UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON NUCLEAR FUEL PERFORMANCE

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ROCKVILLE, MARYLAND

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THURSDAY, FEBRUARY 24, 2005

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The Commission met in open session at 10:30 a.m., at the Nuclear Regulatory Commission, One White Flint North, Rockville, Maryland, the Honorable Nils Diaz, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

NILS J. DIAZ	Chairman of the Commission.
JEFFREY S. MERRIFIELD	Member of the Commission
GREGORY B. JACZKO	Member of the Commission
PETER B. LYONS	Member of the Commission

(This transcript was produced from electronic caption media and audio and video media provided by the Nuclear Regulatory Commission.)

STAFF AND PRESENTERS:

JOE SHEPPARD, PRESIDENT & CEO, STPNOC

ROSA YANG, TECHNICAL EXECUTIVE, EPRI

JERRY HOLM, DIRECTOR, REG AFFAIRS, FRAMATOME ANP

JACK FULLER, CEO, GLOBAL NUCLEAR FUELS

MIKE SAUNDERS, SENIOR VP, NUCLEAR FUEL, WESTINGHOUSE

JIM MALONE, VP, NUCLEAR FUELS, EXELON

LUIS REYES, EDO

BILL BORCHARDT, DEPUTY DIRECTOR, NRR

FRANK AKSTULEWICZ, CHIEF, BWR SYSTEM & NUCLEAR PERF.

DR. CARL PAPERIELLO, DIRECTOR, RES

DR. FAROUK ELTAWILA, DIR, DIV OF SYSTEMS ANALYSIS & REGULATORY EFFECTIVENESS.

P R O C E E D I N G S

CHAIRMAN DIAZ: Ready?

Good morning. It says in here good afternoon.

[Laughter].

CHAIRMAN DIAZ: But since I never pay attention to what is written in here, I'm doing good.

I appreciate you changing your schedule to accommodate the weather. Got a lot of brave people in here. Anybody that is here from the NRC, I want to just tell you, you can take Saturday off.

[Laughter].

CHAIRMAN DIAZ: But you guys, I don't deal with that. We are pleased to welcome this panel to talk to us about the nuclear fuel performance. Experience has shown that plants have been operating well. Occasionally there is a little problem and you guys are going to address those issues.

The Commission is interested in hearing what the industry has been experiencing and the programs and issues that you are addressing and how those connect with the regulatory decisions that we need to make.

I want to acknowledge that Commissioner Merrifield was instrumental in putting this briefing together. He has actually been spearheading the issues and we are going to give him some privilege today so he can really get deeper into what his interests are. I understand that Commissioner Merrifield has some introductory comments.

COMMISSIONER MERRIFIELD: Yes. Thank you, Mr. Chairman.

As you mentioned, this is a meeting I have sought for some time. And in spite of the snow storm today, I'm glad and I'm anxious that we can proceed as planned.

Since joining the Commission in 1998, I have taken the opportunity to visit all 103 operating reactors in the United States, as well as all of the fuel cycle facilities from the fuel side.

As I concluded that effort, I began to notice that fuel reliability was becoming a more and more frequent topic of the discussions that I had at the plants. According to the information that we have received from our licensees, we recently had between a quarter and a third of the plants operating with failed fuel, a trend that is dramatically different than the significant improvement in fuel reliability we had seen in late 1990's.

Indeed, the more recent increase in fuel failures approach levels that we have not seen since the early 1990's.

Now, just so that there is no misunderstanding in my concerns in this area, I'm not here to suggest that there is a significant risk -- an increase in the risk of a severe accident resulting from this trend. Indeed, data from our Office of Research validates that there is no significant change in the core damage frequency from this trend.

Further, as some will point out, when compared with the total number of fuel pins in the total inventory, we are not talking about big numbers. Nonetheless, this is a trend that we can neither ignore nor tolerate. The fact is that damaged fuel creates significant and frequently long-lived operational challenges to the plants and the individuals who work there.

Greater difficulty in managing worker dose, limitations on the allowable time workers and inspectors can enter high-dose areas, higher costs and complexity of future decommissioning activities and greater challenges in managing spent fuel may result from this problem.

In addition, increasing complications in material control and accountability are an issue that we all face.

The loss of public confidence results when nuclear plants operate with leaking fuel. Or worse yet in this post-9/11 world when licensees cannot account for some failed fuel elements that are supposed to be stored in their spent fuel pools, should be a concern of both the NRC and the industry.

Today a vast majority of the operating fleet has reconstituted fuel in its spent fuel pools where failed pins have been removed and new pins installed so that fuel bundles can be fully utilized. Unfortunately, this has led to the difficulties we have recently faced at Millstone, Vermont Yankee and Humbolt Bay. This is a history that we will be living with for sometime.

Now, from a regulatory perspective, fuel cladding is the first of the three primary barriers to the release of fission products.

Erosion of this first barrier weakens the foundation of our defense-in-depth strategy.

Now, while some, including the NRC staff, will focus on the fact that the current level of fuel failures does not exceed our technical specifications, the fact is that while a utility may not be in violation of an NRC requirement, using the NRC tec specs as an operating goal that neither makes good business sense, nor is it consistent with the goal of excellence established by the Institute of Nuclear Power Operations.

When one begins to look at the reasons for the recent trend, there are a variety of potential causes: The failure of licensees to keep on top of foreign material exclusion, new designs in reactor fuel, changes in cladding materials, higher fuel burn-up, power uprates and longer operating cycles are among the potential causes that come to mind.

What is clear is that there is no single cause nor is this an issue isolated to any one licensee or fuel vendor.

To their credit, Nuclear Energy Institute, which includes both the users and the vendors of the fuel, has recognized that this is an important challenge and have committed significant resources to understanding the potential solutions. With research money directed toward the Electric Power Research Institute, it is clear that NEI is putting its money where its mouth is.

For our part I think NRC has to closely monitor this effort, as well as ensure that our staff understands these trends and is providing the Commission with timely and useful options for any policy decisions that may arise.

Today, Joe Sheppard and others will explain how they intend to meet their self-imposed goal of zero defects. I think this is a laudable goal and I look forward to understanding how they intend to get there.

Thank you, Mr. Chairman.

CHAIRMAN DIAZ: Thank you, Commissioner Merrifield.

Commissioner Jaczko, do you have any questions? Commissioner Lyons?

COMMISSIONER LYONS: No, sir.

CHAIRMAN DIAZ: With that, I'm going to turn this panel to Mr. Sheppard, who is the President and CEO of the South Texas Project.

And since I'm good at delegating, Mr. Sheppard, I hope you will introduce your panel members as you go and save me the --

MR. SHEPPARD: Absolutely. Thank you. Thank you, Mr. Chairman, Commissioners.

I am Joe Sheppard and I'm the President and CEO of the STP Nuclear Operating Company. But I'm talking today as the Chairman of the Fuel Reliability Projects Executive Committee. And we really do appreciate this opportunity.

If we could go to the next slide.

What I'm going to cover is listed here. We will talk about the materials initiative, the fuel reliability programs, trends, our focus areas and overall impact assessment.

When I finish, Rosa Yang from Electric Power Research Institute will talk a little bit about some of the research that we have ongoing. And then Jack Fuller from Global Nuclear Fuels and Jerry Holm from AREVA Framatome ANP and Mike Saunders from Westinghouse will have some brief remarks about what they are doing as major fuel vendors to support this overall effort.

And then we will wrap up with Jim Malone, another licensee who happens to have a large number of reactors to discuss. Their particular experience with fuel reliability.

If we go to the next slide.

I'm going to try not to use acronyms. Some of the slides do have them on there for brevity. And these are the explanations of those.

But to get to the body of the discussion, if we go to the next slide.

I think to put this overall issue in context, we first have to talk about the industry's material initiative. And we as an industry in 2003 recognized that we needed to coordinate what we were doing in the overall materials efforts. This was largely spearheaded by the Alloy-600 issues. But we almost immediately realized that fuel reliability needed to be brought into this overall mix of how we were dealing with materials issues.

And there was an initiative, NEI 03-08, that was endorsed by all Chief Nuclear Officers that do that. And the real effort here is to coordinate the large amount of research and development money that's being spent by the industry every year to make sure that we have the right priorities, that we are working on the right things and we are doing things in a coordinated effort.

There is about $60 million in research and development money being devoted to materials issues from the industry. Of that, the fuel reliability program has about $10 million a year. But I need to point out that each of these vendors is also spending about $10 million a year on their own to support the overall effort as we go forward.

If we go to the next slide.

The purpose of the initiative was to really provide a consistent process for addressing these issues, prioritize things and coordinate the effort and look for solutions and approaches to resolve these issues, and where necessary, to impose requirements on licensees to do certain things to avoid the issues. And therein is built into the initiative oversight of implementation as well.

And on the next slide, just the basis of the initiative was that licensees would be committed to fund these programs, supply talent to support the programs, and act in a united manner. And this is a united effort between the utilities, the vendors, NEI, EPRI and INPO as we go forward.

And we have created a management structure, which is shown on the next page, from the Nuclear Strategic Issues Advisory Committee, NSIAC, down through an oversight group that we call MEOG, Materials Executive Oversight Group.

There is a Materials Technical Advisory Group that does the technical coordination of these groups. And then there are the actual issue programs of all these materials issues, including the fuel reliability program and the materials issues that are -- programs that are under the various owners group as well.

The next two slides list all these programs, and I'm not going to go into those individually. But you can see the fuel reliability program is one of the predominant programs that's carried under the overall materials initiative.

I would like to now really sort of focus in on the fuel reliability program and what we are doing there.

We began this program in 1998. It was then called the Robust Fuel Program. It really focused on fuel design and fuel performance. In response to the materials issues that we saw in the industry in 2003, we refocused the program to support the materials initiative and to focus in on fuel reliability issues.

And as Commissioner Merrifield pointed out, this is the first fission product barrier. We take that very seriously. And our objective is to have highly reliable fuel with zero defects. That's what we are working toward.

If we go to the next slide, there are really four specific areas that the fuel reliability program focuses in on. One of our biggest areas is root cause investigations of failures. Rosa is going to talk a little bit more about that here in a minute.

We also have large efforts underway to understand the environment that the fuel operates in. And that's -- so we have a group that looks at crud and water chemistry in boilers and in pressurized water reactors.

We also have a working group that does an interface with the NRC on things like loss of coolant accident testing and reactivity-initiated accident type testing as well.

If we go to the next slide.

This is again what Commissioner Merrifield was referring to. There are several U.S. plants that are still experiencing small fuel defects. The number of assemblies with fuel defects declined in 2004. We think we have reversed the trend. But, again, our desire here is to have that highly reliable fuel with zero defects.

And if we look on the next page, this is the graph of the percentage of plants that are operating without any defects, 2003 -- rather, 2002 and 2003 were not good years. And the industry, I believe, has taken aggressive action. Jim will talk a little bit more about some of those actions.

We think we have an improving trend. But, again, we are not satisfied. We are going for the overall objective of zero defects.

If we look at the next slide, these show the predominant failure mechanisms that we found in 2004. And they are roughly the same in previous years in terms of percentages. But the boilers tend to have issues both with pellet-clad interaction-type failures and debris-type failures. The pressurized water reactors tend to be dominated by fretting-type issues, grid to rod, fretting, those kinds of things.

COMMISSIONER JACZKO: Mr. Chairman, can I just ask. What is a pellet-type clad interaction failure? Can you explain what that is?

MR. SHEPPARD: Certainly. The pellet fits snugly within the rod and it tends to swell as it's in its service. And if that pellet is not manufactured correctly or is not shaped correctly or is not in the tube correctly, you can create stresses in the cladding from that interaction. And that can, in fact, lead to a failure.

COMMISSIONER JACZKO: Thank you.

MR. SHEPPARD: Again, as Commissioner Merrifield pointed out, there are literally tens of thousands of fuel rods in any reactor core. So we are talking about small numbers. But irregardless, that does not meet the objective because of the other issues that these very small failures can cause. But I think just to put in perspective, these are very small numbers, but they are not acceptable.

One of the things that we think is very important to resolve these issues is that everybody has the information as to what's going on with the fuel. We have worked hard with INPO to improve and upgrade the sharing of operating experience associated with the fuel experiences and fuel design. And that is contained in what we call the fuel reliability database or the acronym is FRED.

And we think that this is going to be a really, really important tool as we go forward. Because for the first time, we have, I think, really good across-the-board sharing of information of what kind of failures occurred, what the generic implications are, those kinds of things.

And so we have populated that database this first quarter of the year. It's available to all U.S. utilities. We are making it available to the fuel vendors and also our international members of EPRI.

COMMISSIONER MERRIFIELD: And that's hosted by INPO?

MR. SHEPPARD: Yes. Yes, it is.

If we go to the next slide. Just as any other materials issue, the components that one has to look at to look for potential solutions and also potential problems resolve really around four areas: Manufacturing techniques and designs that you put this material in the actual specs of the material and the duty and the water chemistry that you subject the material to.

And if we go to the next page.

This is a rather complicated chart that I don't intend to try and go through. But what we can see is how these four factors tend to interact to cause the outcomes that may or may not be desirable as you go forward.

So we look at this chart and this is how we focus our efforts within the fuel reliability program and in our research to go after certain areas here so that we can mitigate or eliminate the consequences that come from these particular issues.

If we then go to the next slide.

We believe that we are starting to have a positive effect on the overall reliability. We have solved issues like actual offset anomaly. We have got some across-the-board water chemistry guidelines now that we think are really going to have a very positive effect. Some of the research that Rosa is going to talk about here in a second, again, I think has given us very positive effects as we go forward.

And as Commissioner Merrifield pointed out, most fuel defects do represent a very, very small fraction of the limits that could affect off-site dose. Again, that's not acceptable to us.

This is a performance issue. This is an excellence issue for us.

And then if we go to my last slide here. I think that the licensees and the vendors are taking aggressive action to correct issues. We do have several successes. We know that fuel defects can cause operational issues and it can cause economic issues. But we are making progress.

But I just want to reiterate that the overall objective that all of us are committed to is this highly reliable fuel and zero defects.

And what I would like to do now is let Dr. Yang talk a little bit about some of the research that's being done, a small portion of the research that's being done to support the overall program.

CHAIRMAN DIAZ: Thank you.

DR. YANG: Thank you, Joe. I'm Rosa Yang. I work for Electric Power Research Institute.

If you go to the next slide.

EPRI's role is to provide technical expertise and project management for the utilities. And currently we have mostly U.S. utilities, but we have some international members as well.

If you go to the next slide.

I think both Commissioner Merrifield and Joe talk about the complexity of fuel and some of the changes recently occurred, like water chemistries, longer cycles.

And to make sure we can achieve the zero defect goal, we try to understand the phenomena and at the same time a very important part of our program is to monitor the performance. And the way we monitor to make sure that the fuel is performed as designed as we expect it. So the key aspect of it is to confirm performance margin.

And in the case of fuel failures, we will try to identify the failure root cause.

To accomplish both confirming the performance margin and identifying root cause, there are two classical ways of doing it. One is the poolside inspection. You inspected the fuel at the reactor spent fuel.

And the other is to bring the fuel, both sound rod, to confirm the margin, or the failed rod to the hot cells. And we do this in close collaboration with the utilities and the fuel suppliers.

If you will go to the next slide. I think I already talked about that.

Let me just say a few words about monitoring the performance. Whenever there is a new fuel design or something new, be it material, be it water chemistry or be it operating condition changed, we monitor the effect of that change. That's the only way we know how good the performance is and how much margins we have.

And we do it by poolside and hot cell as I already said.

The hot cell exam gives you the most definitive answer. You basically cut up the rods in the shielded laboratory and you look at details of the composition, the shape, a lot of information you can gain. It gives you the most definitive answer. However, it takes time to ship the fuel from the reactor site through public road, then to the hot cells. It on the average takes about a couple of years. And most of the time is really the time it takes to ship the material, rather than the time doing the examination.

Although costly and consuming, we do it when it's necessary, because that's the best way to give you the detailed information.

If you go to the next slide. Asked earlier about PCI, you can see on the right-hand side of the graph, the inside is the fuel, the shiny part is the cladding. What happens is during operation, fuel expands more than the cladding and particularly during the power change. So it puts a stress on the cladding.

In this particular picture, you can see a little missing surface from the pellet. And that creates extra amount of bending stress on the cladding. And you see this little fine cracks through the cladding. That's a typical classic signature of a PCI crack. If there is no missing pellet surface, this will not have occurred.

The left-hand side is just the much lower magnification of the fuel rod. You can see a tiny little crack there. And the right-hand side was a cut-up through that tiny little crack. And both pictures are taken at the hot cell. See, this kind of information you will not be able to obtain by just performing poolside inspection, because when you look under 30, 40 feet of water, it is very difficult to see that tiny little crack. So these have to be done at the hot cell.

And as a result of this hot cell exams, the manufacturing practice has been changed to avoid this type of missing surface, and the utility has also changed to the operation practices to make the stress less on the cladding material.

m is going to address a bit on that. This is from one of the Jim's rack.

The next examination, type of examination we do is called poolside examination, which is done at the reactor poolside. It's much faster because you can do it right away and it's less expensive and you can do it more frequently. So that gives you timely information, it gives you more information and timely. So we try to balance the need for the two. You know, we conduct a lot more poolside inspections.

And when that cannot yield the findings, then we have to conduct the hot cell examinations. And when we try to have a full understanding of new fuel designs, we usually do hot cell examinations. And as I discussed earlier, that the hot cell exam takes some time.

So when you look at fuel failures, it's going to take some time to get the problem corrected. It's not something that occurred today that can be solved or corrected right away. But we are on top of it.

The next picture is just a nice picture of showing what we got from a small piece of material on the surface of the fuel rod from the poolside inspection, as I talk about the difficulty and expense of the hot cell examination. So a key part of our program is to try to develop techniques so that we can try to gain as much information about the health of the fuel rod at the poolside.

And one of the new things we found is that if you take a small piece of crud, which is the corrosion product on the fuel surface, and that actually gives you a lot of information of how water chemistry is actually affecting the fuel performance. And this picture just shows the details about what we actually found by taking some small piece of crud from the fuel rod. So then the summary is really --

COMMISSIONER MERRIFIELD: Just for clarification, can you explain what a steam chimney is?

DR. YANG: Yeah. When the corrosion product, which are naturally circulating in the system, they tend to deposit on fuel rods. And when they are deposited, quite often they deposit in a form so that it forms chimney among the fuel rods.

That actually is a very good thing because it helps conduct heat away. So it really enhances heat transfer. And that's a desirable feature.

What is not desirable is when these chimneys are plugged with undesirable material. So we are very careful in monitoring the composition of the material in the chimney. So we would like to see chimneys.

MR. SHEPPARD: Commissioner, as the heat is transferred from the fuel through the cladding to the water, steam is formed. And you need a way to get that out into the coolant stream. So these chimneys are that conduction path, unless they are plugged by some other kind of impurity.

DR. YANG: Okay. To summarize, this is really a very small and quick summary of what we do. We are very -- we have a pretty comprehensive program, as Joe described earlier. We are trying to understand the issue. We are trying to monitor the performance.

We are trying to make sure there is enough margin.

And whenever we find fuel failures, we try to do poolside inspections, trying to identify the root cause. And if that's not possible, we take the fuel to the hot cell.

So I think the industry, along with the utilities and vendors, are proactive in trying to identify the root cause, trying to ensure good performance.

I guess my only message is this is not a process that can be -- it takes time, you know. It's a complex issue. And we are on top of it and we are trying to improve the performance.

CHAIRMAN DIAZ: Thank you.

MR. SHEPPARD: Now, I would like to allow each of the fuel vendors to give their particular perspective on this issue. We will start with Jerry Holm from AREVA Framatome.

MR. HOLM: Good morning. My name is Jerry Holm. I'm with Framatome ANP. John Matheson, our vice president of nuclear fuels, was scheduled to speak this morning. He sends his respects. He was planning to fly up from Lynchburg to D.C. this morning. But the weather and the rescheduling of the meeting prevented him from being here. I have his talking points and I'll speak from those this morning.

Framatome ANP is committed to a goal of zero fuel failures --

COMMISSIONER MERRIFIELD: If you will pull that microphone a little bit closer down and try to speak into it.

MR. HOLM: Framatome ANP is committed to a goal of zero fuel failures in all of the reactors which operate with our fuel. This commitment is embodied in our zero tolerance for failure philosophy.

Zero tolerance for failure is a mind set, the way each of our employees thinks about their work. The quality of our product depends on the attitude of each employee and is embodied in four principles: Failures are avoidable; zero failures is our goal; we respond rapidly to any failure; and we succeed when we fix failures and they do not reoccur.

We train our operations personnel and our engineering personnel to these principles and reinforce the zero tolerance for failure philosophy every day. The philosophy is global. Our European sub-components suppliers also embrace this philosophy.

We have focused our efforts on developing solutions to eliminate fuel failures from all causes, and I will give a few examples.

In PWRs grid to rod fretting is our predominant failure mode. The HDP spacer for PWRs has design characteristics which minimize the potential for fuel failure due to spacer fretting.

Since the introduction of the HDP spacer, no fuel rod has failed due to fretting at an HDP spacer location. And this solution is being implemented in many of the plants which continue to have fretting failures using other spacer types.

We have developed lower nozzles which capture debris in the coolant before it can interact with the fuel. Fuel guard lower nozzle is an example that has been implemented for both PWR and BWR reactors.

We have improved our fuel reliability by installing best practices equipment and processes in both our Lynchburg and Richland manufacturing facilities during the last year. Included in these upgrades are improved wielding equipment and soft loading for pellets. And these investments have been made to ensure built-in quality rather than inspected-in quality.

The soft loading for pellets was introduced, for instance, to minimize the potential for the type of missing surface that Rosa showed you.

Our fuel maneuvering guidelines are being continuously tested by our fuel inspections and experience and are designed to prevent pellet clad mechanical interaction failures.

We are focusing additional attention to the issue of reactor coolant chemistry in order to minimize crud formation in BWRs. We are providing training and recommendations to our customers to help ensure reliable fuel operation in challenging coolant environments.

The impact of these efforts is that today all of our BWR customers are operating failure free, and solutions for our PWR customers are being implemented.

In order to improve the performance of the first barrier to the release of fission products, the cladding, developmental programs have been pursued for a number of years to improve the cladding characteristics. The —5 cladding for PWRs has significantly improved performance with respect to corrosion, dimensional stability and hydrogen update. And we are continuing to invest in cladding development programs for both BWRs and PWRs to further improve the cladding performance.

And the result of these design improvement efforts has been to significantly reduce the number of fuel failures over the past two decades and over the past year, in fact. We have 41 plants in the United States and the Far East which operate with our fuel. Of these, six PWRs currently have fuel failures for a total of nine failed rods. Eight of these fuel rods failed due to grid to rod fretting and the HDP is being introduced in many of these plants as a solution. And we look forward to the day when the total number of fuel failures in plants operating with our fuel will be zero.

Framatome ANP vigorously supports the efforts of the fuel reliability program. We have engaged in joint R&D programs with the fuel reliability program to characterize the failure mechanisms of failed fuel through hot cell examinations and poolside examinations. We continue to work with EPRI in establishing coolant chemistry guidelines for both PWR and BWR utilities. The most recent cooperative effort is the detailed examination of the failed and intact rods from the Exelon operated La Salle Unit Two. And these examinations have yielded new information relative to both manufacturing and operations that will help ensure reliable fuel operation in the future.

Finally, we support the concept of the fuel reliability database, FRED. It is our hope that this collection of data will provide the industry information in a timely manner to help ensure reliable zero defect fuel operation. We believe the fuel reliability program to be fully in line with our zero tolerance for failure philosophy.

Thank you for your time and attention.

CHAIRMAN DIAZ: Thank you.

MR. SHEPPARD: Now Jack Fuller from Global Nuclear Fuels.

MR. FULLER: Thank you, Joe.

Good morning. My name is Jack Fuller. I'm the leader of Global Nuclear Fuel, which is a joint venture company between GE, Hitachi and Toshiba formed in the year 2000.

GNF has committed to a zero leaker level of reliability for all the products we deliver to our customers. Working with our global customer base and key industry initiatives, we are focused on improving the reliability of our products.

We believe leaking fuel is not truly a safety issue. Plants have been designed with significant margins to their licensed radiological limits, and utilities have done an excellent job in focusing on sound ALARA processes.

A number of leakers in any impacted plant is relatively small compared to historic measure. In BWRs today there are 4.3 leakers for 1 million rods that are actively in operation. But that's still not good enough.

Finally, in our modern tools and analytical techniques working in concert with our plant operations, the effects of a leaking fuel rod are easily tracked and managed. Our focus on zero leaker recognizes the significant customer operational impact on the plant and its personnel and the impact on cycle efficiency.

The operational impacts may include but are not limited to operational maneuvers to locate and suppress a leaking rod. Follow-up surveillance and soft operation can minimize any future damage. And in rare cases mid-cycle outages to remove that bundle from the core.

GNF has focused for many years with the industry and our utility customers on understanding the root causes of fuel leakage. Many of the issues discussed by others here today, debris fretting, pellet cladding interaction and corrosion have received tens of millions of dollars in technology research and investment. The results have been significant. All failure mechanisms encountered to date have been characterized and addressed.

We have achieved an order of magnitude reduction in the historic leaker rate across the fleet. And today the majority of the BWR units are leaker free on extended two-year cycles.

We recognize that our journey for zero leakers is not done. We are actively involved with programs to address the failure mechanisms remaining. These programs are in concert with EPRI and the industry fuel reliability programs.

Independently, we are investing our research and development resources with the intent to drive the continuous performance improvement of our products.

GNF continues to collaborate with our customers to provide innovative enhancements to eliminate leaking fuel. We have partnered with our customers on lead use assemblies to ensure our product robustness prior to commercial introduction. We are investing and testing new debris catching technologies for the bundle design. We are learning from the corrosion events over the past few years and adapting our materials for additional robustness in the reactor environment.

And we are enhancing and updating our analytical codes and methods to improve our understanding of the complexity of the nuclear designs.

And we continue with our customer support to do about 20 poolside inspections each year, both for leaker and non-leaker fuel to verify that our hardware is performing as designed.

In summary, GNF in conjunction with our customers, EPRI and the industry, will not be content until we have reached a zero leaker status. We have made good progress. But we still have a lot to do.

We have the personal commitment of the people, the corporate commitment of our parents and the resources of our company focused on achieving zero leaker goal. I would like to thank you and the rest of the Commissioners for the opportunity to share my thoughts.

MR. SHEPPARD: And finally, we will have Mike Saunders from Westinghouse.

MR. SAUNDERS: Good morning. My name is Mike Saunders from Westinghouse. I'm the senior vice president for the global fuel business.

Firstly, the Westinghouse fuel organization is focused on and committed to achieving our goal of zero defect fuel, which includes but is not limited to fuel reliability.

In order to achieve this goal, approximately three years ago we established a flawless fuel program which integrated and coordinated our global engineer manufacturing activities.

More recently, we have also introduced a Westinghouse-wide program called customer first, which is explicitly focused on achieving a step change in our overall performance and quality, including fuel. The flawless fuel program now sits under the umbrella of customer first and is my organization's primary focus.

As part of the fuel performance program, we continue to invest significantly in research and development focused on robust fuel products, improved design methods and test facilities. This investment and focus is, I believe, paying off.

In the last four years an environment where -- passive factors and fuel duties have increased, we have seen a 50% decrease in the number of fuel defects including debris-related defects for the fuel that we have supplied globally.

We now have solutions to all known causes of fuel failures and these are being implemented across our global business. For example, grid to rod fretting was and remains the major failure mechanism in our PWR fuel. It counts for approximately 60% of fuel failures.

The design we have implemented beginning in 1999 has had zero failures due to this mechanism. While we are pleased to be making substantial progress, we, like everyone else, is by no means satisfied. We are working closely with our customers and industry to ensure an integrated approach to fuel design, manufacturer and operation in order to meet the goal of zero defects.

We also continue to promote an open culture with a question and attitude to ensure that we are anticipating fuel future issues and take preventive actions rather than corrective actions.

In summary, Westinghouse is committed to working with our utility customers and industry partners such as EPRI and INPO to achieve the goal of flawless fuel performance. We are actively monitoring fuel performance and performing fuel exams both on-site and hot cells to improve our understanding of fuel behavior with a goal of preventing future fuel reliability issues.

We continue to invest heavily in R&D and positively engage in cooperation programs with industry and customer groups.

We have the people, the programs and the leadership to make the aspiration of zero defect fuel a reality.

Thank you again for your time.

CHAIRMAN DIAZ: Thank you.

MR. SHEPPARD: What we would like to do now is kind of conclude our prepared discussion with a discussion from Jim Malone of Exelon.

MR. MALONE: Thank you, Joe.

Good morning. Thank you for the opportunity to address you and to inform you about our efforts at Exelon to achieve zero defects with fuel.

Our problem statement is concise. At one point in 2003, Exelon had failed fuel in 11 units, the epitome of an unacceptable number of fuel failures.

In about two weeks from now we will be operating with failed fuel in one unit, a significant improvement, but still unacceptable. Not good enough. Our goal is zero defects.

Next slide, please.

The industry has made significant strides in fuel reliability from 1989 through 2000, increasing the number of leaker free units from less than 50% to about 85%. The number of leaker free units began to decline and hit a low point of 74% in 2003, before beginning to improve once again.

The improvement has come about as a result of cooperation between the fuel suppliers and the utilities, EPRI, where both are represented in the fuel reliability program, has made a significant contribution to understanding the root cause of La Salle and Quad Cities failures.

Next slide, please.

Fuel failures can occur for a number of reasons. Among them are debris fretting, as has been mentioned; grid to rod fretting, which has been mentioned; manufacturing flaws; water chemistry environment; nuclear design; and fuel operating duty.

We examine each of those areas at Exelon each time we encounter a fuel failure. And we try to zero in on the most likely cause.

In order to more clearly understand the root cause of a fuel failure, it must be examined, as Dr. Yang had pointed out. Note that PCI or pellet cladding interaction and flaw assisted PCI is noted as a probable cause for failures examined at Exelon in 2004.

Once again, the majority of failures can be attributed to PCI when we look at Quad Cities 1 and 2 and Three Mile Island. One interesting point is that the failure mode identified for La Salle 1, 2 and Quad Cities 1 opened some eyes to the fact that a similar failure mode could occur in Pressurized Water Reactors. Specifically, the failures at Three Mile Island and Braidwood 2 most likely have a flaw-induced component to them.

What have we done about failures? While Exelon was frustrated with the situation, we did not sit back and watch. We judged each situation on its merits, learned from our own fleet and industry operating experience, developed a unit-specific plan and executed the plan.

Plans were as aggressive as removing an entire batch of fuel at Quad Cities, removing failed fuel at La Salle, managing other leaking fuel to permit continued operation without degrading the fuel, and incorporating lessons learned in subsequent reload design and operating strategies.

Ramp rate controls in conjunction with power suppression were used to protect BWR fuel from degrading. PWR ramp rate restrictions have resulted in successful start-ups, meaning no defects at start-up at both Byron and Braidwood.

COMMISSIONER MERRIFIELD: I'm sorry. If I may just clarify.

On your slide relative to Quad Cities, you said you replaced 233 fuel assemblies susceptible to failure, not the individual rods, but fuel assemblies?

MR. MALONE: That is correct.

COMMISSIONER MERRIFIELD: Without getting into too great detail, I trust that that was a relatively expensive undertaking?

MR. MALONE: It was quite painful. It was expensive. It was disruptive. It required a lot of attention to detail to make it successful. But we felt that in order to not put the operators in a situation where every time they did a sequence exchange with the control blades, they were seeing fuel failures. So we felt it was important to make that change.

COMMISSIONER MERRIFIELD: One further, just a quick clarifying remark. Was it not Quad Cities -- I think my numbers are right, was it not Quad that was, for lack of a better word, was it leading the industry in terms of the amount of total overall dose?

MR. MALONE: That's also correct. I would like to address that, if I might. But perhaps I should finish here and then come back to your question.

Okay.

Exelon has successfully operated failed BWR fuel for approximately 24 months without significant degradation. La Salle 2 and Limerick 2 were both able to complete these long cycles with fuel failures that emerged cycle start-up.

Now that we have an understanding of the failure mechanisms, we have focused on efforts on making sure that our suppliers are taking action to eliminate flaws. Each has a good program in place.

But this is a big job. So we are working much more closely with the other utilities, the vendors, INPO and EPRI to share information and to try to get out in front of the issues.

Most of the significant impact of a fuel defect falls on the reactor operators, as Commissioner Merrifield referred to earlier. This impact is in the form of operating restrictions and operating the reactors slightly differently than they were accustomed to because of the ramp rate restrictions.

Our experience with fuel defects is that they do not increase dose relative to the existing source term, to your point with respect to Quad Cities. Quad Cities is a very high source term, predominantly cobalt 60 from the various sources of Stellite within the reactor coolant system and the turbine generator.

Checking with the radiation protection managers at several sites revealed that their main concern is reducing the source term. There haven't been any instances of missed surveillance or deferred maintenance at an Exelon unit due to dose.

For 2004, all of the Exelon sites met or exceeded their goals for on-line corrective maintenance. Examining the dose revealed that units without fuel defects often had a higher source term than those with fuel defects. This information framed Exelon's desire to take steps to reduce the source term.

To this end, we worked to find an acceptable level of zinc that could be added in order to reduce the dose while not putting the fuel at risk.

We also performed the first pilot ultrasonic fuel cleaning program for Boiling Water Reactor fuel at Quad Cities.

In summary, fuel defects are definitely unacceptable. With the help of EPRI and our suppliers and the other utilities, Exelon has actively and successfully managed fuel failures and investigated the root causes. We observe that dose does not increase significantly when a fuel defect is present, and Exelon has not experienced any delays or elimination of any surveillance or maintenance due to fuel defects.

Thank you very much.

CHAIRMAN DIAZ: Thank you.

MR. SHEPPARD: Mr. Chairman, that concludes our prepared remarks. We have tried to very quickly kind of give you a snapshot of what the industry -- across the board, utilities, EPRI, fuel vendors, NEI, INPO are all doing to address this issue. But we would be pleased to answer any questions that you might have.

CHAIRMAN DIAZ: Thank you. We appreciate the panel's views and comments and the fact that you come here under this weather it's also appreciated. I will turn now the meeting to Commissioner Merrifield.

COMMISSIONER MERRIFIELD: Thank you, Mr. Chairman. And I appreciate the detailed briefing that we have received so far this morning.

I think virtually every member of the panel made the pledge of a desire to meet the zero defects goal, which is an appropriate one. Right now, even though the trends have bottomed out and risen in 2004, 78 out of 100 -- and I think the Chairman knows about grading better than I -- still puts you at about a C, at least it was when I was in college.

So while progress has been made, there's obviously, as you well know, there is a ways to go.

Looking again at the trending information. And really, you topped out in 2000 and then started a decline which took you to 74 percent of the units showing of zero defects in 2003. What caused that?

MR. SHEPPARD: Well, that's a -- Mr. Commissioner, that's exactly what we have been trying to look at. And I think that's the -- caused the, I think, really the focused effort that we brought together both under the materials initiative and the fuel reliability program to bring -- to try and bring together all the information to be able to look at that.

And I think the answer is not that there is any single cause. What we did have in that time period was significant problems with the Boiling Water Reactors in terms of corrosion-related issues. And we were also seeing the vestiges of some of the older fuel designs that were having a great deal of fretting issues as well in the Pressurized Water Reactors.

But it was through work like with Jim from Exelon and his contemporaries at Tennessee Valley Authority and Intergy that we were able to, through the fuel reliability program and other efforts, start to bring together the data so that we could start seeing how to make these changes.

And so I don't think that there's any one cause. But I think that that was a low point for us. It galvanized us to action so that we stopped working in silos and started bringing all this together.

Maybe Jim might want to comment a little.

MR. MALONE: I think the comment with respect to no longer working in silos is very germane to the reasons that we are going to seek improvement. Your point with respect to the end of 2004 is right on target. It's an unacceptable C.

I can tell you, as I mentioned, we are going from starting the year from four units with defected fuel down to one in a space of the next two weeks, which to me is good. That's a 94.

[Laughter].

MR. MALONE: But it's not good enough, really.

Mr. Sheppard mentioned the failures that occurred due to corrosion in a couple of Boiling Water Reactor units in the early 2000, 2001 time frame. We also experienced failures in four of five of our units with a single cause that was identified as the missing pellet surface area. So there you get another five that are kind of an anomaly.

But collectively, we didn't do it ourselves at Exelon, but working with the fuel reliability program, the fuel vendor and our own team, we successfully identified the root cause. And we did it rather quickly, all things considered.

We were able to ship the fuel to Sweden for examination in the hot cell, got excellent results and cooperation from the people operating the hot cell. And again, it was an industry effort to reach that conclusion and eliminate the source of that failure.

Framatome, to their credit, went before and actually modified their factory before the whole root cause report was in. So we took very positive proactive steps to eliminate that root cause.

COMMISSIONER MERRIFIELD: Would you say -- and I have talked -- you have all talked about a variety of things that could cause this, is any of it -- is there any correlation in terms of lack of attention to some of the details? And I wouldn't focus this on either the vendors of the fuel or the users of the fuel but perhaps both.

You know, on the vendors side is the issue of quality assurance and making sure you are doing the right things with the manufacturing of the fuel. On the part of the licensees, it's the intention to form material exclusions, chemistry control and things of that nature.

Is this confluence of events that brought us to these trends in 2002, 2003, a correlation of some of the drop-off in those areas?

MR. SHEPPARD: I think that certainly those may be somewhat contributors. But I think that, again, it's a complex issue.

I think the other thing that both Rosa and Jim pointed out is that the time constancy here, unfortunately, in some cases are a little longer than what we would really want. In terms of being able to, one, find the root cause and then have solutions begin to have effect, the fuel can be in the reactor for four and a half years or six years and in the case of some of the Boiling Water Reactors.

So, I think that -- I don't think that we can point generically to a lack of attention to detail or FME processes or et cetera. I think all those things can contribute.

And I think what we are beginning to see is that by working together, that we are raising the overall awareness across the board, by the operators, by the manufacturers, by the designers that you have got to deal with all these things.

COMMISSIONER MERRIFIELD: You were talking about the issue of silos. And I think that it is very widely known as to the number of variations we have in the designs of the units in our fleet, widely known. What I think is less widely known and appreciated is the variation in the designs of the fuel.

You know, I have been to plants and I have been to fuel manufacturers. There is an awful lot of difference between one plant and another in terms of how the fuel is designed, whether it's the actual enrichment of the fuels themselves or the placement of the grids or other materials in the construction of that fuel.

Is that something that is being discussed at all in terms of trying to have some greater degree of consistency with that?

MR. SHEPPARD: Well, I think, Commissioner, what we are looking at is, again, by raising this awareness and really starting at the Chief Nuclear Officer level with the commitment to zero defects and the Chief Executive Officer level at the fuel vendors, then making that work it back down and requiring that people work together so that the people dealing with the water chemistry are talking to the fuel designer or talking to the fuel vendors. So that when we make a decision that we want to change the water chemistry to support some other goal like alloy 600 mitigation, that kind of stuff, that we have taken that into consideration as to what is the effect on the fuel, what is that going to do to formation of corrosion products, et cetera.

And so it's -- integration, I believe, is a key, and not just leaving the fuel designer in his cubical to do what he thinks is best for him and not consider the rest of the overall goals.

COMMISSIONER MERRIFIELD: Rosa, I would like to sort of turn to you on that question and sort of add to it a bit. I mean, in terms of the things that you are looking at, at EPRI, we sort of went over in fairly high level of detail things that you are looking at.

But can you give me some sense of the prioritization -- I mean, there is a whole number of things that are potential causes and are contributors to the down trend that we saw in 2002, 2003. What's the prioritization of the efforts that you have in EPRI to identify which of those are the most significant issues to focus on?

DR. YANG: Yes. The priority first is we want to find out why. You know --

COMMISSIONER MERRIFIELD: I know you want to find out why. But I'm saying what are the activities that you are actually -- where are you putting the money?

DR. YANG: If you go back to one of Joe's slides, we are putting money in actually four areas. And most of the money -- let's see. Which slide --

COMMISSIONER MERRIFIELD: You have got slide 16, manufacturing techniques, materials, duty and water chemistry. Is that the one you are referring to?

DR. YANG: Slide number 11, the four areas. The first area which under there says root cause investigations of failures. That is our most important priority, because until you know what is the problem, it's kind of hard to correct the situation.

And in that particular area, I would like to say we are a little bit broader than just identifying the failure. We actually go beyond that. We have had a fairly extensive program for several years now.

We take from the fuel rods, typical today's fuel. You know, Commissioner Merrifield, you mentioned about water chemistry changes. You mentioned longer cycles. You mentioned different designs. Fuel design has come a long ways. Different today from 10 years ago.

So what we want to do is to make sure that we know exactly the condition of the fuel. So we actually have fairly extensive hot cell programs to look at major fuel designs of both BWRs and PWRs.

We take them to the hot cell, and we characterize the integrity of the cladding, the condition of the fuel, the design, the manufacturing and everything. So we really look at great detail in that aspect.

I think that is one key focus of our program.

A couple of other areas I think you probably heard in some of the discussions, there are some water chemistry related issues. As plants age, we needed to improve the water chemistry condition to protect the plant, materials, to reduce the dose. So all of those would affect the fuel performance.

So we have two other areas. We specifically look at how these water chemistry changes affect fuel performance. One focus on the boiling water reactor area, one focus on the PWR, pressurized water reactor area.

So our key focus is really reliability, reliability, reliability. But not just root cause, but also identifying the condition of the fuel, if there are problems we don't understand.

For example, a lot of these water chemistry changes are somewhat new to us and we try to understand how that affects fuel performance.

COMMISSIONER MERRIFIELD: Mr. Chairman, I know my time is up.

An issue I think I would like to come back to, among these four specific focus areas is the issue of regulatory interface. And I think this questioning today, the concern about the potential for stove piping raises an issue to me I think we teed to consider and that is, is there anything we need to do as a regulator -- are there any regulatory barriers that are forcing some of this stove piping?

I mean, obviously you have different vendors at the table. There are competition concerns amongst them which obviously they need to protect -- is there anything that we need to do to make it easier for our licensees to talk to each other to resolve some of these issues? But I'm out of time.

CHAIRMAN DIAZ: It might be that the issue of communication is important. But putting my engineering hat on, I can ensure you that the regulatory interface doesn't cause any fuel failures.

[Laughter].

COMMISSIONER MERRIFIELD: Well, even though I'm a lawyer --

[Laughter].

CHAIRMAN DIAZ: With that, let me turn to Commissioner Jaczko.

COMMISSIONER JACZKO: A question -- similarly I think this chart is helpful that Commissioner Merrifield had brought forth.

I'm actually more interested in this period '91 to '93. What were the major changes that brought you from about 50% facilities with fuel failures to up in the 70 range?

MR. SHEPPARD: Do you want to address that, Rosa?

DR. YANG: You mean, what --

MR. SHEPPARD: Why did it get better?

COMMISSIONER JACZKO: Why did it get better? What did you do right then that --

[Laughter].

DR. YANG: I think at that time probably some of the CILC related failures --

COMMISSIONER JACZKO: Some of the what?

DR. YANG: Oh, I'm sorry. It's C-I-L-C, crud induced localized corrosion, which is a boiling water reactor issue as a result of impurity in the coolant. That and probably debris. I think the industry is much better in keeping the debris out of the system. Those with better practices, better design.

So I think those two major failure mechanisms have gotten behind us.

COMMISSIONER JACZKO: So you have kind of sometimes the low hanging fruit there, some way which you are looking at now, the new problems that have been identified and once you kind of have that problem solved.

Were there methods or techniques that allowed you to identify those problems and then address them that you are applying now or are there things you could be doing from that experience that would help to kind of address some of the issues now?

MR. SHEPPARD: Yeah, go ahead.

COMMISSIONER JACZKO: And anyone who wants to answer. I'm not –

DR. YANG: I think a lot of the good practices that we continued -- continuing, for example, the debris. You know, I think the plants -- or Jim can address that later -- are a lot more vigilant today in keeping the debris out of the system and a lot more successful.

And the debris filter is a good example. It started out from the pressurized water reactor side. Now almost all the designs, both pressurized and boiling water reactors have debris filter, so there is a filter at the bottom.

COMMISSIONER JACZKO: My question was more in terms of the process in identifying fuel failure problems and corrective action and things like that, if there are things.

I know I have a brief amount of time, so I'm move on to another one.

One of the things that a lot of people talked about is the zero defect. That's your goal. And it's a very laudable goal and I applaud you on looking for that goal. But you are not very -- I mean, you know, you are close, but still there is a long way from -- you know, roughly 15% of your plants with fuel failure -- getting to zero defect.

I mean, do you see that -- is that a realistic goal or is that kind of the benchmark -- I mean, that's where you want to be. But right now we are looking at around 20% of plants that still having fuel failure -- how do we get that jump from getting to zero defect?

MR. SHEPPARD: Well, Commissioner, I think the first thing is that that has to be a priority. And I believe in the last three or four years we have made a paradigm shift in that direction. And that we view this as a performance and an excellence issue and not as a -- just say an economic issue, because we do know that these failures are really, from a public health and safety standpoint are not big contributors.

But I think that since the late '90s, we have made that paradigm shift. And we have come back to the first principle, that this is the first fission product barrier, and that leaks -- they are not acceptable.

And having made that paradigm shift, then starts to force the integration and the sharing of information and making sure that what Jack has found out on his fuel, somehow we can get that transferred to what Jerry is dealing with his fuel, so that if there is a generic issue there, that it is not bottled up in some proprietary document that I can talk to him, then I can talk to him, but I can't talk to both of them kind of a thing.

And so I think that's going forward.

MR. FULLER: Joe, I would like to address that.

I think the industry was more reactive at a certain period of time. And I see a much more proactive industry today.

I think people are looking at multi-generational products. We certainly are and I'm sure my competitors are as well, but say, here is today's issue, how do we address that. But how do we address the next three potential issues that come down?

COMMISSIONER JACZKO: I guess my initial question was -- I should have made it more succinct -- when are we going to get to zero defects? I mean, that's the question. I mean, we have talked about it a lot --

[Laughter].

COMMISSIONER JACZKO: Everyone wants it to be the goal. We are still pretty far away from that. I guess my question is, are you moving -- and this is just a yes or no answer, are we looking at five years, are we looking at ten years, or is it even an achievable goal?

And again, this is not a criticism. I think it's very laudable that you have set that as a goal. But just in terms of what resources are going into this, at what point do we get --

MR. FULLER: I think it's a five- to ten-year view because, quite honestly, we have got six years of fuel in that reactor today. Any one year you only trade out a third of that fuel.

So you have got five or six years ahead of you that if you put it in a change today, it takes that much time. So I think you are in the five- to ten-year time period before you see this happening.

COMMISSIONER JACZKO: Probably my time --

COMMISSIONER MERRIFIELD: I'm sorry, do any of the other fuel vendors want to make a comment on what Mr. Fuller just said?

MR. SAUNDERS: I think Jack is absolutely right. I think the lifetime in our industry is such that it's a difficult proposition to do it any sooner. I mean, I think the five- to ten-year time frame is a reasonable prospect.

We have forecasted that certainly in the next four years that we will half our leak rate again. We will halved it in the last four years and we will halved it again in the next four years.

COMMISSIONER JACZKO: I have one more quick question.

COMMISSIONER MERRIFIELD: I'm sorry, we didn't get a chance to hear from AREVA on that.

MR. HOLM: I think Framatome would agree with that. I mean, you have asked a difficult question about is zero realistic, and I think the answer we need to give you is that that is our goal and we are going to work hard to achieve it. But getting 100 on every test is hard.

COMMISSIONER JACZKO: And this is just a quick question also.

On the pellet cladding issue, you mentioned the surface area problem, is that the cause for all pellet cladding failures, or are there other causes for that as well?

DR. YANG: There are other causes as well. That's what's going to make it easier.

COMMISSIONER JACZKO: Thank you.

CHAIRMAN DIAZ: All right. Commissioner Lyons?

COMMISSIONER LYONS: I would start by commending the industry for what you have done, working together. And certainly the leadership shown by EPRI is very, very impressive. But I never heard anyone mention the Department of Energy.

And I'm just curious, and I don't know if this is a question to Rosa or Joe or any of the others. Where is DOE in this?

And they have research programs like NEPO, like NARI. Are they coordinated in some way, are they contributing in some way?

MR. SHEPPARD: Go ahead, Rosa.

[Laughter].

MR. SHEPPARD: I will start off. In the past the Department of Energy has been very active in looking at fuel. That activity has trailed off in the most recent budget cycles.

We are in active discussions with the Department of Energy on how to reinvigorate their partnership in this effort and especially how to better utilize the facilities that they have in Idaho and whether or not we can successfully integrate the resources that they bring to bear into our program to in some ways start accelerating some of these root causes to bring those time lines down, and et cetera.

So I guess at my level, DOE has not been very active lately. But we are -- they are interested in re-engaging. We are interested in re-engaging. And we are working on that.

Rosa can probably provide more detail.

DR. YANG: I think Joe is exactly right. They have provided very limited funding up to now. But I think the future is we will work closer and particularly with the opportunity at some of the national labs that would help.

COMMISSIONER MERRIFIELD: So you would welcome DOE funds?

[Laughter].

DR. YANG: Of course.

MR. SHEPPARD: I just tell you we went to talk to DOE about six, seven months ago, and they were looking to where to put some of their NEPO funds and they were advocating security. I told them I thought I had enough help on security already, that I would really welcome the support of fuel --

[Laughter].

CHAIRMAN DIAZ: I think you have all the help. We can help you further.

COMMISSIONER MERRIFIELD: But DOE can help you on fuel.

MR. MALONE: There is, to your point, Commissioner, a program being discussed now with DOE and NEPO to examine the performance of control rod blades and for boiling water reactors in the control clusters, for the PWR's, their nuclear lifetime and their performance in the reactors. And we hope we can be successful with that one.

COMMISSIONER LYONS: Thanks for your comments. And I'm glad those discussions are ongoing, because I did find it very puzzling that programs like NEPO didn't seem to be contributing.

DR. YANG: They have a limited amount of money right now.

COMMISSIONER LYONS: True, but, yes.

If you help them on establishing goals, it might change. I don't know.

One other question that I wanted to ask was if you feel that in the research that you are doing at this point, you are examining the failure mechanisms at a sufficiently fundamental level, that you can extrapolate performance to perhaps higher burn-up in the future -- in other words, you are solving today's problems -- and maybe that gets to Jack's comment -- do you have confidence that you are also understanding tomorrow's failures?

DR. YANG: Are you asking --

COMMISSIONER LYONS: Rosa, I don't know who I'm asking. It's a general question.

DR. YANG: I'm sorry. I think I have to say yes and no. I think we are trying to -- we are understanding today's problem. And I think that forms a good basis for tomorrow's condition. But we need to look a little bit more closely at what tomorrow's condition is.

Are you referring to --

COMMISSIONER LYONS: I was referring to higher burn-up as the industry talks about and expresses an interest in. And as you go to higher burn-up, at least I would assume different factors could contribute to different failure mechanisms --

DR. YANG: Yes. Yes. Okay. Let me modify my answer somewhat.

I think in terms of burn-up, I think we are very confident that we know the most major phenomena and how that affects fuel performance, because we have already looked at fairly high burn-up as far as we are going to go. I think we have a good understanding of that. So high burn-up, per se, I don't think is an issue. So I think we have a good understanding of that.

COMMISSIONER LYONS: I didn't mean my question to be something like a --

DR. YANG: I thought you were talking about advance plants.

COMMISSIONER LYONS: I didn't mean that. I meant extension of existing. Thank you.

Those are my questions, sir.

CHAIRMAN DIAZ: Thank you, Commissioner Lyons. I just experienced a sense of deja vu as I sat through this meeting through so many years of looking at fuel failures. It just reminded me of what a professor expert in the fuel used to start his class by saying that not all fuel is born equal, not all fuel is operated equal, not all fuel have the same parenthood or progeny, and that the issue is very complicated.

I think that like, Commissioner Jaczko said, you are now working at the, what I call an esoteric behavior, in which you are now selecting those things that are really very difficult to deal with.

Crud, you are not going to get rid of. You are going to have it. You know, differences in manufacturing, you might minimize them, but they are not going to be zero.

You know, installation and issues that deals with the difference between reactors could introduce occasionally another failure. Cycling, we talk about -- you are talking about pellet fuel interactions and how the difference in the pellet growth and the thermal cycling, all of those things that were raised with are still there, and I think they are still there. So I'm going to rephrase Commissioner Jaczko's question.

I don't think it's possible for you to reach zero defects in five to ten years, okay. So fundamentally, I think the goal is great.

I think what you should set up is an expectation. And I think Jim said, you know, we are going to have -- you know, you are going to have -- well, I can tell you, you take any number and you have it every year, you still don't get to zero, all right.

[Laughter].

CHAIRMAN DIAZ: You don't get to zero. So I believe it is important -- it is important to us to know that when you put these things together, what are the expectations so we can actually program our work, resources and our issues with a program that is really maybe phasing defects out by half every three years.

But, you know, we need to understand and I think we understand that this is not, like Commissioner Merrifield said, you know, a safety issue, but it becomes an operational issue. One of our key things is let's make sure it doesn't become a safety issue. Let's make sure that when you make changes and you change your performance put it in the plant and operate it longer, that it doesn't become a safety issue.

We have already overrun our time. I want to thank you for being here.

Commissioner Merrifield had a very important question regarding what is the role of regulatory interface in making sure that either because of established inspections or monitoring or issues that really you might know and that are there, although the staff might be able to address it. If you know some of these issues, we would appreciate it if you will analyze them and send them to us in a letter and say we believe these are issues that we should look at. And then we will certainly give it our serious consideration.

COMMISSIONER MERRIFIELD: Mr. Chairman, on that score, I'm perfectly fine with getting a written answer to that question. But I hope when you go back and you think about that question, you don't necessarily limit yourselves just to what it is solely within the regulatory authority of the Nuclear Regulatory Commission.

It may well be that there may be other regulatory requirements outside of NRC, the Federal Trade Commission or others, that unnecessarily limit an opportunity for members within the field to discuss issues of safety concern because of a concern about competition issues. And if that -- if it were something that was keeping us from improving the safety of this fuel that we need to take up with another member of the federal family, I would certainly want the know about that as well.

Not that we can necessarily effectuate that. Certainly if we agreed with that assertion, we would be at least in a position to notify the members of the federal family of that concern, if indeed we thought it was a correct one.

CHAIRMAN DIAZ: Thank you, Commissioner Merrifield.

And with that, I want to thank the panel for their very, very interesting presentation. I love to see panels with sellers and buyers. It always makes for an interesting morning.

[Laughter].

CHAIRMAN DIAZ: We will have now a couple of minutes before the staff joins us. Thank you so very much.

MR. SHEPPARD: Thank you, Mr. Chairman.

DR. YANG: Thank you.

(Brief recess).

MR. REYES: Carl Paperiello, the Office Director of the Office of Research, and Farouk Eltawila, the Division Director for the Division of Systems Analysis and Regulatory Effectiveness.

Also at the table, Bill Borchardt, the Deputy Office Director for the Office of Nuclear Reactor Regulation; Jared Wermiel, Chief of the Reactor Systems Branch; and Frank Akstulewicz -- I think I did that close -- Chief of the BWR, Boiling Water Reactor System and Nuclear Performance Section.

I am going to turn over the meeting to Bill.

MR. BORCHARDT: Good morning.

Nuclear field performance is addressed in the regulations, the general design criteria and each of the plant's technical specifications. These controls are in place to assure that public and worker radiation exposures resulting from normal plant operations and transients are well within regulatory limits.

Our fuel performance regulatory approach utilizes the defense-in-depth philosophy and does not rely solely on any single barrier to fission product release. But rather recognizes that the fuel cladding, the reactor coolant system boundary and the reactor containment together assure that radiological doses from normal operation and postulated accidents will be acceptably low.

As the first barrier to the release of fission products, the integrity of the fuel and fuel cladding has been and remains important from a safety perspective. The staff reviews the performance of fuel under both accident and normal operating conditions before fuel is introduced into operating reactors.

The regulatory requirements and controls that are in place, while not specific to fuel failures, are constructed to assure, even in the event of some fuel failures, that public and worker exposures will be very small.

We continue to monitor fuel performance to assure that performance issues are identified and actions are taken by the fuel vendors and licensees that promptly resolve performance issues.

The second slide is the list of acronyms for today's briefing, and the third slide is the agenda. And I will now turn it over to Carl and Farouk.

DR. PAPERIELLO: Dr. Farouk Eltawila will make our presentation.

DR. ELTAWILA: Good afternoon. I'm going to just give you a brief summary of our research activity to support the regulatory process here at NRC. More details are provided in a research plan which is in the background information that you have.

If I go to the first slide, please, slide number 5. Next one.

Okay. Just to put in perspective our research program, you can see in the picture here what the fuel rod looks like. And you have the pellets stacked in the cladding.

During normal operation, most of the fission products are retained in the fuel pellets itself. Very small fraction of these fission products are outside the pellet and is retained by the fuel cladding. The fuel pellets retain their fission product until temperature gets very high, as we will see in the next viewgraph.

In most postulated design basis accidents fuel cladding will fail. But at the same time it has another function which is to maintain its structure integrity to ensure core coolability.

So even though you might have cracks and things like that, what is important from regulatory perspective is to ensure that the fuel will remain cool.

Next viewgraph, please.

As I mentioned that the fission product is retained in the fuel pellet itself, most of the fission product are retained in that. This photo from a scanning electro microscope shows the porosity that accumulate on the green boundary in the UO_2 fuel, and there is porosity within the grain as well.

Most fission products are trapped inside these pores and UO_2 -- in the fuel pellet. The fission product cannot get out until the temperature gets very high. For example, when it gets very high, the atoms start moving around and that happens around 2,000 degrees centigrade.

Just for reference point the cladding itself starts melting at 1,800 degrees C, and the fuel in contact with cladding starts melting about 2,000 degrees C, and UO_2 pure UO_2 starts melting at 2,840 degrees C. So to avoid the release of large fission product, we want to assure that the fuel temperature remains lower than 2,000 degrees C.

Next slide, please.

Our research in the Office of Research –

COMMISSIONER MERRIFIELD: I'm sorry, Mr. Chairman, can I get a clarification here?

On that slide, you are focusing on the temperature. If you do have a breach of the cladding, and it is due to the jetting nature of the water fuel interaction, you can't have the fuel degrade and release -- or be taken out of the matrix, is that not correct?

DR. ELTAWILA: The fuel will be taken out --

COMMISSIONER MERRIFIELD: Right. If you have a breach of the cladding --

DR. ELTAWILA: Yeah.

COMMISSIONER MERRIFIELD: -- will the fuel -- you lead me to the conclusion that the fuel pellet inside will always remain intact. That is not necessarily the case; is that right?

DR. ELTAWILA: I will get you a clarification on that. But the fuel will remain intact with the ingress of water.

CHAIRMAN DIAZ: You can get some erosion --

COMMISSIONER MERRIFIELD: Erosion of the fuel?

DR. ELTAWILA: Some erosion of the fuel, yeah.

COMMISSIONER MERRIFIELD: Right. That was the point I was trying to make. And I just wanted to clarify that.

Carl, did you may want --

DR. PAPERIELLO: The size makes a difference. Pinhole leaks are going to release iodine and radioactive gases into the primary coolant. But, I mean, discussions within the last decade -- in the '70s, there were major fuel defects and pellets fell to the bottom of the reactor vessels. So now you are talking much more, so defect size is also important.

DR. ELTAWILA: Okay. Next slide, please.

As I mentioned, it only has to get to very high temperatures in order to release large quantity of fission product. So the focus of our research plan is on the two accidents that can produce this high temperature.

The first one is by inserting large amount of energy into the fuel that can increase the temperature and can cause release of fission product. And that is known as reactivity insertion accident.

The second type of accident is to deprive the core from coolant, like loss of coolant accident. And that also can lead into increase in the temperature of the fuel and the release of the fission product.

We conduct our research program on these two, the overpower event and under cooling event in cooperation with the industry. So, for example, in our activity insertion accident we cooperate with EPRI in conducting research program in France in the Capri reactor.

In the LOCA program, we have program at Argonne National Laboratory where we work with EPRI and the vendors, and they provide us with the cladding material and perform the tests and we share the data. But we don't interpret the data they do their own interpretation of the data and we do our own interpretation of the data.

So I'm going to talk about each of these accident scenarios in the next Viewgraph.

So I'm going fast because of the time we have here.

The first accident is the reactivity insertion accident. The most severe of the postulated reactivity accident is the rod ejection accident in a boiling water reactor and similar rod drop accident in a boiling water reactor. First one, I'm sorry, pressurized water reactor.

To ensure coolable situation after such an accident, a regulatory limit was established in 1974 based on data from fresh and low-burn-up fuel. The limit appears in Regulatory Guide 1.77.

In the early '90s, data appears from the test reactor in France and in Japan, which indicates that the high burn-up has an effect and the criteria that we have might not be suitable for high-burn-up fuel.

We joined this research program and started getting data from them. And we have received enough sufficient data right now that based on our evaluation of this data, we concluded right now that even though the criteria needs to change, there is no safety issue.

If you have reactivity insertion accident and you have a cladding failure, it still will assure that the fuel will retain its coolant geometry and we will not have a large core degradation situation in this case.

In addition to that, we have performed three-dimension kinetic analysis which indicate that the energy deposited in the fuel during an accident, reactivity insertion accident, is much smaller than any of the failure that we have witnessed in these test programs overseas.

So realistically, you cannot put that much energy in the fuel during the reactivity insertion accident.

I would like to go to the next slide, please.

And I would just discuss briefly the second accident that we address in our research program which is a loss-of-coolant accident.

The regulatory limits to ensure cooling are peak clad temperature and maximum clad oxidation. The limits were developed in 1973 based on unirradiated Zircaloy tubes. They appear in 10 CFR 50.46(b).

The criteria of 2200 degrees or 1204 C on peak cladding temperature and 17% on maximum cladding oxidation are intended, again, to ensure that after you activate ECCS, you don't get a significant fracture of the cladding which will result in not having a coolable geometry. So these limits were established in the early '70's based on fresh cladding.

As the burn-up starts increasing, we have found that the effect of the oxide layer that forms during normal operation will have an effect on the 17% cladding. So in 1999, NRC issued a clarifying letter stating that the amount of oxidation that's formed during normal plant operation should be subtracted from the 17%. That's usually about

10%.

So it should be subtracted from the 17% and the difference is that what you should be expecting during an accident condition.

The improvement in cladding material, we know that, for example, —5 and – are very slow in oxidizing during normal operation. So I don't think there are any issues associated with these accumulation of the corrosion during normal operation for the new type of cladding.

The program that we have at Argonne National Laboratory to have the additional benefit that we are going to be developing criteria for modifying 50.46, to have a performance-based regulatory requirement. And that addresses Commissioner Lyons' question about we are prepared, for instance, if any industries are interested in additional burn-up or producing different cladding material, we have the fundamental understanding of the performance of this cladding, so we will be able to address these issues in the future as they come up.

Last thing that we developed as part of our research program is we developed an analytical tool and we have programmed the FRAPCON code and the FRAPTRAN code. One of them is a steady state and the other one is a transient code.

And these codes are being used by both NRR and staff in Research. NRR uses it, for example, to complete the fuel temperature, rod pressure, fission gas releases. And they use it to audit applicant's code.

In Research we use this code to be able to identify the research and to print the information that's coming from the research. And we continue to update this code based on information we get from our international activity. For example, we have the Halden Test Reactor in Norway and, for example -- Argonne program.

We get all this information and we update this so we can use the information, for example, high burn-up fuel and others, for example MOX and things like that.

So that completes my presentation. It was done in a hurry. And now I would like to introduce Frank Akstulewicz to complete the staff presentation.

MR. AKSTULEWICZ: Thanks, Farouk.

My name is Frank Akstulewicz and I will discuss the regulatory envelope governing fuel performance under accident and normal operating conditions, and the oversight activities that my staff performs in monitoring in reactor performance.

The regulatory requirements that bear on fuel performance under accident conditions are governed by the regulatory consequence criteria contained in 10 CFR 50.67, and the control room radiological consequence criteria contained in General Design Criteria 19.

Staff reviews the plant transient response to estimate the degree of postulated fuel damage and assures that the exposures to the population meet our regulatory requirements. To provide additional assurance that regulatory requirements are met, staff imposes a technical specification that limits the amount of activity that can be present in the reactor coolant.

This technical specification indirectly places a maximum on the amount of leaking fuel rods that can be present under normal operations.

Under normal operations and anticipated operational occurrences, administrative and engineering controls limit radioactive lead levels and releases from the gases and liquid effluence to as low as reasonably achievable.

Licensees rely upon radiation protection programs and radioactive effluent control programs to comply with Part 20 and Part 50 Appendix I. Licensees control effluent release rates by adjusting gaseous and liquid RAD waste systems based on their dose projections.

Licensees are required to submit the following annual reports. They submit an occupational radiation exposure report, a radiological environmental operating report and a radioactive effluent release report.

Current fuel reliability statistics indicate a limited number of fuel rod failures, typically one or two rods in less than a quarter of the reactors. Estimated fuel rod defects in current operating reactors remain relatively low at 6.7 and 4.3 failed rods per million manufactured for PWRs and BWRs, respectfully.

This level of fuel rod failure is well within the technical specifications limit on reactor coolant system activity.

Further, plants operating with limited -- continue to maintain worker and public exposure to as low as reasonable achievable. Recent trends in both fuel rod failures and worker doses have been provided in the background material. And in general, the industry has exhibited improvements in both of those areas.

The staff monitors fuel performance trends and maintains knowledge of industry initiatives via periodic meetings with the fuel vendors and licensees. During these meetings, the staff along with participants from the fuel vendors and the licensees, discuss recent performance data and trends, results from poolside and hot cell examinations, industry initiatives to resolve a particular design issue or problem, fuel design changes and also upcoming submittals and license amendments.

NRR is responsible for the review and approval of all fuel design changes. Regulatory guidance for the review of fuel design systems is provided in the staff Standard Review Plan, Section 4.2.

The main objectives of the fuel system safety review are to provide assurance that the fuel system is not damaged as a result of normal operation or anticipated operational occurrences, that fuel damage is never so severe as to prevent control rod insertion if it should be required.

The number of fuel rod failures is not underestimated for a postulated event, and core coolability is always maintained.

During the review of fuel designs in supporting performance models, the staff considers the need to impose limitations or conditions. Whether or not to impose a limitation depends on many factors, including a new fuel designs in reactor experience database, the design's mechanical or hydraulic testing database, and the ability of computer models to predict in reactor performance.

Based on our reviews to date, we actually implemented conditions on such things as fuel duty, oxidation limits and burn-up.

Next slide.

In summary, I would like to echo what Bill mentioned earlier, that as the first barrier of the release of fission products the integrity of the fuel and fuel cladding has been and remains important from a safety perspective. Staff reviews the performance of fuel under both accidents and in normal operating conditions before it can be introduced into operating reactors in large quantities.

Regulatory requirements, while not specific to fuel failures, are constructed to assure that should a fuel failure occur, exposures to workers and public are very small.

We continue to monitor the performance in the reactor population to ensure that performance issues are identified, that actions are taken by the vendors and the licensees to promptly resolve them.

Furthermore, the staff recognizes that economic pressures on the utilities and competitive pressures on the fuel vendors demand improved fuel reliability.

That completes my presentation.

CHAIRMAN DIAZ: Thank you.

MR. REYES: That completes the staff presentation. We are now available for questions.

CHAIRMAN DIAZ: Thank you, Mr. Reyes and members of the staff. I turn it to Commissioner Merrifield.

COMMISSIONER MERRIFIELD: Thank you, Mr. Chairman.

Farouk, going back to my question earlier. In the slide, particularly on slide 6 and slide 7, the staff is understandably focused on a reactivity insertion accident or a loss of coolant accident, which clearly, as you described, are the drivers for fission product release.

I take it and I was trying to and that's why I was asking the question, that the staff is not suggesting that there's not zero issues from the breach of fuel that we talked about today.

DR. ELTAWILA: Absolutely.

COMMISSIONER MERRIFIELD: You didn't mean to leave that impression?

DR. ELTAWILA: Absolutely.

COMMISSIONER MERRIFIELD: And then the public should not take any impression that we think this is a no-never mind.

DR. ELTAWILA: That is not the intention. I was just trying to tell you the focus of our research program.

COMMISSIONER MERRIFIELD: I just wanted to make sure there was no misunderstanding about the intention there.

In the discussion today on slide 8 you noted that Reg. Guide 1.77 needs to be revised based on your analysis of tests that were performed in France and Japan in the 1990's. And I'm wondering if you could describe in layman's terms what you think the significant revisions that will be needed to be made in that Reg. Guide and what timetable for that will be?

DR. ELTAWILA: I think in layman terms what the criteria that originally was written in Reg. Guide 1.77 was based on limited information in the early '70s and tried to avoid, for example, the expulsion of molten material into the active coolant system to prevent steam explosion.

Now we can say with certainty there will be no steam explosion that can lead into what you call uncoolable geometry. So we know that.

We also understand it very well now that the energy, the position in the fuel would be much lower than the energy deposited in any of these steps that caused failure. So we have confidence there is some margin between what can -- if it's happened in a nuclear power plant would be much lower than what we tested the fuel for.

So these are -- so what we want now to bring is the criteria, bring it down. And instead of the 280 calorie per gram, we wanted to bring it down to be representative of what really the test result shows. That it has no safety implication whatsoever.

MR. REYES: The margins we have today are very ample. And they were based on information we had before. And all the research has shown that perhaps it's too conservative. And we need to reflect on the latest technology and information that Farouk was talking about.

DR. PAPERIELLO: More realistic.

COMMISSIONER MERRIFIELD: And the timing?

DR. ELTAWILA: The timing, we'll issue in about in April of this year. But we would like to get some peer review of this information because we really -- there are some interpretations we have made and some of them might be conservative. So although that we have ample margin, we really don't want to introduce unnecessary conservatism in the criteria.

COMMISSIONER MERRIFIELD: A couple of years away?

DR. ELTAWILA: A couple of years away.

COMMISSIONER MERRIFIELD: Okay. On slide 15, we talked about discussion of periodically meeting with fuel vendors. How long have these kind of meetings been going on?

How often do you meet and do you think it's a productive exercise on our part?

MR. AKSTULEWICZ: From what I understand, the meetings have been going on for the better part of four years now. I mean, they have been going on since I have been in this position. And they were going on before I arrived.

The meetings are extremely beneficial. They are very frank discussions about the research that's ongoing, the quality of the material that's being developed, what types of developmental problems the vendors are experiencing in terms of their trying to resolve an issue. Where their new research programs are going and what issues they are trying to solve by that research.

So it gives the staff a very good heads up so that we are prepared when we see that material come in for review.

MR. REYES: What frequency?

MR. AKSTULEWICZ: Oh, we meet pretty much semiannually with the major vendors. Framatome is a little bit less than GE and Westinghouse. But in that general cycle, we meet at least annually.

COMMISSIONER MERRIFIELD: And those are one-on-one meetings with those vendors?

MR. AKSTULEWICZ: Yes. Exactly.

And they invite their licensees to come in and sit in on the meetings with us. So there is a discussion even with the licensees about regulatory matters, that, you know -- in terms of the experience that they are having at the time. So it's a three-way discussion, not just us and the vendors.

COMMISSIONER MERRIFIELD: One of the issues that was raised in the earlier panel was whether there may be some issues with the regulatory interface and some difficulties in being, you know, sort of the stove-piping issue amongst the vendors and amongst the licensees.

Have you identified that or have you seen that in terms of the discussions you have had?

MR. AKSTULEWICZ: In my experience, the discussions have always been very frank within the circle. And I think the concern that I heard voiced here was how much freedom would, say, Framatome have to go and discuss an issue with Westinghouse because of the unique proprietary nature of the design. And we don't have that problem when we meet, because we don't have multiple vendors in the room where we can run across that situation.

So as far as I know, what I would say is that each of the vendors is attacking the same set of problems. So it's not, you know, only one vendor is looking at this issue while the other one is not.

So like the example of debris, everybody is attacking debris. How they are going about doing it is different, all right. But they all recognize that it's an important issue that they will have to resolve. And so from that standpoint, the design changes that are coming in would be different. But they are all going to impact that issue.

COMMISSIONER MERRIFIELD: Well, we are supposed to get a submission from NEI encompassing some of these issues. And it will be interesting to play this one out a bit.

The last thing I want to say, Mr. Chairman, before I close. You know, I recognize and I think we have all discussed today that this is not an enormous problem. We are talking about a relatively, a relatively small number in terms of the failed fuel.

That having been said, when it bites you, it can really bite. And we haven't talked about and I don't like to really focus on one entity. But the situation that Quad Cities had in 2002, which they have aggressively addressed, as it is talked about today, resulted in 1,786 person rem at that site, which made them the U.S. leader in that particular regard, and I think perhaps if not the leader, one of the leaders internationally.

So it's a small number. When it bites, it can be difficult for a licensee. And I think we need not belittle the numbers when we have issues such as that.

Thank you, Mr. Chairman.

CHAIRMAN DIAZ: Commissioner Jaczko?

COMMISSIONER JACZKO: I just have one question and it involves kind of this issue that came up in the previous panel with this large lag time that you have in terms of replacing fuel and getting good data on new fuel and how it's performing.

How does that affect kind of the research program that -- it seems like you almost have to operate in jumps and then maybe have some ideas, you make some changes and then have to wait.

DR. ELTAWILA: It was difficult at the beginning because as Dr. Yang indicated, it takes, for example, to get the fuel shipped from the nuclear power plant and we send it to hot cell to cut it to pieces and then we ship it to another lab.

So it took at least two years.

In developing the infrastructure to be able to do tests with irradiated cladding, that took a long time. But we are now geared to be able to produce results very quickly. The hot cell is operational. The staff at the lab is very experienced in doing work in this area.

So I think if we have --

CHAIRMAN DIAZ: Which lab?

DR. ELTAWILA: Argonne National Laboratory.

So if we have new cladding material and things like that, we will be able to make a decision on these things, because as I indicated earlier, we are working at fundamental basis. As long as the cladding is going to be Zircaloy with some kind of alloy that is not different significantly from the alloys that we are understanding, we will be able to make a decision quickly.

COMMISSIONER JACZKO: As far as reactor operations, I mean, you still have about a six-year lag time, because that's how long the fuels, on average -- you can't take the fuel out and make any changes to it until that time period. Or is that an improper --

MR. REYES: You need to make a difference between the accident analysis that we do, in that the changes have been relatively small when you compare it to that.

COMMISSIONER JACZKO: Okay.

DR. PAPERIELLO: Because fuel will remain in a reactor for several cycles, and part will recycle, a certain percentage will be taken out. In particular when you are looking at high burn-up fuel, which is one of the thrusts, we have a number of thrusts to our program -- you have to get the burn-up. That takes a number of cycles and years to do.

In fact, some of the concerns we could have, one of the variables is how much burn-up does it have and how long was it in the reactor vessel along with, even though the alloys are generally the same, we have found subtle differences have made a difference, not in cladding used in this country, but there have been cladding, the Russian E110 had looked superficially like something else but had significantly different properties. So for that aspect.

One last thing I want to add is our research is not just confined to what it does in the vessel. We have to deal with the performance of fuel in dry cask storage and the spent fuel pool, how it behaves in transportation and even final disposal.

So there is a lot of things that the cladding -- the cladding is important, very important. And we have to look at it through a whole cycle from beginning to end.

COMMISSIONER JACZKO: Thank you.

CHAIRMAN DIAZ: Commissioner Lyons.

COMMISSIONER LYONS: Just perhaps one question. In slide 10, you refer to the FRAPCON and FRAPTRAN codes.

I'm just curious if you could give me just a couple of sentences on the extent to which those codes are based on fundamental knowledge as opposed to phenomenology. I'm just wondering how confident you are in your ability to extrapolate beyond standard conditions with the codes.

DR. ELTAWILA: I will give you a quick answer, and if you need more details, I will ask Dr. Meyers to provide you with additional information.

Our codes are not based on fundamental physics. They are based on a correlation based on experimental data. So they are experimentally-driven codes. So the confidence in extrapolation I think is mechanical properties, you know, that we usually try to correlate the mechanical properties with the oxide's thickness, for example.

And we are confident that the relationship between oxide -- does not depend -- the mechanical properties does not depend on the cladding itself as much as it depends on the thickness of the oxide. So once we correlate it with the oxide thickness, we can calculate what is the oxide layer that can be formed during normal operation. And from that we can predict the behavior.

Is there anything else you can add?

COMMISSIONER LYONS: That's sufficient, yeah.

At some point in the future I would be interested in just a separate briefing on that point perhaps.

DR. ELTAWILA: Okay.

COMMISSIONER LYONS: Thank you.

CHAIRMAN DIAZ: Thank you, Commissioner Lyons.

I think it's my time to have some fun in here.

First, let me go back to a question that Commissioner Merrifield asked, and I refer to the industry regarding the issue of the regulatory interfaces. And I'm going to repeat that I don't think we are the cause of the problem.

But if there is things that we can do better to be proactive, to be making sure that we have analyzed the problems not only from the standpoint of the accident, but from the standpoint of day in, day out operations, I think the staff should take a look at that. And, you know, let the Commission know that they have reviewed the issues from the normal day operations. And we used to call it normal operations and anticipated transient. How old I am.

MR. REYES: We won't talk about when the Reg Guide was issued.

CHAIRMAN DIAZ: But that continues to be the bulk or the majority of the issues. And I think we need to refocus whether there are things that we can do in that area.

Dr. Eltawila, I'm glad to know that you have confirmed something that we have intuitively known for so many years, that the rod ejection accident is not only a low probability, but doesn't really cause those things. But I'm delighted to know that it has been confirmed.

It remains the fact that the issue has always been and continues to be and I hope it will continue to be the issue of under coolant or how we provide the right amount of coolant. And all of the things we have seen with crud and so forth. They all go to the issue of removing heat, in the right time and at the right place. And that continues to be the overriding issue. And I'm glad to know that we are at those conclusions.

Let me go a little bit -- gee, I have plenty of time. You talk about 50.46. And this is really now a technical question. You are taking about changes to 50.46.

We are considering potential changes to 50.46 to really make it a more safety focused rule on the part of the ECCS and the large break LOCA.

Is that going to introduce changes that would actually allow the licensees to improve fuel performance?

MR. AKSTULEWICZ: I will try to answer that question.

I don't know that it would improve fuel performance. I know that it has the potential to change some elements of the performance. For example, I know it could have an effect on the linear heat generation rate that a particular assembly could have.

CHAIRMAN DIAZ: That's right.

MR. AKSTULEWICZ: It could affect some of the analysis methods for accidents like steam line break where you are worried about center line melting of the rod and return to power conditions and things like that. So it could have some what I will call downstream effects that we are not looking at right now because we are primarily looking at what you do with the break size and that kind of stuff.

But eventually we are going to have to pay attention to that. It's just that it hasn't been a focus yet.

CHAIRMAN DIAZ: Okay. But it could have something to do with the regulatory interface that we have been talking about and how you actually play requirements against the way that licensees monitor their fuel or the way they construct their tech specs and so forth.

MR. AKSTULEWICZ: There's a potential issue there, yeah. I can't say that there isn't one. I just don't know how it would play out. Analytically, the staff would engage everybody in that point. So, it's not like it would go unnoticed.

CHAIRMAN DIAZ: Well, if you would have known the full answer, I would bring you to my staff today.

Let me just make a comment in here because it was done in passing. The NRC/EPRI collaboration, which is something that we have been endorsing, I just want to, for the record, say that I do believe it's very important for the NRC to corroborate with the right scientific institutions, that it is of tremendous value to us. That we maintain our regulatory independence by making an independent analysis of the result.

And I think that every one of these things have been proven to be valuable, and I continue to strongly support those efforts.

Let me go to the next issue.

COMMISSIONER MERRIFIELD: Mr. Chairman, I would like to associate myself with that comment.

CHAIRMAN DIAZ: Thank you very much.

Now, are we investing, the NRC, the necessary resources to be proactive in this area, not only in the, you know, accident area, but in the day-to-day operations? Are we putting -- do we have the necessary infrastructure in service?

MR. AKSTULEWICZ I will speak for the day-to-day business. We have all the resources that we require. And I think the industry would probably say we probably have too many, because we are always talking to them about issues like this.

CHAIRMAN DIAZ: I like that.

MR. AKSTULEWICZ: But I think the support for the periodic meetings goes to demonstrate the importance that the staff, the management has placed on our ability to interact with licensees on matters like this, which gets into the day-to-day business.

We don't have problems getting out to licensees any time we feel a need to get there if there's -- no matter what the issue is, how big or how small, we get the support that we need to go there.

So from NRR's side, I know we feel we have what we need.

MR. BORCHARDT: Chairman, I would also add that at some point this issue comes down to plant operations, and the ability for auxiliary operators to go around the plant and look at equipment operations and those kinds of things.

And there are a number of inspection procedures that are implemented on a daily or a periodic basis that the resident and region-based inspection staff goes out and observes those activities.

So, if there was a degradation in the ability to perform rounds or to operate the plant, that that would be very quickly picked up by the inspection program. So that's kind of the ultimate check really because it comes down to plant operation issues.

CHAIRMAN DIAZ: All right. And in the research arena, I know we have -- we are getting at the end of some of these issues. But are we still pro-actively engaging and determining what the following issues or the common issues are going to be?

Commissioner Merrifield mentioned the fact that, you know, higher burn-ups. But I know there are other issues coming into play as people --

DR. PAPERIELLO: I think the work that we have ongoing, I think the resources are adequate. And I was listening to the problems the industry described here. And I wouldn't know what -- whether or not we could take on -- well, I was thinking about what could cause the failures and you start creating a matrix. And I couldn't tell you whether or not I would have resources to take on those new problems.

I think of design, manufacturing, operations, burn-up changes, operational and power upgrades, when you start look at all those variables. I mean, when you look at the data, something may stand out and may be an easy fix. I don't know.

Clearly, with what we are doing now, we have adequate resources. And we have adequate resources to keep track of the consequences of what's happening.

CHAIRMAN DIAZ: And that's important.

MR. REYES: We have been invited to Sweden by Westinghouse to look at some of their facilities. So I would like to make a pitch for money for --

[Laughter].

CHAIRMAN DIAZ: The answer is no.

MR. REYES: I told them that you wouldn't let me.

[Laughter].

CHAIRMAN DIAZ: And the last question is, from what you know, not only what you heard today, from what you know, is industry devoting the necessary resources to get ahead of this problem?

This is the NRC opinion now.

DR. ELTAWILA: In the area of research, for example, LOCA and reactivity insertion accident, we are working very closely with them, partner on this program so that we are continuously interacting and regarding the test matrix and the information that is needed. So we have positive participation by the industry, EPRI in addition to the vendors too.

CHAIRMAN DIAZ: And, of course, we would like to entice DOE to pitch in.

DR. ELTAWILA: Believe it or not, DOE is part of our LOCA program at Argonne because they take the position of the material after we finish testing.

MR. BORCHARDT: And considering the feedback from Frank's group and the activities and interactions he has with the industry as well as the feedback from the regional offices, you know, the impacts at the plants, we are quite comfortable with the current situation.

CHAIRMAN DIAZ: Very good. Thank you very much.

Do my fellow Commissioners have any further questions or comments?

COMMISSIONER MERRIFIELD: Mr. Chairman, I would make one -- a brief closing comment.

Having heard an extensive amount of testimony from both panels this morning, I think like others I feel comfortable that utilities, the fuel vendors and our staff and their partners do have their eye on the ball on this matter. And I think it's one that we need to keep our eye on the ball. But I feel good about the plan that has been laid out today.

Now, whether zero defects is an achievable goal or whether it is a holy grail, perhaps remains to be seen. But I think at least the striving of that goal is a meritorious one. And I wish them well. Thank you.

CHAIRMAN DIAZ: Thank you, Commissioner Merrifield. I want to thank you for your leadership in having this briefing, and both the industry and the staff for doing what they were supposed to do, and my fellow Commissioners. I do believe this is an issue, that it is ongoing -- yes, sir?

MR. GUNTER: Can I ask a brief question?

CHAIRMAN DIAZ: If you want to come over here, identify yourself. And if it's a brief question, yeah.

MR. GUNTER: Yes, sir. Paul Gunter, Nuclear Information Research Service.

With regard to the issue of regulatory interface, the question comes up for NIRS and others, does the SDP have a red finding or -- at what level does fuel cladding or fuel performance initiate a red finding?

That's the question.

CHAIRMAN DIAZ: Well, I don't think I can give you a specific answer or a number. But I can tell you that to find it would become red when it impacts public health and safety at the time that either the radiation level to the workers or to the public could be, not approach, but at the level that will impact it.

I don't know that we have the answer. We will be happy to provide you with the answer.

MR. GUNTER: We would like to present that as a formal question. I can do that in writing if you wish.

CHAIRMAN DIAZ: Could you, please.

MR. GUNTER: Certainly. Thank you.

CHAIRMAN DIAZ: And with that, we are adjourned.

(Whereupon, the hearing was adjourned.)