UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
***
BRIEFING ON SPENT FUEL POOL COOLING ISSUES
***
PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Room 1G-16
Rockville, Maryland

Thursday, August 1, 1996

The Commission met in open session, pursuant to notice, at 3:05 p.m., Shirley A. Jackson, Chairman, presiding.

COMMISSIONERS PRESENT:
SHIRLEY A. JACKSON, Chairman of the Commission
KENNETH C. ROGERS, Member of the Commission
GRETA J. DICUS, Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

JOHN C. HOYLE, Secretary of the Commision
KAREN D. CYR, General Counsel
JAMES TAYLOR, Executive Director for Operations, NRC
BILL RUSSELL, Director, Office of Nuclear Reactor Regulation, NRC
ASHOK THADANI, Associate Director for Technical Assessment, NRC
GARY HOLAHAN, Director of Systems Safety and Analysis, NRC
STEVE JONES, Reactor Systems Engineer, NRC
JOE SHEA, Project Manager for Spent Fuel Pool Issues

P R O C E E D I N G S
[3:05 p.m.]

CHAIRMAN JACKSON: Good afternoon, ladies and gentlemen. The purpose of this meeting is for the NRC staff to brief the Commission on the status of spent fuel pool action plan issues.

Postulated events, such as loss of off-site power at Susquehanna and actual events such as the freezing at Dresden One have pointed to the need for further review of spent fuel pool design issues. Recent reviews of practices at other sites have indicated that design assumptions may not have fully been carried out in routine operation of the spent fuel pools.

In order to ensure that we address these concerns in a comprehensive manner, the NRC staff developed an action plan to evaluate the range and relative importance of spent fuel pool issues in sites across the country and to resolve the issues that remain uncorrected. We look forward to discussing the resolution of these spent fuel pool issues.

I understand that copies of the presentation slides are at the entrance to the meeting.

CHAIRMAN JACKSON: Do you have any opening comments, Commissioner Rogers, Commissioner Dicus?

COMMISSIONER ROGERS: No.

COMMISSIONER DICUS: No.

CHAIRMAN JACKSON: Proceed, Mr. Taylor.

MR. TAYLOR: Good afternoon. With me at the table are Bill Russell, Ashok Thadani, Gary Holahan, Steve Jones and Joe Shea, all from NRR.

The staff's evaluation of spent fuel pool design and operation is being conducted in three segments. The first segment involved an evaluation of the compliance of refueling practices at each operating reactor with that reactor's licensing basis. The second segment has involved the technical evaluation of spent fuel pool design and operation. The final segment is an AEOD independent review of spent fuel pools to include the NRR evaluations.

We presented our findings in the area of refueling practice compliance to the Commission in a briefing held on May 31 of this year. From these findings, the staff has developed a list of lessons learned regarding the licensing process and guidance for enforcement action. The staff has established the lessons learned task group to identify policy issues and improvements to our own internal processes. The task group's finding will be addressed in a separate report.

Today, we will present the finding of the staff's technical evaluation and planned safety enhancements. AEOD, I believe, will present its findings later in this year.

Today's briefing will be given by Ashok Thadani

and Gary Holahan. Ashok will begin.

MR. THADANI: Thank you, Jim.

Good afternoon.

May I have the first viewgraph, please?

[Slide.]

MR. THADANI: I am going to go over some of the background and some of that is probably a little repetitious of what you said, Chairman Jackson, but it is useful to go back and see why we are doing what we are doing, some background.

The two major factors that are addressed in the action plan, the first one came about because -- as a result of two engineers who raised substantial concerns with Susquehanna spent fuel pool design on their Part 21 report. The thrust of the concerns that these engineers had related to the spent fuel pool cooling capability for design base accidents. It was driven by a concern that the primary spent fuel pool cooling system was not powered by on-site AC power and that certain operator actions would be required to make sure backup cooling was provided for some accidents, particularly the concern was design basis accidents.

The staff conducted, I believe, a very extensive review of the concerns that were raised by the two engineers and also not only did the staff conduct engineering evaluations but also did a limited risk assessment as well

to try to put in context some of the concerns that had been raised. And during that review process, in fact, the staff identified other scenarios which were deemed to be more safety significant than those related to the specific design base accident issue that was raised by the two engineers.

Having identified these sequences that could be important at other facilities, it was clear that we had to initiate a generic action plan to follow up on those initial findings from the Susquehanna review that was conducted. So that was one major reason for developing this action plan.

The other reason, other element in the action plan, came about because of an event at Dresden One which, as you know, is a permanently shut down facility. There was -- they experienced freeze damage to their service water system piping that led to flooding in the containment. And at Dresden One, that kind of an event could have caused failure of spent fuel pool cooling piping and that could have led to draining of the spent fuel pool and uncovering the stored fuel.

That -- once that issue was identified, the staff conducted inspections at all permanently shut down facilities and concluded that that feature, that the design at Dresden One was, indeed, very unique and that was the reason for that particular potential problem area. But, nevertheless, the staff decided that that issue and perhaps

other issues related to inventory control for spent fuel pool needed to be evaluated. So that became sort of the focal point of the evaluation activity.

As you will hear from Gary later on that we also have looked at reactivity issues. But the real thrust of the action plan was in these two areas.

The staff has conducted, as I said, fairly detailed technical review of fuel pool designs and operational issues. The process that was used included

visiting four sites to gather detailed information from sites. As Mr. Taylor noted, completing a survey of design information and comparing design information to regulatory requirements as well as our guidance documents.

Based on the technical evaluations to date, the staff has not identified a big safety problem at any of the plants. On the other hand, the staff has identified for several plants certain enhancements that could, in fact, improve both the cooling capability as well as the inventory control. For some plants, some deficiencies have been identified in both areas, cooling capability as well as inventory control. But these appeared to be small problems based on our evaluation.

Our intention now is to pursue some plant specific enhancements following our backfit rule requirements. As you know, the backfit rule calls for the staff to

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demonstrate that these changes would lead to substantial improvement in safety and then the second part of the backfit rule says these changes out to be cost effective. That is the process that we would follow for design issues.

There are some operational issues, as you will hear from Gary later on. We are going to try and pick those up as part of the shutdown rule because shutdown rule really does address operational issues and many of the concerns here relate to shutdown-related activities. So all of those actions will be integrated under the shutdown rule. Of course, the staff is also going to look and develop revised review guidance as well, based on some of the lessons that we have learned for ourselves.

The licensees involved, that is, where we have identified plans that perhaps some backfit studies should be initiated on, those licensees have now been informed that the staff plans to conduct such evaluations. We do want to make sure that the basic design information that we have, facts we have, are correct. So we are going to ask those licensees to first make sure that the information we are using is correct and we also are going to do several other things during this process.

We are planning to brief the ACRS I believe it is August 9 with these findings and we plan to brief periodically both the Advisory Committee on Reactor

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Safeguards as well as Committee for Review of Generic Requirements on periodic basis as we collect more information, as we conduct our evaluations in terms of regulatory analysis so that they are pretty much up to speed on real time basis as to what we are finding from these evaluations.

That is our plan and Gary will now go through the details of the findings from the technical evaluations.

MR. HOLAHAN: Thank you.

Could I have slide number three, please?

[Slide.]

MR. HOLAHAN: The presentation will be done in four areas. First, present information on the design and safety function of spent fuel pool. Then to cover some of the history of regulatory guidance. Then as a result of the studies that have been done from the information collected on the surveys, we will give general observations and conclusions. And then, at the end, a more specific list of those areas where the staff will pursue potential safety enhancements based on the backfit rule.

Can I have backup slide number one?

[Slide.]

MR. HOLAHAN: To introduce the pool safety functions, I would just like to go over how a typical BWR spent fuel pool is arranged and I think that might be

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helpful in putting the safety functions into context.

In the center of the diagram, you will see there is the spent fuel pool itself with the fuel racks at the bottom of the pool. Generally 23 feet of water is contained in the pool above the level of fuel.

The fuel is contained in the pool. The pool is a concrete reinforced structure designed to withstand seismic events and with a stainless steel liner to prevent leakage. You will see on the left of the figure is a typical cooling system. In this case, it shows two pumps and two heat exchangers, although there are variations. Some plants have two pumps and one heat exchanger. One of the things we are looking at is the variation in these kind of systems.

You will note that both the suction and discharge

of that system are arranged either high in the pool or with some anti-siphon features, so that the water in the pool cannot be drained out down to the level where the fuel is. So that is an important thing that we look for.

The pools generally have temperature and level instrumentation available in the control room and then some arrangement for moving the fuel through a transfer canal into the area where the reactor vessel would be in a flooded condition inside containment during fueling activities.

In some cases, the spent fuel pool sits directly on bedrock. In other cases, there could be some lower

features in the containment and it is even possible that there should be equipment below the pool in some arrangements, although I think that is not done very often. That is why there are some question marks at the bottom because there are some variations among the plants. So this is drawn as a kind of general diagram.

I ought to acknowledge that the diagram was actually drawn by the group in AEOD that is doing their independent study but we thought it demonstrated the general functional features very well so we borrowed it.

Can I have slide four, please?

[Slide.]

MR. HOLAHAN: I will be discussing the spent fuel pool safety functions in three broad areas. First, inventory control. Keeping water in the pool so that the fuel is kept in a submerged condition.

As I mentioned before, the structural design of the pool is such that it is a leak-tight system and designed to withstand seismic events. And all -- as part of the survey, we have identified that all operating plants has seismically qualified pools with leak-tight liner. Leak-tight is a design feature and it is possible for there to be leakage develop during the lifetime of the plant and in general there are collection systems for monitoring any liner leakage that occurs.

Also, anti-siphon features are an important element of keeping proper inventory in the control instrumentation as I mentioned. And there is makeup capability of various sorts which would rely on operator action. I don't believe any of the pools have an automatic feature that would fill the pool from a low level indication.

The basic safety functions for inventory control are cooling of the fuel in the pool. It also provides radiation shielding and it may be important to note that 23 feet that we normally refer to above the fuel is really there for radiation shielding and, in fact, it covers not only the fuel that is stored in the pool but when the fuel is moved, it is held up above the spent fuel racks and then inserted into the racks. So the 23 feet also provides sufficient shielding so that when the fuel bundle is, in fact, 12 feet higher above its normal location, there is sufficient shielding in that case too.

As part of safety analysis of fuel handling accidents, potential for dropping or damaging the fuel in the pool, the water also provides some scrubbing of any radiological release that could occur from damaging fuel while it is in the pool.

CHAIRMAN JACKSON: Is reactivity ever an issue?

MR. HOLAHAN: Reactivity is an issue and I am

going to speak to that as the third general safety function.

Fifth slide.

[Slide.]

MR. HOLAHAN: Pool temperature control or spent fuel pool cooling is the second safety function that I would mention. All plants have some level of redundancy in their spent fuel cooling systems. Some plants have redundant systems with independent pumps, heat exchangers and independent on-site and off-site power supplies. I would say those are -- those are at the one extreme, having the most capability.

All plants have at least some redundancy in the number of pumps available. Some plants do, where there are multiple pumps, they share the same heat exchanger. And we found that some plants rely on off-site power for the power supply for the pumps and those are the kinds of features that we are looking at as potential areas for improvement.

The significant amount of water in the spent fuel pool is itself an important element in temperature control.

It assures that it takes several hours to raise the temperature of the water in the pool to a boiling condition. There are a few cases where the pool could boil just after a full core offload in less than four hours, a few hours. Generally, the numbers tend to be in the range of four to eight hours for boiling and then you can generally consider

it takes about 10 times longer after boiling starts to boil the water level down to reach an area near the top of the fuel and then it would probably take another -- another several hours until the water level was boiled sufficiently low into the fuel area itself so the fuel would actually heat up and there could be some threat to the fuel cladding itself.

So, in general, loss of cooling would result in heating of the water over the first several hours and then if no recovery of cooling or makeup system is put into place, it would boil, generally imagine it on the order of, at minimum, a day, in most cases several days before the water level was down. So that gives an idea of the time frame available for corrective action.

Can I have the sixth slide, please?

[Slide.]

MR. HOLAHAN: The main reason for controlling temperatures in the pool is not actually to cool the fuel itself. The fuel is directly cooled by the water in the pool. The actual circulating system is only indirectly needed to cool the fuel. There is not actually forced cooling in the pool; it is actually cooled by a natural convection in the pool. So the pool cooling system is really maintaining the water temperature in the pool at a level so that the structural elements, the liner and the

concrete are maintained within the design parameters of those structures and so that the environment of the building is a suitable condition for operators.

If the temperature of the water gets too high, there is high temperature, high humidity, which makes it difficult for operators moving fuel or undertaking other activities in the building.

In addition, the cooling system is also used as a purification method for maintaining the water both clarity and chemical control and the resins in the purification system won't function properly unless the temperatures are kept at a temperature generally below 140 or 150 degrees and that is usually how those specific temperatures are chosen for the pool design.

Can I have the seventh slide, please?

[Slide.]

MR. HOLAHAN: The third safety function that we generally think about with respect to the spent fuel pool is reactivity control. That is controlled by the geometry itself, separation of the fuel assemblies by analysis of the reactivity of the individual fuel assemblies and by fixed neutron absorbing material which in some designs is attached to the fuel rack itself.

Soluble boron, that is boron dissolved in the water in the pool itself, is not used to maintain

subcriticality of the fuel in the rack itself but it provides additional margin for conditions such as inadvertently loading the fuel in an unexpected arrangement or a condition, for example, if a fuel assembly were to drop and to be laying across the top of the other racks, that would be a more reactive configuration.

So in some cases, we have given credit to soluble boron in the water for assuring that there is sufficient shutdown margin in those cases. And in all cases there is an analysis of shutdown margin and generally available in the final safety analysis report and this is an area that we have seen very little difficulty in. This is not an area that is giving us any problem.

There is quite a lot of safety margin in the designs and we haven't found difficulties. So we have been focusing on the inventory and the heat removal issues.

CHAIRMAN JACKSON: How does Boraflex degradation play into that?

MR. HOLAHAN: Well, Boraflex is one of the fixed neutron absorbers used in the pools. There has been some difficulty with that material, basically radiation damage allowing, in some cases, some of the boron to leach out of the Boraflex material. The NRC has issued a number of generic communications and has an ongoing program to monitor

the Boraflex and the utilities using Boraflex I think are
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committed to a program that we are comfortable with in monitoring those areas.

It is not that there are no difficulties with the Boraflex material but we think we have dealt with that reasonably well and we are continuing to monitor that so it doesn't -- I guess I don't consider that a problem needing any additional action on the part of the staff.

CHAIRMAN JACKSON: Well, given that you have some licensees who do re-rack their pools and they re-rack them by taking account of Boraflex and there have been some issues associated with the degradation of Boraflex, how much of the shutdown -- how much of the reactivity margin depends upon that material as opposed to the other factors that you have listed here?

MR. HOLAHAN: I don't remember off hand. I would rather not guess. I would rather look up the right answer than guess the wrong answer.

COMMISSIONER DICUS: To your knowledge, have any of the utilities had to yet replace the Boraflex or part of it?

MR. HOLAHAN: I don't recall. I think mostly it has been a matter of test and analysis to assure that the remaining Boraflex is sufficient for the reactivity control functions. I think there may be some licensees who have taken less credit for it, in the sense of not filling the
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fuel racks as closely as they might have if they were taking full credit for the Boraflex but I don't recall any sort of replacement activities.

MR. THADANI: I think we do need to get back to you with the specifics on both those questions.

COMMISSIONER DICUS: I mean, I'm not even sure it's feasible or possible. I was just curious about it.

CHAIRMAN JACKSON: You would probably have to replace the whole rack.

COMMISSIONER DICUS: Right.

MR. THADANI: I believe we better get our facts straight.

MR. RUSSELL: The testing that was done for blackness tests for the boron, which is the poison in this case, had quite a bit of margin in it. The issues that we are seeing with the radiation damage are not necessarily directly to the boron itself but rather to the materials that glue it together. So the issue becomes to whether, with time, you may have a loss of integrity such that under earthquakes or conditions like that, it could be reduced. The testing that has been done thus far indicates that the rate of degradation does not raise at this point a question but it is continuing to be monitored.

CHAIRMAN JACKSON: So under normal conditions, you wouldn't expect it?
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MR. RUSSELL: No. And there were some instances early on with sealed containers with this material in it which required drilling some holes in them to let the gas pressure out that was associated with the radiation induced damage of the glue that holds the material together.

MR. HOLAHAN: Could I have the eighth slide, please.

[Slide.]

MR. HOLAHAN: In order to put some of these issues in an historical context, we have prepared eighth and ninth slide which give some history of how the staff's guidance on the subject has evolved over time. Basically it says in the 1960s there was no generic guidance available and the reviews were done for those early plants on a plant-specific basis. Then, later, in 1971 when the general design criteria were published, that established guidance and criteria and those were really developed based on the experience staff accrued during reviews during the '60s.

Also, in 1971, the staff issued Regulatory Guide 1.13, spent fuel pool storage facility design basis. Later, in 1975, two sections of the standard review plan were issued and in 1978, guidance was issued with respect to spent fuel pool modifications and this really has to do with re-racking.

Can I have the ninth slide?
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[Slide.]

MR. HOLAHAN: Because of the amount of fuel storage re-racking that has been done, there has been a lot

of re-analysis of many of the plants and license amendments on fuel storage capability increases were not unusual. Also, the systematic evaluation program which dealt with 11 of the older plants dealt with these issues. And the staff has issued a number of generic communications, one bulletin, six information notices on inventory control issues and five information notices on cooling system issues.

COMMISSIONER ROGERS: Excuse me. On the inventory control issues, what was the character of those problems?

MR. RUSSELL: Drain down from siphoning. If you have abandoned equipment in place, old cooling systems, particularly some of the purification systems that may have been involved in reducing radioactivity in a pool if you had leaking fuel in the pool, for example, in some cases they didn't work effectively, they were abandoned in place. Valves could be mispositioned, you could siphon and drain the pools.

COMMISSIONER ROGERS: Well, isn't that the drainage system or is that cooling system reliability?

MR. HOLAHAN: No, if it has to do with drainage, we would consider it an inventory control issue.

COMMISSIONER ROGERS: I see.

MR. RUSSELL: We had some plants that had lines off the bottoms of the pools where a failure of the line under seismic conditions or something else could drain it because some of the early designs, particularly those that were inside containment, had lines that were off the bottom of the pools.

So the issues related to inventory control are principally loss of water from the pool, even associated with the cooling systems, temporary water cleanup systems and/or line breaks where there are drain lines off the bottom.

MR. HOLAHAN: In fact, I think Mr. Jones or Mr. Shea who have been dealing with some of these in more detail could correct me if I am wrong, but I think some of what we found in the survey where plants had actually taken action, for example, to weld or to cap a line or to put additional anti-siphon features in place were as a result of not the original design but features put in as a result of a bulletin or some other intervening review.

So, in many cases, what we are looking at is a relatively few number of plants which may not have taken all of the corrective actions or improvements that might have been suggested over the years.

Can I have the tenth slide, please?

COMMISSIONER ROGERS: Just before you leave that,

what were the reactivity control issues that led to the generic letter and information notices?

MR. HOLAHAN: I don't have a list with me but I think most of those are Boraflex issues, I believe.

MR. THADANI: I think they are all essentially related to Boraflex and one may have had something to do with spacing issues but I think they were mostly Boraflex.

MR. JONES: They are all Boraflex.

MR. THADANI: They are all Boraflex, okay.

MR. JONES: Yes.

CHAIRMAN JACKSON: You had a '96 generic letter related to Boraflex degradation, I guess it's 96-04. And will that allow you to deal adequately with all the remaining fuel reactivity concerns in spent fuel pools?

MR. HOLAHAN: I think it is -- we are not planning on any additional ones so that is our current plan, yes.

MR. RUSSELL: There are other materials besides Boraflex which are used as poison absorbers. They have trade names. I guess I would prefer not to get into the trade names. They all use boron. Sometimes they are matricised in aluminum, sometimes B4C matrix and other approaches. The ones that we have been having problems with are Boraflex.

CHAIRMAN JACKSON: But this particular kind.

MR. RUSSELL: There could be pool water

interactions with other materials. At this point in time, we are not aware of any problems with those other materials. The qualification testing that was done to support those other materials is still consistent with what we are observing.

CHAIRMAN JACKSON: So it is fair to say that this generic letter then should allow you to deal adequately with any remaining known at this point?

MR. HOLAHAN: Yes.

MR. RUSSELL: As it relates to the remaining Boraflex material, that's correct.

CHAIRMAN JACKSON: Okay.

MR. HOLAHAN: The industry has indicated some interest in visiting the subject of additional credit for soluble boron in the pools. I wouldn't say that's a problem but that is a review area we may get into in the future.

MR. RUSSELL: Particularly some plants that are using checkerboard patterns and not allowed to use all of the spaces in the racks because of some question in an earlier review. If they were allowed to take credit for soluble boron, they could put more fuel in existing racks, so it would be an economic issue rather than re-racking or something like that, so we do expect there could be reviews along those lines.

CHAIRMAN JACKSON: Then the soluble boron issue,

since it is in the water, ties in a little more directly to some of these other things having to do with inventory?

MR. RUSSELL: Yes, but your makeup systems generally don't have boron in them so if you end up making up the pool with a fire hose, you could end up going from a cooling problem to a criticality problem.

CHAIRMAN JACKSON: A criticality problem, that's right.

All I am trying to say is that the soluble boron is a little more dicey for that reason?

MR. THADANI: Yes.

MR. RUSSELL: That is why the staff has not generally given credit for soluble boron except in dropping events where you are talking about a limited number of assemblies.

MR. HOLAHAN: Could I have the tenth slide, please?

[Slide.]

MR. HOLAHAN: In terms of observations, what we see is that the guidance that the staff has put out over the years seems -- we found that licensees seem to be fully conforming to that guidance and where we do see problems it is not because they have chosen alternatives or that they have not used the guidance, it's that there may have been some difficulties in the actual implementation and those are

being dealt with, as we mentioned.

With respect to inventory control, some operating reactors have what we have characterized as low-risk deviations from pool inventory control guidance and I will cover those in a little more detail. Basically it is things like anti-siphon features which are provided by an open valve as opposed to an actual hole drilled in a pipe or a pipe with limited access into the pool.

With respect to power supplies for the heat removal pumps, we have found some plants which do not have on-site power for maintaining the pool in a sub-cooled condition if there should be a loss of off-site power. In those cases, the plants would have to rely on a makeup system or recovery of off-site power or developing some other backup scheme. So those are the ones that we have looked at fairly closely.

The other place where we have seen --

CHAIRMAN JACKSON: So where do things stand with respect to those plants?

MR. HOLAHAN: I will go into a list of those but, in general, I would say those are the ones we are interested in studying fairly closely.

MR. RUSSELL: These are facilities where the original licensing basis may have been allowing the pool to boil with a safety related makeup capability at the pool

where you are using that to compensate for safety-related or on-site power. Generally the single failure criteria was applied and the early designs did not consider failure of power, because it was felt you had a long period of time. It only dealt with mechanical failures of active components such as pumps. So if a pump failed, you had a backup pump that was already installed. It didn't treat heat exchangers as active components, so you find some plants with redundant pumps, single heat exchangers and no access to off-site power because that was generally the approach that was taken considering the long period of time before boiling and opportunity for recovery of off-site power as well as the ability to makeup to the pool if you did not recover off-

site power.

MR. HOLAHAN: And the last item on this page indicates that although the staff's guidance in the standard review plan does indicate a 140 degree temperature, in fact, a lot of licensees have chosen other temperatures as their basis for the spent fuel pool. So it is not unusual to see temperatures of 150 degrees or 165 degrees. That is not necessarily unacceptable but it is different from the guidance and, in fact, we have seen a fair amount of variation on that parameter.

CHAIRMAN JACKSON: Are you also going to say what we are doing about that?

MR. HOLAHAN: That sounds like a good idea.

CHAIRMAN JACKSON: I think we were going to both ask you the same question.

COMMISSIONER DICUS: Clearly, if it is so common it is not particularly critical, or are you going to address that?

MR. HOLAHAN: I think it is not so critical. It does have some influence on how long it would take for the plant to increase from where they are to a boiling condition but I would say it is probably one of the minor issues at this stage.

Could I have slide number 11?

[Slide.]

CHAIRMAN JACKSON: If it is minor and fairly common, you know the issue about across-the-board deviations as opposed to if the safety case is there that perhaps there needs to be a change.

MR. HOLAHAN: It suggests that perhaps our guidance was not such an imperative safety issue, the number that was chosen.

MR. RUSSELL: I think the controlling feature is not structural or necessarily time to boiling, it is more the resins that are used for the cleanup systems which are used for radioactivity control, that is to keep the activity in the pool low as well as to control the clarity of the

water, et cetera. And resins, depending upon who your resin manufacturer is, you may have an upper temperature limit of 140, 150 or 165 for the cleanup systems associated with it, and that is the resin on the discharge of the cooler or on the suction of the pool, et cetera, and can you continue those systems.

So it is more associated with the chemistry control than resins, long term.

MR. HOLAHAN: Slide number 11.

With respect to the staff's conclusions, we have concluded that the existing facilities provide adequate protection for public health and safety and this is based on our looking at the basic safety functions associated with the spent fuel pool and looking at the number of levels of defense and depth and having a confidence that there are layers of defense in the sense of quality of design and operation to minimize the likelihood of a drainage or loss of cooling event that, in all cases, there is some redundancy in cooling water systems. There are backup water supply systems in all cases. There are emergency plans to deal with the eventuality of damaging fuel in the pool.

That is not to say that we don't think that there are potentially desirable safety enhancements. It is that we have not found the fundamental flaw, the fundamental weakness in any of the safety functions with respect to the

spent fuel pool safety functions.

In addition to looking at the safety functions and the layers of defense in depth, there has been some limited amount but some insightful risk analysis done by the staff and by some of the national labs which tend to indicate that spent fuel pool issues are a small fraction of the overall risk associated with operation of a plant.

The other general observation we have is looking at design issues is not sufficient, that operational decisions and controls are an important element to the safety of spent fuel pools. Decisions like how long to wait before putting a new batch of fuel into the pool has a significant effect on the cooling capability and the time to boiling, for example, and that is one of the reasons that we are pursuing the issue of including the spent fuel pool in the shutdown rule because at least the draft of the rule that we are working on seems to be a good mechanism for addressing the operational characteristics.

Can I have the eleventh slide?

[Slide.]

MR. HOLAHAN: I think I got one bullet ahead of myself. I'll skip over the first one. It is pretty clear at this point that the regulatory guidance is not entirely clear and, as a matter of fact, in some cases it is downright confusing with respect to the staff's

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expectations, especially for cooling system capability of the spent fuel pools and that is an area that needs clarification. So we are committed to revise the standard review plan to clarify that situation.

Lastly, based on what we have seen in terms of the various design features in the plants, we think there are areas for potential safety enhancements. We will go through the plant-specific backfit process to justify those and I would just like to spend the rest of the time defining what those issues are.

COMMISSIONER DICUS: Could we go up to the bullet that you skipped over? I had a couple of questions about it.

On the shutdown operations rule, just for my own educational background, that rule is or is not out?

MR. HOLAHAN: No.

COMMISSIONER DICUS: That's not out.

MR. HOLAHAN: The staff is still drafting.

COMMISSIONER DICUS: It is my understanding --

MR. RUSSELL: We issued a draft rule that had tech specs with it. We have gone back to redo the rule to make the rule performance based to eliminate the need for technical specifications to identify the functions to be maintained.

The industry at this point does not agree with the

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staff's approach to include fuel pools in the scope of this rule. The issue, particularly for a boiling water reactor, where you are inside a secondary containment with the containment open moving the fuel 50 feet horizontally and putting it in a system that has not as much heat removal capability, you have basically the same types of functions.

So the issues, the functions to maintain are the same. So the staff views these as both able to be handled with functional requirements.

You can determine what is the heat load you are putting in the pool before you put it there. It is very amenable to a performance-based approach. You can do a heat load calculation, a heat balance. And if you find you want to put more fuel in a pool than you've got heat removal capability in a pool, you don't put all that fuel in a pool.

We think that these would be amenable to these type of functional controls and looking at what actions are taken on loss of redundancy, et cetera. So that is generally the approach and we are trying to apply some of the earlier Commission direction on going to a more performance-based rather than a prescriptive base for these reviews.

MR. THADANI: But I think there is another important element with that proposed rule that we have now, the one we are working on, is significantly changed from

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what went out for public comment previously. So we plan to again propose that we go back through the process of public comment period.

CHAIRMAN JACKSON: When do you expect this rule to come forward to the Commission?

MR. HOLAHAN: Our current schedule is near the end of the year, I believe.

CHAIRMAN JACKSON: Do you have a date?

MR. TAYLOR: I believe we do.

MR. HOLAHAN: Yes.

MR. RUSSELL: I didn't bring that with me. I do a report every month on where we are and how we are making progress. It is one that I review monthly with the staff.

We have CRGR, ACRS --

CHAIRMAN JACKSON: You want me to let you tell us the date rather than my tell you the date, right?

MR. RUSSELL: We will come back to it.

CHAIRMAN JACKSON: Excellent.

COMMISSIONER DICUS: I'll get off this subject in a few minutes, I promise.

My understanding is the rule has been in the works for some time; i.e., years. And it keeps undergoing some sort of modification or things keep being added to it and I

guess it is an observation of mine that rules, sometimes it's guidance, sometimes it's even response to a request or

something, seem to take a very, very long time to get finalized which raises the issue sometimes. If it has taken years for this rule to get out, do we need the rule? I mean, what has been done in the interim to address an issue? Is it an issue at all.

Then leading to the next part of, I guess, my comment more than a question is maybe you are going to do this in your regulatory analysis again, unless it is part of my education to get up to speed on this. But have you determined that, indeed, to address these enhancements which you say we are concluding that we don't have a big risk here but we have enhancements that perhaps will be beneficial that it is necessary to have a rule to address them. Is it necessary to put it in this rule?

MR. RUSSELL: The enhancements we spoke to earlier would be changes to design. We are proposing not to do operational matters through the classic approach which would be through facility technical specifications or something like that.

So in the operational matters, we are proposing to do those performance based. We did start down the path of tech specs for shutdown operations and the concern from industry was that they were so prescriptive that they would significantly impact outage length. As a result, we would receive direction back to go to a performance-based rule and

we are trying now to --

COMMISSIONER DICUS: To address the operational aspects.

MR. RUSSELL: To address the operational aspects, yes.

COMMISSIONER DICUS: But the question might still apply, is it necessary to do that in rulemaking? I mean, I don't know. I am not stating an opinion, I am asking a question in light of the fact of the length of time it has taken to do this rule.

MR. TAYLOR: The Agency never had a shutdown rule and we went through an experience at Vogtle, when was it, a number of years ago, shut down risk. And out of that, we began this effort at looking -- that had to do with a partially drained vessel with fuel in the vessel, containment open, loss of off-site power. Many people remember it.

It was based on that experience, after even how many years of reactor operation, that the staff began to consider how do you get in a shut down condition, which can vary a great deal because of outages. And I am moving back into the plant itself. This is sort of an adjunct to that kind of experience.

MR. RUSSELL: I think in the studies that we did, we identified that essentially all of the problems that had

occurred during shutdown were avoidable, that they were generally human induced, not controlling configuration, errors that were made, particularly mid-loop. In the BWR case, the dominant concerns are loss of inventory from the vessel and we have had cases where people made errors and pumped the vessel into the dry well spray system during testing through misalignments.

The frequency of human performance events have continued, although there have been improvements and industry awareness of the problems. We have issued technical reports identifying what the issues are.

What has happened is we have shifted paths a number of times from a generic letter requesting tech specs to a rule imposing technical requirements to now a performance rule so the vehicle that we've been working on has caused quite a bit of interaction back and forth in time and generally the industry has been opposing throughout, saying that it is sufficient for them to address these, these are really management people operational issues and we ought to not be regulating those. So it has been back and forth.

MR. THADANI: There are a couple of other points that I think are relevant. We were tracking operational events, as Bill said, during shutdown and sensitivity went up significantly after some of the events that occurred at

mid-loop operation way back in 1988 at Diablo Canyon.

We have issued generic communications and industry

has put together some better guidance for better management of outage activities. There is actually the NUMARC 9106 document which does a pretty good job of giving guidance to the industry in terms of managing outages.

What we see happening is frequency of events during shutdown, some sorts of transients, so to speak, has not really gone down that much. Severity of some of the events, it looks like, has gone down and very likely because of the generic communications that have been issued and the guidance from NUMARC. But we are still seeing a number of events are still taking place during shutdown.

As you have heard, industry has all along been against any rule during shutdown conditions. We were pretty well convinced there was a need for some regulatory involvement for those activities and that has been part of the reason for the delays really.

And the regulatory analysis became the key reason for the last delay when we went out with the proposed rule. There was considerable criticism of the staff regulatory analysis that was done by the staff and, in fact, on reflection, in looking at additional data, the staff acknowledged that that should be improved as well.

COMMISSIONER DICUS: Well, if it is important, I

think it needs to be finalized.

MR. THADANI: Yes.

MR. RUSSELL: Yes.

COMMISSIONER DICUS: Or dropped. Sort of fish or cut bait.

CHAIRMAN JACKSON: That's why we will discus dates, right?

MR. RUSSELL: Right.

MR. HOLAHAN: I am still hopeful that the industry will see the wisdom and desirability of a flexible rule with many performance elements in it.

CHAIRMAN JACKSON: Okay, why don't you go on.

MR. HOLAHAN: Okay, slide number -- I think I go to slide number 13.

[Slide.]

MR. HOLAHAN: I will discus the areas identified for safety improvements in each of the functional areas. First, the staff found nine reactors with some weaknesses with respect to passive anti-siphon or drainage prevention features and these tend to be examples, as I mentioned earlier, of using a valve as opposed to a passive device like a hole drilled in a pipe to prevent drainage.

With respect to instrumentation, we found seven plants which had either indirect or some other weakness with respect to the directness of information, level of

information being provided from the pool to the reactor operators.

We have also looked into the issue of leakage isolation capability and that refers to the fact that there is generally a space between the liner and -- the metal liner and the reinforced concrete structure of the pool and there is a drainage system to capture that, in part to identify which portion of the pool might have leakage.

CHAIRMAN JACKSON: I was at a reactor I think fairly recently where there was an issue having to do with something like that with some water behind the liner and actually causing buckling of the lining. Is that -- do I have a correct recollection?

MR. HOLAHAN: I think that is possible, yes.

CHAIRMAN JACKSON: Is this one of the kinds of issues you are talking about?

MR. HOLAHAN: Well, the specific issue here has to do with the fact that most plants would have isolation capability, so that if the leakage became excessive, that the area behind -- between the liner and the concrete has small pipes that leak off so that the water can be taken to a rad waste system. That leakage can be isolated in most cases as a way of preventing excessive leakage from the pool if the leakage gets too large.

We found some plants which don't have isolation

capability and so if there was, for example, a break in the drain-off piping itself, there would be no mechanism for stopping that leakage short of operator actions to put a freeze plug in the line or something rather -- a difficult operation.

So in effect what we are seeing is some plants have less capability to isolate liner leakage if it should

get too high than others.

MR. RUSSELL: We have had cases where things have been dropped on the liner and you punch a hole in it. So isolation of the leak-off to prevent you from losing inventory from the pool until such time as you are able to effect a repair or take some other action is another aspect. So it is not so much the loss of -- the amount of water going to rad waste but it is really the inventory control in the pool.

MR. HOLAHAN: This is an area where I would say we are not sure that we actually want to pursue safety enhancements on those. Most of these are rather small lines and we may be able to, by looking a little deeper, screen out those cases and not actually pursue any plant-specific backfits.

On the first two I listed, I think unless the licensees come back to us and say, no, you misunderstood some detail of our design or they have made some changes

since the information that we have reviewed, I think we are pursuing those nine and the seven reactors.

CHAIRMAN JACKSON: Are any of these the issues that have been identified by Monsieurs Lockbaum and Prevatte?

MR. HOLAHAN: No, I don't believe so.

CHAIRMAN JACKSON: Are any of the ones that you are discussing those?

MR. HOLAHAN: On the next page.

MR. RUSSELL: I might just comment that yesterday all of the facilities that were identified in the report were provided copies of the report so the particular facilities understand which facilities we have concerns about for which issues and we got confirmation back from the project managers that that information had been received. So we are starting the process as it relates to plant-specific backfit.

And there is one other outcome and that could be that the facility, looking at this issue on its own, concludes that some action is needed and, in that case, the staff would not perform a detailed regulatory analysis backfit if the company, on its own, concluded that some enhancement was appropriate.

MR. HOLAHAN: If we can go to slide number 14, I think that has some specific examples that go to answering

your question.

[Slide.]

MR. HOLAHAN: The first -- with respect to spent fuel pool temperature control, the first item in fact is very directly related to the issues raised by Monsieurs Lockbaum and Prevotte. In fact, there are eight units, eight sites in the country, not seven, that share systems. However, because we have already reviewed Susquehanna in some detail, we don't propose to redo that analysis.

But the concept of preventing adverse environmental effects on an operating plant from something in a spent fuel pool or vice versa is, I would say, the heart of the issue that they raised. So we will look at those possible interactions between units.

With respect to the reliability of spent fuel pool cooling, the -- we have identified seven reactors and the real concern that we are interested in following up on in that area is the dependence on off-site AC power. I would say I think that is an issue related to the concerns of Mr. Lockbaum and Prevatte in the sense that these are not -- by virtue of their needing off-site power, they are not safety-related in the same sense as the design basis for loss of coolant accident for example.

The third item on the page refers to the capability of a spent fuel pool cooling which really refers

to the fact of the capacity of the cooling systems, the number of pumps and sizes of heat exchangers as opposed to for the reliability issue really looking at equipment redundancy and whether there are any vulnerabilities to off-site power.

With respect to capability, it really refers to the fact that some plants would run, given a full core offload shortly after a shutdown, would take the pool to a relatively high temperature and that would give them a relatively short time for recovery actions before boiling.

So, in that sense of having shorter recovery time, those 14 reactors at 10 sites, we will look at those to see

whether some enhancements in hardware or in operational decisions could provide significant substantial safety improvements which would be cost beneficial. So those are candidates for backfit analysis.

The last item on this page is temperature instrumentation. We have identified 10 reactors where some instrumentation improvements look like they may be helpful.

That is a complete list of the areas that we have identified. We can -- we can identify the individual plants and what specific features fit in each of these categories.

I think we will all understand these -- the details of these better as we discus them with the licensees and begin our regulatory analysis over the next several

months.

CHAIRMAN JACKSON: Let me ask you a couple of questions.

How much overlap is there between them? You know, you have nine reactors here and seven there, 14, seven, seven.

The question is, net, how many reactors are we talking about?

MR. HOLAHAN: There is a fair amount of overlap. I didn't count the number of --

MR. THADANI: I didn't bring my metrics with me but there is in some cases.

As I said, early on, in terms of some deficiencies as we see them anyway --

CHAIRMAN JACKSON: I mean, are you talking 10 reactors net, are you talking 20?

MR. HOLAHAN: We are talking, overall, 38 reactors at 22 sites.

COMMISSIONER DICUS: How many sites?

MR. HOLAHAN: 22 sites.

CHAIRMAN JACKSON: Have you developed an actual schedule for completing the activities relative to these sites?

MR. HOLAHAN: Not yet.

MR. RUSSELL: We just finished notifying them

yesterday. We need to make sure that the facts that we are basing our analysis on are correct and then start the plant-specific backfit review process.

MR. HOLAHAN: Because of the number of cases involved, we will hope to search out for some deficiency measures. For example, what we would do is to put these cases in categories and then pursue what looks like where there is the strongest case, where there is the most substantial improvement. Because if you can't justify the most substantial one, it is not worth doing the other analyses.

CHAIRMAN JACKSON: So you are going to factor risk into your plan?

MR. HOLAHAN: Absolutely.

CHAIRMAN JACKSON: This is kind of a follow-on question and really a comment that is, in some sense, not unlike Commissioner Dicus's comment relative to the rulemaking. And that is, you know, the issue is not to have things drag on and that I appreciate there is a difference between having a plan to get the work done versus getting the work done. But it is very important that there is a plan to get the work done that reflects, as you would call, the deficiency measures and the risk significance. So I think that is something the Commission would like to see.

But then let me ask you another question.

You know, it appears there is some question about the guidance regarding spent fuel pool design issues and you even alluded to this, for plants with construction permits that were issued before the standard -- existence of a standard review plan.

I know you came in here to talk about spent fuel pools but do you have a sense there are other areas besides spent fuel pool design where the design guidance coming out after construction permit might lead us to think we have some other issues?

MR. RUSSELL: Yes. In the early 1980s, we did a review of the 11 old facilities. There were some provisional operating license to full-term license conversions in the group also, so there were a few old facilities that were not reviewed as a part of the SEP review.

We went through that review and on completion we

identified a number of issues where modifications were required to the older facilities that were deemed to be practical that would provide increased protection. We did use, at that time, risk insights. Mr. Thadani was the branch chief of the PRA branch at the time. One of the first applications of a use of risk on a relative basis to make judgments. It was also the first approach of collecting all the issues and doing an integrated review.

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When that was completed, we did report to congress a number of issues. Those issues have subsequently been reviewed and incorporated into our generic issues tracking systems. Some of them are being addressed in the context of the IPEs or the IPEEEs, that is, issues associated with winds, tornadoes, flood hazards in the IPE reviews. Others are being dealt with on other generic issues, decay heat removal issues.

They all have been prioritized, they are in the generic issue tracking system and they are at various stages of implementation, depending upon where an individual plant stands with some of the subsequent reviews. So that is generally the point we're at with those reviews.

It was identified in the context of the license renewal rulemaking activities and the process that unresolved safety issues and these old SEP issues would need to be addressed for facilities or could be a process challenge issue for those facilities. So I expect that particularly for facilities that may be contemplating license renewal it would ensure that at the time of the application their slate is clean with respect to those issues and that they have completed and done the appropriate implementation. That is generally the history of the SEP issues but there were design issues.

Most of the changes were in what I will

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characterize as external hazards. Some of the early designs did not consider seismic at all, for example. So you are backfitting a plant with no seismic design to have a seismic design based upon what the hazard is.

There were other substantial reviews associated with high winds and tornadoes, so I would characterize that the external event reviews are probably the area where there is most information. There were other areas that have been incorporated in subsequent review issues generically.

MR. HOLAHAN: There is another activity that went on over the last few years that I think also relates to the question and that is back about three years ago a study of the fire protection program was done and I think those recommendations have been implemented. But one of those was to go back and to look at generic programs, generic concerns broadly to see whether there were other areas that might have had some review weaknesses or some inspection weaknesses that might warrant additional attention and I think the one that was identified was the equipment qualification program and there has been a relatively broad study nearing completion on that topic.

I think the broad range of generic issues that was rethought didn't identify any other ones that needed followup studies.

MR. THADANI: Except, I think, besides the ones

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that Gary mentioned. I think one key point is what Bill was saying.

We did have a number of issues identified from the systematic evaluation program and a significant number of those issues were subsequently planned to be covered under individual plant examination for external events. We have formed teams now, both research and NRR. In fact, NRR is going to be involved in the reviews as well because of some of these licensing considerations. So our intention is to go back, take a closer look to see in view of the designs being based on earlier requirements, are there any particular deficiencies or vulnerabilities that one can identify through review of these studies. And that would, in fact, be very appropriate because it would not only identify any problems if they exist but it will give us a clear indication of safety significance right away.

So that is our plan.

MR. HOLAHAN: And, lastly, I think there is NRR and the regions and AEOD have a strong program for reviewing operating experience, which is a way of having the plants tell you where their areas of possible weaknesses are that need to be followed up.

CHAIRMAN JACKSON: Commissioner Rogers?
COMMISSIONER ROGERS: Just a couple little ones. You mentioned boiling. Is there any -- is there

any effect from a health radiation exposure point of view to workers in the pool when boiling starts? Is the radiation field changed, you know, in areas that normally would be relatively safe as a result of pool boiling?
MR. HOLAHAN: I don't believe that boiling of the water in the pool would be a problem. If that were associated with some failure of the fuel or additional leakage from the fuel, that might make it more difficult.
I think the water itself is pretty clean.
COMMISSIONER ROGERS: I was thinking of changing sky shine and things like this.
MR. RUSSELL: Loss of shielding would be a very substantial issue.
COMMISSIONER ROGERS: Yes, a change in the shielding but also the fact that you've got water vapor over the pool now. If you go to a limiting case with pretty severe boiling and pretty high vapor density over the pool, I wonder if that might just change the radiation fields to where catwalks and places like this that might normally be pretty safe would suddenly become more dangerous. I don't know.
MR. HOLAHAN: I think the primary concern would be loss of shielding. That probably wouldn't occur unless you boiled the water level down to within something like seven feet at the top of the fuel. Because there is quite a lot

of shielding.
Then damage or off-gassing or something of the fuel for going into boiling, I think, would be the secondary concern.
But, because of the normal water purity, I think, shine from the water itself and whatever associated particulates, I think, would be relatively low.
COMMISSIONER ROGERS: Probably, the density is low.
MR. RUSSELL: It depends upon whether the pool has been maintained. I visited one that had very high levels of cesium in it. Had to go in in double PCs and found that just the contamination around the edge of the pool was quite severe. So if you have boiling in that pool, you would have radioactive material evolving just from what's contained in the water.
If they have maintained the cooling systems and the cleanup systems and the clarity of the water, you generally would not have those kinds of levels of activity.
COMMISSIONER ROGERS: Well, the other question has to do with nonpower reactors. Have you thought at all about any spent fuel pool questions involving nonpower reactors? Normally, they are pretty low power and the amount of fuel that is stored in the pool is small and so on and so forth. But some of them are not so small and I wonder if there

might be some issues there that might be overlooked because they are not in the same loop with the power reactors in considering these spent fuel pool issues.
So I wonder -- I mean, it seems to me that's a place that you might look. A lot of them are very small but some of them are not so small.
MR. RUSSELL: We have not looked at it so let us get back to you.
COMMISSIONER ROGERS: And the other is whether, you know, the particular types of fuel that they have might have some problems. Aluminum clad fuel, I understand, has had some questions about it in the past and that, in connection with some of these other issues, may be something that we ought to take at least a quick look at.
CHAIRMAN JACKSON: Commissioner Dicus?
COMMISSIONER DICUS: One quick question and one quick comment.
The question has to do -- at what point are you going to consider your action plan completed?
MR. HOLAHAN: The action plan is meant to deal with the generic concerns and so once we have moved from generic concerns and we can identify these as plant-specific issues that would be followed on an individual plant basis, I think we would declare the action plan complete.
MR. RUSSELL: We are actually relatively close.

If the generic issues on operations are incorporated into

the activities for the shutdown rulemaking, we would track that issue as a part of our overall efforts on shutdown rulemaking.

The plant specifics, once we have notified the licensees and the appropriate notification letters are out and we are tracking that on an individual issue basis with each licensee, at that point in time we would be tracking it as an implementation item on a plant specific basis and so it would no longer fall into the generic and we would be able to close the items out.

COMMISSIONER DICUS: Okay, and the final comment has to do with Slide 11. I think it is just important to point out that in all the noise of the activities ongoing with regard to enhancements and rulemaking that we don't lose sight of the fact that the existing facilities do provide the added protection for the public health and safety and I think it is important to make that point.

CHAIRMAN JACKSON: Any other comments?

[No response.]

CHAIRMAN JACKSON: Well, I would like to thank the staff for briefing the Commission. Your survey results and evaluations appear to be quite comprehensive and it would seem that, based on inventory configuration and administrative controls, the risks associated with spent

fuel in spent fuel pools across the country is low.

Nonetheless, as you have identified, we can do more to ensure that risk is minimized, particularly in the specific cases you have outlined.

I think the point is whether the corrective action is in rulemaking, such as a performance-based rule for shutdown operations or requirements to address specific design features, which reduce reliability, or whether it is supplying information regarding potential weaknesses which might decrease reliability and spent fuel pool cooling systems, we should evaluate the benefits, which you have already said, from a risk perspective associated with these actions. But then to proceed expeditiously to bring them to closure with a plan that has milestones that ensures that when the issue is closed, it is closed.

If there are no further comments, we're adjourned.

[Whereupon, at 4:22 p.m., the briefing was concluded.]