, the calculation was just redone early this year. So, it is essentially a two-year span or more that this was not acted on. And, obviously, as most people know this regeneration of the response spectra, any discrepancies in that could cause a substantial amount of work and requalification of equipment and anything else that needs to withstand an earthquake.

Also, the ERCW design pressure, again, we saw ECNs that go back to 1986. And we still find it is not totally resolved today.

One thing we thought that was -- and I guess this is more of an observation. It appeared to the team that from the different findings that we saw that TVA lacks systems integration function. It appears to us that there is no essential group that really can assess the safety significance of different things. One group that has the big picture, essentially, of things work and how things need to fit together.

And there's a couple of examples. In the station air compression brake isolation, for example. The radiation monitor, the fact that the thing will saturate during accident conditions, it seemed like the design is kind of focused in one area. People are wondering about, you know, looking at the effluent monitor or monitoring effluent radiation, however, not really considering the fact that this was also used in an accident besides normal operation.

Appendix R problem with the indicate lights on traveling screen. It appeared to us that there was some confusion within different areas of TVA as to whether or not the traveling screens were safety related or the screen watch pumps were needed after an accident.

There are a couple of others. The fuse coordination between Class 1 anomaly, it appeared that the significance of the isolation between 1 anomaly was not totally recognized.

You know, it is a hard thing to quantify and, again, this is really an observation on our part, but there seems like there needs to be one essential group of people that really understands the safety significance of the different systems and how they all fit together and can over view and make sure that people are not looking at things essentially with blinders on and that they can assess all the implications. And there are many in a nuclear plant.

MR. GRIMES: You might say that based on the team's working in other organizations with such a function.

MR. IMBRO: Right. Also, we feel that there may be a problem in design verification. For example, in the civil area, particularly, these are the findings that we came up with and essentially they are baseline calculations that were checked and reviewed. Again, they are not recent calculations. They were calculations done, say, back in the early Seventies or in mid-Seventies.

So, you kind of wonder, well, what does a check connote? You have another engineer that reviews calculation and signs off on it and misses your really, what we consider basic things, was the checker not qualified to do the job or did he just review it and sign it off? It doesn't give us a good feeling, you know, that the checking process didn't really seem to be adequate.

Also, for example, dimensions on pipe supports. That is a problem that Andy mentioned. There was incorrect dimensions that were used in calculations. Again, all this was checked information.

The environmental qualification for the mild environment, at least, particularly in the ERCW pump house. The equipment really didn't match the temperature profiles that were specified in different TVA documents.

Another example would be the improper use of the stress intensification factors from B3011. Again, these are things that should have been picked up at a normal checking process or design verification process, but weren't. So, we think that there may be some basic problem with how TVA does their design verifications.

And I guess the last area I had was it seems to be that there is a lack of timely implementation of operation procedures. And, in some areas such as -- going back to the ERCW design pressure, there were, I guess some statements that were to be put in, system operating instruction, SOI, regarding header pressure control. This was again something that was identified a ways back and has yet not been incorporated in the operating procedures, although we have seen drafts of those.

In the area of screen wash manual operation, screen wash essentially was initially automatic. However, the automatic feature was disabled, but we would have expected at least that in a timely fashion, operations would have picked up the fact that this needs to be incorporated into the operating procedures. Now, we understand that TVA may be doing the screen washes and some manual operation. But it is not really proceduralized. So, I think there needs to be a more close communication between the operations and the engineering staff.

So, that essentially concludes the overall observations we had. And, again, these are preliminary. We tried to pull them together yesterday, but I think that this essentially represents the consensus of the team as to where we think their areas are weakest that TVA may need to look at further.

Just a quick note on schedule, just to review what everybody already knows. On October 9th, we are due letter -- we owe a letter to TVA to define fully the restart issues. What we mentioned today are some of the restart issues, the ones we consider most important and have the most impact. There are probably a few that we haven't considered, but we think those are more of a minor nature. For example, minor changes to FSAR and things like that, documentation things.

On November 6, according to our schedule, we owe you a completed inspection report and we will try and do that. Also, in -- we understand that there is new information available and we will try and make ourselves available to do that. And we were planning on, just for rough planning purposes right now, to come back maybe in late October or early November, maybe just before or after the report is issued, to do an inspection of TVA corrective actions. And we would like to really focus on actions that are corrected, not really come down to inspect the things you intend to do. We would rather restrict our inspection to when you actually finish things and we have something solid to look at.

And, again, going back to this additional program we think is necessary in the structural area. That will be handled as far as I am concerned as apart, separate from the IDI. And the IDI will then address the specific functions in the civil structural area. I think the additional structural calculation review program should be more properly addressed by TVA as part of their calculation program that is currently ongoing.

That's all I have to say. I think Brian would like to add something.

MR. GRIMES: Yes, I wanted to just clarify the issue that was raised earlier on new information that had been proffered by TVA but not accepted by the team for review. And I just want to put that in a little perspective.

The design inspection methodology is to perform an in depth inspection of a single system as representative of the entire design process. And from this, look at a system as it stands. We try to draw generic inferences for the whole design. Our usual practice in a design inspection is to establish a cut-off date beyond which new calculations are not considered. This is related to the announcement of the specific system which is to be inspected. This is to allow the team to not have to look at what I call wet ink calculations, which may have been done in anticipation or as a result of the team inspection. Considering those, we believe would distort our picture of the design as it stands and limit our ability to extrapolate those conclusions to other parts of the design which had not been similarly amended.

I have, in the structural area, spoken with the team members and I know of no incidence in which the team declined to review relevant information which is related to the adequacy of the design as it stands.

In fact, the opposite appears to be true that the method of the inspection of the team is to request and review such information. I would also note that in the structural area, most of the significant issues were identified early in the inspection process.

I think it is important to distinguish between the information bearing on the adequacy of the design as it exists which is relevant to our inspection conclusions on what corrective actions may be necessary, such as in the structural area, an increased scope of sampling and, on the other hand, the review of corrective actions in response to these findings. And the team in this case I believe gave top priority to the inspection process itself to look at existing design.

There will also be a structured inspection process, as Gene mentioned, to look at your corrective actions, but this should not be confused with the current inspection or the development of the current inspection report which defines the problems on which that corrective action program must be based.

So, I thought it was just worth a few minutes to try to make sure everybody understood why we were focusing on existing design.

MR. KEPPLER: Well, I think it is still important, though, that if there is information that relates to the findings from this inspection, which I understand the TVA feels they have, we need to have that information.

MR. GRIMES: Yes, we would be most happy to get that as soon as possible.

MR. WHITE: I, first, in response to what you are saying, Mr. Grimes, I have no quarrel with the fact that you had to have a cut-off date. I told Mr. Imbro earlier today that in his position, I would have done the same thing. There has to be some date at which you have to say, "Don't give me any more information. I've got to write a report. I've got to prepare for this meeting."

I have no quarrel with that. And Mr. Imbro is the team leader. It is his responsibility to determine when that is. So, there is no quarrel.

I would like to say a couple of things. One is I wanted to thank Mr. Imbro personally and, through you, the members of your team for your hard work. And they worked hard. For your cooperative attitude in this whole effort. I think, Mr. Imbro, you and your team have -- you know, this is really, no matter how you look at it, it is a unique first of a kind effort. And I think we also have to put that in the right context that I understand the difficulty, I truly do, of looking at a plant designed in the Sixties, built in the Seventies, and now inspected in the late Eighties in trying to get your mental attitude necessarily I think an impossible thing to do to say, "Well, how would I have looked at this in the Sixties and Seventies based on what the industry knew in the Sixties and Seventies."

In the late Seventies and certainly in the Eighties, the industry has, with regard to our knowledge of how to go about looking at things and even new codes and so forth, we look at things differently. I understand, therefore, the extreme difficulty each of you must face in trying to get your mental attitude to: What would I have looked at if I were here in 1960, would it have been -- or '70's, would that have been acceptable and, therefore, is this just like any other plant built -- designed and built in that time?

I want to thank your people because I think they have tried to do this. And, as I say, maybe it is impossible, but I think they have given it a good try.

The other point I would like to make is that I understand that your conclusions and your recommendations are based on the information you now have. You couldn't do it any other wise. And I understand that. I think we have other information available to you that I think in many cases will persuade you -- and I don't blame you for this. It is our -- it is my responsibility to give you the information. It is not your responsibility to go in our file cabinets and find it. So, it is our responsibility to provide that to you. And I think when you see some of this, I think you will be persuaded that some of these problems perhaps are not as severe as what you now think based on the information you have.

So, we look forward to our meeting next week. I understand it is already scheduled for Wednesday. And we hope at that meeting to provide you a lot of information. And, in some areas, necessarily, we will tell you the corrective actions we intend to take if there are -- and there will be, I'm sure, some of those.

MR. WHITE: I think it is important that your people and our people work closely, particularly, with respect to prioritization of the efforts that need to be done, dealt with here. Obviously, the civil structural area is going to be a major issue with us. There are other areas that I think, as you people look at it and as we look at it further, will have schedular implications that we will want to focus attention on quicker. So, I think that is an effort that needs to be undertaken on your side as well as our side, but I think it is important to start off next week particularly in the civil structural area.

Let me add one comment to what you have just said. You talked about the complications, the difficulty of doing an inspection of this type. For whatever reason, TVA didn't receive an IDI at the beginning of this, so, when it got licensed, I don't want to defend or attack that comment, that situation. But it was one of the very few plants and, in fact, it may have been the only plant that did not receive one since the TMI accident.

However, we have not only looked at NTOL plans this way, this team has gone back at plants older than Sequoyah. Efforts have been done at Dresden. Efforts have been done at Fort Calhoun. And there may be others, for all that matter. In general, we find that TVA Sequoyah is better from a design standpoint than Dresden and Ft. Calhoun, which you would expect, and less than what you would expect at an NTOL today.

Not a very profound statement. But I think the message we want to leave you with is the civil area, what is the civil structural area was an area that came out much lower than our expectation based on this type of experience that we have had. So, that is the area that is burning with us right now. Not to overlook the other points that were mentioned, but that's the one that needs the primary emphasis on both parts. And it is apparent to me, as we sat here and talked, that the people on two-thirds of this table feel very strong that this has a strong scheduler implications with you. And I hope it proves out that you are right. I hope you are able to dissuade our concerns. But right now, it is a big issue with us.

So, we look forward to our meeting on Wednesday. Thank you very much.

MR. ZWOLINSKI: Let the meeting stand adjourned.

(Whereupon, at 11:05 a.m., the meeting was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name: Findings From the Integrated Design Inspection (IDI) at TVA

Docket Number: NRC-342-29

Place: Knoxville, Tennessee

Date: September 11, 1987

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken stenographically by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/S/ Dan NEUNUEBEL

(Signature typed): Dan Neunuebel

Official Reporter

Heritage Reporting Corporation