S. HRG. 108–507

OVERSIGHT OF THE NUCLEAR REGULATORY COMMISSION

HEARING

BEFORE THE

SUBCOMMITTEE ON CLEAN AIR, CLIMATE CHANGE, AND NUCLEAR SAFETY

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED EIGHTH CONGRESS

SECOND SESSION

MAY 20, 2004

Printed for the use of the Committee on Environment and Public Works

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ONE HUNDRED EIGHTH CONGRESS

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OVERSIGHT OF THE NUCLEAR REGULATORY COMMISSION

THURSDAY, MAY 20, 2004

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON CLEAN AIR, CLIMATE CHANGE, AND NUCLEAR SAFETY,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:33 a.m. in room 406, Senate Dirksen Building, the Hon. George V. Voinovich, (chairman of the subcommittee) presiding.

Present: Senators Voinovich, Carper, Reid, Clinton, Jeffords [ex officio] and Inhofe [ex officio].

OPENING STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Senator VOINOVICH. The subcommittee will come to order. I would like to thank the witnesses for being here today.

I apologize for the delay in starting the hearing today. We had the pleasure of spending 45 minutes with the President of the United States where he did an outstanding job of laying out where we have been and where we are going with our domestic policy, and also in foreign relations.

Today's hearing continues our ongoing oversight of the Nuclear Regulatory Commission. This is the sixth in a series of oversight hearings that began in 1998 when Senator Inhofe was Chairman of this subcommittee. I thank Chairman Inhofe for his leadership on this issue as strong oversight of the NRC is critical to the welfare of the American people.

Nuclear power is necessary and a sound part of our energy future. It makes sense for our environment and for our economy. It is a reliable and stable source of energy, providing 20 percent of the country's electricity with zero harmful air emissions. In my State it provides about 12 percent of the energy that is produced.

In order to harmonize our economic, energy, and environmental needs, nuclear power must continue to grow. The NRC plays a vital role in its future. The three basic components of NRC's mission are to regulate the Nation's civilian use of nuclear materials in order to promote the common defense and security, protect the environment, and ensure fail safe protection of public health and safety.

While we so often talk about the goals of our Agencies, we need to also talk about whether they have the work force and the budget to get the job done. We have goals that we set. Too often, my observation has been, that we do not spend enough time on the human resources and the budget we need to get the job done.

As I have done in the two previous oversight hearings that I have chaired, I want to make myself perfectly clear.

The No. 1 issue for the NRC is safety. Period. There is no greater issue. It is critical that the NRC be a credible Agency that can guarantee the safety of the Nation's 103 operating nuclear plants.

Unfortunately, the NRC's credibility is in serious questions these days due to the March 2, 2002, shutdown of the Davis-Besse Nuclear Power Station, which is located in my home State in Oak Harbor. The discovery of a pineapple-sized cavity in the plant's vessel head forced the shutdown of the plant for 2 years. This incident has been referred to as: "The most serious safety issue confronting the Nation's commercial nuclear power industry since the accident at Three Mile Island in 1979."

While I am pleased that the plant has been restarted, is running at 100 percent, and has had no additional problems, many questions remain about the NRC's actions before and after this incident. I asked the General Accounting Office: "The NRC needs to more aggressively and comprehensively resolve issues related at the Davis-Besse Nuclear Power Plant shutdown." The report was released this week to be put into the record.

Without objection, so ordered.

[The referenced document follows on page 73.]

Senator VOINOVICH. This report looked at three questions: No. 1, why did not the NRC identify and prevent the vessel head corrosion at Davis-Besse? No. 2, was NRC's process for deciding to allow the plant to delay shut down credible? No. 3, is sufficient action being taken to prevent similar future problems?

I have serious concerns about the answers GAO found to these three questions. I want to hear from the Commissioners today on the following issues: Communication failures, questionable risk analysis, and the NRC's refusal to assess licensee safety culture, or to develop specific guidelines for when to shut down a plant.

Let me be clear. I do not want these issues addressed in the context of what happened, but what is going to be done to make sure that nothing like this happens again. Since this is my main concern, the following from the GAO report is even more appalling:

> "The underlying causes of the Davis-Besse incident underscore the potential for another incident to occur. This potential is reinforced by the fact that both prior NRC Lessons Learned Task Forces and we, GAO, have found similar weakness in many of the same NRC programs that led to the Davis-Besse incident. NRC has not followed up on prior Task Force recommendations to assess whether the lessons learned were institutionalized."

They are talking about not only the lessons learned from this investigation that was made, but other investigations that have been made in the past. They have said that the lessons learned from those other incidents have not been followed through by the Nuclear Regulatory Commission.

Basically, the GAO found that many of the same problems identified in this investigation were also identified in incidents before Davis-Besse but never have been fully addressed. This is unacceptable. I am not going to let the Davis-Besse Lessons Learned Task Force recommendations fall by the wayside.

Unfortunately, the GAO claims that this may happen because of resource constraints at the NRC which gets back to their budget and the number and quality of individuals that are working for the Commission.

At this point, I want to state for the record that this is not a Davis-Besse hearing. This incident basically serves as the model to what can happen when we lose focus on the main issue—safety. The NRC and the industry must hold themselves to a higher standard. In fairness to the Commission, I was impressed by their fastidiousness in deciding when Davis-Besse was ready to be restarted. This is the kind of scrutiny that I want to see for all the facilities of our country.

As Chairman of the Subcommittee on Oversight of Government Management in the Federal Work Force, and the Governmental Affairs Committee, I know that this level of oversight is dependent upon the human capital needs of the NRC, which I have long been concerned about. I am convinced that if both the NRC and FirstEnergy had the right people with the right knowledge and skills and the right place at the right time, the Davis-Besse incident would never have happened.

Moreover, if the NRC is going to be able to move forward and credibly guarantee the safety of our nuclear facilities, they need to make sure they have enough people with the necessary level of knowledge and experience. I was shocked when I first reviewed the NRC and found that they had six times as many employees over the age of 60 than under 30. I know, Mr. Diaz, you have been working on that. But I want to hear more about it today. I know the Commission has been working hard, as I said, on this issue. I am interested to know what progress is being made in that regard.

In addition to the implementation of the Lessons Learned Task Force recommendations, several important licensing issues are all occurring at the same time—relicensing for existing plants, which is an enormous responsibility, potential applications to build new facilities, and Yucca Mountain.

Everybody should understand this.

I am interested in hearing from all the witnesses today about the human capital situation throughout the industry. I am glad we have representatives here from academia on what is being done out there to address this issue.

I welcome all the witnesses here today and look forward to a good and thorough discussion about how the NRC and the industry will move forward with credibility with the right people and with safety at the forefront of all actions to ensure that nuclear power continues to be an important part of meeting our economic energy and environment needs.

That being said, the most important thing we need to do is to give complete assurance to the people of this country that our nuclear facilities are fail safe. This is very important because many people have come to me over the last 2 years and expressed concerns about being safe.

I will never forget the telephone calls I got from friends of mine after the Davis-Besse incident that are in the area and said, “George, what is going on? I thought things were fine. People of this country have to know when they go to bed at night that these are fail safe. They have nothing to worry about. Our stress level is enough as it is to be worrying about nuclear power in this country." Simply put, people ought not to go to bed, as I said, worrying about the safety of our nuclear power plants.

I notice that our distinguished Chairman is here, who was the Chairman of this subcommittee. Before you came in, I acknowledged to our witnesses and to those here that you started this in 1998 to review the Nuclear Regulatory Commission.

OPENING STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. That is right; we did. Mr. Chairman, I appreciate your carrying this on. That is right; in 1998 we had an oversight hearing when I became Chairman of this subcommittee. It was the first oversight hearing in over 10 years. That is not right. We corrected it. Many good things have happened since that time. We have made progress. Each one of you has been a part of that. You are aware of this progress.

The relicensing program, which no one thought would work in 1998, has become almost routine. Major reforms have taken place on the enforcement side. We have seen real progress with the NRC moving toward risk-based approaches.

Recent events have tested the NRC and thus far I am generally pleased with how the Commission has responded. We need to learn from these challenges, implementing solutions, and moving forward. Backsliding into the inefficient and ineffective days of the past is not an option. We are just not going to do it.

Acting Chairman Diaz, Commissioners Merrifield and McGaffigan—the three of you and the staff of the NRC should be commended for the work that you have done. Of course, no job is ever finished. I believe that you have as many challenges facing you today as we did in 1998, if not more.

Unfortunately, unless the White House can find a replacement for Admiral Grossenbacher, whose nomination languished over 7 months before he withdrew in pursuit of other opportunities—in frustration, I might add—I fear that you will be the three-person Commission for a while.

During today's hearing and over the coming months, I would like to hear your thoughts and views from the second panel on this issues. There have been a few safety issues in the last few years, such as: No. 1, some recent events at Vermont Yankee. No. 2, how well is the risk-based approach working? As an Agency are you able to identify the real risks and address them in a safe manner?

No. 3, the NRC and the nuclear industry has a large number of employees, close to retirement age, as was stated by the Chairman, do you and will you have a staff to replace them in order to address the major problems that are coming up, such as the continuing relicensing process, the permit application for Yucca Mountain, and the potential permits from the different consortiums who are interested in building new nuclear facilities? All three of these events will be occurring at roughly the same time. Do you have the resources that you need to address these?

In addition to the employees that the NRC headquarters and the Resident Inspectors, we also have four NRC regions which have been in place since the 1970's. Would the NRC function more effectively if we consolidated all of the staff to the headquarters keeping the Resident Inspectors in place?

This could eliminate some redundancy and overhead and help provide the headquarters with the experienced staff they need.

How is the interaction between the EPA and the NRC on the setting of radiation standards? I have long thought the EPA does not do an adequate job assessing the real risks involved in radiation. Now that the politics of the standards set by the EPA for Yucca Mountain are over, perhaps it is time to address EPA's performance also.

I would just like to say both Senator Voinovich and I are very concerned with the crisis we have in this country. It is an energy crisis. I cannot think of any group, any Commission, that is going to have to be more proactive in helping to resolve this. We often say that we had a good Energy bill that passed the House. It just did not pass the Senate. But it addressed nuclear energy as well as all the other forms. I think Senator Voinovich and I are together in saying that we need all of them. We need fossil fuel. We need coal. We need nuclear. We need renewables. You folks will be playing a very active part in that as we pursue new opportunities in nuclear energy.

I look forward to hearing my three good friends who are witnesses.

[The prepared statement of Senator Inhofe follows.]

STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

First, I would like to thank Chairman Voinovich for holding today's annual oversight hearing which continues the process I started in 1998 when I was the Chairman of this subcommittee. Since 1998 the NRC has made tremendous progress.

The relicensing program, which no one thought would work in 1998, has become almost routine. Major reforms have taken place on the enforcement side, and we have seen real progress with the NRC moving toward risk-based approaches.

Recent events have tested the NRC—and thus far I am generally pleased with how the Commission has responded. We need to learn from these challenges, implement solutions and move forward. Backsliding into the inefficient and ineffective days of the past is not an option.

Acting Chairman Diaz, and Commissioner's Merrifield and McGaffigan; the three of you and the staff at the NRC should be commended for the work you have done. Of course no job is ever finished and I believe you have as many challenges facing you today as we did in 1998, if not more. Unfortunately, unless the White House can find a replacement for Admiral Grossenbacher, whose nomination languished for over 7 months before he withdrew to pursue other opportunities, I fear you will be a three-person Commission for awhile.

During today's hearing and over the coming months, I would like to hear your thoughts, and the views from the second panel, on several issues.

(1) There have been a few safety issues in the last few years, such as some recent events at Vermont Yankee. How well is the risk-based approach working. As an Agency, are you able to identify the real risks and address them in a safe manner?

(2) The NRC, and the nuclear industry, has a large number of employees close to the retirement age. Do you and will you have the staff in place to address the major upcoming issues such as:

- the continuing relicensing process,
- the permit application for Yucca Mountain, and
- the potential permits from the different consortiums, who are interested in building new nuclear facilities.

All three of these events will be occurring at roughly the same time, do you have the resources that you need?

(3) In addition to the employees at the NRC headquarters and the resident inspectors, we also have four NRC Regions, which have been in place since the 70's. Would the NRC function more efficiently if we consolidated all of the staff to the headquarters, keeping the resident inspectors in place? This could eliminate some redundancy in overhead and help provide the Headquarters with the experienced staff they need.

(4) How is the interaction between the EPA and the NRC on the setting of radiation standards? I have long thought that the EPA does not do an adequate job assessing the real risks involved in radiation. Now that the politics of the standards set by EPA for Yucca Mountain are over, perhaps it is time to address EPA's performance.

With these issues in mind, I am interested in today's testimony and the views of the witnesses from both panels. Thank you.

Senator VOINOVICH. Thank you very much, Senator Inhofe.

Due to the late start of the hearing, I am going to ask my colleagues and the witnesses to limit their remarks to 5 minutes.

Mr. Diaz, I think we made it clear that we expect you to lead off. We are expecting 2-minute summaries from Mr. McGaffigan and Mr. Merrifield. We welcome you. You have a heavy responsibility. We know that. We are anxious to hear from you.

Mr. Diaz.

STATEMENT OF NILS J. DIAZ, CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION

Mr. DIAZ. Thank you, Mr. Chairman, Senator Inhofe, and members of the subcommittee. I appreciate the opportunity to appear before you today with Commissioner McGaffigan and Commissioner Merrifield. We are, of course, here to discuss the Nuclear Regulatory Commission's activities, to protect the public health and safety, to protect the common defense and security, and to protect the environment. We also appreciate the past support that we have received from the subcommittee and the committee as a whole, and we look forward to continuing working with you.

In recent years we have seen significant changes in the oversight exercised by the NRC in the areas of safety, security, and emergency preparedness. Perhaps, like Senator Inhofe said, we have seen significant changes since 1998. We are pleased to be working with the subcommittee since that time, and the committee as a whole.

Overall, the industry has performed well in these three areas of safety, security, and preparedness. The NRC has become increasingly focused on those matters that are most important to safety and continues to increase the use of risked-informed decision-making.

From a regulator's viewpoint, there are grounds for cautious optimism about the state of nuclear safety today.

The level of reactor safety has increased steadily. From the standpoint of American public protection, the record is indeed admirable with not a single member of the public ever exposed to a harmful level of radiation from a U.S. nuclear power plant. We intend to keep it that way.

The revised Reactor Oversight Process, which we established over 3 years ago, continues to provide to the Agency a disciplined approach to the determinations of licensees' performance. At the end of the 2003 calendar year, there were two plants designated for the highest level of scrutiny under the Reactor Oversight Process—

the Cooper Plant in Nebraska, and the Point Beach Plant in Wisconsin.

The Cooper and Point Beach Plants have received significant attention from our regional and headquarters office. We are confident that these plants are on the path to resolving long—standing problems.

Over the past 2 years, the NRC staff has also devoted significant resources for enhanced regulatory oversight of the Davis-Besse Plant following the discovery of extensive degradation of the reactor vessel head, including the in-depth assessment of the startup oversight process.

The existence, undetected for so long, of a hole in the head of the reactor was an unacceptable failure on the part of the licensee and of the NRC. Specifically, it was a failure to conduct the activities necessary to minimize the potential for degradation of the primary coolant pressure boundary. In other words, process execution, including communications, broke down.

On March 8, 2004, after an extensive plant recovery program and comprehensive corrective actions by the licensee,

FirstEnergy, and after considerable NRC inspection and assessment, the staff gave approval for the restart of Davis-Besse. Our full statement discusses the critical review and actions the NRC has taken to address the Davis-Besse Lessons Learned Task Force and the Inspector General's recommendations.

We have already provided our comments on the GAO's draft report on Davis-Besse. We are reviewing the GAO's recently finalized report.

Let me turn for a minute to other significant achievements, specifically in our reactor licensing programs.

A significant type of reactor licensing action, called a power uprate, is a request to raise the maximum power level at which a plant may be operated. Power uprates range from requests for small increases of less than 2 percent based on the recapture of power measurement uncertainty, to large increases in the range of 15 percent to 20 percent of full power that require substantial hardware modification to the plants.

To date, the NRC has approved 101 power uprates which have added safely approximately 4,175 megawatts electric to the nation's electric general capacity, and this is the equivalent of about four large nuclear power plants.

Currently, the NRC has four power uprate applications under review and expects to receive an additional 25 applications through calendar year 2005. This would add approximately 1,760 megawatts electric to the Nation's electric generating capacity. The focus of our review of this application has been, and will continue to be on safety.

License renewals are another significant type of licensing action. In 2003, 13 units had their licensees renewed for an additional 20 years. We expect that almost all of the 104 reactors licensed to operate will apply for renewal of their licenses. The NRC also is ready to accept applications for new power plants. In September and October of last year, we received three early site permit applications for sites in Virginia, Illinois, and Mississippi where operating reactors already exist.

We have already certified three new reactor designs. In addition, the NRC is currently reviewing the Westinghouse AP—1000 design certification application. The staff has met all scheduled milestones for the AP–1000 design review and is on track to issue a recommendation to the Commission this fall on final design approval. The NRC staff is also actively reviewing pre-application issues on two additional designs and has four other designs in various stages of pre-application review.

The Commission has continued to enhance security of licensed nuclear facilities and materials through close communication and coordination with other Agencies in the intelligence and law enforcement communities, and with the Department of Homeland Security. We have established an enhanced set of security requirements for power reactors that are appropriate in the post-9/11 threat environment.

In treating emergency preparedness as another level of defense in-depth, we are recognizing it as an integral part of our approach to protecting the public. Reactor fuel, reactor coolant system, containment, emergency preparedness—these are four barriers, each one complementing the others and each one designed, tested, and inspected to provide reasonable assurance of protecting the public and the environment from radiological releases.

In the area of material security, we have coordinated closely with other Federal Agencies, State, and affected licensee groups to develop additional security requirements for two classes of materials licensees who possess high-risk radioactive materials. Our full statement discusses our activities and comprehensive programs for ensuring the safety of importing, exporting, and transportation of nuclear materials.

The Commission's activities also extend to the front end of the fuel cycle and they continue to increase. The first proposed new enrichment facility will be located in New Mexico and the second in Ohio. Louisiana Energy Services submitted an application for its facility in Eunice, New Mexico, to the NRC in December 2003. U.S. Enrichment Corporation is expected to submit its application to the NRC for its site in Piketon, OH, in August 2004.

The Commission has directed its staff to conduct reviews of the applications for the two proposed enrichment facilities in a timely manner. The staff continues to review a request to authorize construction of a mixed oxide fuel fabrication facility at the Savannah River site in South Carolina as part of the Department of Energy's program to dispose of excess weapons grade plutonium.

The NRC has also made progress on a wide array of programs relating to the safe disposal of nuclear waste. A central focus on these programs is to ensure that the Agency is prepared to review an application by the Department of Energy to construct a high-level radioactive waste repository at Yucca Mountain, NV. The application is expected to be submitted to NRC in December 2004, and we are prepared to fulfill our role.

We continue to develop the programs and dedicate resources to ensure that the human capital of the Agency is adequate to meet the needs of the Agency and, in this respect, we also are adding significant resources to develop the critical thinking skills of our work force.

Mr. Chairman, I can assure you that the Commission will continue to be very active in directing and managing the staff efforts in ensuring adequate protection of public health and safety, promoting the common defense and security, and protecting the environment in the application of nuclear technology for civilian use.

We appreciate the opportunity to appear before you today.

We welcome your questions. I would ask that my written statement be placed in the record in its entirety.

Senator VOINOVICH. Thank you very much, Mr. Diaz.

I appreciate your testimony this morning. I notice you went over the 5 minutes, but I wanted to give you more of an opportunity to get your statement out in front of us.

Mr. DIAZ. I appreciate that, Mr. Chairman.

Senator VOINOVICH. Mr. Merrifield.

STATEMENT OF JEFFREY S. MERRIFIELD, COMMISSIONER, U.S. NUCLEAR REGULATORY COMMISSION

Mr. MERRIFIELD. Mr. Chairman, in light of the time, I would just want to say thank you for the opportunity and the challenges you have presented for us, the opportunity to show off what we do, a challenge to do better in terms of our effort to make sure that safety remains our No. 1 issue, as you outlined it.

I think also today we want to thank you for the strong interest that the committee as a whole has shown in issues of human capital and your particular interest. Again, I think that is something that we would be prepared to discuss in our testimony and questions.

Thank you, Mr. Chairman.

Senator VOINOVICH. Thank you, Mr. Merrifield.

Mr. McGaffigan.

STATEMENT OF EDWARD McGAFFIGAN, JR., COMMISSIONER, U.S. NUCLEAR REGULATORY COMMISSION

Mr. McGAFFIGAN. Mr. Chairman, I concur in Chairman Diaz's statement. I look forward to your questions. I want to maximize the amount of time to answer your questions.

Senator VOINOVICH. Thank you, very much, Mr. McGaffigan.

The Ranking Member of the subcommittee is here. Senator Carper, would you like to share with us an opening statement?

Senator CARPER. I have a statement for the record that I would like to insert into the record.

Senator VOINOVICH. Without objection, so ordered.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Thank you. I would just like to jump right into questions. I thank our witnesses. We are delighted that you are here. Thank you.

Senator VOINOVICH. We have had six NRC oversight hearings, as I mentioned, since 1998. Before this time, it is my understanding that not many of these hearings were held, and that the Commission basically had a free reign.

Over the past 2 years, I have watched the NRC disagree with just about anyone who has analyzed the Commission's actions surrounding the Davis-Besse incident, including the Inspector General, and now the GAO. I am concerned about that. I feel strongly, and I know my fellow colleagues agree with me that this committee must provide strong oversight.

Based on some of your recent actions, what kind of assurances can you give us and the American public that you take our oversight seriously? We have talked at past hearings about the human capital needs in the NRC and the industry as a large number of employees are close to retirement age. There are several important licensing. You have gone into them.

The list of things that you have to do is just overwhelming. It must be unique in the history of the NRC to have so much work that is on your plate that you need to deal with. The GAO claims that you have been slow in implementing lessons learned because of resource constraints. They specifically cite too few staff and experience levels among existing staff.

What I want to know is: Is that true? What are some of the constraints? How can we fix this? I want you to be candid with me. If you do not have the budget, or if there is something wrong that you need that you do not have that you cannot get the job done, we want to know about it today.

Mr. Diaz, we will start with you. If the other Commissioners want to chime in, we would welcome that.

Mr. DIAZ. Mr. Chairman, I want to say that we welcome the oversight. I believe that it has actually helped the Agency to become more focused on the issues that are of concern to the Congress and to the Nation. In no way do we see this as anything but actually helping us do our job better.

We do disagree with some of the criticism from outside, and probably it is because we are always looking forward at what we are going to do, and not only going back. Some of the criticisms are probably past their time. Some of them have a significant basis and we have taken the necessary actions to correct them.

Senator VOINOVICH. Mr. Diaz, one of the things I like to do is this. Let us zero in on your budget and the human resources that you have. Are they adequate to get the job done? That is what I want to hear. Where are you on this?

Mr. DIAZ. Our budget is adequate. Our human resources are getting systematically upgraded. We have established a program to improve the capabilities of our inspectors and our staff to deal with issues. We are working in a very disciplined manner to address the issues of communications.

We want everybody in the Agency that needs information to have that information. We want that information to go up the ladder.

Senator VOINOVICH. Let me ask you this. How much retirement have you had in the last years? How many new people have you brought in? What is the level of the number of employees that you have versus what you had before?

Mr. DIAZ. We are increasing our staffing to over 3,100 FTEs. We were around 2,850 in fiscal year 2002. So we actually have an increase of about 250. I do not know the exact number. We continue to bring in not only people that are young that we can train, but we bring in mature people with the right skills. We have been able to develop a data base that allows us to match skills with the needs. We continue to work these issues in a very systematic manner.

Mr. MERRIFIELD. Mr. Chairman, one of the things you mentioned and pointed out before is the concern about the age of our work force. That is one that we have worked very hard on in the last few years. You mentioned the statistic that at one time we had six times as many people over the age of 60 as we did under the age of 30. I do not know the exact ratio at this point. I think it is somewhere in the nature of about 1½-to-1 or 2-to-1. We have dramatically reduced that number by a significant effort to reach out to a wide diversity of universities and colleges. We have brought in a lot of very exciting, new, well educated, members of our work force that are really going to allow us to grow in the future and maintain that high level of expertise we have had in the past.

Senator VOINOVICH. My past recollection is that some of the universities where they have some of these reactors at the universities, that they were closing those down. I recall for example, the University of Michigan. What is the status out there in terms of the availability of people?

Mr. DIAZ. The level of the decline has stabilized. In fact, many of the large programs have actually experienced some increases. We continue to be concerned with the capability of the infrastructure to give us the right person.

I think it is a problem across the industry.

But I do believe that right now we are getting the talent that we need. It might be more difficult in the years to come as more people retire and we lack the experienced personnel to fill their places. That is why one of the things that we have asked, Mr. Chairman, is the ability to retain some of our senior people that are retiring without a penalty. In other words, when they retire from the Federal work force, if they come to work for us, they lose some of their benefits.

Senator VOINOVICH. I understand that. One of the things that I am trying to do with the legislation that we introduced would deal with that problem. But right now you are being restricted because if you bring them back, they lose their retirement. Would you like to be able to bring them back to work part-time to help you with the transition?

Mr. DIAZ. We have had exceptions made, but we certainly will welcome your support in that area.

Mr. MERRIFIELD. Mr. Chairman, I would also say that you have championed in the Energy bill legislation that would enhance the training programs for our Agency and provide an additional $1 million in training. That is Section 622 of the Energy bill on the House side and a similar provision on the Senate side. We would certainly appreciate your support of that legislation. It would certainly help us as well.

Mr. MCGAFFIGAN. Mr. Chairman, if I could, I would respond to your question on resources. Chairman Diaz is absolutely correct. We have the resources if we got our budget to do what we need to do in the year ahead. All of you know better than we do what the prospects of our getting our budget this year are.

If we are in a continuing resolution situation with a flat budget, we basically are flat in all areas except for preparing for the Yucca

Mountain application and in advanced reactors. There could be significant instability in those two areas. But in areas such as following up on the Davis-Besse lessons learned, we are absolutely committed to dedicating the resources necessary there.

I have been at all six of these hearings. Chairman Diaz has as well. Agencies over their lifetimes go through ups and downs. When Chairman Diaz and I came on the Commission in 1996, we were in a sustained down period. There had been significant erosion in staff. There had been no promotions, essentially. We had not had an SES development class for many years. Our first SES development class was chosen in 1999.

We have had a second, and we are about to have a third. But for many years, with declining budgets and the need to manage an Agency in decline, things were postponed.

We, over the last 5 years, have been actively trying to recover from that period. Will the recovery be complete?

We are going to face challenges in the years ahead because there was that period where we had to manage a very significant decline in resources, anticipating an industry in decline, which turned out not to be true.

Senator VOINOVICH. Thank you very much.

Senator Carper.

Senator Carper. Thank you, Mr. Chairman.

I know we have a couple of panels here. Is the expectation that we would have one round of questions for each panel?

Senator VOINOVICH. Well, I anticipated two rounds for the Commission of 5 minutes each.

Senator CARPER. Thank you. I think I want to start with a more general question and then maybe come to something more specific to a part of the country in which I live and represent. A couple of months ago I took a bunch of Boy Scouts from Wilmington, DE down to the Norfolk Naval Station, as I do every few years. Both our boys are active in scouting. I took Troop 67 back to the Norfolk Naval Station.

We visited submarines and nuclear powered submarines and ships, and an aircraft carrier in port.

The aircraft carrier itself is about 1,000 feet long. It is at least 20 stories high. There are roughly 5,000 sailors aboard the ship. When the airplane is on board, I think it brings a lot more people and maybe 75 or so aircraft. The interesting thing for me about the nuclear-powered carrier is that it stops to refuel about once every 25 years, unlike the other ships that were on either side of it which need to refuel about every week. For me, that is always a good reminder that nuclear energy is not just an important part of our military and our naval forces, but it is also an important part of our energy.

Looking over the briefing materials, I was reminded again of the amount of CO_2, carbon dioxide, that the nuclear power plants do not put into the air. I was reminded of the amount of dollars that reliance on nuclear energy does not add to our trade deficit. I was reminded of the reduction in imported oil that a reliance on nuclear power for the generation of electricity affords us.

I sit here today as one who believes that it is important that we continue to maintain and strengthen going forward our reliance on nuclear energy as part of, not all of, but part of our energy needs in this country.

I was going to get into some of the questioning that our Chairman got into with respect to qualified personnel. I think he has covered that about as much as I would want to. I would to focus instead on the future of nuclear energy in our country and a little bit about the transportation of nuclear waste. Then I have a couple of specific questions that deal with the nuclear power plant on the other side of the Delaware River from us in Salem, NJ.

I would just start off with a couple of questions about nuclear energy. I am going to ask you to be fairly brief in responding to these questions. I will direct them, Chairman Diaz, to you and ask you to defer to your colleagues and your fellow Commissioners to jump in whenever you feel the need.

I think today about 22 percent of our electricity supply comes from nuclear energy. I guess my first question is: Twenty years from now, do you think we will still be getting 22 percent of our electricity from nuclear power? Do you think it will be more? Do you think it will be less?

Mr. DIAZ. I believe that that question probably should be answered by the next panel. We are ready to do our job of regulating the industry. The industry is considering additions to the fleet. We believe that we have done what we needed to do which was to ensure that anyone that wanted a license to be renewed for an extra period of time of 20 years would have a fair, equitable, and disciplined approach to renewing that license. I think the process that is in place is working well.

So in many respects, one of the things that has happened is that we have been able to have the existing fleet working. We have also been able to certify new designs that if the industry wants to, they will be able to use those certified designs to add new plants to the fleet. But it is the industry which needs to make that decision.

I believe that the best that they can do under the present circumstances is to maintain over the next 15 years the 20 percent to 21 percent that they are presently generating. That would include a few new nuclear power plants because the overall capacity is increasing.

Senator CARPER. Thank you. You alluded to this. Maybe somebody is going to be proposing to build a new nuclear plant or two. Just sketch for me very briefly the approval process that they go through with respect to your Agency.

Mr. DIAZ. Very quickly, we have two processes—an old process and a new process, that we believe is better, which the Congress actually established. These new processes combine an operating license, which allows the industry to apply simultaneously for the construction license and the operating permit. We already have three applications for early site permits to clear the environmental concerns of a site. We also have certified the designs, which means that the industry or the utility can actually apply to put that certified design on a pre-approved site, making the period of the license for their construction and operation shorter, something the industry is very much in favor of. The Congress approved that process in 1992.

Senator CARPER. Thank you. Could we talk a little bit about the transportation of nuclear waste to Yucca Mountain? I seem to recall that there is some full-scale testing of these casks that were to carry the nuclear waste that was either scheduled to take place or has taken place. Can you just bring us up to speed on that? What is involved in these tests? What kind of schedule do you have for them? Is there some kind of system for double-checking the results from those tests?

Mr. DIAZ. We have conducted what is called one-quarter scale testing. The science and technology for such a test is sufficient to scale this one-quarter scale to full size. We have had one railroad cask built under these conditions. But I think 2 years ago precisely in the Senate, the Commission concurred that we were going to do full-scale testing, meaning that we were going to take a cask and actually in its full size we are going to conduct all the necessary testing to ensure that it will be protective of public health and safety, as it is used to transport spent fuel.

We have not done the tests. They are scheduled. The Commission just approved the purchase of a full-scale rail cask. We have now published and we have received comments on the testing procedures. We expect that this will be done probably in the next 3 to 4 years.

Senator CARPER. Thank you.

Thank you, Mr. Chairman.

Senator VOINOVICH. Without objection, I would like to enter into the record the amendment to the Energy bill, S. 14, which was an amendment that was part of the bill that passed in 2003 and to bring to the committee's attention that these very important amendments are in the Energy bill, which we have not passed. I think that the public should understand that this Energy bill, in addition to dealing with natural gas, oil, and so many other areas, including another issue that was before this committee, and that in terms of the reliability of standards that we need in order to avoid a black out as we had last year, are all in this Energy bill.

If this Congress goes home without passing an Energy bill, we are doing a great disservice to the people of this country. So I just want to enter these into the record so that it appears why it is so important that we get that legislation passed.

Without objection, so ordered.

[The referenced document follows:]

SA 1423. Mr. VOINOVICH submitted an amendment intended to be proposed by him to the bill S. 14, to enhance the energy security of the United States, and for other purposes; which was ordered to lie on the table; as follows:

On page 145, between lines 18 and 19, insert the following:

Subtitle D—Growth of Nuclear Energy

SEC. 4___. COMBINED LICENSE PERIODS.

Section 103c. of the Atomic Energy Act of 1954 (42 U.S.C. 2133(c)) is amended—

(1) by striking "c. Each such" and inserting the following:

"c. LICENSE PERIOD.—

"(1) IN GENERAL.—Each such"; and

(2) by adding at the end the following:

"(2) COMBINED LICENSES.—In the case of a combined construction and operating license issued under section 185(b), the duration of the operating phase of the license period shall not be less than the duration of the operating license if application had been made for separate construction and operating licenses.".

Subtitle E—NRC Regulatory Reform

SEC. 4___. ANTITRUST REVIEW.

(a) IN GENERAL.—Section 105 of the Atomic Energy Act of 1954 (42 U.S.C. 2135) is amended by adding at the end the following:

"d. ANTITRUST LAWS.—

"(1) NOTIFICATION.—Except as provided in paragraph (4), when the Commission proposes to issue a license under section 103 or 104b., the Commission shall notify the Attorney General of the proposed license and the proposed terms and conditions of the license.

"(2) ACTION BY THE ATTORNEY GENERAL.—Within a reasonable time (but not more than 90 days) after receiving notification under paragraph (1), the Attorney General shall submit to the Commission and publish in the Federal Register a determination whether, insofar as the Attorney General is able to determine, the proposed license would tend to create or maintain a situation inconsistent with the antitrust laws.

"(3) INFORMATION.—On the request of the Attorney General, the Commission shall furnish or cause to be furnished such information as the Attorney General determines to be appropriate or necessary to enable the Attorney General to make the determination under paragraph (2).

"(4) APPLICABILITY.—This subsection shall not apply to such classes or type of licenses as the Commission, with the approval of the Attorney General, determines would not significantly affect the activities of a licensee under the antitrust laws.".

(b) CONFORMING AMENDMENT.—Section 105c. of the Atomic Energy Act of 1954 (42 U.S.C. 2135(c)) is amended by adding at the end the following:

"(9) APPLICABILITY.—This subsection does not apply to an application for a license to construct or operate a utilization facility under section 103 or 104b. that is filed on or after the date of enactment of subsection d.".

SEC. 4___. DECOMMISSIONING.

(a) AUTHORITY OVER FORMER LICENSEES FOR DECOMMISSIONING FUNDING.—Section 161i. of the Atomic Energy Act of 1954 (42 U.S.C. 2201(i)) is amended—

(1) by striking "and (3)" and inserting "(3)"; and

(2) by inserting before the semicolon at the end the following: ", and (4) to ensure that sufficient funds will be available for the decommissioning of any production or utilization facility licensed under section 103 or 104b., including standards and restrictions governing the control, maintenance, use, and disbursement by any former licensee under this Act that has control over any fund for the decommissioning of the facility".

(b) TREATMENT OF NUCLEAR REACTOR FINANCIAL OBLIGATIONS.—Section 523 of title 11, United States Code, is amended by adding at the end the following:

"(f) TREATMENT OF NUCLEAR REACTOR FINANCIAL OBLIGATIONS.—Notwithstanding any other provision of this title—

"(1) any funds or other assets held by a licensee or former licensee of the Nuclear Regulatory Commission, or by any other person, to satisfy the responsibility of the licensee, former licensee, or any other person to comply with a regulation or order of the Nuclear Regulatory Commission governing the decontamination and decommissioning of a nuclear power reactor licensed under section 103 or 104b. of the Atomic Energy Act of 1954 (42 U.S.C. 2133, 2134(b)) shall not be used to satisfy the claim of any creditor in any proceeding under this title, other than a claim resulting from an activity undertaken to satisfy that responsibility, until the decontamination and decommissioning of the nuclear power reactor is completed to the satisfaction of the Nuclear Regulatory Commission;

"(2) obligations of licensees, former licensees, or any other person to use funds or other assets to satisfy a responsibility described in paragraph (1) may not be rejected, avoided, or discharged in any proceeding under this title or in any liquidation, reorganization, receivership, or other insolvency proceeding under Federal or State law; and

"(3) private insurance premiums and standard deferred premiums held and maintained in accordance with section 170b. of the Atomic Energy Act of 1954 (42 U.S.C. 2210(b)) shall not be used to satisfy the claim of any creditor in any proceeding under this title, until the indemnification agreement executed in accordance with section 170c. of that Act (42 U.S.C. 2210(c)) is terminated.".

Subtitle F—NRC Personnel Crisis

SEC. 4___. ELIMINATION OF PENSION OFFSET.

Section 161 of the Atomic Energy Act of 1954 (42 U.S.C. 2201) is amended by adding at the end the following:

"y. exempt from the application of sections 8344 and 8468 of title 5, United States Code, an annuitant who was formerly an employee of the Commission who is hired by the Commission as a consultant, if the Commission finds that the annuitant has a skill that is critical to the performance of the duties of the Commission.".

SEC. 4___. NRC TRAINING PROGRAM.

(a) IN GENERAL.—In order to maintain the human resource investment and infrastructure of the United States in the nuclear sciences, health physics, and engineering fields, in accordance with the statutory authorities of the Commission relating to the civilian nuclear energy program, the Nuclear Regulatory Commission shall carry out a training and fellowship program to address shortages of individuals with critical safety skills.

(b) AUTHORIZATION OF APPROPRIATIONS.—

(1) IN GENERAL.—There are authorized to be appropriated to carry out this section $1,000,000 for each of fiscal years 2004 through 2007.

(2) AVAILABILITY.—Funds made available under paragraph (1) shall remain available until expended.

Senator VOINOVICH. One other thing, before I forget it.

We had a big hearing here on the issue of the security of our nuclear facilities. I believe Senator Jeffords was the one who instigated that. As a result of that hearing, there were some questions asked, and you were kind enough to come and meet with us in closed session. I want to compliment Senator Jeffords because he, at that time, said that he thought it was a good idea.

I want you to know that in the near future, after talking with the members of this committee, we may again ask you to come into a closed session to update us on where you are in terms of the security of those facilities from terrorist actions.

Mr. MCGAFFIGAN. Mr. Chairman, if I could, I would make one comment on the legislation. In 1998, when Senator Inhofe had the first hearing, we also had not had a lot of legislation passed in many years. The Energy Policy Act of 1992 was the last significant piece of legislation that affected the NRC. Chairman Diaz just referred to one of its provisions.

In the intervening 6 years, aside from Senator Inhofe's provision with regard to the fee base, we are still anxiously waiting for the legislation. There are a whole series of provisions in the Energy bill that we believe are noncontroversial. We appreciate both Houses' support in the safety, security, and budgeting area. We would dearly appreciate this being passed.

Some provisions involve safety, some security, others budgeting matters, such as our ability to have fees for other Agencies. There are a whole host of provisions that you, Senator Inhofe, Senator Jeffords, and others have supported, which we would very much like to see enacted, if at all possible.

Senator VOINOVICH. There is one other thing that I would like would be a memo from the Commission about the harm that is done to you with a continuing budget resolution. We have, in the last couple of years, had this continuing resolution. I do not think my colleagues in the Senate and the House of Representatives understand how negative and how bad that has been for our Agencies. We just kind of take it for granted. "Well, we were not able to get the job done, so we are going to have a continuing resolution."

But they do not understand what a terrible impact that has on your ability to plan and get things done in your respective Agencies. It is not only yours, it is right across the board. We do not talk about it enough. So I would like you to prepare something that maybe I can share with our colleagues and let them know why we need to get our appropriations passed on time around this place.

Mr. DIAZ. We will be pleased to do so.

Senator VOINOVICH. Without objection, so ordered.

[The referenced document follows.]

CHAIRMAN

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 2, 2004

The Honorable George V. Voinovich, Chairman
Subcommittee on Clean Air, Climate Change, and Nuclear Safety
Committee on Environment and Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

During the U.S. Nuclear Regulatory Commission (NRC) oversight hearing on May 20, 2004, you requested a letter from the Commission on the impacts of having to operate under an FY 2005 continuing resolution. As discussed in greater detail below, operating under an FY 2005 continuing resolution would delay the NRC's review of the Department of Energy's (DOE's) high-level waste repository application and the NRC's review of various advanced reactor applications. It would likely have lesser impacts on other key programs, such as the licensing of new uranium enrichment facilities.

The FY 2005 President's budget for the NRC is $670.3 million, a $44.2 million increase from the FY 2004 budget. Most of that requested increase is in the NRC high-level waste program. Our FY 2005 budget includes $69.1 million for high-level waste regulation, which is $36 million above the FY 2004 appropriation. Consistent with that request, NRC was planning substantial increases in staffing, contractor, administrative, and infrastructure support to meet the statutory time period for NRC review of the DOE's application to build a high-level waste repository at Yucca Mountain, Nevada. That application is currently expected to be submitted in December 2004. Since NRC must fund high-level waste repository-related expenditures from the high-level waste fund appropriation, a continuing resolution that provides FY 2005 high-level waste funding at the FY 2004 appropriation level would disrupt our preparation to review the DOE application and delay our review of that application, once submitted. A continuing resolution would also delay our full-scale testing of a certified transportation rail cask for spent nuclear fuel.

The Commission has much more flexibility in the rest of our budget. The President's FY 2005 budget for non-high-level waste repository activities increases by only $8.2 million to a total of $601.2 million. Under a continuing resolution at the $593 million FY 2004 appropriations level, the Commission would plan to delay our review of various advanced reactor applications (three early site permit requests, the pre-application reviews related to the Advanced CANDU Reactor (ACR-700), and the GE Economic Simplified Boiling Water Reactor (ESBWR), and to delay review of other new license applications, such as those for two new enrichment facilities in New Mexico and Ohio. Since our first priority must be to ensure the safe and secure operation of existing facilities, the Commission would plan to fund fully our oversight programs in both safety and security and to fund fully such key activities as the Davis-Besse lessons learned follow-up items and prompt resolution of generic safety issues.

Should the President's FY 2005 request ultimately be fully funded in spring 2005, many of these impacts of a continuing resolution would be ameliorated. But the time lost through spring 2005 in various licensing reviews, particularly the review of the high-level waste repository application, will not be recoverable.

In summary, a continuing resolution would have significant adverse impacts on our ability to conduct some very important programs and activities.

Sincerely,

Nils J. Diaz

cc: Senator Thomas R. Carper

Senator VOINOVICH. Senator Inhofe.

Senator INHOFE. I think you ought to get it to him today.

[Laughter.]

Senator INHOFE. We talked about this back in 1998. We want action now. I have to say, Commissioner Diaz, I was disappointed in your answer to Senator Carper's question on what you see in the future. I cannot imagine with the serious, serious energy crisis that we have today that we would not be looking out there saying, "Yes, we are going to have more."

I am looking at a chart right now—France, 77 percent; Ukraine, 44 percent; South Korea, 37 percent. I just cannot imagine that we would be looking in the future and not saying, "This is probably singularly the most available one that we can go to, to resolve this crisis."

It is a crisis right now. Finally, the prices have gone up to the point where people realize it is. We have held two hearings in our full committee on natural gas prices, on gasoline, and all this. We know we have to get out there and go after all forms of energy which means exploring in places we have not explored. Yesterday on the Senate floor I reminded the Senators that in my State of Oklahoma, which is a big State in terms of marginal production, that is 15 barrels a day or less.

If we had all the marginal wells flowing today that have been closed in the last 10 years, it would produce more oil than we are currently importing from Saudi Arabia. Then you get into nuclear. I was surprised. I did not know about all these new tests coming up, Senator Carper. I just wonder why you need new tests. I can remember the old tests when they dropped a container a quarter of a mile on concrete and it is sustained it. It went through fire. They put in on the railroad tracks and a train coming along at a hundred miles an hour.

We have progressed to the point where I hope we do not just keep replowing those fields over and over again. Then you look at some of the ways that some of the extreme environmentalist's community look at nuclear. It is kind of interesting that same Green Party that has shut down nuclear in Germany is encouraging it in France, and France is the beneficiary because they are selling the electricity or the power to Germany.

I just hope that you become aggressive and recognize that we have a great need in this country to resolve our energy crisis, and nuclear has to be a major part of it. Are there any comments from any of the Commissioners?

Mr. DIAZ. Senator, we are aggressive in doing our role. My response is based on what the industry estimates their plan is, which is called "2020." My response is based on what the Department of Energy, which is actually actively trying to develop nuclear power, indicates. The electrical capacity of the Nation is growing. Therefore, the 20 percent that nuclear power generates now, 15 years from now, will be less, and maybe will be 15 percent or 16 percent. The industry has proposed a plan to build additional capacity. The Commission is ready to do its role of licensing.

Senator INHOFE. OK. That is the other thing I want to get before my time expires here. In 1999, Chairman Jackson said that the relicensing they are anticipating would take from 30 months to 36 months.

Mr. DIAZ. We are down, sir, to about 25 months.

Senator INHOFE. That is good. I like to hear that. But the concern is with the process slowed down on relicensing when you start preparing for Yucca Mountain. Can you keep the progress going?

Mr. DIAZ. We can keep the progress going. We have to manage our resources because the resources are limited. But we do not believe that there will be a significant impact on the relicensing process. We are going to manage it this year to about 12. We have said that we can manage eight per year. We are working with the industry to make sure they have a disciplined approach in providing us with the applications. So I do not think there is going to be any significant impact.

Mr. MERRIFIELD. In fact, Mr. Chairman, our staff had come to the Commission last year and said, “We want to budget and be prepared to deal with ten license renewals a year.” The Commission said that was not good enough. We wanted them to do 12 a year. We recognize, as you do, we want to deal with this in a disciplined process, but deal with it in a timely way. I agree with the Chairman. We are going to make sure we do both.

Senator INHOFE. Thank you. My time has expired.

You talked about when the Chairman in his opening remarks referred to 60 percent of the employees are over 60. I thought you were describing the U.S. Senate at that time. I thought that we might be having some serious problems in the NRC if that is the case.

[Laughter.]

Senator INHOFE. Thank you, Mr. Chairman.

Senator VOINOVICH. Senator Jeffords, I know that you wanted to have a statement made. Do you want to do that now or do you want to continue the questioning of these witnesses and perhaps give your statement before the second panel of witnesses are called up? I will let you decide that.

Senator JEFFORDS. I think I would like to do that now if I can. I have another engagement I have to get to.

Senator VOINOVICH. All right.

OPENING STATEMENT OF HON. JAMES M. JEFFORDS, U.S. SENATOR FROM THE STATE OF VERMONT

Senator JEFFORDS. Thank you, Mr. Chairman. Today’s hearing continues our ongoing oversight of the Nuclear Regulatory Commission. I believe this is the sixth oversight hearing the subcommittee has had in the last 7 years.

Chairman Voinovich, you and Ranking Member Carper deserve credit for continuing to commitment to hold these hearings regularly.

Today I want to discuss both the NRC’s handling of extended power uprates and a recent incident involving missing pieces of fuel rods at the Vermont Yankee Nuclear Power Plant in my State. I appreciate that Chairman Diaz and Commissioner Merrifield have been willing to discuss my concerns about the recent events in Vermont Yankee with me directly.

I also want to say to the Chairman and all the Commissioners that I am pleased that you are all here today.

The mission of the Nuclear Regulatory Commission is one of the most vital missions carried on by the Federal Government.

Regulating the Nation's civilian use of nuclear materials, ensuring adequate protection of public health and safety when these materials are used or disposed of, and protecting the environment are all critical.

I want to make myself perfectly clear, and I know the Chairman and the Ranking Member of the subcommittee share my views, that the top priority for the NRC is safety. There is no greater issue than safety. I want the people of Vermont and across the country to be safe. It is NRC's job to guarantee that.

As you are well aware, there has been serious problems at Vermont Yankee since this panel's last oversight hearing. Vermont Yankee operated by Entergy, discovered that two pieces of radioactive fuel rods were missing from the plant's storage facilities last month. Officials with Energy Nuclear have said that they could not find the two rods—one 7 inches and one 17 inches long. Either is capable of quickly giving a lethal dose of radiation to an unshielded handler.

The NRC has been involved in Vermont Yankee inspections using a remote control camera to see if they have misplaced the rods among the 2,787 spent fuel rods in the plant's spent fuel pool. The NRC is also working with the utility to review records to see if the two missing fuel rods from the plant are in the waste facilities at South Carolina or Washington.

Company officials speculate that the rods may have been confused with low-level waste and shipped out to out-of-State storage sites. So far, efforts to locate the rods at the Vermont Yankee facility have failed. This is an outrageous and frightening situation for Vermont families. The Commission must commit its resources to ensure that the material is accounted for immediately.

I stand ready to assist the NRC in any way possible to make sure that these materials are found and secured. But I note that this is the second incident of missing nuclear fuels at Northeast nuclear plants in 5 years. When the Millstone incident occurred, NRC said that fuel rods had never before gone missing in the history of the commercial nuclear plants in the United States.

I know that the materials at the Vermont Yankee were found to be missing due, in part, to the new inspection procedures the NRC instituted after Millstone. The sad fact is that the fuel is again missing. I do not want missing fuel to become the norm. It is not enough to tell the public that we think it is likely that highly radioactive material went into storage.

We must improve our nuclear materials accounting system and we must do so now. I want to know what the NRC is going to do to prevent this from ever happening again in Vermont Yankee or anywhere.

Keeping with my view that the safety is job one at the NRC, I would also like to know what the NRC is doing to ensure that any boost in Vermont Yankee's power will be reviewed in a thorough manner. Entergy has asked the NRC to approve its proposal to boost the power from Vermont Yankee by 20 percent. As you know, the NRC must determine whether or not such an extended power uprate will jeopardize the plant's ability to operate safely.

I expect the NRC to explain, design, and conduct a review that will allow Vermonters to have confidence when the uprate is approved for Vermont Yankee. In the long term, I am pleased that the NRC agreed with Senator Leahy and my request to hold a public meeting in Vermont in March to explain the uprate review process.

Many constituents have told me that this was a helpful meeting, but more needs to be done to inform and assure Vermonters. The review of the Vermont Yankee uprate will be the first time that the NRC will conduct such a review using the new extended power rate guidelines issued in December 2003.

I am also pleased that the NRC has agreed to conduct a pilot inspection and collection of additional information as requested by the Vermont Public Service Board. The purpose of this additional inspection will be to collect data about the plant's operations under the proposed boosted power conduction.

This is the information Vermonters want. I am pleased that my State will be doing a service to the country as they work with the NRC through the use of the new guidelines and implementation of the new pilot inspection program.

The NRC has an opportunity to assure this subcommittee that they will make their new site guidelines and inspections work, that they will implement them in a thoroughly transparent way, and that they will strive to address the concerns of the public.

If we are going to be serious about protecting our environment while providing safe, reliable, and affordable electricity for all Americans, we need to increase our use of renewables, improve how to burn fossil fuels, promote energy efficiency, and make sure that nuclear plants operate well and safely.

Thank you, Chairman Diaz and the rest of the Commissioners. I look forward to your response.

Thank you, Mr. Chairman.

Senator REID. Mr. Chairman?

Senator VOINOVICH. Senator Reid?

Senator REID. I apologize to you and the Ranking Member for being late. I have a relatively short statement I would like to give.

Senator VOINOVICH. Without objection, certainly.

OPENING STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

Senator REID. Thank you very much.

First of all, let me say to Chairman Diaz, Commissioner McGaffigan, and Commissioner Merrifield, I think you have one of the most responsible jobs we have in our entire Government. There is no way that I can adequately portray the importance, I think, of the work that you have to do. You have such a long list of critical duties. All of these duties have been made more important as a result of what happened on 9/11. Of course, we know you license, inspect, and oversee nuclear facilities. This is done to assure their safety and make sure that the operations go well at overseas decommissioning of facilities and enforce the laws that we write in conjunction with the President.

The NRC cannot perform these critical functions properly, though, when it is not operating with its full compliment of five Commissioners. But that is the situation we have today. The NRC is operating with only three Commissioners.

For example, the distinguished Chair of the full committee, Senator Inhofe, my friend, indicated earlier today that he thinks that there has been enough testing done on casks. I think if the Commission goes forward on the information, scientific in nature that we now have on these casks, it would be a terrible disservice, not only to our country, but to the world.

In February, the President sent to the Senate a member of my staff to fill one of the two vacancies that now exist with this very short-bodied Nuclear Regulatory Commission. The President's willingness to do this says more about Dr. Jaczko's qualifications than any testimonials that I could offer on his behalf. He has met with every member of this committee that has wanted to discuss his experience, his background, and his views. The committee's view of that role of the NRC has also been something that he has discussed with Senators I thank my colleagues for taking this time to meet with Dr. Jaczko.

But despite these meetings and the fact that several other nominees have had hearings and have been marked up by this committee, his nomination has languished. While I would like to fill the remaining fifth slot at the NRC, there is simply is a nominee with clear paperwork and other items in order to do that. In that way, we could have a Democrat and a Republican.

But I do not think that waiting is an option. The President of the United States felt the same way. I have pledged to work against the committee completing other business here on the floor until this nominee gets a markup. I have served on this committee for 18 years now, and have done so because I really like the work on this committee. I have had opportunities to go elsewhere, but I like what we do. I like our jurisdiction.

I do not take the action of blocking the committee's other business lightly. But I do so here because the Commission is charged with ensuring the safety of the Nation's nuclear power plants. That is very important, as I have already indicated. I do not think you can do your job when you do not have the adequate staff.

I believe not having a hearing is abdication of this committee's duty. At least one of the three Commissioners who has already testified before this committee to date, Commissioner McGaffigan, agrees with me. I think the other two would also acknowledge that it would be better if you had a full complement of Commissioners. In 2003, Commissioner McGaffigan commented, “I personally do not like vacancies. I think we would best when there are five.”

I acknowledge that. I would hope that my colleagues here on the subcommittee would do whatever they could to get this committee to move forward and put Dr. Greg Jaczko on the Senate floor. Then we will take whatever chances we have there. But to hold this up in committee is not going to be good for the work of this committee.

Again, Chairman Voinovich and Ranking Member Carper, I appreciate very much your allowing me to speak, me coming in late and leaving early. I appreciate it very much. The work that is being done here, the oversight of this subcommittee, is extremely important.

Senator VOINOVICH. Thank you, Senator Reid. I, too, am concerned about the lack of two individuals on the committee.

Perhaps we can spend some time working on it. But I would like to remind you from what my staff tells me that your side of the aisle blocked a hearing on Admiral Grossenbacher for 7 months.

Senator REID. That is really not quite true. They gave you some bad information, Senator Voinovich. What happened is that there was an agreement that we would do both of these together. By the time the togetherness came, he had found another job, which was really too bad, because I thought he had some extremely good qualifications to serve on this Commission. I think these gentlemen here would have been better for having had the Admiral on this Nuclear Regulatory Commission.

I would also say this, Senator Voinovich. Up here there is a lot of blame to go around. "He did it; I did it; you did it." But the fact of the matter is that we now have a Commission and we have a man who has a Ph.D., in physics who has had experienced administratively. He has had it in the Legislative Branch of Government. He would do an outstanding job working with these three gentlemen.

I have said a long time ago, but the Admiral withdrew not because of anything I did, I wish the Administration would come forward with someone else. For reasons I do not understand they have not. I am willing to work any way that I can to make sure that there are five and not four.

Thank you very much.

Senator VOINOVICH. Senator Carper.

Senator Carper. I have a story that relates to the Admiral before you got here, Senator Reid, I shared with my colleagues that every couple of years I take a bunch of Boy Scouts down to the Norfolk Naval Station to spend a weekend and sleep in the barracks, eat in the galleys, and climb all over the submarines, ships, and aircraft carriers.

You and I are runners. We like to exercise. One morning, 2 years ago when I was down there, I got up real early and went out and ran on a Sunday morning. As I was running around the base, it was just about daybreak, I ran by this one house.

There are some beautiful homes on the Norfolk Naval Station where some of the senior officers live. I went by this one home and I looked. There was a flag in front of the home. It looked just like the Delaware flag. Just like it. It was about half dark. I stopped my run. I went over there and I held the flag in my hands. By golly, it was the Delaware flag.

It turned out that the house was the Delaware House. They have like 20 or 25 houses on bases that are named after various States. The person who lives in the Delaware House is the head of U.S. Submarine Forces around the world. That person was the Admiral. He lived there at the time.

We went back after breakfast that Sunday morning and knocked on his door and got him up to let him know that there were some people there from Delaware. Later on he came back for a hearing to be nominated. He seemed like a good guy. I am sorry it did not work out.

Senator REID. Yes, he is the best. I would just say that anytime we talk about submarines, my being from Searchlight, NV, I hope you understand that we are responsible for the submarines communicating with each around the world. We have a huge Lorenz Station there in Searchlight. Those very interesting lights are flashing at night all the time. They have all kinds of ghost stories and everything. But the Lorenz Station makes our submarine fleet as successful as it, and that is in Searchlight. Well, a little out of Searchlight.

Senator CARPER. Would that be the suburbs of Searchlight?

Senator REID. Yes.

[Laughter.]

Senator VOINOVICH. We will be continuing with the questioning.

NRC's concern about safety culture was one of the last issues resolved before Davis-Besse was allowed to restart. As a condition of the restart, you required FirstEnergy to conduct an independent assessment of the safety culture at Davis-Besse annually for the next 5 years. I remember that part of the reason why you did not do it was that you came in and you said, "The safety culture has not changed. Get it right." You came back. It may have been three times that you did that before you let it open up.

Additionally, NRC's Advisory Committee on Reactor Safeguards recommended that the NRC pursue the development of a methodology for assessing safety culture. This assessment is performed widely in other countries.

With all that being said, why do you disagree with everyone that you should put in place a regulation to monitor safety culture? Why do we not have a regulation in terms of safety culture? It seems to me that if the internal people that are running these operations, if there is not a high safety culture, that is something that we should be very concerned about it. You were concerned about it.

The issue is: Why are you not doing something about it?

Why have you looked at the GAO report and said, "We are not going to do that."?

Mr. DIAZ. Sir, obviously the Commission is very concerned with the safety culture at each and every one of our facilities. However, we believe that the safety culture as a whole becomes sometimes ambiguous. We are not in the business of managing these utilities or these reactors.

Senator VOINOVICH. The question I have is this. Why do the Europeans do it? They have a lot of nuclear facilities in Europe. It is my understanding that they do go in and they do monitor the safety culture. You are going to be going into Davis-Besse for the next 5 years. You certainly are going to have to have some standard that you used to assess the safety culture during that period.

You had a standard to use because you said you were not going to let them open because they did not have the safety culture. Why do not we make that applicable to all the facilities?

Mr. DIAZ. Because it will get into an area that the Commission believes that we should not be, which in managing the facility.

Senator VOINOVICH. But you are doing it at Davis-Besse. You are going to go in there for the next 5 years.

Mr. DIAZ. But what we are going to do is that we are going to assess what the safety culture is and then we are going to assess how the management of the facility deals with the safety issues. That is our responsibility. We will deal with how they manage safety. We have indicators. We have many ways of actually addressing that issue. The safety culture issue becomes imbedded inside of the relationships between the employees and the management. We do not believe that is the role of the Commission.

Senator VOINOVICH. We have another 102 of these facilities around the country. The Commission does not have, as part of their regulatory responsibilities, some appraisal to come back? Somebody says, "Hey, we talked to some of the employees. It appears that they are not really that cognizant of safety. They are not concerned about it."

Mr. MERRIFIELD. We are concerned with safety.

Mr. MCGAFFIGAN. Mr. Chairman, we do deal with safety culture issues as they arise, but they tend to manifest themselves somewhere else in our system. We can get our hands around it that way. We have an allegations process. We take allegations that we get from individuals at nuclear power plants very, very seriously.

Senator VOINOVICH. Do you have a survey of employees about certain questions you ask about safety?

Mr. MCGAFFIGAN. We do not ourselves survey, but if we detect that there is a problem at a facility—and we have done this on more than one occasion—we require the licensee to do surveys. I believe we did this at South Texas.

Senator VOINOVICH. I have to tell you there is a disagreement here. I think you should do it. I want to talk to you about it. I do not think you are giving a good enough reason. If they do it in Europe, you are doing it at Davis-Besse, you ought to have the same kind of thing. An independent survey. You might have disgruntled employees. But there are certain questions that you can ask. There are certain observations that you can make in terms of whether or not you have that kind of safety consciousness there. That is very important because it deals with the internal people that are there every day. If they do not have safety utmost in their mind, they are not going to get the job done.

Mr. MERRIFIELD. Senator, there is something that we do that some of the Europeans do not. We have onsite inspectors every day who talk to plant personnel in the control room, in the engineering spaces, to line staffs, the mechanics who are doing the piping work—we have an opportunity first hand——

Senator VOINOVICH. You did not find it out at Davis-Besse. You had somebody there. That is the next question I am asking is about the communication. GAO and the Inspector General identified communications as one of the major factors that led to the NRC not to prevent the Davis-Besse incident. Perhaps most concerning is the statement in the GAO report, "The Resident Inspector at the Davis-Besse Plant never saw generic bulletins and letters issued by NRC on boric acid and corrosion, although only a few are generated each year."

That is communication. So you had somebody on board and they did not know that the safety culture there was not there because of some reason that it was not part of their job. Second of all, you get into the issue of communications.

Mr. DIAZ. We do agree that communications were faulty. We have taken every necessary step to address the issue of communications. I believe that it was more than communications. It was lack of the technical know-how that this issue could really result in a significant corrosion of the head.

We have addressed both the communication issues and the technical issues and how to deal with them.

Senator VOINOVICH. Do you have people on board on all 103 other facilities?

Mr. DIAZ. Yes, sir.

Mr. MERRIFIELD. Yes, sir.

Mr. MCGAFFIGAN. Yes, sir.

Senator VOINOVICH. And probably the company pays for it, I would suspect.

Mr. MERRIFIELD. Yes, they do.

Mr. DIAZ. Through fees.

Senator VOINOVICH. I have to tell you something. If I were running a show, those would be the most important people that I would have in my organization. They are onsite. I would have them really trained. I would have them being watchdogs, to know the technical aspects of it, to be able to look at the management, to look at the attitudes of the employees, and to be able to get back to you. How much training do you give these people?

Mr. DIAZ. We totally agree. We give significant training, but if you look at the directives and what the staff has been asked to do during the last year and a half, we are going to increase the training, both the technical capabilities and the communication capabilities.

I believe we have been responsive to the issues. I assure you that we have taken this very seriously. Corrections are being put in place.

Senator VOINOVICH. I am going to tell you. I am going to visit a couple of facilities and I am going to check up for myself. I want to know what you are doing on those individuals. I would like some further discourse with you about this issue of safety. I think the attitude of people, in terms of safety, is paramount. They are the ones that are doing the work.

Mr. DIAZ. Absolutely. I will work on the opportunity Senator.

Mr. MERRIFIELD. Senator, I was going to say that obviously you have gotten into some areas we can give additional detail through your staff, through briefings. Obviously this is something you have a great interest in. We will make sure that we get you the information.

Senator VOINOVICH. Without objection, so ordered.

Mr. MCGAFFIGAN. Mr. Chairman, I would just mention that we have been following Resident Inspector demographics. You are interested in our demographics as a whole Agency. But we require an annual report from our staff on Resident Inspector demographics. We discuss Resident Inspector demographics at an annual meeting that we have with the staff. We have had problems. Clearly Davis-Besse was our worst hour. We have challenged our regional administrators to bring in additional people. In some instances, they are double encumbering these positions now so that you will have a trainee there while the person who is rotating out is still there.

We are dedicated to having at least two individuals at every site. At some sites like Indian Point we have a lot more, but at least two individuals. We have three, I believe, at the moment, at Davis-Besse. We have turnover. About the time that Chairman Diaz and I came on the Commission, we mandated instead of a 5-year rotation for Residents, that it be a 7-year rotation. Well, we are coming up on the 7th year. At the moment, there is a tremendous amount of movement from one site to another.

We do that because we do not want people to homestead and get too comfortable. We want new eyes coming into the site and a new perspective, a different engineering background, perhaps, so they will see different things. But we have a lot of turnover at the moment in our Resident Inspector corps. They move from one site to another. But we have been monitoring it and we have been challenging our regional administrators to do a good job in managing it. We pay attention to it. We have all the data we can share with your staff.

Senator VOINOVICH. Thank you.

Senator Jeffords.

Senator JEFFORDS. Thank you, Mr. Chairman.

I have several questions about our little problem in Vermont. I would like to try a couple here and then will submit others in writing.

At the briefing in preparation for this hearing, your staff indicated that the remote camera search of the spent fuel pool in Vermont Yankee is complete and the missing fuel rod pieces have not been found. This information was repeated in a May 19, 2004 story, in the Rutland Herald.

Is it the case that the search pool is complete? What are the next steps that will be taken to locate the missing fuel?

Mr. DIAZ. The licensee, with oversight from the NRC, has completed the search of the spent fuel pool. They have not found the missing fragments of the spent fuel. That does not mean that the issue is closed. We will continue to work with the licensee to ascertain whether these pieces of fuel were shipped outside of the facility with other waste. We are going to try to make sure that we find out where it ended. We are not sure that we can really find these pieces. I am going to be perfectly honest with you.

In the case of Millstone, we conducted with the licensee a major year-and-a-half process. The possibility is that this was packaged with other radioactive waste and it did not alarm. Therefore, it did not show up as a significantly radioactive piece. It ended up probably in one of the low—level waste disposal sites.

Mr. MERRIFIELD. But just to clarify, too, we are still doing our investigation. But as we found with Millstone, it is plausible that those activities may be a legacy issue for us and the licensee and may have been activities that dated back to the early 1980's.

Mr. DIAZ. It was a 1980 piece of fuel; yes.

Senator JEFFORDS. On May 4, 2004, NRC responded to the Vermont Public Service Board's request for additional independent reviews of Vermont Yankee. Your letter stated that "A pilot engineering assessment would be conducted. The assessment team will be comprised of NRC staff, State officials, and at least two independent contractors."

What will the NRC do to ensure that the independence of the independent contractors? What will be the process for selecting them? What qualifications will they need to have?

Mr. DIAZ. Our staff has very defined procedures for selecting contractors. This is a new type of risk-informed inspection that we believe that would become a mainstay of the way we do things with facilities. As an engineering assessment, we are going to ensure that there is absolutely no connection between the contractors or even the staff that is going to be dedicated to this activity. They will have a certain amount of separation from the Vermont facility.

We, of course, are an independent Agency. We are going to ensure that this work is done independently. You can have our complete assurances of that.

Senator JEFFORDS. I have additional questions, Mr. Chairman which I will submit to you in writing for answers in writing.

Thank you, Mr. Chairman.

Senator VOINOVICH. Without objection, so ordered. Thank you, Senator Jeffords.

Senator Clinton.

OPENING STATEMENT OF HON. HILLARY RODHAM CLINTON, U.S. SENATOR FROM THE STATE OF NEW YORK

Senator CLINTON. Thank you, Mr. Chairman. Mr. Chairman I thank you for holding this hearing. I appreciate your statement with respect to Davis-Besse. I would like to associate myself with the concerns in this GAO report. It is clearly a finding that we need additional resources and support for the safety mission that the NRC is responsible for implementing.

I am concerned, as the Commissioners know, about the overall safety of these aging plants and, in particular, the situation at Indian Point. In March of this year the NRC upgraded the Indian Point safety rating to green. It is my understanding that this change in rating reflected work that had been done to conduct training, modify electrical systems, fix a firewall, and take other steps to improve safety. These are all welcome steps.

But I am concerned that one consequence of this green rating is less frequent inspections by the NRC. I am concerned for three reasons: First, NRC's year-end inspection report for Indian Point lists a range of tasks that have yet to be done, including a repair backlog and improving staff performance.

Second, Indian Point is unique among nuclear facilities in that about 20 million people live within a 50-mile radius of the plant. Third, the documented oversight failures by the NRC at Davis-Besse call into question the effectiveness of the NRC's business-as-usual oversight.

My question is this: How does the NRC justify less frequent inspections at Indian Point? Would you not agree that the unique setting, and certainly the public concern about Indian Point argue for continued NRC oversight at the highest possible levels?

Mr. DIAZ. Senator, we are continuing to increase oversight at Indian Point. You are correct that we found that the licensee has made progress in addressing a series of issues. That does not mean that we are satisfied or that we are going to actually do much less than what is required.

We intend to maintain oversight at a level that is commensurate to the findings that we have. We believe that we have sufficient oversight to maintain the facility in the safe condition that it should be. We have an extra inspector. Yesterday I was at the plant. I was assured by the Regional Administrator that we are maintaining the level of oversight that is commensurate with the needs of Indian Point.

Mr. MCGAFFIGAN. I might add that our Regional Administrator, Mr. Miller, has asked for a deviation from our normal oversight process for heightened oversight at Indian Point. Similarly, our Regional Administrator in Region IV has asked for continued maintenance of heightened oversight at the Cooper Station in Nebraska.

Both of those plants got themselves into Column 4 of our so-called "action matrix" which is the multiple degraded cornerstone column. In both cases, our Regional Administrators are saying, "We are going to be extra careful and do extra inspections until such time as we are really satisfied that everything is OK."

They are in Column 2 of our action matrix at the moment, but they are being treated as if they are in a higher column. Mr. Miller has maintained the inspection resources, I believe, at Indian Point, that are unprecedented at any other plant.

Mr. DIAZ. Absolutely. So it is recognizing that the licensee has made progress and it should be so indicated. But we are continuing to increase the oversight at Indian Point.

Senator CLINTON. Thank you. As you know, the Federal Emergency Management Agency is scheduled to conduct a drill at Indian Point during the week of June 7th to gauge the effectiveness of the emergency plans for the surrounding counties. This whole issue of evacuation in the event of an emergency has been one of my highest priorities.

Now I know that FEMA has the primary responsibility to evaluate emergency planning at nuclear power plants, but ultimately an effective emergency plan is a condition of an operating license from the Nuclear Regulatory Commission. It just impractical and not believable that a 10-mile radius, as currently envisioned in the emergency plan, in an area as densely populated as metro New York City, represents a fair and realistic emergency evaluation plan.

Let me ask you this. To what extent is the NRC involved in the planning of the June 7th drill? Would it not make sense to be realistic and broaden the geographic scope of the exercise to get a clearer idea of what our real challenges are?

Mr. DIAZ. Senator, the NRC is directly, intensely, and aggressively participating in the issue of the exercise. The fact is that was the reason for my visit yesterday. It was exclusively dedicated to the exercise. I did this at the plant, but it was all emergency planning.

I believe that from yesterday we had very fruitful meetings, including meeting with the county executives. Out of the meeting, even a more realistic plan that we have devised is now taking place.

Senator CLINTON. Good.

Mr. DIAZ. We actually addressed some of the issues of concern directly with those who have the responsibility of carrying out those responsibilities. We did not resolve all the issues, as you can imagine. We still have some questions to answer. But I believe we went a long way toward planning and eventually executing an exercise that is realistic. I believe the exercise calls for a series of measures that will be testing the capability of the counties to evacuate people. I believe that many of those things are now being put in a better perspective. I really appreciate the opportunity to have been there and to listen directly to what their concerns were. They are being addressed.

Senator CLINTON. Thank you.

Thank you, Mr. Chairman.

Senator VOINOVICH. Senator Carper, you have one last round, and then we are going to go to the next panel.

Senator CARPER. Thank you, Mr. Chairman.

I think it was last year it was revealed that a small amount of a substance called tritium was discovered in the ground water either next to or beneath the ground on part of the Salem One Nuclear Reactor. Over the last year or so, efforts have been underway to try to understand and to respond to the contamination that had been ongoing.

I have a couple of questions. Let me just sort of run through them and then we can go back and pick them up, if you will. What is the role of the NRC in a case like this? Could we start when the reactor's owner, which is PSEG, notified your Agency of the elevated readings in the ground water. What steps does the NRC take in order to protect workers and to protect public safety? How do you go about identifying the scope of the problem? How do you ensure that the response plan is adequate? If we could start there, that would be helpful.

Mr. DIAZ. Sure. The NRC is directly involved, not only in the oversight of the protection of the workers and of the people, but in any release of radioactivity from the side boundary. That is one of our major areas of responsibilities.

In the case of tritium, tritium is not a very hazardous radioactive material. If we put them on a scale, it probably comes, I would call, at the very bottom. However, that does not mean that we are not concerned with it. We, of course, do things in a risk-informed manner. Tritium is a very insidious material. You think you have got it, and it will escape. It mixes with water. It mixes with steam. It really has many ways of flowing where it should not be.

In the case of the Salem Hope Creek, tritium was found outside leaking from the spent fuel pool in a very small concentration. We have been working with the licensee. We have ascertained that there has been no further contamination of the water which is our main concern. The dilutions are still relatively low, but we are trying to make sure that the licensee addresses why this escaped. They think they know where the issue is. It is a liner error of the spent fuel pool.

We have taken this issue very seriously and continue to work with them to make sure the issue is addressed and satisfied.

Mr. MERRIFIELD. Senator, just to put a little of a boundary around this, this leak was identified as a result of a well that is very close in proximity to the plant. The water that had come from the pool containing the tritium has not gone across the boundaries of the plant property. It does not present any danger to the wildlife or people who live around the plant.

So we are very much on top of it in terms of monitoring that release. We are working very closely with the State of New Jersey to make sure that we monitor that and have the licensee deal with it in the appropriate way.

Senator CARPER. What is the responsibility, if you will, of the owner of the plant, PSEG in this particular case? Do you believe that they have met their responsibilities to the NRC and to the community?

Mr. DIAZ. Yes, presently they are meeting those responsibilities in this particular operation.

Senator CARPER. The second question also relates to the Salem Hope Creek Plant. It deals with the culture of safety that exists at the plant. I understand that over the past year or so that the NRC has been engaged in a special review of the safety culture of the Salem Hope Creek reactors in New Jersey.

This is a couple of plants that are about 15 miles away from my house on the other side of the Delaware River. You can see it on a pretty clear day. Apparently this review that was launched in response to questions about the ability of the plant management and the operators to maintain an environment where questions, including those about the operation and the safety of the place could be freely raised by the employees and would be fully addressed by the management.

I just want to know what is the status of this review by the NRC. Are you satisfied that the plant operator, PSEG, has addressed any areas that need improvement? Are there any additional steps that need to be required of the plant and the plant operator?

Finally, is the safety culture a concern at other reactors and at other plants?

Mr. DIAZ. Safety culture is an issue that we gauge from my viewpoint from how the managers of the plant manage safety.

In the case of the Salem Hope Creek, our Regional Administrator saw signs that there could be a degradation of the safety culture. He aggressively addressed it even before there were really any major issues that were identified. He used the processes that we have to call it to the attention of the licensees. The licensees have been responding.

We are not satisfied yet that everything that needs to be done has been done, but a process has begun. We believe they are doing the right thing. We are going to be watching carefully to make sure that they actually take the entire matter not only very seriously, but take it into a completion that we can say, "Yes, you have satisfied what we wanted you to do." It is ongoing.

Mr. MERRIFIELD. One thing, also, both Senator Carper and Mr. Chairman, that we did not mention when we were answering the Chairman's questions on safety culture. We, in fact, are sponsoring as an Agency a workshop in which we bring licensees in to meet with our staff to try to identify best practices in safety culture. So we do have a direct engagement on this issue in terms of trying to enhance and identify better ways for licensees to enhance the culture of their own plants.

The Institute for Nuclear Power Operations, which is a separate industry-funded organization in Atlanta has 300 or 400 people who work for it. They have a separate initiative underway in which they are intensively looking at this very same issue, again to try to enhance the overall level of the safety culture at the plants. We are collaborating with them to the extent that they are keeping us informed of their activities. We are very interested in the work that they are doing. We want to assess where they are in relation to where we are.

I did want to fill that in to give you a little bit better understanding that we do take the issue of safety culture quite seriously. We recognize what other of our international partners are doing. We want to make sure that we are doing it in the right way for the licensees that we oversee.

Mr. DIAZ. If I may add, on the issue of Davis-Besse, on safety culture, the licensee did not meet its own standards of safety culture. We do hold them accountable for those standards. We want every licensee to have very high standards.

Senator VOINOVICH. You should set the standards for them.

Mr. DIAZ. Well, that is an issue that is a very difficult issue. Again, we might be getting into the prerogative of the management of this facility. The Commission has been discussing this for many years. We actually do much more than our European colleagues in the area of oversight, much more intrusive, much more in there, much more looking over what happened.

I do not think there is a match in the world for the way that the NRC conducts oversight of nuclear facilities anywhere. I will stand by that statement.

Mr. MCGAFFIGAN. Mr. Chairman, I might just add that you are citing the European example. The main European example that I am aware of is that our UK counterparts have a license condition that they have imposed on their reactors that basically gets the regulator, the Nuclear Installations Directorate involved in any staff change at the plant. So if you want to decrease the number of people in Department "X" by "y," you have to come in to the regulator and talk to him about it.

I remember Chairman Inhofe got wind of that a few hearings ago and asked us about whether we thought that that was our role. We said very firmly that that was not our role. I am not sure that gets at safety culture.

Senator VOINOVICH. The thing is that is not the role I am asking you to make.

Mr. MCGAFFIGAN. No, no; I understand. But that is a European precedent. The European precedent that is often—times cited is the UK license condition that gets them involved in essentially labor management issues and having a regulator trying to determine what number of people are needed in each department.

We have respectfully said no to that. There are other approaches to safety culture. I think our approach, which is when we find a problem, whether it is at Hope Creek Salem, or South Texas, or Davis-Besse, we then ask the licensee to do a lot of the surveying that you do. But do you do that for all 103 plants where, for the most part, we do not have any other symptom coming up? That could be quite burdensome. Then in judging the results, it gets to be very, very subjective. So that has been the problem that we have faced.

Mr. MERRIFIELD. Mr. Chairman, if I may, I would add two quick things. When I worked as a counsel on this committee, it was quite popular to look at what are the Europeans doing versus what we are doing. I think those translations are not always made correctly. There is an issue of what does the regulation or law look like on paper versus where are you in terms of the enforcement of those regulations. There are quite stark differences between the Europeans and between this country.

Senator VOINOVICH. In the GAO report, "The International Atomic Energy and its member nations have developed guidance and procedures for addressing safety culture at nuclear power plants. Today, several countries, such as Brazil, Canada, Finland, Sweden, and the United Kingdom assess plant safety culture or licensee's own assessments of their safety culture."

I am just saying that we are going to have to spend a little more time on this issue of safety. I want to know just exactly what you are doing. Why did not the person who was on board at Davis-Besse understand that they did not have a culture of safety in the place? Where were the standards? Do you negotiate the standards?

There are a lot of questions here in terms of management. I am not asking you to micro-manage these outfits. We should set some standards that are agreed upon, and then make sure that they are being upheld.

Mr. MERRIFIELD. Mr. Chairman, one of the very important things that we do as an Agency is benchmark. We meet collaboratively with our international partners and try to identify best practices. Members of the Commission do as well. I have been to most of the major European partners, as have others. These are most of our counterparts internationally.

I could tell you in private my observations about some of them. I think we do a pretty damn good job in this country. I am not going to back away from that statement. Now, the heart of your matter is that we missed an issue of safety culture at Davis-Besse. It led to an identifiable problem. I think there is complete agreement with you that we need to get to the heart of the issue.

Senator VOINOVICH. Well, there is the other facility that Senator Carper mentioned where they missed a safety culture.

Mr. MCGAFFIGAN. Mr. Chairman, one of the issues Commissioner Merrifield mentioned is INPO's involvement. INPO has a lot more credibility, frankly, than Federal bureaucrats do going in and talking frankly with their industry peers, "We do not like your incentive system for your executives here."

But to legislate a rule that says that you will have a safety gate for executive incentive payments is another issue. The South Texas project last year did absolutely wonderfully in dealing with a problem that showed up in March of last year. We have commended them for it. The industry has commended them for it. They took an absolutely first-rate approach to dealing with the issue.

But their incentive structure, they once told me, is that they have a safety gate in their executive incentives. Should that be a rule that you first have to meet all your safety goals before you get paid other incentive payments?

Senator VOINOVICH. You let them decide how they achieve it. If they want to put a safety rule in, and that is the way they get high performance evaluation of their people to meet the standard, if they want to do it that way, fine. They can do it anyway they want to. The main thing is to make sure that we have the highest standards of safety and the people working in the plant get it.

Mr. MCGAFFIGAN. We agree. That is the benchmarking that Commissioner Merrifield talks about. We think we are going to get to a point where people adopt very good practices in areas that are very hard to regulate through the processes that the industry itself regulates.

I think this industry, through the Institute of Nuclear Power Operations established after Three Mile Island, is absolutely committed to what the late Bill Lee, the Duke executive said, "They are only as good as the weakest member." They are trying to learn the lessons of Davis-Besse every bit as much as we are trying to learn the lessons of Davis-Besse. Davis-Besse was on their good guy list, too, just like they were on ours. They are committed to not letting that happen again. They are looking at these issues that executives peer reviewing each other——

Senator VOINOVICH. I want to know if you are dedicated to making sure that it does not happen again.

Mr. DIAZ. Of course, we are.

Mr. MERRIFIELD. Yes, sir; yes, sir.

Senator VOINOVICH. You are a regulatory Agency.

Mr. MCGAFFIGAN. Yes, sir. And we are going to do everything that we can do within the bounds of what a Federal regulator should do to make sure that Davis-Besse do not happen. We are absolutely dedicated to that. We wake up every day. Our staff wakes up every day dedicated to that purpose.

Mr. MERRIFIELD. Mr. Chairman, you have shown great leadership in holding our feet to the fire on the safety issues arising from Davis-Besse. We fully appreciate and recognize the concern that you have and the concerns raised by GAO. The issues of the safety culture are tough issues. They are not easily discussed or resolved.

I think that you are pointing out that we need to have further dialog with you and others on this matter. I think that is a reasonable request and one that we can certainly say that we will continue in the future.

Mr. DIAZ. But I would like to reassure you that we are totally dedicated to making sure that every aspect of the safety of these plants, including how the managers manage safety culture, is not only important, but we are committed to making sure that happens.

Senator VOINOVICH. We are going to talk about setting standards. If you will not do it, I will get legislation passed to get it done. But we are going to talk about it. I would rather do by regulation and by working with the industry. But this is a big issue. I have run some operations. It is the mentality of the people who work there that make the difference. If they slough it off and they do not care about it, and it is not high on the list—performance evaluations are very important. That is one of the ways that you get people's attention.

They ought not to be mandated, but if I were a business and safety was very important, I would give that some consideration in terms of performance evaluations so everybody knew this was important and if you did not do your job in that area, then you are not doing your job.

Mr. MCGAFFIGAN. Sir, I could not agree with you more that that is exactly what we would like all of our licensees to do—to make sure that the incentive system puts safety first. I do not think that necessarily was the case at Davis-Besse. I think the industry is learning that lesson, but it is very, very hard. We have gotten reports from GAO, as they have said before, that we should regulate in this area. No one has given us an existence proof of a regulation that can be implemented. That is what we are looking for.

Senator VOINOVICH. We can talk about that.

We should get onto to the next panel. Thank you very much. We look forward to spending some time with you about this issue and a couple of others.

Mr. DIAZ. Thank you.

Mr. MCGAFFIGAN. Thank you.

Mr. MERRIFIELD. Thank you.

Senator VOINOVICH. The record is going to be held open for questions from Members of the committee.

Without objection, so ordered.

Senator Inhofe asked that this be submitted in the record in response to Senator Reid.

"I understand in my absence that Senator Reid said there was an agreement to hold Admiral Grossenbacher until a Democrat had been nominated, thereby linking the two nominees. I want to state for the record that we never had such an agreement. We tried to hold a hearing on Admiral Grossenbacher several times. Each time we were blocked by the minority."

Without objection, we will put this in the record.

Senator VOINOVICH. I apologize to the second panel for the delay. I hope it has not inconvenienced you too much. We are going to ask that you limit your statements to 5 minutes. We want to assure you that your full statements will be in the record before this committee.

We are pleased to have Marvin Fertel, senior vice president of Nuclear Generation; David Lochbaum, nuclear safety engineer, Union of Concerned Scientists; Marilyn Kray, vice president for project development, Exelon Generation; and Barkley Jones, professor, Department of Nuclear, Plasma, and Radiological Engineering, University of Illinois at Urbana—Champaign.

Thank you all for being here today with us. We will start with Mr. Fertel.

STATEMENT OF MARVIN FERTEL, SENIOR VICE PRESIDENT OF NUCLEAR GENERATION, NUCLEAR ENERGY INSTITUTE

Mr. FERTEL. Thank you, Chairman Voinovich, and Ranking Member Carper.

I appreciate the opportunity to represent NEI's member companies before this subcommittee today. While my written testimony is much broader, my comments today will briefly discuss three key points.

No. 1, our country's 103 nuclear power plants are critical to our economy, energy security, and environmental goals, and currently produce electricity for one in every five homes and businesses.

No. 2, an effective, credible, stable, and efficient NRC is vital to both assuring protection of public health and safety, and to providing an environment that allows for positive business decisions concerning our existing plants and those of tomorrow.

No. 3, I will comment on industry actions to address the issue of the degradation of materials used in nuclear plant components and systems.

Over the past decade, our 103 nuclear plants have achieved record levels of production and efficiency while maintaining the highest levels of safety. As our second largest source of electricity, U.S. nuclear power plants produced 767 billion kilowatt hours in 2003, which represents a 25 percent increase compared to 10 years ago.

Nuclear power plants are also the most affordable baseload source of electricity today, with costs lower than those for coal and natural gas and oil. In an economy that is seeing great volatility in the course of oil, gas, and coal, electricity from nuclear plants provides consumers and businesses with a high degree of price stability.

As this subcommittee is responsible for Federal clean air policy, I am sure that you are aware that nuclear power generates three-fourths of all emission-free electricity in the United States. This Monday, Exxon-Mobile ran a full-page ad in the Washington Post, talking about its efforts to reduce greenhouse gas emissions. The company was rightfully proud to advertise that its 80 co-generation facilities reduced emissions by an amount equivalent to taking a million cars off the road, a rather impressive feat.

But to put nuclear's clean air value to our Nation in perspective, annually the nuclear energy industry impact on greenhouse gas emissions is over 100 times greater, the equivalent of eliminating the greenhouse gas emissions from 138 million cars, or about 9 out of every 10 U.S. passenger cars.

Nuclear is indeed our largest source of emission-free electricity. To enjoy this benefit, our existing plants must continue to operate and new plants must be built in the coming years. This depends on the NRC's effectiveness as a safety regulator as well as its efficiency.

As others on this panel will emphasize, regulatory uncertainty is the largest perceived risk with new nuclear plant construction. Providing certainty, predictability, and stability will be essential to attract investment in our new advanced design reactors.

We now have 4 years of experience with the NRC's revised oversight process. This new oversight process is a major success for safety and for improved regulatory stability. The new process focuses on those areas of the plant that are most important to safety. It has improved transparency to all stakeholders, as well as enhanced objectivity and regulatory stability.

The industry fully supports the NRC's efforts to make the regulatory process more safety focused. We believe it work is far from complete. The Agency must move forward systematically and aggressively to incorporate its safety focused approach into the rules themselves.

We also acknowledge the Agency for its progress in reviewing applications for license renewal of existing plants. Four years ago the process was anything but certain. Today the Agency's businesslike approach to the reviews has resulted in a renewal of the licenses for about one-quarter of the Nation's plants. We expect almost all plants will go for license renewal.

The lessons learned from the license renewal process and the discipline inherent in it must be applied as the Agency faces new challenges in the licensing process for the Yucca Mountain project, and the licensing of new facilities such as the new uranium enrichment facilities.

We urge this committee to systematically monitor NRC's progress on changing the regulations to be more risk—informed, on their continued activities to review license renewable applications, and on all of their new facility licensing reviews.

As you are aware, the nuclear industry fully pays for all the costs associated with NRC regulation. In fact, nuclear power plant owners pay for all costs associated with their operation, including all externalities. We are the only industrial facilities to do so.

Four years ago this committee supported, and Congress passed, a law that reduced the fees paid by the industry as a share of the NRC budget by up to 10 percent. The industry urges this committee to renew carefully the NRC's fee structure and its budget which has grown significantly over the past few years. Industry fees should not be used for services that do not directly support regulation of the industry.

As discussed in my written testimony, industry also believes that the NRC could operate more efficiently at reduced costs to licensees. To achieve this would require a systematic review of NRC resources, their priorities, and a holistic view of the NRC work force and attrition issues.

Finally, I would like to mention the industry's response to the issue of material degradation at the Davis-Besse plant. While significant materials management programs were in place for decades, the industry aggressively responded and has acted on the Davis-Besse experience. We have expanded our programs in this area, and more importantly, through NEI have developed an integrated, coordinated, and much more proactive material management program. The industry will invest at least $65 million annually in this effort.

I can assure you that along with the NRC we are fully committed to detecting and resolving material issues well before they pose any challenge of safe operations of our plants.

Mr. Chairman, no one values the safe operation of our plants more than the people that work at the plants and the owners of those plants. Sound business practice is not just regulations that require the owners to maintain and operate the plants with safety as the top priority. Your concern about safety culture is fully appreciated and shared by us. I would welcome the opportunity to discuss with you and your colleagues the bases for achieving the type of safety culture we all would strive for.

The continued oversight of the NRC by this committee to ensure a credible, effective, efficient, and stable regulatory process is both appreciated and needed. Furthermore, a disciplined focus on NRC resources and budget issues has never been more appropriate than now.

We thank this committee for its past actions. We welcome your continued focus on achieving greater efficiencies in the future. Thank you. I would ask that my written statement be placed in the record in its entirety.

Senator VOINOVICH. Thank you very much, Mr. Fertel.

Mr. Lochbaum.

STATEMENT OF DAVID LOCHBAUM, NUCLEAR SAFETY ENGINEER, UNION OF CONCERNED SCIENTISTS

Mr. Lochbaum. Thank you, Mr. Chairman, and Senator Carper.

Twenty-five years ago, a Three Mile Island reactor outside Harrisburg, PA experienced the worst nuclear power plant accident in U.S. history. That accident was not caused by uniquely bad conditions. It resulted from broad-based problems at many reactors that eventually produced a meltdown at one of them. The post-accident inquiries resulted in extensive changes at both the nuclear industry and the NRC.

This history is relevant to today's hearing because compelling evidence suggests that extensive degraded conditions at many reactor sites are again being tolerated. The NRC's response to these warning signs have amounted to little more than rearranging the deck chairs on the Titanic.

Fortunately, there is still time for the NRC to plot a different course so as to avoid the icebergs looming on the horizon. Earlier this week, GAO released a report on the NRC's mishandling of safety issues at the Davis-Besse Nuclear Plant. GAO identified several problems NRC should correct. The GAO and the media made much of the fact that the NRC rejected many of the findings.

The larger concern is that the NRC has seldom fixed findings made by its internal and external auditors, even those findings to which it agreed. I reviewed reports issued by the NRC's Lessons Learned Task Forces, the NRC Inspector General and the GAO over the past 8 years and saw the same regulatory problems contributing to unacceptable safety levels at plant after plant.

Earlier this week the GAO reported that the NRC is not addressing three systemic problems underscored by the Davis-Besse incident. The first problem is that the NRC's process for assessing safety at nuclear power plants is not adequate for detecting early indications of deteriorating safety. GAO reported this very same finding in January 1999, July 1998, May 1997, and January 1996.

The second problem identified by GAO was NRC's decision—making guidance does not specifically address shutdown discussions or explain how different safety considerations, such as quantitative estimates of risk should be weighed. The NRC Inspector General reported virtually identical findings in May 2003, December 2002, and August 2002. The GAO reported this very same problem in February 1999.

The third problem identified by GAO was that the NRC does not have adequate management controls for systematically tracking actions that it has taken in response to incidents at plants to determine if the actions were sufficient. GAO reported a virtually identical problem in September 2003, involving security. The NRC Lessons Learned Task Force reported this problem in September 2002. The NRC's Inspector General reported this problem in August 2000. GAO reported this problem more broadly in May 1997.

Thus, the NRC is much like Bill Murray in the movie, Groundhog Day. They keep relieving the same problems over and over instead of fixing them. Bill Murray's movie lasted about 90 minutes. The NRC's rut dates back two decades and continues today.

Davis-Besse is the 28th reactor in the past 20 years to be shut down for a year or longer to fix safety problems. The NRC must fix its chronic problems to end its "Groundhog Day."

The 28 reactors that endured these lengthy outages brought in new management to direct the recovery efforts. New managers can assess policies and practices unencumbered by tradition. New managers can strike out new paths without implicitly conceding that it led workers down the wrong roads in the past. New management is a tried-and-true method for bringing about timely reforms, yet it is an untried method at NRC.

A few of NRC's managers are new to the Agency. Most worked their way up through the ranks. Consequently, they all come from the same mold and have the same habits. Retirements and reorganizations merely put different faces on the same management styles. Reform efforts fail because repackaging and reapplying that management style cannot yield meaningful changes.

UCS is not advocating a massive infusion of new managers at the NRC. That would be unfair. That would be the fastest and surest fix, but it would be unfair to oust many fine public servants.

Instead, we urge changes to the NRC's hiring and promotion practices. Retirements and voluntary departures should become opportunities for finding the most qualified replacement, not just the most qualified replacement within NRC.

One of the NRC's strengths is talented, capable, and dedicated employees. Properly led, they can make sure that nuclear power's costs are not too high and nuclear power safety levels are not too low.

On behalf of UCS, I wish to thank this subcommittee for conducting this hearing and inviting our views on this subject. Thank you. I would ask that my written statement be placed in the record in its entirety.

Senator VOINOVICH. Thank you very much, Mr. Lochbaum.

Ms. Kray.

STATEMENT OF MARILYN KRAY, VICE PRESIDENT FOR PROJECT DEVELOPMENT, EXELON GENERATION

Ms. KRAY. Good afternoon, Mr. Chairman and Senator Carper. I am with Exelon Nuclear. I am also here in the capacity as a lead representative for NuStart Energy Development.

I preface my remarks today with an observation of the opportune timing of this hearing. There are a number of factors converging to establish a platform requiring not only our attention but also our action. These factors are: the heightened concern with the stability of our electricity supply, the recognized need for fuel diversity, and less dependence on foreign energy sources, the increased concern with the environment, and increasing demand for electricity, both domestically and globally.

These factors suggest the need to revisit each component of our generation mix. I will be here to discuss only the nuclear power component which provides, as stated, approximately 20 percent of our electricity needs. In response to an earlier question, it is my opinion that our current fleet of operating reactors cannot uphold the current 20 percent contribution.

As with any form of energy, nuclear power has both its risks as well as its benefits. We must be forever vigilant of the need to continuously assess the operational safety of our plants, internalizing the lessons learned from TMI, and more recently, Davis-Besse. We must also identify a long-term solution to our nuclear waste problem.

It is fair also to acknowledge the benefits of nuclear power—being clean, reliable, and currently economic. I assert that the benefits outweigh the risks, implying that this generation alternative, along with the others, needs to be preserved.

Preserving the nuclear power option, may sound like a passive strategy, but the reality is that it requires coordinated actions by both the Government and the nuclear industry. I was pleased when the DoE announced the Nuclear Power 2010 Initiative. It was established to confront some of the challenges which are unique to nuclear investments. As part of this program, the DoE issued a solicitation inviting power companies to submit proposals to address two of the significant investment challenges, these being regulatory predictability and completion of designs.

The NuStart Energy Development, LLC, was formed solely for the purpose of responding to this solicitation. It was one of three industry consortia to submit a proposal. Since submitting my written testimony only a few days ago, I am pleased to announce that Florida Power and Light has also joined the consortium, making it now eight power companies and two reactor vendors.

Our proposal to the DoE spans a 7-year-period from 2004 to 2010. The total cost is $800 million, with the industry committed to providing one-half, or $400 million. The end result of this project will be a full demonstration of the NRC licensing process, and the completion of the design engineering work for the two selected U.S. reactors. Together these will significantly reduce the time to market for new plants and also alleviate some major areas of uncertainty.

Beyond the Nuclear Power 2010 program, however, is a need to financially incent first mover investors. Possible incentive mechanisms include those modeled after other energy and public works projects.

In summary, preserving the nuclear power option requires action. In the near term, we must fund the Nuclear Power 2010 Initiative, specifically $80 million for fiscal year 2005, to cover all three consortia proposals. In the long term, we must adopt energy policy that establishes methods to promote large capital investments into our energy sector while presenting reasonable risks to shareholders.

Thank you for the privilege to share these thoughts with you. I would ask that my written statement be placed in the record in its entirety.

Senator VOINOVICH. Thank you very much, Ms. Kray.

Mr. Jones.

STATEMENT OF BARCLAY JONES, PROFESSOR, DEPARTMENT OF NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Mr. JONES. Chairman Voinovich and Senator Carper, I am pleased to be here as representative of the nuclear engineering educational community. My background is listed in the front end of the material that I have submitted for the record.

What I would like to do is highlight a few issues that I brought up in the testimony, but would like to expand briefly upon. I listed four of the timely jobs that the NRC has before it. Those have been brought forward this morning.

There is discussion about whether there is sufficient manpower available to meet job demand. From the production of manpower point of view and where the universities fit in, it is unclear that the present shortfall in the production of nuclear engineers will satisfy the demand. The difference currently is in the order of hundreds per year.

We are increasing our number of undergraduates in the programs, but you must realize that as you add freshmen to programs, it is 4 years, at least, before they graduate and arrive on the work force scene. It is several year beyond that before you would say they are experienced to the point where they would be trusted to handle significant positions within the power companies, NRC and other positions into which they go.

So my urging to you is to keep track of the demographics and look where resources can be spent in order to ensure that the production of nuclear engineers will be there when needed.

The current work force demographic is very skewed to upper age levels. We have heard this morning of the shortfall of experienced people as retirements are occurring. We think that the universities can and will play a pivotal role, but their resource base is one that is limited by what the universities can afford to put into small programs which nuclear engineering programs typically are.

Nuclear engineering programs tend to be much smaller than those in mechanical, electrical, computer sciences, et cetera. Therefore, a demand for new faculty and for increased expenditures is hard fought by other departments within the university organization.

I indicated in my statement that it takes an enlightened administration to respond favorably to the nuclear engineering national needs. My institution has just gone through a 1-year review of whether our nuclear engineering program should be retained or dismantled. This is in a State with 11 operating reactors and over 50 percent of the electrical power supplied from nuclear power. We are the only university in the State with a nuclear engineering program. I am happy to report that the outcome was positive and we are now in a position of being able to recruit for new faculty.

It is worth noting that Illinois has a similar demographic in its work force with other nuclear engineering educational programs. Three of us are at or past retirement age. That is out of nine faculty, currently. To replace us and to have overlap requires immediate hiring. The internal competitive pressures are such that is difficult to gain in numbers. The future at Illinois and at sister institutions requires that Government aid, which has been coming from the Office of Nuclear Energy part of DoE, and other government and industry sources is very helpful. It supports fellowships, research and more recently infrastructure for the programs.

It has basically saved the day in a lot of cases for nuclear engineering departments.

But the number of departments has continued to shrink. So our ability to be able to produce the output required is still limited. Fortunately, the young people coming into universities are signing up in nuclear engineering departments in larger numbers. We think that, overall we will be able to supply an increased number of graduates and to sustain the discipline.

I would be happy to respond to other points that I have raised, if you have questions. I appreciate the opportunity to speak with you. I would ask that my written statement be placed in the record in its entirety.

Senator VOINOVICH. Thank you very much, Mr. Jones.

I really am interested, Dr. Jones, in this issue of where we are going to get the people to get the job done. Is it the Department of Energy that is providing you some help right now?

Mr. JONES. Yes, they have instituted various research programs which basically support the graduate side of the house, but these supply the grist, if you will, to sustain undergraduate programs as well. They have the Nuclear Engineering Education Research (NEER) program, which recently has had increased funding level. They also have had a Nuclear Energy Research Initiative (NERI) program in conjunction with National Laboratories and Industry. Unfortunately, that one has shrunk dramatically in funding. They also have introduced an International Nuclear Energy Research Initiative I–NERI which provides resources for the Federal role in International Cooperation on Energy Innovation. The Innovations in Nuclear Infrastructure and Education (INIE) program, which was established in FY 2002, strengthens the Nation's university nuclear engineering education programs through innovative use of the university research and training reactors and encouraging strategic partnerships between the universities, the DOE national laboratories, and U.S. industry. These are restricted to being run through universities. These programs are very helpful.

The fellowships and scholarships that DoE provides and that INPO provides, and that NRC, to a limited extent provides, are also very helpful. If you look back at the beginning of nuclear engineering in the late 1950's and throughout the 1960's and into the 1970's, the traineeships and fellowships that were provided at that time basically attracted the interest and talent that made the robust programs that initiated the discipline. I think we need to go back into that mode, where we have larger numbers of them to attract the quality people that are needed to sustain the industry, to sustain the security and oversight levels that we need for the plants, and to provide the needed continuing manpower.

Senator VOINOVICH. Do you have a national organization that you belong to?

Mr. JONES. Yes, it is an ad hoc one. It is called NEDHO, the Nuclear Engineering Department Heads Organization. I chaired it 10 or 12 years ago. It interacts and works closely with the Department of Energy, the Nuclear Energy Institute, the National Academy for Nuclear Training (Educational Assistance Program) of the Institute for Nuclear Power Operations (INPO) and with the American Nuclear Society, as well as other nuclear related entities.

Senator VOINOVICH. I would be very interested if you could get your organization to provide me with a memorandum or whatever that would lay out what you really think needs to be done in terms of the Federal Government's role in providing the people that we are going to need for this industry in this country.

I understand that some of the schools have closed down their nuclear engineering departments; is that correct?

Mr. JONES. That is correct. We are down to less than 30 now.

Senator VOINOVICH. How many were there before?

Mr. JONES. It started out in the 1970's and 1980's with about 60.

Senator VOINOVICH. Well, I would welcome that from you.

Mr. JONES. Absolutely.

Senator VOINOVICH. Without objection, so ordered.

[The referenced document follows on page 224.]

Senator VOINOVICH. Mr. Fertel, what is the industry doing about this also? You have to be as much concerned as the people in the NRC. You need them in the industry.

Mr. FERTEL. Actually, from NEI's perspective, we are actually very much involved with the program. We work very closely with NEDO, and actually with the American Nuclear Society and then with NRC and DoE looking at the manpower and womanpower the work force needs going out over the next 20 years and have identified where the real needs are.

For instance, Dr. Jones mentioned the fact that DoE supports the program. They are now going to support program for health physics schools because we are seeing that we are really shorted in health physicists going out over the next 10 years. That has been very useful.

We will provide you, Mr. Chairman, the results of the work that we have been doing which is an effort to be much more integrated across the entire community, not just the industry side, but really what Government thinks they will need, what the industry thinks it will need, and where we see the resources coming.

I was at a DoE Advisory Committee meeting in the last two days and they talked about the program that was just mentioned. Their program is doing pretty well there. It is run by Bill Magwashot. They are spending about $21 million supporting everything from fellowships and scholarships to research reactors at the universities.

While we have lost a number of schools and, in fact, lost three research reactors in recent years, the trends are all much better now. School programs are growing. One of the things that DoE has been able to facilitate the universities working together rather than competing with each other to try to use resources. That has actually turned out to be a positive for everybody.

We will share with you, Mr. Chairman, the work that NEI has done with the others. It is not just us.

Senator VOINOVICH. I would like to see it just to see where you are and where you think you need to go and what role you should be playing because you are interested in it and the university should be in it, as well as DoE.

Without objection, so ordered.

[The referenced document follows on page 239.]

Mr. FERTEL. We just completed a survey that will be very insightful as to where the resource needs really are.

Senator VOINOVICH. Are you familiar with the Partnership for Public Service?

Mr. FERTEL. Just vaguely.

Senator VOINOVICH. Well, there is a guy named Sam Heyman that contributed $25 million to set up this Partnership for Public Service. The whole aim of the organization is to make universities knowledgeable of the needs that we have in the Federal Government for the best and brightest people. Many of the industries in this country are participating in that program.

Dr. Jones, are you familiar with the Partnership for Public Service?

Mr. JONES. No, I am not.

Senator VOINOVICH. I will get you information on it.

They are out talking to universities about the opportunities that are available and how they can help them advertise those opportunities.

What do you attribute the fact that you are getting more students than you did before, more interest?

Mr. JONES. I think partly with the support that has come in from the several programs mentioned earlier. The job market is good, the salaries are high. There is an enhanced recruiting program that goes into the high schools to make the discipline more visible to the incoming student. I think there are a variety of these activities that are occurring and making the difference. In addition, we are working much harder at attracting students than we have previously.

Senator VOINOVICH. Good. Dr. Jones, do not retire. We need you.

In this Energy bill, we do have some really good provisions that will help to deal with that. I am trying to get some flexibility through. This specifically deals with this retirement and bringing people back on a part-time basis to take care of the transition and move along. There is other legislation that we have that bring in people from outside on a contract basis to come in and help them out. There is just a lot more flexibility for them.

There are little simple things like if they go out and hire somebody that is maybe in the middle of their career, that when they come to work for the Federal Government they do not have to wait 15 years before they get a month's vacation. There are a lot of little simple things that we could be done to make it a lot easier.

But I am very interested in that. I have another hat and that is the Oversight of Government Management in the Federal Work

Force. So that is why I am so interested in this whole issue of human capital.

The other question I would like all of you to comment on, if you feel that you have something constructive to say about it is this whole little debate I had with the members of the Commission in regard to safety and the safety culture.

Mr. Fertel, I think if I heard you right, you said we are not there yet. I am not asking for micro-managing, but it seems to me that there are certain kinds of standards that the NRC can recommend through regulation or what have you, and then have people that are onsite that are aware of the standards. They said 7 years, but I am not sure it should be 7 years. That may be too long for people to be at a place. I think maybe after three or 4 years it is time to go because you do, after a while, get kind of used to the "Old Boy" network and stuff.

It seems to me that if you had some really competent people that were paid competitively, they could be looking after a lot of stuff. It is a no-brainer, I think, to find out that people are pretty sloppily about safety.

Mr. FERTEL. First of all, on Davis-Besse, there is no excuse for the licensee, for the NRC, or actually even for the industry overall because SAMPO had gone into Davis-Besse on evaluations and not identified the problem. So it was a total breakdown of every aspect of what you should look for to make sure that those things do not happen.

David mentioned Three Mile Island 25 years ago. He is concerned that we are maybe on the crest of another situation like that. After Three Mile Island, as he said, INPO was formed, the Institute of Nuclear Power Operations, an awful lot of other things happened, too, as an industry and as regulators at NRC.

As an industry, we changed the whole way we look at training. We got into a systematic approach to training. We put simulators at every site. There is a whole different regime for training.

We looked at procedures, the way our operators react to events. They went from basically thinking we could figure out every event and you could just take Event "A" and I will react to it, to a process that is more symptom based, almost like doctors treat patients when they come in. What are the symptoms? How do I stabilize the patient? How do I stabilize the reactor? It was a massive culture change.

I think when I look at the Davis-Besse event, and when I look at it, I am saying, as a sort of collective group of people in the industry, what we felt was that it was a breakdown in safety. Now, NRC has a role to play in helping learn from that. The industry has a role to play in the aggregate, which is INPO, NEI, and others. Then the licensees have a role to play. I think that the struggle you are hearing when you spoke to the Commissioners, and the struggle that we would have is figuring out the right roles for each of those.

You are exactly right. The NRC should set standards. They should set regulatory standards on safety that if you are meeting, it is clear that you are focused on the right things. Beyond that, the industry, and what was alluded to by the Chairman was the industry is responsible for management. What we do not want to ever do is take that accountability away. You want to maintain the accountability of safety as job one from the top CEO on down through the people on the floor doing the work.

INPO has now gone out and basically did a self—assessment on why they did not find a safety culture people. They are out talking to people at the plants as part of their evaluations regularly. The type of safety culture that allowed Davis-Besse to occur should have been identified. So they have now reassessed how they do their evaluations because there was a failure there.

They have also developed a safety culture program that we are now going to out to share with the rest of the industry.

How would you know good safety culture when you saw it? How would you know it when it was not there? Some of the easy things that people say is: If you walk around the plant, basically cleanliness is an indication. Well, if you look at what was going on at Davis-Besse, changing filters every week rather than monthly, is an indication of a problem.

It should have been picked up. Some of this is not rocket science. It is a breakdown. I think that figuring out where you regulate and where you make sure things are visible, and I think using a resident much more effectively is important. You commented that those are your really important people. Get them trained the right way. I think the Commission has heard that. I think it is hard for a resident to look at everything.

Coming over here in a car, I was talking with Dr. Jones and he said, “Well, what does the resident look for?” I said, “Well, maybe that is one of the things that NRC has to reassess. Rather than checking every little thing, they should be looking for bigger and broader indications of problems.”

I would encourage right now at this point this. We are very seriously looking, from an industry standpoint, what do you do about the Davis-Besse experience? Complacency is the worst thing that can happen in our industry. Everybody knows it. Everybody says it. It has been said repeatedly by NRC Commissioners.

Senator VOINOVICH. I want to tell you something. The reason I am interested in this is because I support nuclear power.

Mr. FERTEL. I understand that, sir. You want it to succeed.

Senator VOINOVICH. But the fact of the matter is that you are not going to have more nuclear power until you resolve some issues. One of the big issues over the years has been, and it has prevented us from moving power, is? What do we do with nuclear waste? We think that problem has been solved with Yucca Mountain and so forth. We still have a long way to go with that.

But the fact of the matter is that if the public feels that these are fail-safe, that we have a responsible way of dealing with nuclear waste, you will be able to get the support that we need to move in that direction. So we agree. We should have coal. We should have nuclear. We should have all of it and be working toward renewables; the whole thing.

But if you do not have the regulation, if you do not have the environment, then in terms of support for that, it is difficult. The same thing is even with investors. You are going to go out and try to find investors to put it in. If you have a problem of: “Where do you put this stuff? I have these problems with safety things. The public is not for it." Then I do not want to invest in one of these deals.

That is what we are trying to do here. It seems to me that the industry itself should be way out in front on everything you do.

Mr. FERTEL. Well, it certainly is. David's comment about what he have seen on the industry side when we change people around when there is a problem, I think is true. I think maybe that is a lesson that NRC could look at. It may not be standards that have to be changed, even though there probably are some. It may be the way people look at things when they are there. Your comment that if you are there for a long time, it all blends together.

It may not even be an "Old Boy" network as much as I have always seen it look like this. I am not seeing a difference. It is not the kind of eyes you want looking at stuff.

What I would like to do is probably share with you what we are doing in the industry, and share with you what INPO is doing and maybe offer some suggestions on what we think NRC could do. I am not sure that there is a silver bullet stand that they could issue. I think it is more of a menu of things that we all need to do to assure that safety culture is correct and that safety is always on everybody's mind.

Senator VOINOVICH. Thank you.

Mr. Lochbaum, do you want to comment on that?

Then we are going to have to wrap it up. First it was the President, and now it is the Secretary of Defense who is going to meeting with the members of the Senate. I want to make sure I get over there and hear what he has to say.

Mr. LOCHBAUM. Just very briefly. I just wanted to say that the NRC has a safety culture problem of its own. Surveys conducted by the Inspector General and the GAO have shown that, for example, that the NRC workers who have raised safety issues, one-third of them feel that they have been retaliated against for having done so. Those kinds of problems that Davis-Besse had to fix, we feel the NRC needs to fix internally so it has a good safety culture, as well as all the plants in the country. Thank you.

Senator VOINOVICH. I would be interested in working with the GAO and maybe getting input from you folks is: What is the standard is that we use to make sure that these things that have been long standing are taken care of?

I think that is the problem. I think we should lay this out, work with some people, get the standards, and then just basically say, "Here are the problems." Then when we come back for the next hearing, we want to do some things in the office beyond the hearings. But I am just saying that you have some measuring device to know whether or not you actually have made an improvement in the area.

Mr. LOCHBAUM. One thing the NRC has incorporated into its reactor oversight program is a formal feedback mechanism every year where they go out and see: "Have we achieved the expectation we set out for this?" I think broadening that and continuing that is a good way to see if whatever fixes you implement, did you achieve what you were trying to do, and not cause some unintended consequences somewhere else.

So I think that NRC initiative was a good thing to do. I think they should continue that.

Senator VOINOVICH. Mr. Fertel, Mr. Lochbaum, or anybody, maybe one of the nicest things that we could do for the NRC would be to maybe find the best program in the country that monitors those kinds of things from a business point of view, and institute it there. It seems to me that that is missing. Maybe we could get a little public/private partnership going here and come in and help them out with that. It seems that they have had an ongoing problem with that.

Like Mr. Diaz, they are all conscientious people that want to do the right thing. I do not mean hiring a consultant, but maybe the industry should think about that. This is an Agency that is very important to you.

Dr. Lochbaum, it is important to you. I challenge you. Could we sit down with them and say: "Here is what you should do. Find the best outfit in the country and say: 'Would you be willing to come in and spend some time over there?' "

When I was Governor, I had private sector people to come in and spend 6 months and some of them for a year pro bono to help shape up some of the operations that we had in city and State government. It is very frustrating to me that we have these lessons learned but from Mr. Lochbaum's point, we have had lessons learned and lessons learned. We have had GAO reports, and we have had inspectors generals. I do not think that these are people who do not care. But maybe they need some help.

Mr. LOCHBAUM. We did send a letter to the Commission on February 2nd volunteering to help on the safety culture issues. We thought they did a good job in addressing the Hope Creek and Salem issues. We volunteered to help work with the industry and with the NRC to figure out what is the right answer.

Senator VOINOVICH. I am going to suggest that to Mr. Diaz that maybe we could get a little group together in my office and talk about it and see where we can go.

Mr. LOCHBAUM. We would be glad to.

Senator VOINOVICH. That would be very good.

I want to thank you very much. You have been very patient. I appreciate your conscientiousness. We have a challenge ahead of us.

Thank you.

[Whereupon, at 1 p.m., the subcommittee was adjourned, to reconvene at the call of the chair.]

[Additional statements submitted for record follow:]

STATEMENT OF CHAIRMAN NILS DIAZ, NUCLEAR REGULATORY COMMISSION

Mr. Chairman and members of the subcommittee, it is a pleasure to appear before you today with my fellow Commissioners to discuss the Nuclear Regulatory Commission's programs. We appreciate the past support that we have received from the subcommittee and the committee as a whole, and we look forward to continue working with you.

As you know, the NRC's mission is to license and regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment. The Commission does not have a promotional role—rather, the agency seeks to ensure the safe application of nuclear technology if society elects to pursue the nuclear energy option. The Commission recognizes, however, that its regulatory system should not establish inappropriate impediments to the application of nuclear technology. Many of the Commission's initiatives over the past several years have focused on maintaining or enhancing safety and security while simultaneously improving the effectiveness and efficiency of our regulatory system.

With your permission Mr. Chairman, I will highlight a few of our ongoing initiatives and achievements.

REACTOR SAFETY PROGRAMS

The past 3 years have seen the maturing of the reactor oversight process. We believe that this program is a significant improvement over the former inspection, enforcement, and assessment processes. We received external recognition of the effectiveness of our Reactor Inspection and Performance Assessment program when the Office of Management and Budget evaluated it using its Performance Assessment Rating Tool (PART) and awarded the top rating, "effective," a rating achieved by only 11 percent of the Federal programs assessed. One of its strongest attributes is its transparency and accessibility to members of the public. You will find performance indicators and inspection findings for every power reactor on NRC's public web site page, as well as our current assessment of each reactor's overall performance. The transition to the reactor oversight process has gone well, and we will strive to make further improvements.

Overall, the industry has performed well. As of the end of CY 2003, there were two plants designated for the highest level of scrutiny under the reactor oversight process, the Cooper plant in Nebraska and the Point Beach plant in Wisconsin. In addition, the Davis-Besse plant in Ohio has been treated under our Manual Chapter 0350 Startup Oversight Process. The Cooper and Point Beach plants have received significant attention from our regional and headquarters offices, and we are confident that these plants are on a path to resolving long-standing problems.

Over the past 2 years, the NRC staff has devoted significant resources for enhanced regulatory oversight of the Davis-Besse plant following the discovery of extensive degradation of the reactor vessel head. After an extgensive plant recovery program and comprehensive corrective actions by the licensee, FirstEnergy, and considerable NRC inspection and assessment, the staff determined that there was reasonable assurance that the plant could be safely restarted and operated. This decision was made in a deliberate manner, based on sound regulatory and technical findings, and in accordance with the requirements of Federal statutes and NRC regulations. On March 8, 2004, the NRC staff gave approval for the restart of Davis-Besse. In addition, the staff issued a confirmatory Order requiring independent assessments and inspections at Davis-Besse to assure that long-term corrective actions remain effective. The NRC's oversight panel will continue to coordinate the inspection and regulatory activities for Davis-Besse until plant performance warrants resumption of the normal reactor oversight process.

We acknowledge the extensive interest in, and concerns about, the restart of Davis-Besse by area residents; public interest groups; Federal, State, and local officials; and others. We have conducted our regulatory responsibilities in an open and candid manner, keeping the public informed to the maximum extent possible at each step of the process. We have not been able to share the results of our Office of Investigations' reports because those have been referred to the Department of Justice for its consideration. Those reports have, however, been fully considered by NRC staff prior to restart. We have had extensive communication with our stakeholders, including establishing a web site and issuing monthly newsletters. Also during the past 2 years, the NRC staff conducted 75 public meetings on Davis-Besse most of these meetings were held in the vicinity of the plant and held 50 briefings for Federal, State, and local government officials. The oversight panel will continue to hold periodic public meetings near Davis-Besse with FirstEnergy officials to review the status of ongoing activities at the plant.

Concurrently, we have undertaken a significant and critical review of our programmatic and oversight activities to evaluate our own actions associated with the reactor vessel head degradation at Davis-Besse. These actions have considered the Davis-Besse Lessons Learned Task Force Report. The Task Force completed its review in September 2002 and issued a report that contained a number of recommendations for improvements to the reactor research, oversight, and licensing programs. These recommendations are being implemented as part of four action plans, encompassing: (1) stress corrosion cracking, (2) operating experience program effectiveness, (3) inspection, assessment and project management guidance, and (4) barrier integrity requirements. Of the 49 recommendations, 16 were completed in 2003, including all seven high priority items scheduled to be completed that year. Inspection program guidance was revised to address the high-priority recommendations regarding followup to long-standing equipment issues and oversight of plants in extended shutdowns. Enhancements to inspector training programs were initiated. Guidance was issued regarding the adequate documentation of certain decisions. We continue to work on addressing the remaining recommendations and are making significant progress. Except for three items, all other high-priority recommendations will be completed by the end of 2004. The remaining high priority items will be completed during 2005.

In April 2004, we completed an examination of reactor vessel cladding and structural analyses. Based on these efforts, the staff concluded that near-term vessel failure was unlikely and that it was highly likely the vessel could have operated safely for at least several more months following the February 2002 Davis-Besse shutdown. As you are aware, the plant restarted with a new reactor vessel head; thus, the degraded condition no longer exists.

The NRC's Office of the Inspector General conducted an inquiry into our oversight of the Davis-Besse reactor vessel head degradation. The issues identified in the IG's report are similar to a subset of those identified by the Lessons Learned Task Force; and as such, corrective actions have either been completed or are in progress for each of the IG's findings. The IG was particularly concerned with the flow of information within the agency—communication between headquarters, the regional offices, and the resident inspector staff. We are committed to improving this communication and have already witnessed a lowering threshold for raising issues. For example, there has been a significant increase in the scope and level of detail discussed during daily status meetings among NRC regional, headquarters, and site offices, as well as improvements in internal communications. We have also placed renewed emphasis on improving communication with the international nuclear community to ensure that new issues are promptly communicated as they arise. Going forward, we are dedicated to improving our inspection and assessment programs to prevent recurrence of this or similar significant challenges to safety.

REACTOR LICENSING PROGRAMS

Let me now turn to significant achievements in our reactor licensing programs. The reactor licensing program ensures that operating nuclear power plants maintain adequate protection of public health and safety throughout the plant's operating life. NRC licensing activities include reviewing license applications and changes to existing licenses, reviewing reactor events for safety significance, and improving safety regulations and guidance. In fiscal year 2003, the NRC met or exceeded all established measures for the timeliness and quantity of completed nuclear power plant licensing-related actions.

The reactor licensing program's timeliness in responding to licensee requests has improved dramatically since 1997. At the end of fiscal year 2003, 96 percent of licensing actions in the working inventory were less than 1 year old and 100 percent of licensing actions in the working inventory were less than 2 years old. We also completed 500 other licensing activities, most of which were associated with identification and resolution of emerging technical issues. For example, we issued generic communications to the industry alerting them to emerging issues such as leakage from reactor pressure vessel lower head penetrations, the potential impact of debris blockage on emergency sump recirculation at pressurized-water reactors, and control room habitability. We will not be able to sustain this level of timeliness in fiscal year 2004 because of a very large volume of security licensing actions which we are giving the highest priority. We are managing our licensing action inventory to ensure that appropriate timeliness goals are being established for each action, and that no safety-significant issue is left untreated.

A significant type of reactor licensing action, called a power uprate, is a request to raise the maximum power level at which a plant may be operated. Improvement of instrument accuracy and plant hardware modifications have allowed licensees to submit power uprate applications for NRC review and approval. The focus of our review of these applications has been and will continue to be on safety. In addition, we continue to monitor operating experience closely to identify issues that may affect power uprate implementation.

Power uprates range from requests for small increases of less than 2 percent based on the recapture of power measurement uncertainty, to large increases in the range of 15 to 20 percent that require substantial hardware modifications to the plants. In all instances, the NRC must be satisfied that appropriate safety margins remain. To date, the NRC has approved 101 power uprates which have safely added approximately 4175 megawatts electric to the nation's electric generating capacity and is the equivalent of about four large nuclear power plants.

Currently, the NRC has four power uprate applications under review and expects to receive an additional 25 applications through calendar year 2005. This would add approximately 1760 megawatts electric to the nation's electric generating capacity. The NRC recently issued a Review Standard for Extended Power Uprates (i.e., uprates that increase the current power by 7 percent or more), which is available publicly, that enhances the NRC's focus on safety and improves consistency, predictability, and efficiency of these reviews.

As stated earlier, the NRC monitors operating experience at plants that have implemented power uprates. Cases of steam dryer cracking and flow-induced vibration damage affecting components and supports for the main steam and feedwater lines have been observed at some of these plants. We conducted inspections to identify the causes of several of these issues and evaluated many of the repairs performed by the licensees. We continue to monitor the industry's generic response to these issues and will consider additional regulatory action, as appropriate.

License renewals are another significant type of licensing action. In 2003, thirteen units—North Anna Units 1 and 2 and Surry Units 1 and 2 in Virginia, Peach Bottom Units 2 and 3 in Pennsylvania, Saint Lucie Units 1 and 2 in Florida, Fort Calhoun in Nebraska, McGuire Units 1 and 2 in North Carolina, and Catawba Units 1 and 2 in South Carolina—had their licenses extended for an additional 20 years. Thus far in 2004, 2 units—H.B. Robinson, Unit 2 and V.C. Summer, Unit 1 in South Carolina—have had their licenses renewed. That brings the total of renewed reactor licenses to twenty-five. The staff currently has license renewal applications under review for seventeen additional units. In every instance, the staff has met its timeliness goals in carrying out the safety and environmental reviews required by our regulations. If all of the applications currently under review are approved, approximately 40 percent of the nuclear power plants in the U.S. will have extended their operating licenses. We expect that almost all of the 104 reactors licensed to operate will apply for renewal of their licenses. The staff will continue to face a significant workload in this area with the sustained strong interest in license renewal by nuclear power plant operators due to many benefits of license renewal.

While improved performance of operating nuclear power plants has resulted in significant increases in their electrical output, it is expected that continuing increased demands for electricity will need to be addressed by construction of new generating capacity. As a result, industry interest in new construction of nuclear power plants in the U.S. has recently emerged. The NRC is ready to accept applications for new power plants. New nuclear power plants will likely utilize 10 CFR Part 52, which provides a stable and predictable licensing process. This process ensures that all safety and environmental issues, including emergency preparedness and security, are resolved prior to the construction of a new nuclear power plant. The design certification part of the process resolves the safety issues related to the plant design, while the early site permit process resolves safety and environmental issues related to a potential site. The issues resolved in these two parts can then be referenced in an application which would lead to a combined construction permit and operating license, referred to as a combined license. This license contains inspections, tests, analyses, and acceptance criteria that must be attained before the facility can commence operation.

As you know, the NRC has already certified three new reactor designs. These designs include General Electric's Advanced Boiling Water Reactor and Westinghouse's AP600 and System 80+ designs. In addition to the three advanced reactor designs already certified, there are new nuclear power plant technologies which some believe can provide enhanced safety, improved efficiency, and lower costs. The NRC staff is currently reviewing the Westinghouse AP1000 design certification application. The staff has met all scheduled milestones for the AP1000 design review and is on track to issue its recommendations to the Commission this fall on whether the final design should be certified. This recommendation would be followed by the design certification rule in 2005. The NRC staff is also actively reviewing pre-application issues on two additional designs and has four other designs in various stages of pre-application review.

In September and October of last year, we received three early site permit applications for sites in Virginia, Illinois, and Mississippi where operating reactors already exist. The staff has established schedules to complete the safety reviews and environmental impact statements in approximately 2 years. The mandatory adjudicatory hearings associated with the early site permits will be concluded after completion of the NRC staff's technical review. As with design certification rulemaking, issues resolved in the early site permit proceedings will not be revisited during a combined license proceeding absent new and compelling information.

SECURITY

During the past year, the Commission has continued to enhance security of licensed nuclear facilities and materials through close communication and coordination with other agencies in the intelligence and law enforcement communities and with the Department of Homeland Security. For commercial nuclear power reactors, we issued Orders in April 2003 to impose a revised design basis threat (DBT) and enhanced requirements for security officer work hour limits (to ensure officers remained fit for duty) and standards for their training and qualification. With these requirements, we have established an enhanced set of security requirements for power reactors that is appropriate in the post-9/11 threat environment. The work-hour limits and the previously imposed access authorization enhancements have been fully implemented. Revisions to site security plans (including training and qualification) and site modifications to provide protection against the revised DBT have been submitted to the NRC for review and implementation. The review is in progress with full implementation scheduled for October 2004. We have redefined our baseline inspection program for security and are phasing in the new inspection program consistent with the new requirements. As a complement to licensee security measures, NRC is working with the Department of Homeland Security and the Homeland Security Council, and other partners to enhance the integrated Federal, State, and local response to threats.

We continue to conduct force-on-force exercises to evaluate licensees' defensive capabilities and identify areas for improvement. During 2003, we implemented a pilot force-on-force exercise program and conducted exercises at 15 power plants to evaluate the significance and impact of enhanced adversary characteristics and associated compensatory measures and to develop program improvements to enhance the realism and effectiveness of the exercises. In 2004, we are conducting exercises roughly twice a month to evaluate the effectiveness of program enhancements including the use of Multiple Integrated Laser Enhancement System (MILES) equipment, adversary force standards, improved controller training, and other enhancements to improve the realism of the exercises while maintaining safety of both the plant and personnel. In November of this year, we will begin full implementation of the triennial force-on-force exercise program for power reactors.

In the area of materials security, we have coordinated closely with State agencies and affected licensee groups to develop additional security requirements for two classes of materials licensees who possess high-risk radioactive materials (irradiator licensees and manufacturers and distributors of radioactive materials). We are preparing proposed Orders for other materials users. We are developing enhanced import and export controls for high-risk sources. In addition, we have developed an interim data base for high-risk sources and, with the assistance of other Federal agencies as well as the States, we are laying the foundations for the national source tracking system. We are also engaged with other Federal agencies to increase security involving transportation of large quantities of radioactive materials and are conducting a comprehensive review of material control and accounting requirements and practices.

The NRC has completed most of its work on vulnerability assessments and identification of mitigation strategies for a broad range of threats to NRC-licensed activities involving radioactive materials and nuclear facilities. Thus far, the results of these studies have validated the actions NRC has taken to enhance security. These efforts have continued to affirm the robustness of these facilities, the effectiveness of redundant systems and defense-in-depth design principles, and the value of effective programs for operator training and emergency preparedness. Our vulnerability studies confirm that the likelihood of damaging the reactor core and releasing radioactivity that could affect public health and safety is low. Further, the studies confirm that even in the unlikely event of a radiological release due to terrorist use of a large aircraft, NRC's emergency planning basis remains valid. The aircraft vulnerability studies also indicate that significant damage to a spent fuel pool is improbable, that it is highly unlikely that the impact on a dry spent fuel storage cask would cause a significant release of radioactivity, and that the impact of a large aircraft on a transportation cask would not result in a release of radioactive material. Thus, we believe that nuclear power plant safety, security, and emergency planning programs continue to provide reasonable assurance of adequate protection of the public health and safety.

In summary, NRC licensees had robust private sector security programs long before the attacks of September 11, 2001, and those programs have been further enhanced over the past 30 months. We continue to ensure that our licensees implement effective security programs for the current threat environment. In addition, we continue to work closely with our Federal, State, and local partners and with the private sector to ensure an appropriate integrated response to threats to licensed nuclear facilities and materials.

EMERGENCY PREPAREDNESS PROGRAM

The events of September 11, 2001, highlighted the need to examine the way the NRC is organized to carry out its safeguards, security, and incident response functions. Consequently, the NRC has taken several actions in response to the new environment, including the issuance of compensatory measures and Orders to licensees, re-examination of the emergency planning basis, creation of the Office of Nuclear Security and Incident Response, and evaluation of reactor integrity to new threats. In addition, the NRC as well as our stakeholders have become increasingly aware of the importance of emergency preparedness to mitigating the effects of potential security threats. Along with this increased awareness, the NRC recognizes the need for increased communication of our emergency preparedness activities with internal and external stakeholders, including the public; industry; the international nuclear community; and Federal, state, and local government agencies. As a result, the NRC established the Nuclear Emergency Preparedness Project Office. The Project Office is responsible for the continuing development and refinement of emergency preparedness policies, regulations, programs, and guidelines for both currently licensed nuclear reactors and potential new nuclear reactors. The Project Office provides technical expertise regarding emergency preparedness issues to other NRC offices and also coordinates and manages emergency preparedness communications with internal and external stakeholders including the public, industry, the international nuclear community, and Federal, State, and local government agencies.

MATERIALS PROGRAM

The NRC, in partnership with the 33 Agreement States, conducts a comprehensive program to ensure the safe use of radiological materials in a variety of medical and industrial settings. As some of NRC's responsibilities, including inspection and licensing actions, have been assumed by Agreement States, our success depends in part on their success, and we closely coordinate our activities with the States.

Recently, the Commission has completed a complex rulemaking on the medical uses of byproduct material—a rulemaking in which there was significant interaction with Congress. We are now implementing that rule and assuring that compatible regulations are adopted by the Agreement States.

The NRC is developing a web-based materials licensing system. The system is expected to provide a secure method for licensees to request licensing actions and to view the status of licensing actions on the Web. In addition, the NRC, with assistance from other Federal agencies and the States, is creating a National Source Tracking System that will be used to monitor radioactive sources in quantities of concern with respect to a radiological dispersal device (RDD) threat. The development of the National Source Tracking System will remain a high priority effort.

The Commission has also implemented a major rule change related to large fuel cycle facilities. This rule requires licensees and applicants to perform an integrated safety analysis that applies risk-based insights to the regulation of their facilities. Major licensing reviews currently underway, or soon to be submitted, will test the new rule. These licensing reviews include two new gas centrifuge enrichment facilities.

The first proposed enrichment facility would be located in New Mexico and the second in Ohio. Louisiana Energy Services submitted an application for its facility in Eunice, New Mexico, to the NRC in December 2003. U.S. Enrichment Corporation is expected to submit its application to the NRC for its site in Piketon, Ohio, in August 2004. The Commission has directed its staff to conduct reviews of the applications for the two proposed enrichment facilities in a timely manner. The Commission will endeavor to identify efficiencies and provide the necessary resources to reduce the time the agency needs to complete these reviews.

The staff is currently reviewing a request to authorize construction of a mixed oxide (MOX) fuel fabrication facility at the Savannah River site in South Carolina as part of the Department of Energy's program to dispose of excess weapons grade plutonium. The staff is also providing support to its Russian counterparts regarding the licensing of a Russian MOX facility that will have a design similar to the U.S. facility.

In addition to the new facilities discussed above, the NRC regulates several other existing fuel facilities. NRC's oversight of these facilities includes licensing actions, inspection, enforcement, and assessment of licensee performance. Our Fuel Facilities Licensing and Inspection program was the second of our regulatory programs assessed under the Office of Management and Budget's Performance Assessment

Rating Tool (PART) and awarded the top rating, “effective,” a rating achieved by only 11 percent of the Federal programs evaluated.

NUCLEAR WASTE PROGRAM

The NRC staff has made progress on a wide array of programs relating to the safe disposal of nuclear waste. A central focus of these programs is to ensure that the agency is prepared to review an application by the Department of Energy to construct a high-level radioactive waste repository at Yucca Mountain, Nevada. Progress has been made in our pre-application interactions with DOE in addressing technical issues that are significant to repository performance. The application is expected to be submitted to NRC in December 2004. The NRC would make a docketing decision on the license application, and, if docketed, review the license application and make a determination regarding to what extent the Yucca Mountain Final Environmental Impact Statement can be adopted.

We are also preparing to conduct a related licensing proceeding. Our preparations include the creation of an information technology system to handle the large number of complex documents that will be involved and the leasing of a hearing facility near Las Vegas, Nevada. This licensing proceeding will present the NRC with a formidable challenge and the technical issues involved will be substantial. Moreover, no single NRC decision or set of decisions, since the Three Mile Island accident, is likely to be scrutinized as closely as those concerning this one-of-a-kind facility.

In our waste program, the NRC staff also has a substantial effort underway in the area of dry cask storage of spent reactor fuel. Storage and transport cask designs continue to be reviewed and certified. Independent Spent Fuel Storage Installations (ISFSIs) continue to be licensed and inspected. The Atomic Safety and Licensing Board currently is expected to issue its final decision on the proposed Private Fuel Storage ISFSI in Utah early in 2005. The Surry ISFSI in Virginia is the lead facility for license renewal. Indeed, our workload related to ISFSIs and dry cask storage in general will increase substantially in the years ahead. This projection is based on licensees’ plans to adopt dry cask storage at their sites. We are currently formulating a major research program, the Package Performance Study, which will include a demonstration test of the robustness of NRC-certified spent fuel transportation casks.

The NRC staff is also continuing to make significant progress in ensuring the decommissioning of contaminated sites. The staff identified several policy issues requiring Commission direction that will help expedite decommissioning under NRC’s License Termination Rule, and the Commission has provided the necessary guidance. Complicated decommissioning sites that pose technical challenges include the Safety Light site near Bloomsburg, Pennsylvania. We are currently working with the Environmental Protection Agency to have this site included on the National Priority List to make other Federal resources available for the cleanup of this site.

HUMAN CAPITAL

The NRC is very dependent on a highly skilled and experienced work force for the effective execution of its activities. The Commission’s human capital planning integrates strategies for finding and attracting new staff, and for promoting employee development, succession planning, and retention. The Commission has developed and implemented a strategic work force planning system to identify and monitor its human capital assets and needs and to address critical skills shortages. This includes the use of an agency-wide online skills and competency system to identify gaps in needed skills; the ongoing review of NRC’s organizational structure to align with its mission and goals; and the development of a web-based staffing system that includes online application, rating, ranking, and referral features. The agency has also implemented two leadership competency development programs to select high-performing individuals and train them for future mid-level and senior-level leadership positions. In addition, the agency has continued to support its fellowship and scholarship programs and identified a significant number of diverse, highly qualified entry-level candidates through participation in recruitment events and career fairs.

NRC is utilizing a variety of recruitment and retention incentives to remain competitive with the private sector. So far we have been successful in attracting and retaining new staff, particularly at entry levels. Nonetheless, it is likely to become more difficult for NRC to hire and retain personnel with the knowledge, skills, and abilities to conduct the safety reviews, licensing, research, and oversight actions that are essential to our safety mission. Moreover, the number of individuals with the technical skills critical to the achievement of the Commission’s safety mission is rapidly declining in the Nation, and the educational system is not replacing them. The maintenance of technically competent staff will continue to challenge governmental, academic, and industry entities associated with nuclear technology for some time to come.

BUDGET

The NRC has proposed a Fiscal Year 2005 budget of $670.3 million. In developing the budget, the Commission has ensured that we continue only those programs that are effective in meeting our mission and goals. Even with our efforts to be more efficient in our utilization of resources, we must still request a Fiscal Year 2005 budget increase of approximately 7 percent ($44 million) over the Fiscal Year 2004 budget for essential activities. This budget proposal will allow the NRC to continue to protect the public health and safety, promote the common defense and security, and protect the environment, while providing sufficient resources to address increasing personnel costs and new work. Approximately 32 percent ($14 million) of the budget growth is for personnel costs, primarily the pay raise that the President has authorized for Federal employees. The remaining increase supports our High-Level Waste and Nuclear Reactor Safety programs. We are requesting an increase of approximately $30 million for our High-Level Waste program to initiate the review of the anticipated DOE application to construct a high-level waste repository at Yucca Mountain and to conduct a Package Performance Study, which will confirm that our regulations provide for the safe transportation of spent nuclear fuel even under accident scenarios. We are also requesting an increase of approximately $10 million for our Nuclear Reactor Safety programs primarily to keep pace with industry interest in new reactor initiatives and to strengthen our reactor inspection and performance assessment activities. These increases are offset by a decrease of approximately $10 million in our Homeland Security programs for completed homeland security activities.

LEGISLATIVE NEEDS

Over the years, the NRC has repeatedly expressed its support of enactment of legislation needed to strengthen the security of facilities regulated by the Commission. Although we did not support all the provisions contained in bills that addressed nuclear security in the first session of this Congress, we were encouraged by Congressional action on the subject. Although, the Commission has used existing authority to ensure robust security for nuclear power plants and high risk radioactive materials, provisions that the Commission supports would provide the statutory authority for steps that we believe should be taken to further enhance the protection of the country's nuclear infrastructure and prevent malevolent use of radioactive material. In particular, the Commission supports enactment of the nuclear security-related provisions contained in H.R. 6, as approved by the conferees on that bill in the last session of this Congress, and S. 2095, which has been introduced in this session.

The proposals that the Commission believes to be most important are: (1) authorization of security officers at NRC-regulated facilities and activities to receive, possess, and, in appropriate circumstances, use more powerful weapons against terrorist attacks, (2) enlargement of the classes of NRC-regulated entities and activities whose employees are subject to fingerprinting and criminal history background checks, (3) Federal criminalization of unauthorized introduction of dangerous weapons into nuclear facilities, (4) Federal criminalization of sabotage of additional classes of nuclear facilities, fuel, and material, (5) authorization for NRC to carry out a training and fellowship program to address shortages of individuals with critical nuclear regulatory skills, and (6) extension of NRC's regulatory oversight to discrete sources of accelerator-produced radioactive material and radium–226. All but the last of these are included in H.R. 6 and S. 2095.

In addition, enactment of the following proposals would enhance the NRC's ability to protect the public health and safety:

(1) long-term extension of the Price-Anderson Act;

(2) authorization to charge Federal agencies fees for licensing and inspections, rather than recouping the costs of these activities through charges to other licensees;

(3) authorization for costs of security-related activities to be covered from the general fund (except for fingerprinting, criminal background checks, and security inspections);

(4) elimination of NRC's antitrust review authority over new power reactor license applications;

(5) clarification of the length of combined construction permits and operating licenses for new reactors;

(6) allowing rehired annuitants to receive full pay from the NRC for their services without reduction in pension payments;

(7) authorization to compensate individuals with critical skills at rates competitive with rates paid to persons with similar skills in the private sector;

(8) modification of the organizational conflict of interest provisions in the Atomic Energy Act to allow the agency to engage valuable expertise at a national laboratory that also performs work for the nuclear industry; and

(9) authorization to establish and participate in science, engineering, and law partnership outreach programs to increase the participation of Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribes.

All but the last three proposals are included in H.R. 6 and S. 2095. We look forward to working with you on the enactment of these proposals by this Congress.

CONCLUSION

Mr. Chairman, I can assure you that the Commission will continue to be very active in managing the staff's efforts on ensuring the adequate protection of public health and safety, promoting common defense and security, and protecting the environment in the application of nuclear technology for civilian use.

We appreciate the opportunity to appear before you today. My colleagues and I welcome the opportunity to respond to your questions.

RESPONSES BY NILS J. DIAS TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

Question 1. Have you considered the possibility of consolidating the employees at the four Regions to headquarters? Since every nuclear reactor has full-time NRC resident inspectors located at each facility, is it really necessary to have four regional offices? Please provide a breakdown as to the functions performed solely at the Regional Offices, and those functions which are performed at both headquarters and in the regions.

Response. The NRC reviewed regional consolidation as recently as last year. Reviews were also conducted during the 1994–1995 timeframe, which resulted in the closure of NRC's Region V office in California, and in 1998 and 2002. The most recent review was in response to the fiscal year 2003 Energy and Water Development Appropriations Act, (House Report 108–10 and Senate Report 107–220), which directed the NRC to report to the Congress on regulatory efficiencies that would be gained by consolidating or eliminating regional offices. The Commission provided a response on June 26, 2003. The report noted that the Commission believes that in the context of its fundamental mission, a strong regional presence is essential for the effective implementation of the agency's health, safety, and security programs.

Public health and safety are better served with critical NRC expertise located close to the geographical area of our licensed activities. Whether overseeing routine licensed activities or reacting to unforseen circumstances, a regional office can rapidly muster critical resources to a facility when a situation needs immediate attention and time is of the essence.

The regional staff have unique expertise in the area of field inspections and are familiar with the licensee location, procedures, strengths, and weaknesses. The four regional offices each oversee 21 to 32 operating reactors, which enables the NRC to deploy first responders to incidents and emergencies in four different geographical locations. Homeland security initiatives and objectives provide additional compelling reasons for the agency's current regional structure. All the regional offices are involved in heightened security, safeguards, and emergency preparedness activities in light of the current threat environment.

The NRC's regional structure aligns well with the Administration's emphasis on close coordination with constituents and stakeholders. Regional offices bring NRC closer to the public it serves, giving stakeholders access to NRC officials in their own region of the country, thereby enhancing relationships with local and state officials and increasing public confidence in the NRC.

With regard to the functions carried out by the regions and headquarters, the regional offices execute established NRC policies and assigned programs relating to inspection, licensing, incident response, governmental liaison, resource management and human resources. Each of the regional offices implement inspection and public interface activities in the following nine areas: investigations, public affairs, legal affairs, allegations/enforcement, State liaison, resource management, nuclear materials safety, reactor projects, and reactor safety. NRC headquarters develops policy and inspection guidance for programs assigned to the regional offices and assesses the effectiveness and uniformity of the regions' implementation of those programs.

The Commission does look for efficiencies in the operation of its regional offices. For example, the Commission recently consolidated responsibility for all major fuel cycle facilities in its Atlanta office. Additionally, in 2000 the Commission attempted to close the NRC Technical Training Center, which is located in Chattanooga, Tennessee and move the approximately 27 personnel to our Rockville, Maryland headquarters. We had based the decision on justifiable training efficiencies to be gained from such a move. Nevertheless, the NRC was precluded from making the change by language included in Public Law 106–246, The Military Construction Appropriations Act.

Question 2. How is the interaction between the EPA and the NRC on the setting of radiation standards? Now that the standards for Yucca Mountain have been set, I think we should give serious consideration to consolidating the process at the NRC. Is it feasible/possible for the EPA's functions to be consolidated at the NRC?

Response. EPA derives its responsibility to set generally applicable radiation standards from the statutory Reorganization Plan No. 3 of 1970. This plan gives EPA authority to set generally applicable standards for the protection of the general environment from radioactive material. As noted in the OMB Memorandum dated December 7, 1973, known as the Ash Memorandum, EPA initially construed its responsibilities too broadly. The memorandum directed that EPA should continue setting standards for the total amount of radiation in the general environment from all facilities combined in the uranium fuel cycle. Facility specific standards would be set by the NRC (formerly the AEC) with EPA review and comment. Since that time the two agencies have continued to interact to avoid overlap and duplication regarding standards that apply to NRC regulated facilities. However, these interactions have generally been difficult and largely unsuccessful. Interface has occurred in a number of venues, and on a variety of topics under the Atomic Energy Act. NRC's interactions with EPA have consistently focused upon achieving an effective regulatory environment that protects public health and safety and minimizes duplication. NRC has worked to achieve this coordination through the Interagency Steering Committee on Radiation Standards (ISCORS), and through a Memorandum of Understanding. Overlap in legislative mandates continues to result in differences between the agencies.

As to EPA's Yucca Mountain standards (the authority for which derives from the Nuclear Waste Policy Act and the Energy Policy Act of 1992), we would note that the U.S. Court of Appeals for the DC Circuit issued a decision on July 9, 2004, in NEI v. *EPA* that vacated a part of EPA's Yucca Mountain standards in 40 CFR Part 197 (and NRC's identical standards in 10 CFR Part 63). Thus, at this time, we cannot say that the "standards for Yucca Mountain have been set."

EPA's Yucca Mountain standard setting function aside, it would be possible, with legislation, to transfer EPA's radiation standard setting functions established by Reorganization Plan No. 3 of 1970 to the NRC as well as related standard setting for accelerator-produced radioactive material and certain discrete sources not currently covered by the Atomic Energy Act. If such a step were taken, roles and responsibilities would need to be carefully defined to clarify multiple legislative mandates from which each agency's authority derives. In addition, this consolidation would require adjustment of resources.

RESPONSES BY NILS J. DIAS TO ADDITIONAL QUESTIONS FROM SENATOR JEFFORDS

Question 1. I have a question regarding record keeping related to nuclear fuel. It is my understanding that the NRC used to have a more direct role in keeping records on the location of nuclear fuel and waste at power plants, but that it changed its policy in the 1980's. Now the license holders are primarily responsible for this task. In light of what has happened at Vermont Yankee, and with the increase in buying and selling of nuclear plants to new owners, is the NRC reconsidering taking a more active role? Would you need additional authority from Congress to do so.

Response. In general, the NRC Material Control And Accounting (MC&A) inspection program verifies whether licensees have limited their possession and use of Special Nuclear Material (SNM), including spent fuel, to the locations and purposes authorized by their operating licenses. In addition, during these inspections, the NRC determines whether licensees have implemented adequate and effective programs to account for and control the SNM in their possession. Prior to 1988, the NRC routinely inspected MC&A programs at nuclear power plants including the location of spent fuel. This inspection process focused on fuel rod assemblies but not individual components, such as fuel rods. However, the NRC has never had an active or direct role in the creation or maintenance of records for the licensee. This has always been the licensee's responsibility.

Findings from MC&A inspections at power reactors prior to 1988 did not indicate that there were major deficiencies in power reactor licensees' MC&A programs. At that time, the NRC considered there was low risk of improper storage of spent fuel at a power reactor since physical and radiological characteristics of spent fuel made it highly unlikely that spent fuel could be safely removed from the fuel pool without proper equipment and procedures. Therefore, In 1988 the NRC chose to allocate inspection resources to other more risk-significant areas.

In 2001, the NRC staff conducted a re-examination of MC&A vulnerabilities as part of the comprehensive review of the NRC's Safeguards and Security Program which was conducted in response to a November 2000 event at Millstone Unit 1, in which two irradiated fuel rods were reported missing from the spent fuel pool. The Millstone events as well as subsequent equivalent events at other facilities involved individual fuel rods which were removed from fuel assemblies and the disassembly occurred well before 1988.

As part of the lessons learned from the Millstone Unit 1 event, the NRC staff developed Temporary Instruction (TI) 2515/154, "Spent Fuel Material Control and Accounting at Nuclear Plants," dated November 26, 2003, to enhance the NRC's inspection of licensees' MC&A programs. The TI provides specific inspection guidance to NRC inspectors and consists of three phases. The first phase requires the NRC resident inspector at the reactor to determine through interviews if a licensee has ever removed irradiated fuel rods from a fuel assembly. If the answer is yes, Phase II of the TI is then implemented. Phase II of the TI determines, through detailed questions and review of records and physical inspection, if a licensee's MC&A program is adequate to account for items located in the spent fuel pool. At a minimum, Phase III of the TI will be implemented at plants where it has been determined that a licensee's MC&A program has potential deficiencies. Phase III is a much more detailed inspection of the MC&A program, which will be conducted by experienced MC&A inspectors and includes verification of records and the location in the spent fuel pool of all spent fuel rods that have been separated from their parent fuel assemblies. The NRC is developing a Bulletin which will be issued to power reactor licensees and requests information from licensees about their MC&A programs. The responses to this Bulletin will further inform the conduct of the Phase III inspections. A longer term decision regarding NRC inspection activities will be completed after the results of Phase III inspections have been evaluated. No additional authority is needed to conduct inspection activities in this area.

Question 2. The discovery of missing fuel rods at Vermont Yankee resulted from NRC inspections required of all plants as a followup to the loss of fuel at the Millstone plant. Have other plants reported missing fuel? And when will the inspection of other plants be completed?

Response. Yes, Humboldt Bay Nuclear Power Plant has reported missing fuel rod segments. Pacific Gas and Electric, the licensee, was unable to locate the missing segments in most likely and accessible locations. The NRC continues to provide oversight of key search activities and will conduct a management meeting in late September 2004.

MC&A inspections are being conducted under Temporary Instruction 2515/154. Phases I and II of the temporary instruction, which are inspections conducted by the Resident Inspectors, have been completed at all plants. NRC is currently evaluating the information gathered during Phases I and II and plans to conduct additional inspections at some plants under Phase III. The temporary instruction calls for the Phase III inspections to be completed by November 2005.

Question 3a. On May 4, 2004, the NRC responded to the Vermont Public Service Board's request for additional independent review at Vermont Yankee. Your letter stated that a pilot engineering assessment would be conducted. The assessment team will be comprised of NRC staff, state officials, and at least two independent contractors. When will these inspections start?

Response. The inspection team was onsite at the Vermont Yankee facility during the weeks of August 9 and 16 and is scheduled to be onsite the week of August 30.

Question 3b. On May 4, 2004, the NRC responded to the Vermont Public Service Board's request for additional independent review at Vermont Yankee. Your letter stated that a pilot engineering assessment would be conducted. The assessment team will be comprised of NRC staff, state officials, and at least two independent contractors. Will you commit to having an independent observer in addition to the independent contractor on the team?

Response. The Vermont Yankee team will consist of a team leader, three NRC inspectors, three contractors, and a member from the NRC nuclear safety professional development program. The team leader will come from our program office in headquarters and is currently responsible for the overall engineering pilot program effort. He has extensive experience leading engineering team inspections and no previous involvement or inspection experience at Vermont Yankee. The three contractors have diverse backgrounds in the electrical, mechanical, and instrumentation areas, and have never been directly employed by Vermont Yankee or its owner, Entergy, and have not performed contract work for Vermont Yankee or Entergy for at least the last 2 years. The other NRC inspection team members will not have served or participated on engineering inspections at Vermont Yankee in the past 2 years. In accordance with our Memorandum of Understanding with Vermont, there also will be an observer from the State of Vermont who will be able to provide an independent perspective on the inspection. There were no plans for additional observers. Additional observers who do not have unescorted access could impede the effectiveness of the inspection effort as they would need to be continuously escorted while onsite.

Question 4. There have been on-going allegations from nuclear advocacy groups in New England that NRC staff "misled" Senator Leahy and me regarding the extent to which the NRC's new power uprate guidelines were related to the Independent Safety Assessment conducted at Maine Yankee. These allegations have been made to the Commission in writing.

Will you clarify this issue and provide a summary to the subcommittee of the provisions of the extended power uprate guidelines that were explicitly drawn from Maine Yankee Independent Safety Assessment?

Response. The NRC received a letter from Mr. Ray Shadis on March 24, 2004, regarding the NRC communications with yourself and Senator Leahy. He expressed concerns that you were misinformed about the nature and the evolution of the NRC's newly adopted Review Standard for extended power uprates (EPUs) and the scope of the EPU review process.

In a letter to the NRC on February 27, 2004, you accurately stated that the NRC Review Standard for EPUs incorporates lessons learned from an independent assessment conducted at Maine Yankee. On March 29, 2004, the NRC responded to your letter and further reiterated that the Maine Yankee lessons learned was one input, along with others, into the development of the Review Standard. Our letter of March 29, 2004, provides a broader discussion of the NRC's review process and inspections related to the proposed power uprate.

The development of the Review Standard for EPUs included a review of past experience, a part of which was a review of various reports related to the Maine Yankee Lessons Learned such as:

- Memorandum from the Office of the Inspector General to the Chairman and Commissioners, "Event Inquiry—Maine Yankee Atomic Power Station (Case 96–04S)," dated May 8, 1996.
- Letter to C. Frizzle, Maine Yankee Atomic Power Company, from S. Jackson, (former) Chairman, NRC, forwarding the "Independent Safety Assessment (ISA) of Maine Yankee Atomic Power Company," dated October 7, 1996.
- Report of the Maine Yankee Lessons Learned Task Group, dated December 1996.
- Memorandum to W. Travers from S. Collins, "Status of NRR Staff Actions Resulting from the Independent Assessment of Maine Yankee Atomic Power Company," dated January 11, 2001.
- Power Uprate Amendment for Surry Units 1 and 2—License Amendment Nos. 203 and 203, dated August 3, 1995.
- Power Uprate Amendment for Fermi 2—License Amendment No. 87, dated September 9, 1992.

The Maine Yankee Lessons Learned Task Group had identified "Review Areas Not Addressed" by comparing twenty-two previous power uprate safety evaluations to the most recent pressurized-water reactor and boiling-water reactor safety evaluations (i.e., for Surry Units 1 and 2 and Fermi 2) and noting inconsistencies in the review scope. These areas were: human factors, station blackout, standby liquid control system, reactor vessel/internal stresses, control rod drive mechanisms, steam generator tube integrity, reactor coolant pumps, pressurizer, piping, equipment qualification, fire protection, control room habitability, loss-of-coolant accident (LOCA)/main steam line break containment performance, safety-related pumps net positive suction head, post-LOCA combustible gas control, service water, component cooling water, spent fuel pool cooling, heating ventilation air conditioning, radwaste, circulating water system, main steam, main turbine, instrumentation and control setpoints, reactor coolant system flow, auxiliary feedwater, residual heat removal, and general design criteria (GDC)–17 electric power systems.

In the Review Standard for EPUs, the staff included the "Review Areas Not Addressed" identified by the Maine Yankee Lessons Learned Task Group, along with information developed from other past experience reviews. The staff also reviewed the Maine Yankee Lessons Learned Task Group recommendations for improving the overall power uprate review process and this information was used in the development of the process guidance portion of the Review Standard for EPUs.

Specific to the issue of what experience from the Maine Yankee Independent Safety Assessment was incorporated into the EPU review guidance, the letter to C. Frizzle, Maine Yankee Atomic Power Company, from S. Jackson, (former) Chairman, NRC, forwarding the "Independent Safety Assessment of Maine Yankee Atomic Power Company," dated October 7, 1996, contained five issues in Section 6.0, "Regulatory Issues." These areas were: (1) analytical code validation, (2) compliance with Safety Evaluation Reports, (3) Licensing Reviews for Power Uprates, (4) Regulatory Guide 1.1, "Net positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps (Safety Guide 1)," and (5) Inspection Program.

The staff broke these issues into 33 actions in the following action categories: (1) Adequacy of Analytical Code Validation, (2) Adequacy of NRC Review of Analysis Codes, (3) Compliance with Safety Evaluation Reports, (4) Adequacy of Licensing Reviews for Power Uprates, (5) Clarity and Intent of NRC Regulatory Guide 1.1 (Safety Guide 1), (6) Adequacy of the NRC Inspection Program, (7) Agency Expectations regarding Licensee Performance, (8) Cumulative Effect of Operator Workarounds, (9) Agency Policy regarding Licensee Design Basis Recovery Efforts, (10) Public Involvement in the Assessment Process, and (11) Licensee Response to the ISA Report.

The staff has completed 30 of the 33 actions. Three actions are on-going. These three actions are related to adequacy of analytical code validation. The staff's interim action is the issuance of the Draft Regulatory Guide DG–1096, "Transient and Accident Analysis Methods," and Draft Standard Review Plan (SRP) 15.0.2, "Review of Analytical Computer Codes." The staff is resolving the public comments for these documents. The staff's actions will be complete when the final Regulatory Guide and SRP are issued. However, the staff placed guidance in the Review Standard for EPUs (RS–001) for the staff to confirm that licensees used codes and methods approved for the plant-specific application and the licensee's use of the codes and methods complies with any limitations, restrictions, and conditions specified in the approving safety evaluation.

Question 5a. Constituents have raised concerns with me regarding the process for requesting a public hearing on the Vermont Yankee power uprate. I request that you clarify two issues:

First, my constituents believe that the time in which they need to request a hearing begins when the notice of the application appears on the Commission's web site rather than in the Federal Register. Isn't the Federal Register notice, when one is submitted, the official start of the clock for hearing requests? Will that be the case for Vermont Yankee?

Response. The publication date of the Federal Register notice on the Vermont Yankee power uprate amendment begins the period for requesting a hearing. A notice of opportunity to request a hearing for the Vermont Yankee power uprate was published in the Federal Register on July 1, 2004 (69 FR 39976), with a 60 day period for hearing requests.

Question 5b. Constituents have raised concerns with me regarding the process for requesting a public hearing on the Vermont Yankee power uprate. I request that you clarify two issues:

Second, my constituents are concerned about both the evidentiary and standing requirements contained in the new NRC hearing regulations. In response to a request for a hearing, does the NRC have the discretion to decide whether or not to use its current or former regulations to govern the hearing process?

Response. The Commission does have considerable discretion to modify by order, in individual cases, the adjudicatory procedures to be applied in a particular proceeding. However, the new 10 CFR Part 2 rule (69 FR 2182, January 14, 2004), applies (by its terms) to proceedings noticed after February 13, 2004, which includes the Vermont Yankee power uprate proceeding. The new Part 2 is the product of a long and comprehensive rulemaking effort concerning the rules of practice. It does not change the evidentiary or standing requirements that were in the old Part 2. The new Part 2 does include new requirements regarding the submission of admissible contentions in informal proceedings, but these contention requirements are essentially the same as the contention requirements that applied under the old Part 2 proceedings involving power reactor license amendment requests. The new Part

2 requires that contentions be submitted as part of the petition to intervene/request for hearing.

Question 6a. On May 18, 2004, Senator Inhofe and I received a letter from you regarding the Commission's views on nuclear waste that is incidental to reprocessing at Department of Defense facilities. (NOTE: The NRC letter was in reference to DOE facilities, not DOD facilities). I noted with some dismay that while the Vermont Public Service Board waited 7 weeks for a reply to its questions regarding the proposed power uprate at Vermont Yankee, this response was obtained the same day questions were submitted to the NRC. I have a few questions regarding this letter, and I have written to you regarding this matter.

In the letter you write that the NRC "does not have regulatory authority or jurisdiction" over the Savannah River, Hanford, or Idaho facilities. Isn't that because the high-level waste storage tanks at these locations were authorized only for short-term, temporary storage, and not for permanent disposal?

Response. Section 202(4) of the Energy Reorganization Act of 1974 gives NRC licensing and related regulatory authority over DOE facilities "authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by [DOE], which are not used for, or are part of, research and development activities." There are three important elements in this jurisdictional grant: (1) Congress must have expressly authorized the facility for its purpose; (2) that purpose must be long-term storage; and (3) the radioactive wastes to be stored must be high-level radioactive waste (HLW). All three elements must be present for NRC's jurisdiction to attach to a particular DOE facility. NRC currently does not have regulatory authority over the Savannah River Site (SRS), Hanford, and Idaho National Engineering and Environmental Laboratory (INEEL) radioactive waste storage tanks because Congress has not expressly authorized use of these tanks for the purpose of long-term storage of DOE's HLW. NRC's view that it does not have regulatory authority over the DOE radioactive waste storage tanks has been upheld by the courts. See *Natural Resources Defense Council* v. *NRC*, 606 F.2d 1261, 1266–1268 (D.C. Cir. 1979).

Question 6b. On May 18, 2004, Senator Inhofe and I received a letter from you regarding the Commission's views on nuclear waste that is incidental to reprocessing at Department of Defense facilities. (NOTE: The NRC letter was in reference to DOE facilities, not DOD facilities). I noted with some dismay that while the Vermont Public Service Board waited 7 weeks for a reply to its questions regarding the proposed power uprate at Vermont Yankee, this response was obtained the same day questions were submitted to the NRC. I have a few questions regarding this letter, and I have written to you regarding this matter.

Isn't it the case that under Section 202 of the Energy Reorganization Act, the NRC has regulatory authority and jurisdiction over any "facilities authorized for the express purpose of . . . long-term storage of high-level radioactive waste generated by" the Department of Energy?

Response. Yes. As stated above, under Section 202(4) of the Energy Reorganization Act of 1974, NRC has regulatory authority and jurisdiction over any facilities authorized for the express purpose of subsequent long-term storage of HLW generated by DOE, which are not used for, or are part of, research and development activities.

Question 6c. On May 18, 2004, Senator Inhofe and I received a letter from you regarding the Commission's views on nuclear waste that is incidental to reprocessing at Department of Defense facilities. (NOTE: The NRC letter was in reference to DOE facilities, not DOD facilities). I noted with some dismay that while the Vermont Public Service Board waited 7 weeks for a reply to its questions regarding the proposed power uprate at Vermont Yankee, this response was obtained the same day questions were submitted to the NRC. I have a few questions regarding this letter, and I have written to you regarding this matter.

Wouldn't legislation allowing DOE to say that high-level waste isn't high-level anymore circumvent the NRC's responsibility for licensing and regulating the facility in which permanent disposal is to take place? Have you actually reviewed and taken a position on Section 3116 of the DOD Authorization bill that is presently on the Senate floor?

Response. Legislation allowing DOE to exclude radioactive material meeting certain criteria from the definition of HLW would not necessarily affect the scope of NRC's jurisdiction under the Energy Reorganization Act of 1974. NRC does not currently have jurisdiction nor responsibility for licensing and regulating the radioactive waste storage tanks at SRS, Hanford and INEEL because Congress has not expressly authorized use of these tanks for the purpose of long-term storage of DOE's HLW. Unless Congress expressly authorizes use of the tanks for disposal of

DOE's HLW, NRC would not have jurisdiction irrespective of whether the waste remaining in the tanks is considered to be HLW or waste-incidental-to-reprocessing (WIR). NRC has expressed its general views on WIR in the Commission's letter of May 18, 2004 to you and Senator Inhofe. NRC also responded to your June 2, 2004, letter regarding NRC's jurisdiction over HLW tanks at SRS and possible effects of the proposed Section 3116 in a letter to you dated July 15, 2004.

RESPONSES BY NILS J. DIAS TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1. GAO claims that the recommendations are being implemented slowly because of resource constraints at the NRC. What are some of these constraints and what needs to be done to address them?

Response. After the Davis-Besse Lessons Learned Task Force (task force) published its final report in October 2002, the NRC convened a Senior Management Review Team to prioritize the task force's recommendations as high, medium, and low priority and provide guidance on an overall plan to implement the recommendations. An overall plan to put the recommendations in place was provided to the Commission in March 2003. In this plan, four specific action plans were developed to address the high-priority recommendations in the following areas: (1) stress corrosion cracking; (2) operating experience; (3) inspection, assessment, and project management; and (4) barrier integrity requirements. Two medium-priority and 3 low-priority items were included in the action plans because they were closely tied to high-priority items. Resource implications of these action plans were specifically provided in the overall plan, and agency resources were reallocated to carry out the high-priority recommendations effectively. In subsequent reviews as work progressed, additional resources have been allocated.

The overall plan called for implementation of the medium and low-priority recommendations that were not captured by the action plans in accordance with the NRC's Planning, Budgeting, and Performance Management (PBPM) process. The PBPM process is an established process which prioritizes work in accordance with safety benefits. All of the medium and low priority recommendations were reviewed through the PBPM process prior to the first semiannual report (August 2003). Implementation schedules and resource allocation were established commensurate with the perceived safety benefit relative to other NRC activities. These schedules have been periodically revised in accordance with the PBPM process, but are being tracked to completion. Status information is reviewed semi-annually by the Commission. The Commission believes that resources have been appropriately allocated to this program. See the answer to question No. 2 for status of task force recommendations.

The NRC is committed to the effective implementation of the task force's recommendations. In addition to completing the implementation of recommended actions, the NRC will complete effectiveness reviews to ensure implementation meets the intended purposes and to ensure that certain changes are "institutionalized."

Question 2. What progress are you making in implementing the Davis-Besse lessons-learned task force (DBLLTF) recommendations?

Response. There were 49 DBLLTF recommendations that were recommended for implementation after the senior management review. The 21 high-priority, 2 medium priority, and 3 low priority recommendations were captured in four action plans and the remaining 23 recommendations (14 medium-priority and 9 low-priority) were to be completed in accordance with priorities established through the PBPM process, as described in the answer to question No. 1. The status of implementation is reviewed frequently and schedules are adjusted as needed to reflect new information or conditions.

Since my testimony on May 20, 2004, some additional items have been completed and the schedules for others have been changed. The status of the 49 recommendations as of August 19, 2004, is as follows:

- Sixteen were completed in 2003. This included all 7 high-priority items scheduled for completion during 2003, plus 9 lower priority recommendations. Seven lower priority items were rescheduled.
- Eight additional items (4 high-priority and 4 lower priority) have been completed to date in 2004.
- Fifteen additional items (3 high-priority, 10 medium-priority, and 2 low-priority) are planned for completion by December 2004.
- Six additional items (5 high-priority and 1 low-priority) are planned for completion by May 2005.
- The remaining 4 items (2 high-priority, 1 medium-priority, and 1 low-priority) do not have a current completion schedule, primarily because the scope of work de-

pends on the outcome of other recommendations, actions by industry, or completion of research activities. However, work on these items should be substantially complete in 2005.

In summary, as of June 30, 2004, 11 of the 21 high-priority recommendations and 13 of the lower priority items have been completed and work is in progress on the remaining items. In fact, seventy percent of all the recommendations will be in place by the end of calendar year 2004, with the expectation that all will be substantially complete in 2005. The activities that will extend beyond 2005 include rulemaking activities for Reactor Vessel Head inspection, which are expected to be completed in 2006, and other potential regulatory requirement revisions regarding Reactor Coolant System leakage, which will be identified in 2005 following review of a research report on leakage detection and monitoring technologies.

Question 3. GAO claims that several of the issues that led NRC to not prevent the Davis-Besse incident were identified in past GAO reports, Commission lessons-learned task force recommendations, and Inspector General reports. The GAO also states that the NRC is reviewing "the effectiveness of its response to past NRC lessons-learned task force reports." What is the progress of the review you are performing on your effectiveness to fully implement past recommendations?

Response. The charter of the Davis-Besse lessons learned task force included a direction to look back at previous task force reports to determine whether they suggested any recurring or similar problems. The task force's review uncovered potentially recurring programmatic issues and these issues were discussed in Appendix F of the task force report. As a result of this effort, one of the task force's recommendations was to conduct a more detailed effectiveness review of the actions taken in response to past lessons-learned reviews. This recommended action has been completed. The results of the review are being considered by NRC senior management and the Commission to identify and take corrective actions, as necessary.

Question 4. How are you addressing NRC's major communication failures that GAO identified as playing a significant role in the Davis-Besse incident?

Response. The NRC recognize that communications failures were an underlying cause for issues discovered at Davis-Besse (DB). The corrective actions outlined in the lessons-learned task force (LLTF) action plans address communications beyond the topic of boric acid corrosion control. For example, corrective actions in the area of operating experience development and use are focused on enhancing communications. The recommendations to strengthen inspection guidance, institute training to reinforce a questioning attitude on the part of management and staff, and change the Inspection Manual to provide guidance for the staff to pursue issues identified during plant status reviews are intended to establish more definitive expectations for improved communications of operating experience. Developing the most effective and efficient communications channels will be key to the successful implementation of a more effective operating experience program.

Beyond the DBLLTF Action Plan, the agency has several ongoing initiatives that provide examples of efforts to more broadly improve intra-agency communications. These examples include establishment of a Communication Council reporting to the Executive Director for Operations and the creation of a communications specialist position reporting to the Office of Nuclear Reactor Regulation (NRR) Deputy Director. NRR also continues to improve and enhance its Web site as a focused means of communicating with both internal and external stakeholders. From a regional perspective, examples of communication enhancements include lowering the threshold for communication of plant issues on morning status calls, devoting additional time to discussing lessons learned from plant events and inspection findings during counterpart meetings, and developing enhanced guidance for documenting significant operational event followup decisions. In another example, NRC has recently revised guidance for NRC project managers for operating reactor sites to enhance the expectation for communication with NRC resident inspectors at the sites with regard to linkage between licensing actions and relevant operating experience at the sites. Collectively, these examples provide a strong indication that NRC headquarters and regional staff have understood and sought to address two of the most important lessons from the Davis-Besse event. These two issues are (1) that on occasion, information initially considered to have low significance by the first NRC recipient is later found to be of greater significance once the information is shared and evaluated more collegially; and (2) with regard to the complex nature of commercial nuclear power operations, no one person can be aware of all aspects of an issue. As a result, the more information that is shared, the more likely significant problems will be identified and appropriate action(s) taken.

Question 5. What is NRC's human capital situation? What are the top things Congress can do to support NRC's human capital development?

Response. Although NRC continues to make progress in acquiring, developing, deploying and retaining the human capital critical to the accomplishment of its safety, security, and emergency preparedness mission, the agency continues to be challenged by aging work force issues and by new work requiring hard-to-find skills. The agency's systematic strategic work force planning system is identifying potential skill gaps and the agency is devoting resources to address them. The following additional authorities would greatly help the agency meet these challenges quickly and successfully:

- Provide the agency $5M ($1M in fiscal year 2004 through fiscal year 2008) for training to address knowledge transfer and close critical nuclear safety/security/emergency preparedness skills gaps through employee training, and to fund the grant programs described below.
- Allow the agency to establish a fellowship program at institutions of higher learning to pay the tuition of undergraduate students in disciplines of interest to NRC in return for an obligation for the individual to accept employment with the NRC upon graduation. These programs support the development of a supply of graduates with technical skills needed for NRC's future work force.
- Allow the agency to establish a partnership program with historically black colleges and universities, Hispanic serving institutions and tribal colleges. Such a program would broaden the recruiting base from which NRC draws new employees.
- Broaden the authority under Section 31a. and b. of the AEA to provide grants, loans, cooperative agreements, contracts, and equipment to academic institutions in support of courses, studies, training, curriculum, and disciplines important to nuclear safety. The agency would use this authority to support academic research and analysis in disciplines important to nuclear safety. This activity fosters the maintenance of centers of excellence at universities in fields of interest to the NRC. Enhancing such excellence at academic institutions generates a pool of expert faculty members on whom NRC might draw for consultant, advisory board, or administrative judge assignments.
- Provide the agency independent authority to waive the pension offset when hiring retired Federal employees. The agency already has limited authority from OPM to waive the pension offset, but it is time-limited, expiring in fiscal year 2006, and it applies only to engineers and scientists. It does not cover intelligence analysts, security specialists, or others whose knowledge and skill may be critical to the agency and who would decline re-employment absent the waiver. More flexible authority to waive the pension offset would, for example, enable the agency to deal with emergency needs and accomplish knowledge transfer in critical skill areas.
- Provide the agency direct-hire authority where expedited action to meet critical needs is required, for example, in engineering and scientific areas, intelligence analysis, and security to work on high priority safety, security, and emergency preparedness projects, and authority to compensate experts in these areas at higher pay rates. Under very restrictive circumstances, some direct-hire authority may be obtained from OPM, but we believe that independent NRC legislative authority would permit the agency to develop a direct-hire program that best meets its needs. Independent NRC legislative authority to pay salaries and/or additional compensation at a higher rate than the current EX-III cap, $145,600 (e.g., up to the Vice President's salary) would enable the agency to hire critically needed experts for whom the current salary range is inadequate. This would be similar to DOD's unique legislative authority which permits higher salaries to experts, or to NASA's, which permits higher compensation for critical positions.

Question 6. What is required of onsite inspectors in terms of their daily responsibilities? What are their weekly hours, salary, other benefits, etc.? How much do the inspectors move around the country? How are they recruited and what are the basic qualifications? How are they trained?

Response. NRC resident inspectors perform a basic mission in determining whether a licensee operates the plant safely and meets current regulatory requirements and commitments, including in the area of security. Their main focus is on performing in-depth evaluations of materials, systems, incidents, and abnormal conditions. Resident inspectors assist in determining the safety significance of events and findings, recommend enforcement action, and prepare reports of findings and licensee performance. More recently, resident inspectors have taken on an increasing role in security. All resident offices now have secure telephone and fax capability. Additionally, resident inspectors represent the NRC to the licensee, state and local officials, and the news media. Resident inspectors attend daily plant status meetings and review plant status reports. Major daily activities include control room and plant area walkdowns. They also communicate with regional offices on a daily basis to discuss plant status. Reactor resident inspectors are required to relocate from their site no later than at the end of a 7-year assignment. Very rarely are exceptions granted beyond the 7-year maximum tour length. Inspectors also relocate for promotions, voluntary reassignments, or at management's discretion. It is common for resident inspectors to occasionally participate in inspections at other sites.

To recruit and retain qualified resident inspectors, the NRC established a special salary schedule in 1981 for inspectors at nuclear power plants. The special salary schedule provides a 3 additional step increase. Resident inspector pay levels are in the GG–11 ($55,904 for 2004) through GG–14 ($104,071 for 2004) pay range. In addition to this special salary schedule, inspectors receive locality pay. Inspectors typically work 40 hours a week, some of which may be on weekends or backshifts. The inspector policy regarding backshift coverage is described in NRC Inspection Manual Chapter, IMC 2515, "Light-water Reactor Inspection Program Operations Phase." The inspectors are compensated with premium pay for backshift coverages. Additionally, inspectors are offered the same benefits that most other Federal employees are offered, including leave, health benefits, life insurance, retirement benefits, and paid moving expenses.

Resident inspectors are mostly recruited from within the agency, usually from the inspection staff at the regional offices. The goal is to have inspectors who are technically proficient and well-versed in NRC policy, structure, and procedures. In rare cases, a position is advertised outside the agency and any candidate would have to have substantial relevant experience and undertake extensive training and qualification before being qualified as an inspector. The basic qualification for inspectors typically include a bachelor's degree in an engineering, scientific, or technical field. Areas of study include electrical engineering, mechanical engineering, nuclear engineering, fire protection, metallurgy, and health physics. In many cases, inspectors have substantial relevant experience outside of the NRC, either in the nuclear industry or the Nuclear Navy.

NRC has specific guidance that governs inspector training and qualifications for reactor inspectors. New hires are typically assigned to a regional office as an inspector trainee. The training and qualification program is designed to ensure the development of competency in the four general areas of: (1) legal basis and regulatory processes; (2) technical expertise; (3) regulatory practices; and (4) personal and interpersonal effectiveness. The inspector qualification process begins with the Basic-Level Program, designed to allow individuals to begin their training the first day they start work at the NRC. The emphasis in the Basic-Level Program is mainly on structured, self-paced and self-directed individual study and on-the-job activities. As a competency-based program, the emphasis is on practicing specific activities until the individual can meet the evaluation criteria. Therefore, completion of the Basic-Level Training Program can take several months.

Upon completion of the Basic-Level Training Program, the inspector completes the Proficiency-Level Training Program, which consists of two aspects of inspector performance: General Proficiency and Technical Proficiency. General Proficiency focuses on developing the Inspection, Teamwork and Interpersonal Skills needed by an inspector to function either independently or as part of a team to implement the inspection and oversight program. Technical Proficiency develops the appropriate depth of knowledge in one of the seven specific technical inspection areas, such as Operations and Engineering. The final qualification activity is an oral examination before a Board, designed to evaluate the ability of an individual to integrate and apply the acquired knowledge, skill, and attitudes in field situations. Upon passing the Qualification Board, the inspector is fully qualified and can be assigned the full scope of inspection-related activities to be independently performed.

Question 7. Why specifically do you disagree with GAO's recommendation that you develop a set process and guidance for deciding whether to shutdown a plant?

Response. As stated in NRC's response to the draft report entitled "Nuclear Regulation: NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown" (GAO–04–415) dated May 5, 2004, we disagreed with the GAO's finding that the NRC does not have specific guidance for deciding on plant shutdowns and with the report's related recommendation identifying the need for NRC to develop specific guidance and a well-defined process to determine when to shut down a nuclear power plant. We believe our regulations, guidance, and processes on plant shutdown provide sufficient guidance in the vast majority of situations. Plant technical specifications, as well as many other NRC requirements and processes, provide a spectrum of conditions under which plant shutdown would be required. Plants have been shut down numerous times in the past in accordance with NRC requirements, and these shutdowns do not require explicit actions by NRC (i.e., Orders). From time to time, however, a unique situation may present itself in which sufficient information may not exist or the information available may not be sufficiently clear to apply existing rules and regulations definitively. In these unique instances, the NRC's most senior managers, after consultation with staff experts and given all of the information available at the time, will decide whether to require a plant shutdown. Risk information is used consistent with Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." This process considers deterministic factors as well as probabilistic factors (i.e., risk information) to evaluate whether a proposed plant configuration is acceptable for operation. We regard the combined use of deterministic and probabilistic factors to be a strength of our decisionmaking process.

With respect to the recommendation to develop specific guidance for deciding when to shut down a nuclear power plant, we acknowledge that the decisionmaking guidance we used in the Davis-Besse situation, RG 1.174, is guidance for approving license change requests. Although we continue to believe that the risk-informed decisionmaking process in RG 1.174 is generally applicable to a wide range of NRC decisionmaking, we agree that it would be useful to develop additional risk-informed guidance on how to address emergent issues.

The NRC agrees with the GAO that NRC staff lacked sufficient and appropriate documentation of its decision on Davis-Besse. Effective communication, including proper documentation of our decisions, will be the key to improving the accountability and credibility of our decisions in the future. This was one of the task force's findings and a number of recommendations were made to correct this deficiency. The agency is committed to making sure future decisions are documented in a proper and timely manner.

Question 8. Does NRC have the tools needed to quickly license such applications as the gas centrifuge plant that USEC has decided to build in Piketon, Ohio?

Response. The NRC has the tools and resources to conduct gas centrifuge plant license application reviews expeditiously, if we receive our budget request from Congress. The NRC is committed to conducting such reviews in a manner that ensures that the plant would be safe and secure and would not be detrimental to the environment. After the application for USEC Inc.'s commercial gas centrifuge plant in Piketon, Ohio, is submitted, the NRC staff will conduct its safety, security and environmental reviews on a timeframe similar to that established for Louisiana Energy Services' gas centrifuge enrichment plant license application submitted in December 2003. Through identifying efficiencies in the review process and reprogramming resources, we have been able to reduce the projected time needed to complete such reviews. In January 2004, the NRC completed its review for USEC Inc.'s license application for its gas centrifuge demonstration and test "Lead Cascade" facility. This was slightly ahead of the 1-year review schedule that the NRC had projected at the time USEC Inc. had submitted its Lead Cascade license application in February 2003.

However, as I noted in my June 2, 2004, letter to you, a continuing resolution in fiscal year 2005 would likely delay our review of various new license applications, including the enrichment plants in New Mexico and Ohio.

Question 9. Why specifically do you disagree with GAO's recommendation that you develop a methodology to assess early indications of deteriorating safety at nuclear power plants?

Response. GAO's specific recommendation was to develop a methodology to assess licensees' safety culture that includes indicators of and inspection information on patterns of licensee performance as well as on licensees' organization and processes. GAO recommended that NRC should collect and analyze this data, either during the course of the agency's routine inspection program or during separate targeted assessments, or during both routine and targeted inspections and assessments. The GAO maintained this would provide an early warning of deteriorating or declining performance and future safety problems.

Some context would be helpful in addressing this question. When some of the current Commissioners started with the Commission in the 1996–97 timeframe, the NRC staff was using a process for assessing and identifying plants with degraded performance that involved a subjective assessment of licensee performance, the so-called "systematic assessment of licensee performance (SALP)." Plants were given subjective SALP scores in four areas. Performance indicators data, while collected, were not systematically utilized. Indeed, which inputs were most important in a SALP assessment often varied from region to region, even from plant to plant within a region. These subjective SALP assessments then fed into a senior management meeting process, conducted every 6 months, the output of which was a so-called "watch list."

In 1997, the Commission unanimously charged the staff with replacing the SALP/watch list process with a process that was far more uniform (in its use of performance indicators and inspection findings, more systematic, more visible to the public, and more timely. In doing this the Commission had the benefit of an excellent study, done in a very short time period, by a contractor, Arthur Andersen. That study looked at significant deviations in licensee performance based on nine NRC performance indicators, and identified plant trends going back 10 years using the composite performance indicators. The obvious question that arose from that study was whether the NRC staff would have made better decisions on allocating inspection resources and assessing licensee performance if they had simply used the Arthur Andersen methodology rather than the highly subjective SALP/watch list process. There is a very good discussion of the Arthur Andersen report and the NRC staff's and Commission's response to that report in the transcripts (available on our web page) of the February 18, 1997 and the April 24, 1997 Commission meetings.

At the very outset of the design of what we call today the reactor oversight process (ROP), the Commission was interested in trying to get leading indicators of licensee performance. Today, 7 years later, we have an enormously improved assessment process for power reactor licensees, the ROP. It systematically and objectively uses inspection findings and performance indicators to place plants in categories (columns of a so-called action matrix) and assigns inspection resources. It is transparent. It is uniform. It is timely. It was piloted in 1999 at 13 plants at 9 sites and went into full force at all plants on April 1, 2000.

While it is an enormous improvement over the old SALP/watch list process, the Commission recognizes that the ROP must be constantly improved and we have established a process for developing, testing and making improvements, such as improved performance indicators. The ROP process did identify early problems at the Cooper power plant in Nebraska and resulted in NRC and licensee actions to arrest a decline in performance before any significant safety issues arose. However, the ROP process, like the SALP/watch list process before it (and the parallel Institute of Nuclear Power Operations (INPO) assessment process) missed the declining performance at Davis-Besse that contributed so clearly in hindsight to the February 2002 vessel head degradation event.

That all said, the Commission continues to encourage the early identification of declining performance and safety problems. The NRC is committed to licensees' developing and maintaining a strong safety culture, including commitment to safety, technical expertise, and good management. Through the years, the Commission has taken a number of actions in the area of safety culture, including the issuance of the Policy Statement entitled "Conduct of Nuclear Power Operations" (54 FR 3424, 01/24/89). The Commission issued the Policy Statement to help foster the development and maintenance of a safety culture at every facility licensed by the NRC. It also stated that ". . . management has the duty and obligation to foster the development of a 'safety culture' at each facility and to provide a professional working environment, in the control room and throughout the facility, that assures safe operations. Management must provide the leadership that nurtures and perpetuates the safety culture."

In a 1996 Policy Statement, entitled "Freedom of Employees in the Nuclear Industry to Raise Safety Concerns Without Fear of Retaliation," the Commission stated ". . . licensees and other employers subject to NRC authority will establish and maintain safety-conscious environments in which employees feel free to raise safety concerns, both to their management and to the NRC without fear of retaliation." If issues are noted in the maintenance of a safety-conscious work environment, the NRC calls this to the attention of the licensee and states the problem in the NRC's semiannual assessment letters to the licensee.

The Commission recognizes the difficulty in objectively assessing certain aspects of safety culture. As noted in the Commission comments on the draft GAO report, the NRC ROP currently assesses some underlying elements of safety culture such as identification and resolution of problems. NRC will continue to assess, based on objective parameters and direct observations of performance, how effectively licensees are managing safety at each facility. NRC's assessments and actions include:

- direct, daily observation of licensee operation of the facilities.
- problem identification and resolution (PI&R) inspections.
- followup of individual allegations and trending.
- enforcement of employee protection regulations.
- safety-conscious work environment assessments.

• early and aggressive action where safety performance or safety culture issues are confirmed (e.g., recent actions taken to address safety culture issues at the Salem and Hope Creek plants).

In March 2003, the Commission directed the NRC staff to develop guidance that would identify to our licensees the best practices to encourage a safety-conscious work environment. The Commission also directed the staff to monitor efforts by foreign regulators to develop objective measures that serve as indicators of possible problems with safety culture. Following the Congressional hearing on May 20, 2004, I directed the NRC staff to provide options and recommendations in this area. The staff provided information to the Commission on July 1, 2004. The Commission has decided to proceed with public notice of a draft generic communication on establishing and maintaining a safety-conscious work environment. The Commission also decided to enhance the ROP treatment of cross-cutting issues to more fully address safety culture and ensure NRC inspectors are properly trained in the area of safety culture. This is in addition to the evaluations of the licensees' safety-conscious work environment, the problem identification and resolution process, and human performance already included in the ROP. The NRC notifies licensees of degraded performance in these areas in the semiannual assessment letters which are issued to all power reactor licensees and are publicly available.

In summary, the existing regulatory infrastructure previously outlined provides a framework for monitoring the impact of licensee safety culture on performance, and NRC oversight will be enhanced over the next 2 years by:

• revising the ROP to more fully address safety culture.

• taking followup actions in response to the Davis-Besse Lessons Learned Task Force recommendations.

• developing enhanced guidance to our licensees by identifying best practices to encourage a safety-conscious work environment and to promote the NRC's expectations.

• closely monitoring efforts by foreign regulators to measure and regulate safety culture.

Therefore, we believe that we are continuing to make substantial progress on developing and refining an assessment process to assess early indications of deteriorating safety at nuclear power plants. What we can not promise is that the result of these efforts will be a validated methodology in the area of safety culture of declining licensee performance. That is clearly our goal, as it was in 1997, and as it was for our predecessors on the Commission in 1986. A lot of excellent research has been carried out for many years here and abroad without defining such a leading indicator or set of indicators. By carrying out a program of constant improvement in our ROP, the Commission believes that we are moving toward that ideal as rapidly as our knowledge will allow.

Question 10. What steps have you required at Davis-Besse but not at other plants around the country? Why have these steps not been required at other plants? Additionally, you have required that Davis-Besse conduct independent assessments of safety culture over the next 5 years. Why have you not required the same types of assessments, such as surveys, at other plants?

Response. The requirements imposed on the Davis-Besse Nuclear Power Station that are beyond those at other operating reactors in the United States are annual independent assessments for 5 years in the areas of operations, engineering, corrective actions, and safety culture, and inspections of the reactor coolant system pressure boundary during a midcycle outage. These additional requirements are contained in the Confirmatory Order issued to Davis-Besse on March 8, 2004, modifying the Davis-Besse license. These plant-specific actions were designed to ensure sustained safe performance of the facility.

One fundamental regulation applicable to all operating reactors requires that significant conditions adverse to quality be corrected, the cause determined, and actions taken to preclude repetition (10 C.F.R. 50, Appendix B, Criterion XVI). The licensee program in place to implement these requirements is commonly referred to as the corrective action program. The reactor pressure vessel head degradation identified at Davis-Besse in early 2002 was a significant condition adverse to quality. Davis-Besse was required to correct the degradation, understand the cause(s), both from a hardware and organizational perspective, and take actions to address those cause(s) to prevent recurrence as required by NRC regulations.

Since early 2002, following the discovery of the reactor pressure vessel head degradation, Davis-Besse has been removed from the routine reactor oversight process (ROP) applicable to operating reactors and placed under a special oversight process in accordance with the NRC's Inspection Manual Chapter 0350, "Oversight of Operating Reactor Facilities in an Extended Shutdown as a Result of Significant Performance Problems.” Pursuant to that manual chapter, the NRC established a special Oversight Panel and issued a Restart Checklist listing those actions that had to be completed prior to restart of the plant. The items on the Restart Checklist captured the critical actions necessary for the facility to comply with the corrective action program requirements applicable to all operating reactors.

Included in the Restart Checklist is the completion of comprehensive root cause assessments. As part of these assessments, Davis-Besse identified equipment problems, organizational and human performance issues, and program and procedure deficiencies. The organizational and human performance issues Davis-Besse identified included safety culture concerns. Consequently, in addition to the inspection and repair of equipment, and improvement in programs and procedures, enhancements to human performance, organizational effectiveness and safety culture were also included in the Restart Checklist. Pursuant to the corrective action program requirements in 10 C.F.R. 50, Appendix B, similar actions would be required to be accomplished at any operating reactor with equivalent performance deficiencies as Davis-Besse.

One aspect of the performance problems at Davis-Besse was the ineffectiveness of licensee self-assessments and audits to identify degrading performance over time. The additional requirements for independent assessments imposed on Davis-Besse through the Confirmatory Order are unique to Davis-Besse. They are intended to assure lasting improvement in the effectiveness of the licensee’s own internal assessments of performance and to ensure sustained safe performance of the facility. The Confirmatory Order requires the results of these independent assessments be provided to the NRC in publicly available documents.

Question 11. What have you changed since the Davis-Besse incident to address the lessons-learned task force (LLTF) recommendations about safety? How do these changes interact with other initiatives that you are doing or have done?

Response. All of the lessons-learned task force recommendations are tied to safety in either a direct or indirect manner. The items considered by the senior management review team to have direct linkage with corrective actions for Davis-Besse root causes were assigned the highest priority. The NRC staff has been focused on completing actions related to these recommendations in the most expeditious and efficient manner possible. Some examples of changes at the NRC related to the Davis-Besse lessons learned activity include: (1) An enhanced focus on communications, particularly regarding communications between the plant sites, regions, and NRC headquarters; (2) completion of a comprehensive evaluation of the operating experience assessment function with associated organizational changes that are being implemented; and (3) focused enhancements to NRC inspection guidance that relate to maintaining a questioning attitude in all aspects of inspection and assessment activities.

In the communications area, actions taken in response to the LLTF recommendations complement the broader agency initiative on enhancing communications both within the NRC and with external stakeholders. Actions taken in response to LLTF recommendations have also complemented the broader agency initiative on risk-informing agency decisionmaking processes through focusing resources on areas most critical to safety.

Question 12. In the past, have you considered regulating safety culture? If so, what conclusions have been reached and why? What changes (if any) have you made in response to these considerations?

Response. In 1989, the NRC first set forth its expectation that licensees establish a strong safety culture in its “Policy Statement on the Conduct of Operations.” The NRC continues to place a high value on the importance of establishing and maintaining a strong safety culture at licensed facilities. The Commission has considered various staff proposals for directly regulating the area of safety-conscious work environment (SCWE), one attribute of safety culture, and approved assessment of SCWE by the NRC staff on a case-by-case basis. The Commission has also directed the staff to: (1) develop further guidance that would identify for the industry practices to encourage a SCWE; and (2) monitor efforts by foreign countries to develop objective measures that may serve as indicators of possible problems with safety culture. The Commission is taking additional measures as discussed in the response to Question 9.

Question 13a. What are other countries doing to regulate safety culture at their nuclear plants?

Response. Currently, only one country, Finland, has a specific regulation that directly addresses safety culture. Several other countries, including England, Spain, Canada, Sweden and France, inspect for safety culture problems even though they do not have specific regulations in the area of safety culture.

Question 13b. How is this different from what is done in the U.S.?

Response. The United States has no specific regulation for safety culture, but NRC conducts safety culture evaluations on a case-by-case basis. A subset of underlying elements of safety culture, such as identification and resolution of problems and maintenance of a safety conscious work environment, currently are assessed through the Reactor Oversight Process (ROP). Please see the response to part (A) above.

Question 13c. Are there any foreign regulations and/or practices that should be replicated in the U.S.?

Response. The NRC staff continues to monitor activities in other countries to determine how foreign regulators measure and regulate safety culture, but has not identified any regulations or practices in other countries to be considered for implementation in the United States.

RESPONSES BY NILS J. DIAS TO ADDITIONAL QUESTIONS FROM SENATOR LIEBERMAN

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Question 1. Chairman Diaz, should there [be] a no-fly zone around the Indian Point power plant? It is my understanding that we have established no-fly zones around Disney theme parks, for security concerns. Why do we have no fly zones around theme parks, but not our nuclear facilities?

Response. A publicly available map details the three nautical mile, 3000 foot altitude no-fly zone around the Walt Disney theme parks. Commercial air traffic, however, is allowed to transit through the zone. Pursuant to Federal Aviation Administration regulations (14 CFR Section 99.7), a published flight restriction is in place for nuclear power plants, which, in part, states ". . . pilots . . . are advised to avoid the airspace above or in proximity to all nuclear power plants. Pilots should not circle or loiter in the vicinity of such facilities. Pilots who do so can expect to be interviewed by law enforcement personnel . . ."

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May be exempt from public release under the Freedom of Information Act (5 U.S.C. 552)

Exemption Number, 5, Nuclear Regulatory Commission review required before public release.

Name and organization of person making determination, John E. Tomlinson, NSIR/DO

Date of Determination, July 12, 2004

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The Indian Point facility is located in proximity to two major airports and within miles of a third airport. Instituting a broad "no-fly" zone for the Indian Point facility would be problematic and have substantial repercussions for each of those airports and for area transportation. The protection of nuclear plants, including the Indian Point facility, is dependent on multiple measures, which in the aggregate result in the ability to maintain public health and safety. The Federal Aviation Administration (FAA), the North American Aerospace Defense Command (NORAD); and the Transportation Security Administration (TSA) manage programs that are intended to prevent assaults by air. For example, the TSA continues to oversee the implementation of multiple countermeasures such as the Federal Air Marshal program, enhanced passenger and baggage screening, and hardened flight decks. The FAA and NORAD have much improved ability to detect deviations from flight paths today than on 09/11/01. NORAD has the ability to communicate with every nuclear power plant control room, either directly or through the NRC Incident Response Center, upon detection of a possible threat. This allows the plant operator to place the plant in a safe condition while NORAD attempts to intercept this threat. These programs, combined with the response capabilities of local authorities provide a significant defense-in-depth to address such threats.

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Question 2. I am concerned about the Evacuation Plans for the area around Indian Point. My constituents have first-hand experience with the fact that our roads are already carrying nearly twice as much traffic as they were designed for. I–95 and I–84 are reduced to stop-and-go speeds on a daily basis. It will require very careful planning based on realistic assumptions to be sure that our roads aren't reduced to a standstill in the event of an evacuation. Is it realistic to assume, for example, that families will be willing to separate to facilitate the evacuation, or would it be more realistic to assume that families will gather together first, and that each family will stay together, to evacuate as a family? Have we done the best demographic studies possible to facilitate evacuation plans?

Response. The NRC is responsible for evaluating the adequacy of onsite emergency plans developed by the nuclear power plant licensee. The Federal Emergency Management Agency (FEMA) is responsible for assessing the adequacy of offsite (state and local) radiological emergency planning and preparedness activities. FEMA informed the NRC and Governor Pataki of New York, on July 25, 2003, that, "after carefully considering all available information, we have reasonable assurance that appropriate protective measures to protect the health and safety of surrounding communities can be taken and are capable of being implemented in the event of a radiological incident at the Indian Point facility."

FEMA's finding recognized that the affected counties had received an updated "evacuation time estimate " (ETE) study (incorporating 2000 census data and shadow evacuation estimates) for the 10 mile emergency planning zone. The counties had specifically included the updated ETE study in their Radiological Emergency Preparedness Plans. The ETE revisions included the latest census data, consideration that some family units will reunite prior to evacuation, an expanded geographic area of analysis, and an analysis of shadow evacuation. Shadow evacuation refers to people outside the evacuation zone who also decide to evacuate. In addition, the evacuation estimates required for nuclear evacuation plans must examine the sensitivity of evacuation times to key variables, including the nature and limits of transportation facilities in the affected area and other factors that may affect evacuation time, such as the public's use of public transportation or need for special transportation. The New York State and affected county plans provide for an active response to traffic obstructions in the event of a radiological emergency at Indian Point. Alternate evacuation routes are pre-designated. Responsibilities are assigned and resources identified for detecting and responding to traffic bottlenecks using law enforcement and public works personnel and equipment.

Considering those FEMA findings and determinations in conjunction with the NRC onsite assessments, the NRC did not alter its determination that the overall state of emergency preparedness at Indian Point 2 and 3 provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency.

United States General Accounting Office

GAO

Report to Congressional Requesters

May 2004

NUCLEAR REGULATION

NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown

GAO

Accountability * Integrity * Reliability

GAO-04-415

May 2004

NUCLEAR REGULATION

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Accountability · Integrity · Reliability

Highlights

Highlights of GAO-04-415, a report to congressional requesters

Why GAO Did This Study

In March 2002, the most serious safety issue confronting the nation's commercial nuclear power industry since Three Mile Island in 1979 was identified at the Davis-Besse plant in Ohio. After the Nuclear Regulatory Commission (NRC) allowed Davis-Besse to delay shutting down to inspect its reactor vessel for cracked tubing, the plant found that leakage from these tubes had caused extensive corrosion on the vessel head—a vital barrier preventing a radioactive release. GAO determined (1) why NRC did not identify and prevent the corrosion, (2) whether the process NRC used in deciding to delay the shutdown was credible, and (3) whether NRC is taking sufficient action in the wake of the incident to prevent similar problems from developing at other plants.

What GAO Recommends

Because the nation's nuclear power plants are aging, GAO is recommending that NRC take more aggressive actions to mitigate the risk of serious safety problems occurring at Davis-Besse and other nuclear power plants.

NRC disagreed with two of the report's five recommendations—that it develop (1) additional means to better identify safety problems early and (2) guidance for making decisions whether to shut down a plant. GAO continues to believe these recommendations are appropriate and should be implemented.

www.gao.gov/cgi-bin/getrpt?GAO-04-415.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

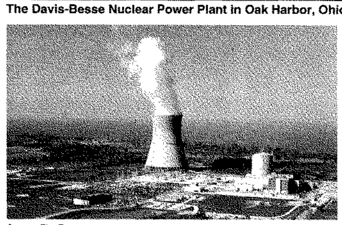
What GAO Found

NRC should have but did not identify or prevent the corrosion at Davis-Besse because its oversight did not generate accurate information on plant conditions. NRC inspectors were aware of indications of leaking tubes and corrosion; however, the inspectors did not recognize the indications' importance and did not fully communicate information about them. NRC also considered FirstEnergy—Davis-Besse's owner—a good performer, which resulted in fewer NRC inspections and questions about plant conditions. NRC was aware of the potential for cracked tubes and corrosion at plants like Davis-Besse but did not view them as an immediate concern. Thus, NRC did not modify its inspections to identify these conditions.

NRC's process for deciding to allow Davis-Besse to delay its shutdown lacks credibility. Because NRC had no guidance specifically for making a decision on whether a plant should shut down, it used guidance for deciding whether a plant should be allowed to modify its operating license. NRC did not always follow this guidance and generally did not document how it applied the guidance. The risk estimate NRC used to help decide whether the plant should shut down was also flawed and underestimated the amount of risk that Davis-Besse posed. Further, even though underestimated, the estimate still exceeded risk levels generally accepted by the agency.

NRC has taken several significant actions to help prevent reactor vessel corrosion from recurring at nuclear power plants. For example, NRC has required more extensive vessel examinations and augmented inspector training. However, NRC has not yet completed all of its planned actions and, more importantly, has no plans to address three systemic weaknesses underscored by the incident. Specifically, NRC has proposed no actions to help it better (1) identify early indications of deteriorating safety conditions at plants, (2) decide whether to shut down a plant, or (3) monitor actions taken in response to incidents at plants. Both NRC and GAO had previously identified problems in NRC programs that contributed to the Davis-Besse incident, yet these problems continue to persist.

The Davis-Besse Nuclear Power Plant in Oak Harbor, Ohio



Source: FirstEnergy.

Contents

Abbreviations

NRC	Nuclear Regulatory Commission
PRA	Probabilistic risk assessment

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United States General Accounting Office
Washington, D.C. 20548

May 17, 2004

Congressional Requesters

In 2002, the most serious safety issue confronting the nation's commercial nuclear power industry since the accident at Three Mile Island in 1979 was identified at the Davis-Besse nuclear power plant in northwestern Ohio. On March 7, 2002, during shutdown for inspection and refueling, the owner of the Davis-Besse plant—FirstEnergy Nuclear Operating Company—discovered a pineapple-sized cavity in the plant's carbon steel reactor vessel head. The reactor vessel head is an 18-foot-diameter, 6-inch-thick, 80-ton cap that is bolted to the reactor vessel. The vessel head is an integral part of the reactor coolant pressure boundary that serves as a vital barrier for protecting the environment from any release of radiation from the reactor core. In pressurized water reactors such as the one at Davis-Besse, the reactor vessel contains the nuclear fuel, as well as water with diluted boric acid that cools the fuel and helps control the nuclear reaction. At the Davis-Besse plant, vertical tubes had cracked that penetrate the reactor vessel head and that contain this water as well as drive mechanisms used to lower and raise the fuel, thus allowing leaked boric acid to corrode the reactor vessel head. The corrosion had extended through the vessel head to a thin stainless steel lining and had likely occurred over a period of several years. The lining, which is less than one-third of an inch thick and was not designed as a pressure barrier, was found to have a slight bulge with evidence of cracking. Had this lining given way, the water within the reactor vessel would have escaped, triggering a loss-of-coolant accident, which—if back-up safety systems had failed to operate—likely would have resulted in the melting of the radioactive core and a subsequent release of radioactive materials into the environment. In March 2004, after 2 years of increased NRC oversight and considerable repairs by FirstEnergy, NRC approved the restart of Davis-Besse's operations.

Under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended, the Nuclear Regulatory Commission (NRC) and the operators of nuclear power plants share the responsibility for ensuring that nuclear reactors are operated safely. NRC is responsible for issuing regulations, licensing and inspecting plants, and requiring action, as necessary, to protect public health and safety; plant operators have the primary responsibility for safely operating the plants in accordance with their licenses. NRC has the authority to order plant operators to take actions, up to and including shutting down a plant, if licensing conditions are not being met and the plant poses an undue risk to public health and safety. In carrying out its responsibilities, NRC relies on, among other things, on-site NRC resident inspectors to assess plant conditions and quality assurance programs, such as those for maintenance and operations, that operators establish to ensure safety at the plant.

Before the discovery of the cavity in the Davis-Besse reactor vessel head, NRC had requested that operators of Davis-Besse and other similar pressurized water reactors (1) thoroughly inspect the vertical tubing on their reactor vessel heads by December 31, 2001, for possible cracking, or (2) justify why their tubing and reactor vessel heads were sufficiently safe without being inspected. This request was a reaction to cracked vertical tubing found on a pressurized water reactor vessel head at another plant. Such thorough inspections require that the reactor be shut down. FirstEnergy, believing that its reactor vessel head was safe, asked NRC if its shutdown could be delayed until the end of March 2002 to coincide with an already scheduled shutdown for refueling—during which time it would conduct the requested inspection. FirstEnergy provided evidence supporting its assertion that the reactor could continue operating safely. After considerable discussion, and after NRC developed a risk assessment estimate for deciding that Davis-Besse would not pose an unacceptable level of risk, NRC and FirstEnergy compromised, and FirstEnergy agreed to shut down the reactor in mid-February 2002 for inspection. Soon after Davis-Besse was shut down, the cracked tubes and the significant reactor vessel head corrosion were discovered.

You asked us to determine (1) why NRC did not identify and prevent the vessel head corrosion at Davis-Besse, (2) whether the process NRC used when deciding to allow FirstEnergy to delay its shutdown was credible, and (3) whether NRC is taking sufficient action in the wake of the Davis-Besse incident to prevent similar problems from developing in the future at Davis-Besse and other nuclear power plants. As agreed with your offices, our review focused on NRC's role in the events leading up to Davis-Besse's shutdown, NRC's response to the problems discovered, and NRC's management controls over programs and processes that may have contributed to the Davis-Besse incident. We did not evaluate the role of FirstEnergy because, at the time of our review, NRC's Office of Investigations and the Department of Justice were conducting separate inquiries into the potential liability of FirstEnergy concerning its knowledge of conditions at Davis-Besse, including the condition of the reactor vessel head. We also did not review NRC's March 2004 decision to allow the plant to restart.

Scope and Methodology

To determine why NRC did not identify and prevent the vessel head corrosion at the Davis-Besse nuclear power plant, we reviewed NRC's lessons-learned task force report;[1] FirstEnergy's root cause analysis reports;[2] NRC's Office of the Inspector General reports on Davis-Besse;[3] NRC's augmented inspection team report;[4] and NRC's inspection reports and licensee assessments from 1998 through 2001. We also reviewed NRC generic communications issued on boric acid corrosion and on nozzle cracking. In addition, we interviewed NRC regional officials who were involved in overseeing Davis-Besse at the time corrosion was occurring, and when the reactor vessel head cavity was found, to learn what information they had, their knowledge of plant activities, and how they communicated information to headquarters. We also held discussions with the resident inspector who was at Davis-Besse at the time that corrosion was occurring to determine what information he had and how this information was communicated to the regional office. Further, we met with FirstEnergy and NRC officials at Davis-Besse and walked through the facility, including the containment building, to understand the nature and extent of NRC's oversight of licensees. Additionally, we met with NRC headquarters officials to discuss the oversight process as it related to Davis-Besse, and the extent of their knowledge of conditions at Davis-Besse. We also met with county officials from Ottawa County, Ohio, to discuss their views on NRC and Davis-Besse plant safety. Further, we met with representatives from a variety of public interest groups to obtain their thoughts on NRC's oversight and the agency's proposed changes in the wake of Davis-Besse.

[1]NRC, *Degradation of Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report* (Washington, D.C.; Sept. 30, 2002).

[2]FirstEnergy, Davis-Besse Nuclear Power Station, *Root Cause Analysis Report: Significant Degradation of the Reactor Pressure Vessel Head, CR 2002-089* (Oak Harbor, Ohio; Aug. 27, 2002) and *Root Cause Analysis Report: Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head, CR-02-0685, 02-0846, 02-0891, 02-1053, 02-1128, 02-1583, 02-1850, 02-2584, and 02-2585* (Oak Harbor, Ohio; Aug. 13, 2002).

[3]NRC, Office of the Inspector General, *NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head* (Washington, D.C.; Dec. 30, 2002) and *NRC's Oversight of Davis-Besse Boric Acid Leakage and Corrosion during the April 2000 Refueling Outage* (Washington, D.C.: Oct. 17, 2003).

[4]NRC, *Davis-Besse Nuclear Power Station NRC Augmented Inspection Team—Degradation of the Reactor Pressure Vessel Head* (Washington, D.C.; May 3, 2002).

To determine whether the process NRC used was credible when deciding to allow Davis-Besse to delay its shutdown, we evaluated NRC guidelines for reviewing licensee requests for temporary and permanent license changes, or amendments to their licenses. We also reviewed NRC guidance for making and documenting agency decisions, such as those on whether to accept licensee responses to generic communications, as well as NRC's policies and procedures for taking enforcement action. We supplemented these reviews with an analysis of internal NRC correspondence related to the decision-making process, including e-mail correspondence, notes, and briefing slides. We also reviewed NRC's request for additional information to FirstEnergy following the issuance of NRC's generic bulletin for conducting reactor vessel head and nozzle inspections, as well as responses provided by FirstEnergy. In addition, we reviewed the draft shutdown order that NRC prepared before accepting FirstEnergy's proposal to conduct its inspection in mid-February 2002. We reviewed these documents to determine whether the basis for NRC's decision was clearly laid out, persuasive, and defensible to a party outside of NRC.

As part of our analysis for determining whether NRC's process was credible, we also obtained and reviewed NRC's probabilistic risk assessment (PRA) calculations that it developed to guide its decision making. To conduct this analysis, we relied on the advice of consultants who, collectively, have an extensive background in nuclear engineering, PRA, and metallurgy. These consultants included Dr. John C. Lee, Professor and Chair, Nuclear Engineering and Radiological Sciences at the University of Michigan's College of Engineering; Dr. Thomas H. Pigford, Professor Emeritus, at the University of California-Berkeley's College of Engineering; and Dr. Gary S. Was, Associate Dean for Research in the College of Engineering, and Professor, Nuclear Engineering and Radiological Sciences at the University of Michigan's College of Engineering. These consultants reviewed internal NRC correspondence relating to NRC's PRA estimate, NRC's calculations, and the basis for these calculations. These consultants also discussed the basis for NRC's estimates with NRC officials and outside contractors who provided information to NRC as it developed its estimates. These consultants were selected on the basis of recommendations made by other nuclear engineering experts, their résumés, their collective experience, lack of a conflict of interest, and previous experience with assessing incidents at nuclear power plants such as Three Mile Island.

To determine whether NRC is taking sufficient action in the wake of the Davis-Besse incident to prevent similar problems from developing in the future, we reviewed NRC's lessons-learned task force recommendations, NRC's analysis of the underlying causes for failing to identify the corrosion of the reactor vessel head, and NRC's action plan developed in response to the task force recommendations. We also reviewed other NRC lessons-learned task force reports and their recommendations, our prior reports to identify issues related to those at Davis-Besse, and NRC's Office of the Inspector General reports. We met with NRC officials responsible for implementing task force recommendations to obtain a clear understanding of the actions they were taking and the status of their efforts, and discussed NRC's recommendations with NRC regional officials, on-site inspectors, and representatives from public interest groups. We conducted our review from November 2002 through May 2004 in accordance with generally accepted government auditing standards.

Results in Brief

NRC should have but did not identify or prevent the vessel head corrosion at Davis-Besse because both its inspections at the plant and its assessments of the operator's performance yielded inaccurate and incomplete information on plant safety conditions. With respect to inspections, NRC resident inspectors had information revealing potential problems, such as boric acid deposits on the vessel head and air monitors clogged with boric acid deposits, but this information did not raise alarms about the plant's safety. NRC inspectors did not know that these indications could signal a potentially significant problem and therefore did not fully communicate their observations to other NRC staff, some of whom might have recognized the significance of the problem. However, even if these staff had been informed, according to NRC officials, the agency would have taken action only if these indications were considered significant safety concerns. Furthermore, NRC's assessments of Davis-Besse, which include inspection results as well as other data, did not provide complete and accurate information on FirstEnergy's performance. For example, NRC consistently assessed Davis-Besse's operator as a "good performer" during those years when the corrosion was likely occurring, and the operator was not correctly identifying the source of boric acid deposits. NRC had been aware for several years that corrosion and cracking were issues that could possibly affect safety, but did not view them as immediate safety concerns and therefore had not fully incorporated them into its oversight process.

NRC's process for deciding whether Davis-Besse could delay its shutdown to inspect for nozzle cracking lacks credibility because the guidance NRC used was not intended for making such a decision and the basis for the decision was not fully documented. In the absence of written guidance specifically intended to direct the decision-making process for a shutdown, NRC used guidance designed for considering operator requests for license amendments. This guidance describes safety factors that NRC should consider in deciding whether to approve a license amendment, as well as a process for considering the relative risk the amendment could pose. However, the guidance does not specify how NRC should use the safety factors, and we could not determine if NRC appropriately followed this guidance because it did not clearly document the basis for its decision. For example, NRC initially decided that several safety factors were not met and considered issuing a shutdown order. Regardless, the agency allowed FirstEnergy to delay its shutdown, even though it is not clear whether—and if so, how—the safety factors were subsequently met. Further, NRC did not provide a rationale for its decision for more than a year. NRC also did not follow other aspects of its guidance. In the absence of specific guidance, and with little documentation of the decision-making process, we could not judge whether the agency's decision was reasonable. Our consultants identified substantial problems with how NRC developed and used its risk estimate when making the decision. For example, NRC did not perform an analysis of the uncertainty associated with the risk estimate; if it had, our consultants believe the uncertainty would have been so large as to render NRC's risk estimate of questionable value. Further, the risk estimate indicated that the likelihood of an accident occurring at Davis-Besse was greater than the level of risk generally accepted as being reasonable by NRC.

Responding to the Davis-Besse incident, NRC has taken several significant actions to help prevent boric acid from corroding reactor vessel heads at nuclear power plants. NRC issued requirements that licensees more extensively examine their reactor vessel heads, revised NRC inspection guidance used to identify and resolve licensee problems before they affect operations, augmented training to keep its inspectors better informed about boric acid and cracking issues, and revised guidance to better ensure that licensees implement commitments to change their operations. However, NRC has not yet implemented more than half of its planned actions, and resource constraints could affect the agency's ability to fully and effectively implement the actions. More importantly, NRC is not addressing three systemic problems underscored by the Davis-Besse incident. First, its process for assessing safety at nuclear power plants is not adequate for detecting early indications of deteriorating safety. In this respect, the process does not effectively identify changes in the operator's performance or approach to safety before a more serious safety problem can develop. Second, NRC's decision-making guidance does not specifically address shutdown decisions or explain how different safety considerations, such as quantitative estimates of risk, should be weighed. Third, NRC does not have adequate management controls for systematically tracking actions that it has taken in response to incidents at plants to determine if the actions were sufficient to resolve underlying problems and thereby prevent future incidents. Analyses of earlier incidents at other plants identified several issues, such as inadequate communication, that contributed to the Davis-Besse incident. Such management controls may have helped to resolve these issues before the Davis-Besse incident occurred. While NRC is monitoring how it implements actions taken as a result of the Davis-Besse incident, the agency has not yet committed to a process for assessing the effectiveness of actions taken.

Given NRC's actions in response to Davis-Besse, severe vessel head corrosion is unlikely to occur at a plant any time soon. However, in part because of unresolved systemic problems, another incident unrelated to vessel head corrosion could occur in the future. As a result, we are recommending that NRC take more aggressive and specific actions in several areas, such as revising how it assesses plant performance, establishing a more specific methodology for deciding to shut down a plant, and establishing management controls for monitoring and assessing the effectiveness of changes made in response to task force findings.

In commenting on a draft of this report, NRC generally addressed only those findings and recommendations with which it disagreed. While commenting that it agreed with many of our findings, the agency said that the report overall does not appropriately characterize or provide a balanced perspective on NRC's actions surrounding the discovery of the reactor vessel head condition at Davis-Besse or its efforts to incorporate the lessons learned from that experience into its processes. More specifically, NRC stated that the report does not acknowledge that NRC must rely heavily on its licensees to provide complete and accurate information. NRC also expressed concern about the report's characterization of its use of risk estimates. We believe that the report fairly and accurately describes NRC's actions regarding the Davis-Besse incident. Nonetheless, we expanded our discussion of NRC's roles and responsibilities to point out that licensees are required to provide NRC with complete and accurate information.

NRC disagreed with our recommendations to develop (1) specific guidance and a well-defined process for deciding when to shut down a plant and (2) a methodology to assess early indications of deteriorating safety at nuclear power plants. NRC stated that it has sufficient guidance to make plant shutdown decisions. NRC also stated that, as regulators, the agency is not charged with managing licensees' facilities and that direct involvement with those aspects of licensees' operations that could provide it with information on early indications of deteriorating safety crosses over to a management function. We continue to believe that NRC should develop specific guidance and a well-defined process to decide when to shut down a plant. In absence of such guidance for making the Davis-Besse shutdown decision, NRC used its guidance for considering operators' requests for amendments to their licenses. This guidance describes safety factors that NRC should consider in deciding whether to approve license changes, as well as a process for considering the relative risk the amendment would pose. This guidance does not specify how NRC should use the safety factors. We also continue to believe that NRC should develop a methodology to assess aspects of licensees' operations as a means to have an early warning of developing safety problems. In implementing this recommendation, we envision that NRC would be analyzing data for changes in operators' performance or approach to safety, not prescribing how the plants are managed.

Background

NRC's Role and Responsibilities

NRC, as an independent federal agency, regulates the commercial uses of nuclear material to ensure adequate protection of public health and safety and the environment. NRC is headed by a five-member commission appointed by the President and confirmed by the Senate; one commissioner is appointed as chairman.[5] NRC has about 2,900 employees who work in its headquarters office in Rockville, Maryland, and its four regional offices. NRC is financed primarily by fees that it imposes on commercial users of the nuclear material that it regulates. For fiscal year 2004, NRC's appropriated budget of $626 million includes about $546 million financed by these fees.

NRC regulates the nation's commercial nuclear power plants by establishing requirements for plant owners and operators to follow in the design, construction, and operation of the nuclear reactors. NRC also

[5]Two commissioner positions are currently vacant.

licenses the reactors and individuals who operate them. Currently, 104 commercial nuclear reactors at 65 locations are licensed to operate.[6] Many of these reactors have been in service since the early to mid-1970s. NRC initially licensed the reactors to operate for 40 years, but as these licenses approach their expiration dates, NRC has been granting 20-year extensions.

To ensure the reactors are operated within their licensing requirements and technical specifications, NRC oversees them by both inspecting activities at the plants and assessing plant performance.[7] NRC's inspections consist of both routine, or baseline, inspections and supplemental inspections to assess particular licensee programs or issues that arise at a power plant. Inspections may also occur in response to a specific operational problem or event that has occurred at a plant. NRC maintains inspectors at every operating nuclear power plant in the United States and supplements the inspections conducted by these resident inspectors with inspections conducted by staff from its regional offices and from headquarters. Generally, inspectors verify that the plant's operator qualifications and operations, engineering, maintenance, fuel handling, emergency preparedness, and environmental and radiation protection programs are adequate and comply with NRC safety requirements. NRC also oversees licensees by requesting information on their activities. NRC requires that information provided by licensees be complete and accurate and, according to NRC officials, this is an important aspect of the agency's oversight.[8] While we have added information to this report on the requirement that licensees provide NRC with complete and accurate information, we believe that NRC's oversight program should not place undue reliance on this requirement.

Nuclear power plants have many physical structures, systems, and components, and licensees have numerous activities under way, 24-hours a

[6]These licensed reactors include Browns Ferry Unit 1—one of three reactors owned by the Tennessee Valley Authority in Alabama—which was shut down in 1985. The Tennessee Valley Authority plans to restart the reactor in 2007, which will require NRC approval.

[7]NRC's oversight program has changed significantly since the beginning of 1998. The third and most recent change occurred in mid-2000, when the agency adopted its Reactor Oversight Process. Under this process, NRC continues to rely on inspection results to assess licensee performance. However, it supplements this information with other indicators of self-reported licensee performance, such as how frequently unscheduled shutdowns occur.

[8]10 C.F.R. § 50.9 requires that information provided by licensees be complete and accurate in all material respects.

day, to ensure the plants operate safely. Programs to ensure quality assurance and safe operations include monitoring, maintenance, and inspection. To carry out these programs, licensees typically prepare several thousand reports per year describing conditions at the plant that need to be addressed to ensure continued safe operations. Because of the large number of activities and physical structures, systems, and components, NRC focuses its inspections on those activities and pieces of equipment or systems that are considered to be most significant for protecting public health and safety. NRC terms this a "risk-informed" approach for regulating nuclear power plants. Under this risk-informed approach, some systems and activities that NRC considers to have relatively less safety significance receive little NRC oversight. NRC has adopted a risk-informed approach because it believes it can focus its regulatory resources on those areas of the plant that the agency considers to be most important to safety. In addition, it was able to adopt this approach because, according to NRC, safety performance at nuclear power plants has improved as a result of more than 25 years of operating experience.

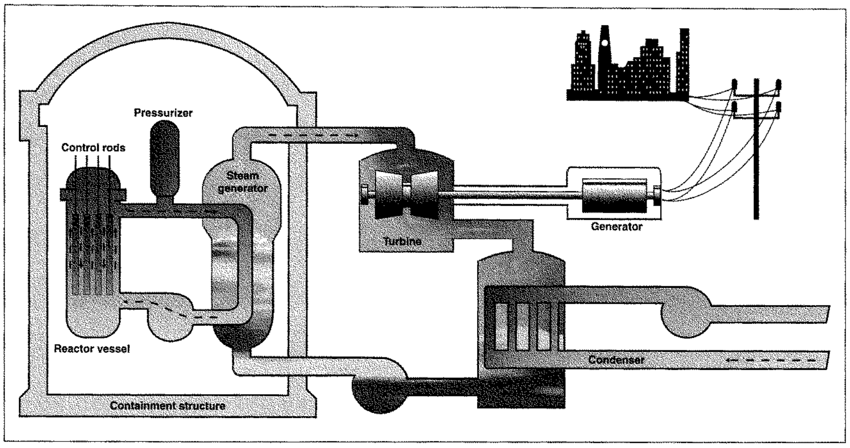
To decide whether inspection findings are minor or major, NRC uses a process it began in 2000 to determine the extent to which violations compromise plant safety. Under this process, NRC characterizes the significance of its inspection findings by using a significance determination process to evaluate how an inspection finding impacts the margin of safety at a power plant. NRC has a range of enforcement actions it can take, depending on how much the safety of the plant had been compromised. For findings that have low safety significance, NRC can choose to take no formal enforcement action. In these instances, nonetheless, licensees remain responsible for addressing the identified problems. For more serious findings, NRC may take more formal action, such as issuing enforcement orders. Orders can be used to modify, suspend, or even revoke an operating license. NRC has issued one enforcement order to shut down an operating power plant in its 28-year history—in 1987, after NRC discovered control room personnel sleeping while on duty at the Peach Bottom nuclear power plant in Pennsylvania. In addition to enforcement orders, NRC can issue civil penalties of up to $120,000 per violation per day. Although NRC does not normally use civil penalties for violations associated with its Reactor Oversight Process, NRC will consider using them for issues that are willful, have the potential for impacting the agency's regulatory process, or have actual public health and safety consequences. In fiscal year 2003, NRC proposed imposing civil penalties totaling $120,000 against two power plant licensees for the failure to provide complete and accurate information to the agency.

NRC uses generic communications—such as bulletins, generic letters, and information notices—to provide information to and request information from the nuclear industry at large or specific groups of licensees. Bulletins and generic letters both usually request information from licensees regarding their compliance with specific regulations. They do not require licensees to take any specific actions, but do require licensees to provide responses to the information requests. In general, NRC uses bulletins, as opposed to generic letters, to address significant issues of greater urgency. NRC uses information notices to transmit significant recently identified information about safety, safeguards, or environmental issues. Licensees are expected to review the information to determine whether it is applicable to their operations and consider action to avoid similar problems.

Operation of Pressurized Water Nuclear Power Plants and Events Leading to the March 2002 Discovery of Serious Corrosion

The Davis-Besse Nuclear Power Station, owned and operated by FirstEnergy Nuclear Operating Company, is an 882-megawatt electric pressurized water reactor located on Lake Erie in Oak Harbor, Ohio, about 20 miles east of Toledo. The power plant is under NRC's Region III oversight, which is located in Lisle, Illinois. Like other pressurized water reactors, Davis-Besse is designed with multiple barriers between the radioactive heat-producing core and the outside environment—a design concept called "defense-in-depth." Three main design components provide defense-in-depth. First, the reactor core is designed to retain radioactive material within the uranium oxide fuel, which is also covered with a layer of metal tubing. Second, a 6-inch-thick carbon steel vessel, lined with three-sixteenth-inch-thick stainless steel, surrounds the reactor core. Third, a steel containment structure, surrounded by a thick reinforced concrete building, encloses the reactor vessel and other systems and components important for maintaining safety. The containment structure and concrete building are intended to help not only prevent a release of radioactivity to the environment, but also shield the reactor from external hazards like tornados and missiles. The reactor vessel, in addition to housing the reactor core, contains highly pressurized water to cool the radioactive heat-producing core and transfer heat to a steam generator. Consequently, the vessel is referred to as the reactor pressure vessel. From the vessel, hot pressurized water is piped to the steam generator, where a separate supply of water is turned to steam to drive turbines that generate electricity. (See fig. 1.)

Figure 1: Major Components of a Pressurized Water Reactor



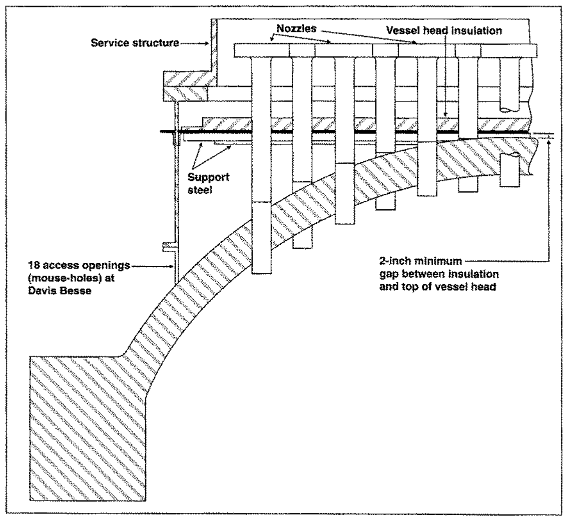
Source: NRC.

The top portion of the Davis-Besse reactor pressure vessel consisted of an 18-foot-diameter vessel head that was bolted to the lower portion of the pressure vessel. At Davis-Besse, 69 vertical tubes penetrated and were welded to the vessel head. These tubes, called vessel head penetration nozzles, contained control rods that, when raised or lowered, were used to moderate or shut down the nuclear reaction in the reactor.[9] Because control rods attach to control rod drive mechanisms, these types of nozzles are referred to as control rod drive mechanism nozzles. A platform, known as the service structure, sat above the reactor vessel head and the control rod drive mechanism nozzles. Inside the service structure and above the pressure vessel head was a layer of insulation to help contain the heat emanating from the reactor. The sides of the lower portion of the service

[9]While Davis-Besse had 69 nozzles, 7 were spare and 1 was used for head vent piping.

structure were perforated with 18 5- by 7-inch rectangular openings, termed "mouse-holes," that were used for vessel head inspections. In pressurized water reactors such as Davis-Besse, the reactor vessel, the vessel head, the nozzles, and other equipment used to ensure a continuous supply of pressurized water in the reactor vessel are collectively referred to as the reactor coolant pressure boundary. (See fig. 2.)

Figure 2: Major Components of the Davis-Besse Reactor Vessel Head and Pressure Boundary



Source: FirstEnergy.

To better control the nuclear reaction at nuclear power plants, boron in the form of boric acid crystals is dissolved in the cooling water contained within the reactor vessel and pressure boundary. Boric acid, under certain conditions, can cause corrosion of carbon steel. For about 3 decades, NRC and the nuclear power industry have known that boric acid had the potential to corrode reactor components. In general, if leakage occurs from the reactor coolant system, the escaping coolant will flash to steam and leave behind a concentration of impurities, including noncorrosive dry boric acid crystals. However, under certain conditions, the coolant will not flash to steam, and the boric acid will remain in a liquid state where it can cause extensive and rapid degradation of any carbon steel components it contacts. Such extensive degradation, in both domestic and foreign pressurized water reactor plants, has been well documented and led NRC to issue a generic letter in 1988 requesting information from pressurized water reactor licensees to ensure they had implemented programs to control boric acid corrosion. NRC was primarily concerned that boric acid corrosion could compromise the reactor coolant pressure boundary. This concern also led NRC to develop a procedure for inspecting licensees' boric acid corrosion control programs and led the Electric Power Research Institute to issue guidance on boric acid corrosion control.[10]

NRC and the nuclear power industry have also known that nozzles made of alloy 600,[11] used in several areas within nuclear power plants, were prone to cracking. Cracking had become an increasingly topical issue as the nuclear power plant fleet has aged. In 1986, operators at domestic and foreign pressurized water reactors began reporting leaks in various types of alloy 600 nozzles. In 1989, after leakage was detected at a domestic plant, NRC identified the cause of the leakage as cracking due to primary water stress corrosion.[12] However, NRC concluded that the cracking was not an immediate safety concern for a few reasons. For example, the cracks had a low growth rate, were in a material with an extremely high flaw tolerance and, accordingly, were unlikely to spread. Also, the cracks were axial—that is, they ran the length of the nozzle rather than its circumference. NRC and

[10]The Electric Power Research Institute is a nonprofit energy research consortium whose members include utilities. It provides science and technology-based solutions to members through its scientific research, technology development, and product implementation program.

[11]Alloy 600 is an alloy of nickel, chromium, iron, and minor amounts of other elements. The alloy is highly resistant to general corrosion but can be susceptible to cracking at high temperatures.

[12]Primary water stress corrosion cracking refers to cracking under stress and in primary coolant water. The primary water coolant system is that portion of a nuclear power plant's coolant system that cools the reactor core in the reactor pressure vessel and deposits heat to the steam generator.

the nuclear power industry were more concerned that circumferential cracks could result in broken or snapped nozzles. NRC did, however, issue a generic information notice in 1990 to inform the industry of alloy 600 cracking. Through the early 1990s, NRC, the Nuclear Energy Institute,[13] and others continued to monitor alloy 600 cracking. In 1997, continued concern over cracking led NRC to issue a generic letter to pressurized water reactor licensees requesting information on their plans to monitor and manage cracking in vessel head penetration nozzles as well as to examine these nozzles.

In the spring of 2001, licensee inspections led to the discovery of large circumferential cracking in several vessel head penetration nozzles at the Oconee Nuclear Station, in South Carolina. As a result of the discovery, the nuclear power industry and NRC categorized the 69 operating pressurized water reactors in the United States into different groups on the basis of (1) whether cracking had already been found and (2) how similar they were to Oconee in terms of the amount of time and the temperature at which the reactors had operated. The industry had developed information indicating that greater operating time and temperature were related to cracking. In total, five reactors at three locations were categorized as having already identified cracking, while seven reactors at five locations were categorized as being highly susceptible, given their similarity to Oconee.[14]

In August 2001, NRC issued a bulletin requesting that licensees of these reactors provide, within 30 days, information on their plans for conducting nozzle inspections before December 31, 2001.[15] In lieu of this information, NRC stated that licensees could provide the agency with a reasoned basis for their conclusions that their reactor vessel pressure boundaries would continue to meet regulatory requirements for ensuring the structural integrity of the reactor coolant pressure boundary until the licensees

[13]The Nuclear Energy Institute comprises companies that operate commercial power plants and supports the commercial nuclear industry; and universities, research laboratories, and labor unions affiliated with the nuclear industry. Among other things, it provides a forum to resolve technical and business issues and offers information to its members and policymakers on nuclear issues.

[14]Reactors that were categorized as having already identified cracking or were highly susceptible included Arkansas Nuclear reactor unit 1; D.C. Cook reactor unit 2; Davis-Besse; North Anna reactor units 1 and 2; Oconee reactor units 1, 2 and 3; Robinson reactor unit 2; Surry reactor units 1 and 2; and Three Mile Island reactor unit 1.

[15]NRC, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles" (Bulletin 2001-01, Aug. 8, 2001).

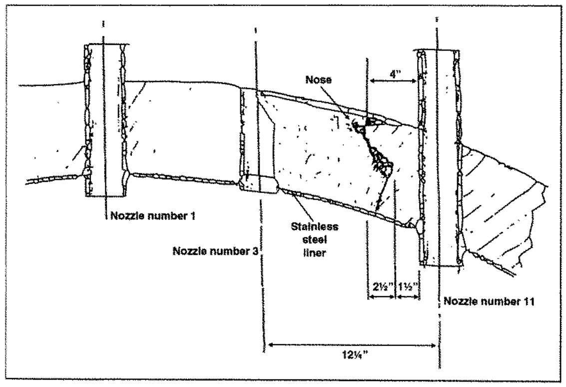
conducted their inspections. NRC used a bulletin, as opposed to a generic letter, to request this information because cracking was considered a significant and urgent issue. All of the licensees of the highly susceptible reactors, except Davis-Besse and D.C. Cook reactor unit 2, provided NRC with plans for conducting inspections by December 31, 2001.[16]

In September 2001, FirstEnergy proposed conducting the requested inspection in April 2002, following its planned March 31, 2002, shutdown to replace fuel. In making this proposal, FirstEnergy contended that the reactor coolant pressure boundary at Davis-Besse met and would continue to meet regulatory requirements until its inspection. NRC and FirstEnergy exchanged information throughout the fall of 2001 regarding when FirstEnergy would conduct the inspection at Davis-Besse. NRC drafted an enforcement order that would have shut down Davis-Besse by December 2001 for the requested inspection in the event that FirstEnergy could not provide an adequate justification for safe operation beyond December 31, 2001, but ultimately compromised on a mid-February 2002 shutdown date. NRC, in deciding when FirstEnergy had to shut down Davis-Besse for the inspection, used a risk-informed decision-making process, including probabilistic risk assessment (PRA), to conclude that the risk that Davis-Besse would have an accident in the interim was relatively low. PRA is an analytical tool for estimating the probability that a potential accident might occur by examining how physical structures, systems, and components, along with employees, work together to ensure plant safety.

Following the mid-February 2002 shutdown and in the course of its inspection in March 2002, FirstEnergy removed about 900 pounds of boric acid crystals and powder from the reactor vessel head, and subsequently discovered three cracked nozzles. The number of nozzles that had cracked, as well as the extent of cracking, was consistent with analyses that NRC staff had conducted prior to the shutdown. However, in examining the extent of cracking, FirstEnergy also discovered that corrosion had caused a pineapple-sized cavity in the reactor vessel head. (See figs. 3 and 4.)

[16]The licensee for D.C. Cook reactor unit 2 proposed to shut down in mid-January 2002 for its inspection. NRC agreed to the delay after crediting D.C. Cook for having been shut down for about a month during the fall of 2001, thus reducing the reactor's operating time.

Figure 3: Diagram of the Cavity in Davis-Besse's Reactor Vessel Head



Source: FirstEnergy.

Figure 4: The Cavity in Davis-Besse's Reactor Vessel Head after Discovery

Source: FirstEnergy.

After this discovery, NRC directed FirstEnergy to, among other things, determine the root cause of the corrosion and obtain NRC approval before restarting Davis-Besse. NRC also dispatched an augmented inspection team consisting of NRC resident, regional, and headquarters officials.[17] The inspection team concluded that the cavity was caused by boric acid corrosion from leaks through the control rod drive mechanism nozzles in the reactor vessel head. Primary water stress corrosion cracking of the nozzles caused through-wall cracks, which led to the leakage and eventual corrosion of the vessel head. NRC's inspection team also concluded, among other things, that this corrosion had gone undetected for an extended period of time—at least 4 years—and significantly compromised the plant's

[17]NRC forms such inspection teams to ensure that the agency investigates significant operational events in a timely, objective, systematic, and technically sound manner, and identifies and documents the causes of such events.

safety margins. As of May 2004, NRC had not yet completed other analyses, including how long Davis-Besse could have continued to operate with the corrosion it had experienced before a vessel head loss-of-coolant accident would have occurred.[18] However, on May 4, 2004, NRC released preliminary results of its analysis of the vessel head and cracked cladding. Based on its analysis of conditions that existed on February 16, 2002, NRC estimated that Davis-Besse could have operated for another 2 to 13 months without the vessel head failing. However, the agency cautioned that this estimate was based on several uncertainties associated with the complex network of cracks on the cladding and the lack of knowledge about corrosion and cracking rates. NRC plans to use this data in preparing its preliminary analysis of how, and the likelihood that, the events at Davis-Besse could have led to core damage. NRC plans to complete this preliminary analysis in the summer of 2004.

NRC also established a special oversight panel to (1) coordinate NRC's efforts to assess FirstEnergy's performance problems that resulted in the corrosion damage, (2) monitor Davis-Besse's corrective actions, and (3) evaluate the plant's readiness to resume operations. The panel, which is referred to as the Davis-Besse Oversight Panel, comprises officials from NRC's Region III office in Lisle, Illinois; NRC headquarters; and the resident inspector office at Davis-Besse. In addition to overseeing FirstEnergy's performance during the shutdown and through restart of Davis-Besse, the panel holds public meetings in Oak Harbor, Ohio, where the plant is located, and nearby Port Clinton, Ohio, to inform the public about its oversight of Davis-Besse's restart efforts and its views on the adequacy of these efforts. The panel developed a checklist of issues that FirstEnergy had to resolve prior to restarting: (1) replacing the vessel head and ensuring the adequacy of other equipment important for safety, (2) correcting FirstEnergy programs that led to the corrosion, and (3) ensuring FirstEnergy's readiness to restart. To restart the plant, FirstEnergy, among other things, removed the damaged reactor vessel head, purchased and installed a new head, replaced management at the plant, and took steps to improve key programs that should have prevented or detected the corrosion. As of March 2004, when NRC gave its approval for Davis-Besse to resume

[18]NRC has an Accident Sequence Precursor Analysis Program to analyze significant events that occur at nuclear power plants to determine how, and the likelihood that, the events could have led to core damage.

operations, the shutdown and preparations for restart had cost FirstEnergy approximately $640 million.[19]

In addition, NRC established a task force to evaluate its regulatory processes for assuring reactor pressure vessel head integrity and to identify and recommend areas for improvement that may be applicable to either NRC or the nuclear power industry. The task force's report, which was issued in September 2002, contains 51 recommendations aimed primarily at improving NRC's process for inspecting and overseeing licensees, communicating with industry, and identifying potential emerging technical issues that could impact plant safety. NRC developed an action plan to implement the report's recommendations.

NRC's Actions to Oversee Davis-Besse Did Not Provide an Accurate Assessment of Safety at the Plant

NRC's inspections and assessments of FirstEnergy's operations should have but did not provide the agency with an accurate understanding of safety conditions at Davis-Besse, and thus NRC failed to identify or prevent the vessel head corrosion. Some NRC inspectors were aware of the indications of corrosion and leakage that could have alerted NRC to corrosion problems at the plant, but they did not have the knowledge to recognize the significance of this information. These problems were compounded by NRC's assessments of FirstEnergy that led the agency to believe FirstEnergy was a good performer and could or would successfully resolve problems before they became significant safety issues. More broadly, NRC had a range of information that could have identified and prevented the incident at Davis-Besse but did not effectively integrate it into its oversight.

[19] FirstEnergy spent about $293 million on operations, maintenance, and capital projects (including $47 million for the new reactor vessel head) and $348 million to purchase power to replace the power that Davis-Besse would have generated over the 2-year shutdown period. In contrast, during a more routine refueling outage, Davis-Besse would spend about $60 million—about $37 million on operations, maintenance, and capital projects and $23 million on replacing the power that would have been generated over a 42-day shutdown period. These latter estimates are based on the Davis-Besse refueling outage in midcalendar year 2000.

Several Factors Contributed to the Inadequacy of NRC's Inspections for Determining Plant Conditions

Three separate, but related, NRC inspection program factors contributed to the development of the corrosion problems at Davis-Besse. First, resident inspectors did not know that the boric acid, rust, and unidentified leaking indicated that the reactor vessel head might be degrading. Second, these inspectors thought they understood the cause for the indications, based on licensee actions to address them. Therefore, resident inspectors, as well as regional and headquarters officials, did not fully communicate information on the indications or decide how to address them, and therefore took no action. Third, because the significance of the symptoms was not fully recognized, NRC did not direct sufficient inspector resources to aggressively investigate the indicators. NRC might have taken a different approach to the Davis-Besse situation if its program to identify emerging issues important to safety had pursued earlier concerns about boric acid corrosion and cracking and recognized how they could affect safety.

Inspectors Did Not Know Safety Significance of Observed Problems

NRC limits the amount of unidentified leakage from the reactor coolant system to no more than 1 gallon per minute. When this limit is exceeded, NRC requires that licensees identify and correct any sources of unidentified leakage. NRC also prohibits any leakage from the reactor coolant pressure boundary, of which the reactor vessel is a key component. Such leakage is prohibited because the pressure boundary is key to maintaining adequate coolant around the reactor fuel and thus protects public health and safety. Because of this, NRC's technical specification states that licensees are to monitor reactor coolant leakage and shut down within 36 hours if leakage is found in the pressure boundary.

In the years leading up to FirstEnergy's March 2002 discovery that Davis-Besse's vessel head had corroded extensively, NRC had several indications of potential leakage problems. First, NRC knew that the rates of leakage in the reactor coolant system had increased. Between 1995 and mid-1998, the unidentified leakage rate was about 0.06 gallon per minute or less, according to FirstEnergy's monitoring. In mid-1998, the unidentified reactor coolant system leakage rate increased significantly—to as much as 0.8 gallon per minute. The elevated leakage rate was dominated by a known problem with a leaking relief valve on the reactor coolant system pressurizer tank, which masked the ongoing leak on the reactor pressure vessel head. However, the elevated leak rate should have raised concerns.

To investigate this leakage, as well as to repair other equipment, FirstEnergy shut down the plant in mid-1999. It then identified a faulty relief valve that accounted for much of the leakage and repaired the valve.

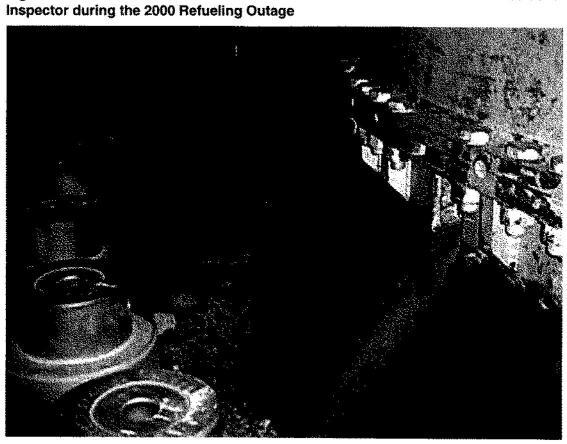
However, after restarting Davis-Besse, the unidentified leakage rate remained significantly higher than the historical average. Specifically, the unidentified leakage rate varied between 0.15 and 0.25 gallon per minute as opposed to the historical low of about 0.06 gallon or less. While NRC was aware that the rate was higher than before, NRC did not aggressively pursue the difference because the rate was well below NRC's limit of no more than 1 gallon per minute, and thus the leak was not viewed as being a significant safety concern. Following the repair in 1999, NRC's inspection report concluded that FirstEnergy's efforts to reduce the leak rate during the outage were effective.

Second, NRC was aware of increased levels of boric acid in the containment building—an indication that components containing reactor coolant were leaking. So much boric acid was being deposited that FirstEnergy officials had to repeatedly clean the containment air cooling system and radiation monitor filters. For example, before 1998, the containment air coolers seldom needed cleaning, but FirstEnergy had to clean them 28 times between late 1998 and May 2001. Between May 2001 and the mid-February 2002 shutdown, the containment air coolers were not cleaned, but at shutdown, FirstEnergy removed 15 5-gallon buckets of boric acid from the coolers—which is almost as much as was found on the reactor pressure vessel head. Rather than seeing these repeated cleanings as an indication of a problem that needed to be addressed, FirstEnergy made cleaning the coolers a routine maintenance activity, which NRC did not consider significant enough to require additional inspections. Furthermore, the radiation monitors, used to sample air from the containment building to detect radiation, typically required new filters every month. However, from 1998 to 2002, these monitors became clogged and inoperable hundreds of times because of boric acid, despite FirstEnergy's efforts to fix the problem.

Third, NRC was aware that FirstEnergy found rust in the containment building. The radiation monitor filters had accumulated dark colored iron oxide particles—a product of carbon steel corrosion—that were likely to have resulted from a very small steam leak. NRC inspection reports during the summer and fall of 1999 noted these indications and, while recognizing FirstEnergy's aggressive attempts to identify the reasons for the phenomenon, concluded that they were a "distraction to plant personnel." Several NRC inspection reports noted indications of leakage, boric acid, and rust before the agency adopted its new Reactor Oversight Process in 2000, but because the leakage was within NRC's technical specifications and NRC officials thought that the licensee understood and would fix the problem, NRC did not aggressively pursue the indications. NRC's new oversight process, implemented in the spring of 2000, limited the issues that could be discussed in NRC inspection reports to those that the agency considers to have more than minor significance. Because the leakage rates were below NRC's limits, NRC's inspection reports following the implementation of NRC's new oversight process did not identify any discussion of these problems at the plant.

Fourth, NRC was aware that FirstEnergy found rust on the Davis-Besse reactor vessel head, but it did not recognize its significance. For instance, during the 2000 refueling outage, a FirstEnergy official said he showed one of the two NRC resident inspectors a report that included photographs of rust-colored boric acid on the vessel head. (See fig. 5.)

Figure 5: Rust and Boric Acid on Davis-Besse's Vessel Head as Shown to Resident Inspector during the 2000 Refueling Outage



Source: FirstEnergy.

According to this resident inspector, he did not recall seeing the report or photographs but had no reason to doubt the FirstEnergy official's statement. Regardless, he stated that had he seen the photographs, he would not have considered the condition to be significant at the time. He said that he did not know what the rust and boric acid might have indicated, and he assumed that FirstEnergy would take care of the vessel head before restarting. The second resident inspector said he reviewed all such reports at Davis-Besse but did not recall seeing the photographs or this particular report. He stated that it was quite possible that he had read the report, but because the licensee had a plan to clean the vessel head, he would have concluded that the licensee would correct the matter before plant restart. However, FirstEnergy did not accomplish this, even though work orders and subsequent licensee reports indicated that this was done. According to the NRC resident inspector and NRC regional officials, because of the large number of licensee activities that occur during a refueling outage, NRC inspectors do not have the time to investigate or follow up on every issue, particularly when the issue is not viewed as being important to safety. While the resident inspector informed regional officials about conditions at Davis-Besse, the regional office did not direct more inspection resources to the plant, or instruct the resident inspector to conduct more focused oversight. Some NRC regional officials were aware of indications of boric acid corrosion at the plant; others were not. According to the Office of the Inspector General's investigation and 2003 report on Davis-Besse,[20] the NRC regional branch chief—who supervised the staff responsible for overseeing FirstEnergy's vessel head inspection activities during the 2000 refueling outage—said that he was unaware of the boric acid leakage issues at Davis-Besse, including its effects on the containment air coolers and the radiation monitor filters. Had his staff been requested to look at these specific issues, he might have directed inspection resources to that area. (App. I provides a time line showing significant events of interest.)

NRC Did Not Fully Communicate Indications

NRC was not fully aware of the indications of a potential problem at Davis-Besse because NRC's process for transmitting information from resident inspectors to regional offices and headquarters did not ensure that information was fully communicated, evaluated, or used. NRC staff communicated information about plant operations through inspection reports, licensee assessments, and daily conference calls that included

[20]NRC, Office of the Inspector General, *NRC's Oversight of Davis-Besse during the April 2000 Refueling Outage* (Washington, D.C.: Oct. 17, 2003).

resident, regional, and headquarters officials. According to regional officials, information that is not considered important is not routinely communicated to NRC management and technical specialists. For example, while the resident inspectors at Davis-Besse knew all of the indications of leakage, and there was some level of knowledge about these indications at the regional office level, the knowledge was not sufficiently widespread within NRC to alert a technical specialist who might have recognized their safety significance. According to NRC Region III officials, the region uses an informal means—memorandums sent to other regions and headquarters—of communicating information identified at plants that it considers to be important to safety. However, because the indications at Davis-Besse were not considered important, officials did not transmit this information to headquarters. Further, because the process is informal, these officials said they did not know whether—and if so, how—other NRC regions or headquarters used this information.

Similarly, NRC officials said that NRC headquarters had no systematic process for communicating information, such as on boric acid corrosion, cracking, and small amounts of unidentified leakage, that had not yet risen to a relatively high level of concern within the agency, in a timely manner to its regions or on-site inspectors. For example, the regional inspector that oversaw FirstEnergy's activities during the 2000 refueling outage, including the reactor vessel head inspection, stated that he was not aware of NRC's generic bulletins and letters pertaining to boric acid and corrosion, even though NRC issues only a few of these bulletins and generic letters each year.[21] In addition, according to NRC regional officials and the resident inspector at Davis-Besse, there is little time to review technical reports about emerging safety issues that NRC compiles because they are too lengthy and detailed. Ineffective communication, both within the region and between NRC headquarters and the region, was a primary factor cited by NRC's Office of the Inspector General in its investigation of NRC's oversight of Davis-Besse boric acid leakage and corrosion.[22] For example, it found that ineffective communication resulted in senior regional management being largely unaware of repeated reports of boric acid leakage at Davis-Besse. It also found that headquarters, in communications with the regions, did not emphasize the issues discussed in its generic

[21]Over the last 10 years, NRC has issued an average of about two generic bulletins and about four generic letters a year.

[22]NRC, Office of the Inspector General, *NRC's Oversight of Davis-Besse during the April 2000 Refueling Outage* (Washington, D.C.; Oct. 17, 2003).

letters or bulletins on boric acid corrosion or cracking. NRC programs for informing its inspectors about issues that can reduce safety at nuclear power plants were not effective. As a result, NRC inspectors did not recognize the significance of the indications at Davis-Besse, fully communicate information about the indications, or spend additional effort to follow up on the indications.

Resource Constraints Affected NRC Oversight

NRC also did not focus on the indications that the vessel head was corroding because of several staff constraints. Region III was directing resources to other plants that had experienced problems throughout the region, and these plants thus were the subject of increased regulatory oversight. For example, during the refueling outages in 1998 and 2000, while NRC oversaw FirstEnergy's inspection of the reactor vessel head, the region lacked senior project engineers to devote to Davis-Besse. A vacancy existed for a senior project engineer responsible for Davis-Besse from June 1997 until June 1998, except for a one month period, and from September 1999 until May 2000, which resulted in fewer inspection hours at the facility than would have been normal. Other regional staff were also occupied with other plants in the region that were having difficulties, and NRC had unfilled vacancies for resident and regional inspector positions that strained resources for overseeing Davis-Besse.

Even if the inspector positions had been filled, it is not certain that the inspectors would have aggressively followed up on any of the indications. According to our discussions with resident and regional inspectors and our on-site review of plant activities, because nuclear power plants are so large, with many physical structures, systems, and components, an inspector could miss problems that were potentially significant for safety. Licensees typically prepare several hundred reports per month for identifying and resolving problems, and NRC inspectors have only a limited amount of time to follow up on these licensee reports. Consequently, NRC selects and oversees the most safety significant structures, systems, and components.

NRC's Assessment Process Did Not Indicate Deteriorating Performance

Under NRC's Reactor Oversight Process, NRC assesses licensees' performance using two distinct types of information: (1) NRC's inspection results and (2) performance indicators reported by the licensees. These indicators, which reflect various aspects of a plant's operations, include data on, for example, the failure or unavailability of certain important operating systems, the number of unplanned power changes, and the amount of reactor coolant system leakage. NRC evaluates both the inspection results and the performance indicators to arrive at licensee assessments, which it then color codes to reflect their safety significance. Green assessments indicate that performance is acceptable, and thus connote a very low risk significance and impact on safety. White, yellow, and red assessments each represent a greater degree of safety significance. After NRC adopted its Reactor Oversight Process in April 2000, FirstEnergy never received anything but green designations for its operations at Davis-Besse and was viewed by NRC as a good performer until the 2002 discovery of the vessel head corrosion.[23] Similarly, prior to adopting the Reactor Oversight Process, NRC consistently assessed FirstEnergy as generally being a good performer. NRC officials stated, however, that significant issues were identified and addressed as warranted throughout this period, such as when the agency took enforcement action in response to FirstEnergy's failure to properly repair important components in 1999—a failure caused by weaknesses in FirstEnergy's boric acid corrosion control program.

Key Davis-Besse programs for ensuring the quality and safe operation of the plant's engineered structures, systems, and components include, for example,

- a corrective action program to ensure that problems at the plant that are relevant to safety are identified and resolved in a timely manner,
- an operating experience program to ensure that experiences or problems that occur are appropriately identified and analyzed to determine their significance and relevance to operations, and
- a plant modification program to ensure that modifications important to safety are implemented in a timely manner.

As at other commercial nuclear power plants, NRC conducted routine, baseline inspections of Davis-Besse to determine the effectiveness of these programs. Reports documenting these inspections noted incidences of boric acid leakage, corrosion, and deposits. However, between February 1997 and March 2000, the regional office's assessment of the licensee's performance addressed leakage in the reactor coolant system only once and never noted the other indications. Furthermore, Davis-Besse was not

[23]Before adopting the Reactor Oversight Process, NRC also assessed licensee performance based on inspection results and other information; however, NRC did not assign color codes to assessment results.

the subject of intense scrutiny in regional plant assessment meetings because plants perceived as good performers—such as Davis-Besse—received substantially less attention. Between April 2000—when NRC's revised assessment process took effect—until the corrosion was discovered in March 2002, none of NRC's assessments of Davis-Besse's performance noted leakage or other indications of corrosion at the plant. As a result, NRC may have missed opportunities to identify weaknesses in the Davis-Besse programs intended to detect or prevent the corrosion.

After the corrosion was discovered, NRC analyzed the problems that led to the corrosion on the reactor vessel head and concluded that FirstEnergy's programs for overseeing safety at Davis-Besse were weak, as seen in the following examples:

- Davis-Besse's corrective action program did not result in timely or effective actions to prevent indications of leakage from reoccurring in the reactor coolant system.
- FirstEnergy officials did not always enter equipment problems into the corrective action program because individuals who had identified the problem were often responsible for resolving it.
- For over a decade, FirstEnergy had delayed plant modifications to its service structure platform, primarily because of cost. These modifications would have improved its ability to inspect the reactor vessel head nozzles. As a result, FirstEnergy could conduct only limited visual inspections and cleaning of the reactor pressure vessel head through the small "mouse-holes" that perforated the service structure.

NRC was also unaware of the extent to which various aspects of FirstEnergy's safety culture had degraded—that is, FirstEnergy's organization and performance related to ensuring safety at Davis-Besse. This degradation had allowed the incident to occur with no forewarning because NRC's inspections and performance indicators do not directly assess safety culture. Safety culture is a group of characteristics and attitudes within an organization that establish, as an overriding priority, that issues affecting nuclear plant safety receive the attention their significance warrants. Following FirstEnergy's March 2002 discovery, NRC found numerous indications that FirstEnergy emphasized production over plant safety. First, Davis-Besse routinely restarted the plant following an outage, even though reactor pressure vessel valves and control rod drive mechanisms leaked. Second, staff was unable to remove all of the boric acid deposits from the reactor pressure vessel head because FirstEnergy's schedule to restart the plant dictated the amount of work that could be performed. Third, FirstEnergy management was willing to accept degraded equipment, which indicated a lack of commitment to resolve issues that could potentially compromise safety. Fourth, Davis-Besse's program that was intended to ensure that employees feel free to raise safety concerns without fear of retaliation had several weaknesses. For example, in one instance, a worker assigned to repair the containment air conditioner was not provided a respirator in spite of his concerns that he would inhale boric acid residue. According to NRC's lessons-learned task force report, NRC was not aware of weaknesses in this program because its inspections did not adequately assess it.

Given that FirstEnergy concluded that one of the causes for the Davis-Besse incident was human performance and management failures, the panel overseeing FirstEnergy's efforts to restart Davis-Besse requested that FirstEnergy assess its safety culture before allowing the plant to restart. To oversee FirstEnergy's efforts to improve its safety culture, NRC (1) reviewed whether FirstEnergy had adequately identified all of the root causes for management and human performance failures at Davis-Besse, (2) assessed whether FirstEnergy had identified and implemented appropriate corrective actions to resolve these failures, and (3) assessed whether FirstEnergy's corrective actions were effective. As late as February 2004, NRC had concerns about whether FirstEnergy's actions would be adequate in the long term. As a result, the Davis-Besse safety culture was one of the issues contributing to the delay in restarting the plant. In March 2004, NRC's panel concluded that FirstEnergy's efforts to improve its safety culture were sufficient to allow the plant to restart. In doing so, however, NRC officials stated that one of the conditions the panel imposed was for FirstEnergy to conduct an independent assessment of the safety culture at Davis-Besse annually over the course of the next 5 years.

NRC Did Not Effectively Incorporate Long-Standing Knowledge about Corrosion, Nozzle Cracking, and Leak Detection into Its Oversight

NRC has been aware of boric acid corrosion and its potential to affect safety since at least 1979. It issued several notices to the nuclear power industry about boric acid corrosion and, specifically, the potential for it to degrade the reactor coolant pressure boundary. In 1987, two licensees found significant corrosion on their reactor pressure vessel heads, which heightened NRC's concern. A subsequent industry study concluded that concentrated solutions of boric acid could result in unacceptably high corrosion rates—up to 4 inches per year—when primary coolant leaks onto surfaces and concentrates at temperatures found on the surface of the reactor vessel.[24] After considering this information and several more instances of boric acid corrosion at plants, NRC issued a generic letter in 1988 requesting licensees to implement boric acid corrosion control programs.

In 1990, NRC visited Davis-Besse to assess the adequacy of the plant's boric acid corrosion control program. At that time, NRC concluded that the program was acceptable. However, in 1999, NRC became aware that FirstEnergy's boric acid corrosion control program was inadequate because boric acid had corroded several bolts on a valve, and NRC issued a violation. As a result of the violation, FirstEnergy agreed to review its boric acid corrosion procedures and enhance its program. NRC inspectors evaluated FirstEnergy's completed and planned actions to improve the boric acid corrosion control program and found them to be adequate. According to NRC officials, they never inspected the remaining actions—assuming that the planned actions had been implemented effectively. In 2000, NRC adopted its new Reactor Oversight Process and discontinued its inspection procedure for plants' corrosion control programs because these inspections had rarely been conducted due to higher priorities. Thus, NRC had no reliable or routine way to ensure that the nuclear power industry fully implemented boric acid corrosion control programs.

NRC also did not routinely review operating experiences at reactors, both in the United States and abroad, to keep abreast of boric acid developments and determine the need to emphasize this problem. Indeed, NRC did not fully understand the circumstances in which boric acid would result in corrosion, rather than flash to steam. Similarly, NRC did not know the rate at which carbon steel would corrode under different conditions. This lack of knowledge may be linked to shortcomings in its program to review operating experiences at reactors, which could have been exacerbated by the 1999 elimination of the office specifically responsible for reviewing operating experiences.[25] This office was responsible for, among other things, (1) coordinating operational data collection, (2)

[24]Westinghouse Electric Company, *Corrosion Effects of Boric Acid Leakage on Steel under Plant Operating Conditions—A Review of Available Data* (Pittsburgh: October 1987).

[25]NRC's Office for Analysis and Evaluation of Operating Data was established in response to a recommendation that we made to the agency in 1978 that it have a systematic process for analyzing operating experience and feeding this information back to licensees and the industry. NRC eliminated this office, and its responsibilities were transferred to other NRC offices in an effort to gain efficiencies.

systematically analyzing and evaluating operational experience, (3) providing feedback on operational experience to improve safety, (4) assessing the effectiveness of the agencywide program, and (5) acting as a focal point for interaction with outside organizations on issues pertaining to operational safety data analysis and evaluation. According to NRC officials who had overseen Davis-Besse at the time of the incident, they would not have suspected the reactor vessel head or cracked head penetration nozzles as the source of the filter clogging and unidentified leakage because they had not been informed that these could be potential problems. According to these officials, the vessel head was "not on the radar screen."

With regard to nozzle cracking, NRC, for more than two decades, was aware of the potential for nozzles and other components made of alloy 600 to crack. While cracks were found at nuclear power plants, NRC considered their safety significance to be low because the cracks were not developing rapidly. In contrast, other countries considered the safety significance of such cracks to be much higher. For example, concern over alloy 600 cracking led France, as a preventive measure, to institute requirements for an extensive nondestructive examination inspection program for vessel head penetration nozzles, including the removal of insulation, during every fuel outage. When any indications of cracking were observed, even more frequent inspections were required, which, because of economic considerations, resulted in the replacement of vessel heads when indications were found. The effort to replace the vessel heads is still under way. Japan replaced those vessel heads whose nozzles it considered most susceptible to cracking, even though no cracks had yet been found. Both France and Sweden also installed enhanced leakage monitoring systems to detect leaks early. However, according to NRC, such systems cannot detect the small amounts of leakage that may be typical from cracked nozzles.

NRC recognized that an integrated, long-term program, including periodic inspections and monitoring of vessel heads to check for nozzle cracking, was necessary. In 1997, it issued a generic letter that summarized NRC's efforts to address cracking of control rod drive mechanism nozzles and requested information on licensees' plans to inspect nozzles at their reactors. More specifically, this letter asked licensees to provide NRC with descriptions of their inspections of these nozzles and any plans for enhanced inspections to detect cracks. At that time, NRC was planning to review this information to determine if enhanced licensee inspections were warranted. Based on its review of this information, NRC concluded that the current inspection program was sufficient. As a result, between 1998 and

2001, NRC did not issue or solicit additional information on nozzle cracking or assess its requirements for inspecting reactor vessels to determine whether they were sufficient to detect cracks. At Davis-Besse, NRC also did not determine if FirstEnergy had plans or was implementing any plans for enhanced nozzle inspections, as noted in the 1997 generic letter. NRC took no further action until the cracks were found in 2001 at the Oconee plant, in South Carolina. NRC attributed its lack of focus on nozzle cracking, in part, to the agency's inability to effectively review, assess, and follow up on industry operating experience events. Furthermore, as with boric acid corrosion, NRC did not obtain or analyze any new data about cracking that would have supported making changes in either its regulations or inspections to better identify or prevent corrosion on the vessel head at Davis-Besse.

NRC's technical specifications regarding allowable leakage rates also contributed to the corrosion at Davis-Besse because the amount of leakage that can cause extensive corrosion can be significantly less than the level that NRC's specifications allow. According to NRC officials, NRC's requirements, established in 1973, were based on the best available technology at that time. The task of measuring identified and unidentified leakage from the reactor coolant system is not precise. It requires licensees to estimate the amount of coolant that the reactor is supposed to contain and identify any difference in coolant levels. They then have to account for the estimated difference in the actual amount of coolant to arrive at a leakage rate; to do this, they identify all sources and amounts of leakage by, among other things, measuring the amount of water contained in various sump collection systems. If these sources do not account for the difference, licensees know they have an unidentified source of leakage. This estimate can vary significantly from day to day between negative and positive numbers.

According to analyses that FirstEnergy conducted after it identified the corrosion in March 2002, the leakage rates from the nozzle cracks were significantly below NRC's reactor coolant system unidentified leakage rate of 1 gallon per minute. Specifically, the leakage from the nozzle around which the vessel head corrosion occurred was predicted to be 0.025 gallon per minute. If such small leakage can result in such extensive corrosion, identifying if and where such leakage occurs is important. NRC staff recognized as early as 1993 it would be prudent for the nuclear power industry to consider implementing an enhanced method for detecting small leaks during plant operation, but NRC did not require this action, and the industry has not taken steps to do so. Furthermore, NRC has not consistently enforced its requirement for reactor coolant pressure boundary leakage. As a result, the NRC Davis-Besse task force concluded that inconsistent enforcement may have reinforced a belief that alloy 600 nozzle leakage was not actually or potentially a safety significant issue.

NRC's Process for Deciding Whether to Allow a Delayed Davis-Besse Shutdown Lacked Credibility

Although FirstEnergy operated Davis-Besse without incident until shutting it down in February 2002, certain aspects of NRC's deliberations allowing the delayed shutdown raise questions about the credibility of the agency's decision making, if not about the Davis-Besse decision itself. NRC does not have specific guidance for deciding on plant shutdowns. Instead, agency officials turned to guidance developed for a different purpose—reviewing requests to amend license operating conditions—and even then did not always adhere to this guidance. In addition, NRC did not document its decision-making process, as called for by its guidance, and its letter to FirstEnergy to lay out the basis for the decision—sent a year after the decision—did not fully explain the decision. NRC's lack of guidance, coupled with the lack of documentation, precludes us from independently judging whether NRC's decision was reasonable. Finally, some NRC officials stated that the shutdown decision was based, in part, on the agency's probabilistic risk assessment (PRA) calculations of the risk that Davis-Besse would pose if it delayed its shutdown and inspection. However, as noted by our consultants, the calculations were flawed, and NRC's decision makers did not always follow the agency's guidance for developing and using such calculations.

NRC Did Not Have Specific Guidance for Deciding on Plant Shutdowns

NRC believed that Davis-Besse could have posed a potential safety risk because it was, in all likelihood, failing to comply with NRC's technical specification that no leakage occur in the reactor coolant pressure boundary. Its belief was based on the following indicators of probable leakage:

- All six of the other reactors manufactured by the same company as Davis-Besse's reactor had cracked nozzles and identified leakage.[26]
- Three of these six reactors had identified circumferential cracking.

[26]Davis-Besse's manufacturer was the Babcock and Wilcox Company, which is an operating unit of McDermott International.

- FirstEnergy had not performed a recent visual examination of all of its nozzles.

Furthermore, a FirstEnergy manager agreed that cracks and leakage were likely.

NRC has the authority to shut down a plant when it is clear that the plant is in violation of important safety requirements, and it is clear that the plant poses a risk to public health and safety.[27] Thus, if a licensee is not complying with technical specifications, such as those for no allowable reactor vessel pressure boundary leakage, NRC can order a plant to shut down. However, NRC decided that it could not require Davis-Besse to shut down on the basis of other plants' cracked nozzles and identified leakage or the manager's acknowledgement of a probable leak. Instead, it believed it needed more direct, or absolute, proof of a leak to order a shutdown. This standard of proof has been questioned. According to the Union of Concerned Scientists,[28] for example, if NRC needed irrefutable proof in every case of suspected problems, the agency would probably never issue a shutdown order. In effect, in this case NRC created a Catch-22: It needed irrefutable proof to order a shutdown but could not get this proof without shutting down the plant and requiring that the reactor be inspected.

Despite NRC's responsibility for ensuring that the public is adequately protected from accidents at commercial nuclear power plants, NRC does not have specific guidance for shutting down a plant when the plant may pose a risk to public health and safety, even though it may be complying with NRC requirements. It also has no specific guidance or standards for quality of evidence needed to determine that a plant may pose an undue risk. Lacking direct or absolute proof of leakage at Davis-Besse, NRC instead drafted a shutdown order on the basis that a potentially hazardous condition may have existed at the plant. NRC had no guidance for developing such a shutdown order, and therefore, it used its guidance for reviewing license amendment requests. NRC officials recognized that this guidance was not specifically designed to determine whether NRC should shut down a power plant such as Davis-Besse. However, NRC officials

[27]Ordinarily, NRC would not suspend a license for a failure to meet a requirement unless the failure was willful and adequate corrective action had not been taken.

[28]The Union of Concerned Scientists is a nonprofit partnership of scientists and citizens that augments scientific analyses and policy development for identifying environmental solutions to issues such as energy production.

stated that this guidance was the best available for deciding on a shutdown because, although the review was not to amend a license, the factors that NRC needed to consider in making the decision and that were contained in the guidance were applicable to the Davis-Besse situation.

To use its guidance for reviewing license amendment requests, NRC first determined that the situation at Davis-Besse posed a special circumstance because new information revealed a substantially greater potential for a known hazard to occur, even if Davis-Besse was in compliance with the technical specification for leakage from the reactor coolant pressure boundary. The special circumstance stemmed from NRC's determination that requirements for conducting vessel head inspections were not sufficient to detect nozzle cracking and, thus, small leaks.[29] According to NRC officials, this determination allowed NRC to use its guidance for reviewing license amendment requests when deciding whether to order a shutdown.

The Extent of NRC's Reliance on License Amendment Guidance Is Not Clear

Under NRC's license amendment guidance, NRC considers how the license change affects risk, but not how it has previously assessed licensee performance, such as whether the licensee was viewed as a good performer. With regard to the Davis-Besse decision, the guidance directed NRC to determine whether the plant would comply with five NRC safety principles if it operated beyond December 2001 without inspecting the reactor vessel head. As applied to Davis-Besse, these principles were whether the plant would (1) continue to meet requirements for vessel head inspections, (2) maintain sufficient defense-in-depth, (3) maintain sufficient safety margins, (4) have little increase in the likelihood of a core damage accident, and (5) monitor the vessel head and nozzles. The guidance, however, does not specify how to apply these safety principles, how NRC can demonstrate it has followed the principles and ensured they are met, or whether any one principle takes precedence over the others. The guidance also does not indicate what actions NRC or licensees should take if some or all of the principles are not met.

[29]Specifically, reactor vessel head inspection requirements do not require that insulation be removed. Because of this, reactor vessel head inspections performed without removing the insulation above the vessel head could not result in 100 percent of the nozzles being visually inspected.

In mid-September 2001, NRC staff concluded that Davis-Besse complied with the first safety principle but did not meet the remaining four. According to the staff, Davis-Besse did not meet three safety principles because the requirements for vessel head inspections were not adequate. Specifically, the requirements do not require the inspector to remove the insulation above the vessel head, and thus allow all of the nozzles to be visually inspected. NRC therefore could not ensure that FirstEnergy was maintaining defense-in-depth and adequate safety margins or sufficiently monitoring the vessel head and nozzles. The staff believed that Davis-Besse did not meet the fourth safety principle because the risk estimate of core damage approached an unacceptable level and the estimate itself was highly uncertain.

Between early October and the end of November 2001, NRC requested and received additional information from FirstEnergy regarding its risk estimate of core damage—its PRA estimate—and met with the company to determine the basis for the estimate. NRC was also developing its own risk estimate, although its numbers kept changing. At some point during this time, NRC staff also concluded that the first safety principle was probably not being met, although the basis for this conclusion is not known.

At the end of November 2001, NRC contacted FirstEnergy and informed it that a shutdown order had been forwarded to the NRC commissioners and asked if FirstEnergy could take any actions that would persuade NRC to not issue the shutdown order. The following day, FirstEnergy proposed measures to mitigate the potential for and consequences of an accident. These measures included, among other things, lowering the operating temperature from 605 degrees Fahrenheit to 598 degrees Fahrenheit to reduce the driving force for stress corrosion cracking on the nozzles, identifying a specific operator to initiate emergency cooling in response to an accident, and moving the scheduled refueling outage up from March 31, 2002, to no later than February 16, 2002. NRC staff discussed these measures, and NRC management asked the staff if they were concerned about extending Davis-Besse's operations until mid-February 2002. While some of the staff were concerned about continued operations, none indicated to NRC management that cracking in control rod drive mechanism nozzles was likely extensive enough to cause a nozzle to eject from the vessel head, thus making it unsafe to operate. NRC formally accepted FirstEnergy's compromise proposal within several days, thus abandoning its shutdown order.

NRC Did Not Fully Explain or Document the Basis for Its Decision

We could not fully assess NRC's basis for accepting FirstEnergy's proposal. NRC did not document its deliberations, even though its guidance requires that it do so. This documentation is to include the data, methods, and assessment criteria used; the basis for the decisions made; and essential correspondence sufficient to document the persons, places, and matters dealt with by NRC. Specifically, the guidance requires that the documentation contain sufficient detail to make possible a "proper scrutiny" of NRC decisions by authorized outside agencies and provide evidence of how basic decisions were formed, including oral decisions. NRC's guidance also states that NRC should document all important staff meetings.

In reviewing NRC's documentation on the Davis-Besse decision, we found no evidence of an in-depth or formal analysis of how Davis-Besse's proposed measures would affect the plant's ability to satisfy the five safety principles. Thus, it is unclear whether the safety principles contained in the guidance were met by the measures that FirstEnergy proposed. However, several NRC officials stated that FirstEnergy's proposed measures had no impact on plant operations or safety. For example, according to one NRC official, FirstEnergy's proposal to reduce the operating temperature would have had little impact on safety because the small drop in operating temperature over a 7-week period would have had little effect on the growth rate of any cracks in a nozzle. As such, this official considered the measures as "window dressing." A proposed measure that NRC staff did consider as having a significant impact on the risk was for FirstEnergy to dedicate an operator for manually turning on safety equipment in the event that a nozzle was ejected. Subsequent to approving the delayed shutdown, NRC learned that FirstEnergy had not, in fact, planned to dedicate an operator for this task—rather, FirstEnergy planned to have an operator do this task in addition to other regularly assigned duties.

According to an NRC official, once NRC decided not to issue a shutdown order for December 2001, NRC staff needed to discuss how NRC's assessment of whether the five safety principles had been met had changed in the course of the staff's deliberations. However, there was no evidence in the agency's records to support that this discussion was held, and other key meetings, such as the one in which the agency made its decision to allow Davis-Besse to operate past December 31, 2001, were not documented. Without documentation, it is not clear what factors influenced NRC's decision. For example, according to the NRC Office of the Inspector General's December 2002 report that examined the Davis-Besse incident, NRC's decision was driven in large part by a desire to lessen the financial impact on FirstEnergy that would result from an early shutdown.[30] While NRC disputed this finding, we found no evidence in the agency's records to support or refute its position.

In December 2001, when NRC informed FirstEnergy that it accepted the company's proposed measures and the February 16, 2002, shutdown date, it also said that the company would receive NRC's assessment in the near future. However, NRC did not provide the assessment until a full year later—in December 2002. In addition, the December 2002 assessment, which includes a four-page evaluation, does not fully explain how the safety principles were used or met—other than by stating that if the likelihood of nozzle failure were judged to be small, then adequate protection would be ensured. Even though NRC's regulations regarding the reactor coolant pressure boundary dictate that the reactor have an extremely low probability of failing, NRC stated it did not believe that Davis-Besse needed to demonstrate strict conformance with this regulation. As evidence of the small likelihood of failure, NRC cited the small size of cracks found at other power plants, as well as its preliminary assessment of nozzle cracking, which projected crack growth rates. NRC concluded that 7 weeks of additional operation would not result in an appreciable increase in the size of the cracks.[31] While NRC included its calculated estimates of the risk that Davis-Besse would pose, it did not detail how it calculated its estimates.

NRC's PRA Estimate Was Flawed and Its Use in Deciding to Delay the Shutdown Is Unclear

In moving forward with its more risk-informed regulatory approach, NRC has established a policy to increase the use of PRA methods as a means to promote regulatory stability and efficiency. Using PRA methods, NRC and the nuclear power industry can estimate the likelihood that different accident scenarios at nuclear power plants will result in reactor core damage and a release of radioactive materials. For example, one of these accident scenarios begins with a "medium break" loss-of-coolant accident in which the reactor coolant system is breached and a midsize—about 2- to 4-inch—hole is formed that allows coolant to escape from the reactor

[30] NRC, Office of the Inspector General, *NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head* (Washington, D.C.; Dec. 30, 2002).

[31] NRC, *Preliminary Staff Technical Assessment for Pressurized Water Reactor Vessel Head Penetration Nozzles Associated with NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles"* (Washington, D.C.; Nov. 6, 2001).

pressure boundary. The probability of such an accident scenario occurring and the consequences of that accident take into account key engineering safety system failure rates and human error probabilities that influence how well the engineered systems would be able to mitigate the consequences of an accident and ensure no radioactive release from the plant.

For Davis-Besse, NRC needed two estimates: one for the frequency of a nozzle ejecting and causing a loss-of-coolant accident and one for the probability that a loss-of-coolant accident would result in core damage. NRC first established an estimate, based partially on information provided by FirstEnergy, for the frequency of a plant developing a cracked nozzle that would initiate a medium break loss-of-coolant accident. NRC estimated that the frequency of this occurring would be about $2x10^{-2}$, or 1 chance in 50,[32] per year. NRC then used an estimate, which FirstEnergy provided, for the probability of core damage given a medium break loss-of-coolant accident. This probability estimate was $2.7x10^{-3}$, or about 1 chance in 370.[33] Multiplying these two numbers, NRC estimated that the potential for a nozzle to crack and cause a loss-of-coolant accident would increase the frequency of core damage at Davis-Besse by about $5.4x10^{-5}$ per year, or about 1 in 18,500 per year.[34] Converting this frequency to a probability associated with continued operation for 7 weeks, NRC calculated that the increase in the probability of core damage was approximately $5x10^{-6}$, or 1 chance in 200,000.[35] While NRC officials currently disagree that this was the number it used, this is the number that it included in its December 2002 assessment provided to FirstEnergy. Further, we found no evidence in the agency's records to support NRC's current assertion.

According to our consultants, the way NRC calculated and used the PRA estimate was inadequate in several respects. (See app. II for the consultants' detailed report.) First, NRC's calculations did not take into

[32]Here is how to calculate the frequency estimate: $2x10^{-2}$ equates to 0.02, or 2/100, which equals 1/50.

[33]Here is how to calculate the probability estimate: $2.7x10^{-3}$ equates to 0.0027, or 27/10,000, which equals 1/370.37.

[34]Here is how to calculate the frequency estimate: $5.4x10^{-5}$ equates to 0.000054, or 54/1,000,000, which equals 1/18,518.52.

[35]Here is how to calculate the probability estimate: $5x10^{-6}$ equates to 0.000005, or 5/1,000,000, which equals 1/200,000.

account several factors, such as the possibility of corrosion and axial cracking that could lead to leakage. For example, the consultants concluded that NRC's estimate of risk was incorrectly too small, primarily because the calculation did not consider corrosion of the vessel head. In reviewing how NRC developed and used its PRA estimates for Davis-Besse, our consultants noted that the calculated risk was smaller than it should have been because the calculations did not consider corrosion of the reactor vessel from the boric acid coolant leaking through cracks in the nozzles. According to the consultants, apparently all NRC staff involved in the Davis-Besse decision were aware that coolant under high pressure was leaking from valves, flanges, and possibly from cracks but evidently thought that the coolant would immediately flash into steam and noncorrosive compounds of boric acid. Our consultants, however, stated that because boric acid could potentially cause corrosion, except at temperatures much higher than 600 degrees Fahrenheit, NRC should have anticipated that corrosion could occur. Our consultants further stated that as evaporation occurs, boric acid becomes more concentrated in the remaining liquid—making it far more corrosive—and as vapor pressure decreases, evaporation is further slowed. They said it should be expected that some of the boric acid in the escaping coolant could reach the metal surfaces as wet or moist, highly corrosive material underlying the surface layers of dry noncorrosive boric acid, which is evidently what happened at Davis-Besse.

Our consultants concluded that NRC staff should have been aware of the experience at French nuclear power plants, where boric acid corrosion from leaking reactor coolant had been identified during the previous decade, the safety significance had been recognized, and safety procedures to mitigate the problem had been implemented. Furthermore, tests had been conducted by the nuclear power industry and in government laboratories on boric acid corrosion that were widely available to NRC. They stated that keeping abreast of safety issues at similar plants, whether domestic or foreign, and conveying relevant safety information to licensees are important functions of NRC's safety program. According to NRC, the agency was aware of the experience at French nuclear power plants. For example, NRC concluded, in a December 15, 1994, internal NRC memo, that primary coolant leakage from a through-wall crack could cause boric acid corrosion of the vessel head. However, because it concluded that some analyses indicated that it would take at least 6 to 9 years before any corrosion would challenge the structural integrity of the head, NRC concluded that cracking was not a short-term safety issue.

Our consultants also stated that NRC's risk analysis was inadequate because the analysis concerned only the formation and propagation of circumferential cracks that could result in nozzle failure, loss of coolant, and even control rod ejection. Although there is less chance of axial cracks causing complete nozzle failure, these cracks open additional pathways for coolant leakage. In addition, their long crevices provide considerably greater opportunity for the coolant to concentrate near the surface of the vessel head. However, according to our consultants, NRC was convinced that the boric acid they saw resulted from leaking flanges above the reactor vessel head, as opposed to axial cracks in the nozzles.

Second, NRC's analysis was inadequate because it did not include the uncertainty of its risk estimate and use the uncertainty analysis in the Davis-Besse decision-making process, although NRC staff should have recognized large uncertainties associated with its risk estimate. Our consultants also concluded that NRC failed to take into account the large uncertainties associated with estimates of the frequency of core damage resulting from the failure of nozzles. PRA estimates for nuclear power plants are subject to significant uncertainties associated with human errors and other common causes of system component failures, and it is important that proper uncertainty analyses be performed for any PRA study. NRC guidance and other NRC reports on advancing PRA technology for risk-informed decisions emphasize the need to understand and characterize uncertainties in PRA estimates. Our consultants stated that had the NRC staff estimated the margin of error or uncertainty associated with its PRA estimate for Davis-Besse, the uncertainty would likely have been so high as to render the estimate of questionable value.

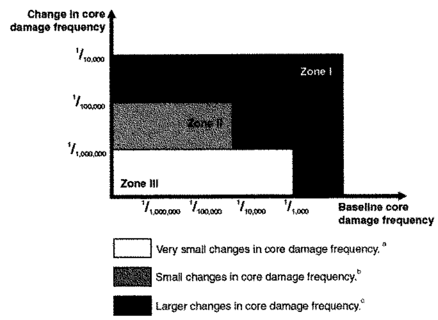
Third, NRC's analysis was inadequate because the risk estimates were higher than generally considered acceptable under NRC guidance. Despite PRA's important role in the decision, our consultants found that NRC did not follow its own guidance for ensuring that the estimated risk was within levels acceptable to the agency. NRC required the nuclear power industry to develop a baseline estimate for how frequently a core damage accident could occur at every nuclear power plant in the United States. This baseline estimate is used as a basis for deciding whether changes at a plant that affect the core damage frequency are acceptable. The baseline core damage frequency estimate for the Davis-Besse plant was between $4x10^{-5}$

and 6.6×10^{-5} per year (which is between 1 chance in 25,000[36] per year and about 1 chance in 15,150[37] per year). NRC guidance for reviewing and approving license amendment requests indicates that any plant-specific change resulting in an increase in the frequency of core damage of 1×10^{-5} per year (which is 1 chance in 100,000 per year) or more would fall within the highest risk zone: In this case, NRC would generally not approve the change because the risk criterion would not be met. If a license change would result in a core damage frequency change of 1×10^{-5} per year to 1×10^{-6} per year (which is 1 chance in 100,000 per year to 1 chance in 1 million per year), the risk criterion would be considered marginally met and NRC would consider approving the change but would require additional analysis. Finally, if a license change would result in a core damage frequency change of 1×10^{-6} per year (which is 1 chance in 1 million per year) or less, the risk would fall within the lowest risk zone and NRC would consider the risk criterion to be met and would generally consider approving the change without requiring additional analysis. (See fig. 6.)

[36]Here is how to calculate the frequency estimate: 4×10^{-5} equates to 0.00004, or 4/100,000, which equals 1/25,000.

[37]Here is how to calculate the frequency estimate: 6.6×10^{-5} equates to 0.000066, or 66/1,000,000, which equals 1/15,151.51.

Figure 6: NRC's Acceptance Guidelines for Core Damage Frequency



Source: NRC.

[a]Risk criterion is met and license changes would generally be considered.

[b]Risk criterion is considered marginally met and while license changes are generally considered, they require additional analysis.

[c]Risk criterion is not met and license changes are generally not allowed.

However, NRC's PRA estimate for Davis-Besse—an increase in the frequency of core damage of 5.4×10^{-5}, or 1 chance in about 18,500 per year—was higher than the acceptable level. While an NRC official who helped develop the risk estimate said that additional NRC and industry guidance was used to evaluate whether its PRA estimate was acceptable, this guidance also suggests that NRC's estimate was too high. NRC's estimate of the increase in the frequency of core damage of 5.4×10^{-5} per year equates to an increase in the probability of core damage of 5×10^{-6}, or 1 chance in 200,000, for the 7-week period December 31, 2001, to February 16, 2002.[35] NRC's guidance for evaluating requests to relax NRC technical specifications suggests that a probability increase higher than 5×10^{-7}, or 1 chance in 2 million[38], is considered unacceptable for relaxing the specifications. Thus, NRC's estimate would not be considered acceptable

[38]Here is how to calculate the probability estimate: 5×10^{-7} equates to 0.0000005, or 5/10,000,000, which equals 1/2,000,000.

under this guidance. NRC's estimate would also not be considered acceptable under Electric Power Research Institute or Nuclear Energy Institute guidance unless further action were taken to evaluate or manage risk. According to NRC officials, NRC viewed its PRA estimate as being within acceptable bounds because it was a temporary situation—7 weeks—and NRC had, at other times, allowed much higher levels of risk at other plants. However, at the time that NRC made its decision, it did not document the basis for accepting this risk estimate, even though NRC's guidance explicitly states that the decision on whether PRA results are acceptable must be based on a full understanding of the contributors to the PRA results and the reasoning must be well documented. In defense of its decision, NRC officials said that the process they used to arrive at the decision is used to make about 1,500 licensing decisions such as this each year.

Lastly, NRC's analysis was inadequate because the agency does not have clear guidance for how PRA estimates are to be used in the decision-making process. Our consultants concluded that NRC's process for risk-informed decision making is ill-defined, lacks guidelines for how it is supposed to work, and is not uniformly transparent within NRC. According to NRC officials involved in the Davis-Besse decision, NRC's guidance is not clear on the use of PRA in the decision-making process. For example, while NRC has extensive guidance, this guidance does not outline to what extent or how the resultant PRA risk number and uncertainty should be weighed with respect to the ultimate decision. One factor complicating this issue is the lack of a predetermined methodology to weigh risks expressed in PRA numbers against traditional deterministic results and other factors.[39] Absent this guidance, the value assigned to the PRA analysis is largely at the discretion of the decision maker. The process, which NRC stated is robust, can result in a decision in which PRA played no role, a partial role, or one in which it was the sole deciding factor. According to our consultants, this situation is made worse by the lack of guidelines for how, or by whom, decisions in general are made at NRC.

It is not clear how NRC staff used the PRA risk estimate in the Davis-Besse decision-making process. For example, according to one NRC official who

[39]The deterministic approach considers a set of safety challenges and how those challenges should be mitigated through engineering safety margins and quality assurance standards. The probabilistic approach extends this by allowing for the consideration of a broader set of safety challenges, prioritizing safety challenges based on risk significance, and allowing for a broader set of mitigation mechanisms.

was familiar with some of the data on nozzle cracking, these data were not sufficient for making a good probabilistic decision. He stated that he favored issuing an order requiring that Davis-Besse be shut down by the end of December 2001 because he believed the available data were not sufficient to assure a low enough probability for a nozzle to be ejected. Other officials indicated that they accepted FirstEnergy's proposed February 16, 2002, shutdown date based largely on NRC's PRA estimate for a nozzle to crack and be ejected. According to one of these officials, allowing the additional 7 weeks of operating time was not sufficiently risk significant under NRC's guidance. He stated that safety margins at the plant were preserved and the PRA number was within an acceptable range. Still another official said he discounted the PRA estimate and did not use it at all when recommending that NRC accept FirstEnergy's compromise proposal. This official also stated that it was likely that many of the staff did base their conclusions on the PRA estimate. According to our consultants, although the extent to which the PRA risk analysis influenced the decision making will probably never be known, it is apparent that it did play an important role in the decision to allow the shutdown delay.

NRC Has Made Progress in Implementing Recommended Changes, but Is Not Addressing Important Systemic Issues

NRC has made significant progress in implementing the actions recommended by the Davis-Besse lessons-learned task force. While NRC has implemented slightly less than half—21 of the 51—recommendations as of March 2004, it is scheduled to have more than 70 percent of them implemented by the end of 2004. For example, NRC has already taken actions to improve staff training and inspections that would appear to help address the concern that NRC inspectors viewed FirstEnergy as a good performer and thus did not subject Davis-Besse to the level of scrutiny or questioning that they should have. It is not certain when actions to implement the remaining recommendations will occur, in part because of resource constraints. NRC also faces challenges in fully implementing the recommendations, also in part because of resource constraints, both in the staff needed to develop specific corrective actions and in the additional staff responsibilities and duties to carry them out. Further, while NRC is making progress, the agency is not addressing three systemic issues highlighted by the Davis-Besse experience: (1) an inability to detect weakness or deterioration in FirstEnergy's safety culture, (2) deficiencies in NRC's process for deciding on a shutdown, and (3) lack of management controls to track, on a longer-term basis, the effectiveness of actions implemented in response to incidents such as Davis-Besse, so that they do not occur at another power plant.

NRC Does Not Expect to Complete Its Actions until 2006, in Part Because of Resource Constraints

NRC's lessons-learned task force for Davis-Besse developed 51 recommendations to address the weaknesses that contributed to the Davis-Besse incident. Of these 51 recommendations, NRC rejected 2 because it concluded that agency processes or procedures already provided for the recommendations' intent to be effectively carried out.[40] To address the remaining 49 recommendations, NRC developed a plan in March 2003 that included, for each recommendation, the actions to be taken, the responsible NRC office, and the schedule for completing the actions. When developing its schedule, NRC placed the highest priority on implementing recommendations that were most directly related to the underlying causes of the Davis-Besse incident as well as those recommendations responding to vessel head corrosion. NRC assigned a lower priority to the remaining recommendations, which were to be integrated into the planning activities of those NRC offices assigned responsibility for taking action on the recommendations. In assigning these differing priorities, NRC officials stated they recognized that the agency has many other pressing matters to address that are not related to the Davis-Besse incident, such as renewing operating licenses, and they did not want to divert resources away from these activities. (App. III contains a complete list of the task force's recommendations, NRC actions, and the status of the recommendations as of March 2004.)

To better track the status of the agency's actions to implement the recommendations, we split two of the 49 recommendations that NRC accepted into 4; therefore, our analysis reflects NRC's response to 51 recommendations. As shown in table 1, as of March 2004, NRC had made progress in implementing the recommendations, although some completion dates have slipped.

[40] These two recommendations were for NRC to (1) review how industry considers economic factors in making decisions to repair equipment and consider these factors in developing guidance for nonvisual inspections of vessel head penetration nozzles, and (2) revise the criteria for reviewing industry topical reports that have not been formally submitted to NRC for review but that have generic safety implications.

Table 1: Status of Davis-Besse Lessons-Learned Task Force Recommendations, as of March 2004

Status	Number of recommendations
Completed as of March 2004	21
Scheduled for completion April through December 2004	17
Scheduled for completion in 2005	6
Completion date yet to be determined	7
Total	**51**

Source: GAO analysis of NRC data.

Note: This table does not include the two recommendations NRC rejected.

As the table shows, as of March 2004, NRC had implemented 21 recommendations and scheduled another 17 for completion by December 2004. However, some slippage has already occurred in this schedule—primarily because of resource constraints—and NRC has rescheduled completion of some recommendations. NRC's time frames for completing the recommendations depend on several factors—the recommendations' priority, the amount of work required to develop and implement actions, and the need to first complete actions on other related recommendations.

Of the 21 implemented recommendations, 10 called upon NRC to revise or enhance its inspection guidance or training. For example, NRC revised the guidance it uses to assess the implementation of licensees' programs to identify and resolve problems before they affect operations. It took this action because the task force had concluded that FirstEnergy's weak corrective action program implementation was a major contributor to the Davis-Besse incident. NRC has also developed Web-based training modules to improve NRC inspectors' knowledge of boric acid corrosion and nozzle cracking. The other 11 completed recommendations concerned actions such as

- collecting and analyzing foreign and domestic information on alloy 600 nozzle cracking,
- fully implementing and revising guidance to better assure that licensees carry out their commitments to make operational changes, and
- establishing measurements for resident inspector staffing levels and requirements.

By the end of 2004, NRC expects to complete another 17 recommendations, 12 of which generally address broad oversight or programmatic issues, and 5 of which provide for additional inspection guidance and training. On the broader issues, for example, NRC is scheduled to complete a review of the effectiveness of its response to past NRC lessons-learned task force reports by April 2004. By December 2004, NRC expects to have a framework established for moving forward with implementing recommended improvements to its agencywide operating experience program.

In 2005, 4 of the 6 recommendations scheduled for completion concern leakage from the reactor coolant system. For example, NRC is to (1) develop guidance and criteria for assessing licensees' responses to increasing leakage levels and (2) determine whether licensees should install enhanced systems to detect leakage from the reactor coolant system. The fifth recommendation calls for NRC to inspect the adequacy of licensees' programs for controlling boric acid corrosion, and the final recommendation calls on NRC to assess the basis for canceling a series of inspection procedures in 2001.

NRC did not assign completion dates to 7 recommendations because, among other things, their completion depends on completing other recommendations or because of limited resources. Even though it has not assigned completion dates for these recommendations, NRC has begun to work on 5 of the 7:

- Two recommendations will be addressed when requirements for vessel head inspections are revised. To date, NRC has taken some related, but temporary, actions. For example, since February 2003, it has required licensees to more extensively examine their reactor vessel heads. NRC has also issued a series of temporary instructions for NRC inspectors to oversee the enhanced examinations. NRC expects to replace these temporary steps with revised requirements for vessel head inspections.

- Two recommendations call upon NRC to revise requirements for detecting leaks in the reactor coolant pressure boundary. In response, NRC has, for example, begun to review its barrier integrity requirements and has contracted for research on enhanced detection capabilities.

- One recommendation is directed at improving follow-up of licensee actions taken in response to NRC generic communications. NRC is currently developing a temporary inspection procedure to assess the effectiveness of licensee actions taken in response to generic communications. Additionally, as a long-term change in the operating experience program, the agency plans to improve the verification of how effective its generic communications are.

The remaining two recommendations address NRC's need to (1) evaluate the adequacy of methods for analyzing the risks posed by passive components, such as reactor vessels, and integrate these methods and risks into NRC's decision-making process and (2) review a sample of plant assessments conducted between 1998 and 2000 to determine if any identified plant safety issues have not been adequately assessed. NRC has not yet taken action on these recommendations.

Some recommendations will require substantial resources to develop and implement. As a result, some implementation dates have slipped and some plans in response to the recommendations have changed in scope. For example, owing to resource constraints, NRC has postponed indefinitely the evaluation of methods to analyze the risk associated with passive reactor components such as the vessel head. Also, in part due to resource constraints, NRC has reconceptualized its plan to review licensee actions in response to previous generic communications, such as bulletins and letters.

Staff resources will be strained because implementing the recommendations adds additional responsibilities or duties—that is, more inspections, training, and reviews of licensee reports. For example, NRC's revised inspection guidance for more thorough examinations of reactor vessel heads and nozzles, as well as new requirements for NRC oversight of licensees' corrective action programs, will require at least an additional 200 hours of inspection per reactor per year. As of February 2004, NRC was also revising other inspection requirements that are likely to place additional demands on inspectors' time. Thus, to respond to these increased demands, NRC will either need to add inspectors or reduce oversight of other licensee activities.

To its credit, in its 2004 budget plan, NRC increased the level of resources for some inspection activities. However, it is not certain that these increases will be maintained. The number of inspection hours has fallen by more than one-third between 1995 and 2001. In addition, NRC is aware that resident inspector vacancies are filled with staff having varying levels of experience—from the basic level that would be expected from a newly qualified inspector to the advanced level that is achieved after several years' experience. According to the latest available data, as of May 2003, about 12 percent of sites had only one resident inspector; the remaining 88 percent had two inspectors of varying levels of experience. Because of this situation, NRC augments these inspection resources with regional inspectors and contractors to ensure that, at a minimum, its baseline inspection program can be implemented throughout the year. Because of surges in the demand for inspections, NRC in 2003 increased its use of contractors and temporarily pulled qualified inspectors from other jobs to help complete the baseline inspection program for every plant. According to NRC, it did not expect to require such measures in 2004.

Similarly, NRC may require additional staff to identify and evaluate plants' operating experiences and communicate the results to licensees, as the task force recommended. NRC has currently budgeted an increase of three full-time staff in fiscal year 2006 to implement a centralized system, or clearinghouse, for managing the operating experience program. However, according to an NRC official, questions remain about the level of resources needed to fully implement the task force recommendations. NRC's operating experience office, before it was disbanded in 1999, had about 33 staff whose primary responsibility was to collect, evaluate, and communicate activities associated with safety performance trends, as reflected in licensees' operating experiences, and participate in developing rulemakings. However, it is too early to know the effectiveness of this clearinghouse approach and the adequacy of resources in the other offices available for collecting and analyzing operating experience information. Neither the operating experience office before it was disbanded nor the other offices flagged boric acid corrosion, cracking, or leakage as problems warranting significantly greater oversight by NRC, licensees, or the nuclear power industry.

NRC Has Not Proposed Any Specific Actions to Correct Systemic Weaknesses in Oversight and Decision-Making Processes

NRC's Davis-Besse task force did not make any recommendations to address two systemic problems: evaluating licensees' commitment to safety and improving the agency's process for deciding on a shutdown.

NRC's Task Force Recommendations Did Not Address Licensee Safety Culture

NRC's task force identified numerous problems at Davis-Besse that indicated human performance and management failures and concluded that FirstEnergy did not foster an environment that was fully conducive to ensuring that plant safety issues received appropriate attention. Although the task force report did not use the term safety culture, as evidence of FirstEnergy's safety culture problems, the task force pointed to

- an imbalance between production and safety, as evidenced by FirstEnergy's efforts to address symptoms (such as regular cleanup of boric acid deposits) rather than causes (finding the source of the leaks during refueling outages);
- a lack of management involvement in or oversight of work at Davis-Besse that was important for maintaining safety;
- a lack of a questioning attitude by senior FirstEnergy managers with regard to vessel head inspections and cleaning activities;
- ineffective and untimely corrective action;
- a long-standing acceptance of degraded equipment; and
- inadequate engineering rigor.

The task force concluded that NRC's implementation of guidance for inspecting and assessing a safety-conscious work environment and employee concerns programs failed to identify significant safety problems. Although the task force did not make any specific recommendations that NRC develop a means to assess licensees' safety culture, it did recommend changes to focus more effort on assessing programs to promote a safety-conscious work environment.

NRC has taken little direct action in response to this task force recommendation. However, to help enhance NRC's capability to assess licensee safety culture by indirect means, NRC modified the wording in, and revised its inspection procedure for, assessing licensees' ability to identify and resolve problems, such as malfunctioning plant equipment. These revisions included requiring inspectors to

- review all licensee reports on plant conditions,
- analyze trends in plant conditions to determine the existence of potentially significant safety issues, and
- expand the scope of their reviews to the prior 5 years in order to identify recurring issues.

This problem identification and resolution inspection procedure is intended to assess the end results of management's safety commitment rather than the commitment itself. However, by measuring only the end results, early signs of a deteriorating safety culture and declining management performance may not be readily visible and may be hard to interpret until clear violations of NRC's regulations occur. Furthermore, because NRC directs its inspections at problems that it recognizes as being more important to safety, NRC may overlook other problems until they develop into significant and immediate safety problems. Conditions at a plant can quickly degrade to the extent that they can compromise public health and safety.

The International Atomic Energy Agency and its member nations have developed guidance and procedures for assessing safety culture at nuclear power plants, and today several countries, such as Brazil, Canada, Finland, Sweden, and the United Kingdom, assess plant safety culture or licensees' own assessments of their safety culture.[41] In assessing safety culture, an advisory group to the agency suggests that regulatory agencies examine whether, for example, (1) employee workloads are not excessive, (2) staff training is sufficient, (3) responsibility for safety has been clearly assigned within the organization, (4) the corporation has clearly communicated its safety policy, and (5) managers sufficiently emphasize safety during plant meetings. One reason for assessing safety culture, according to the Canadian Nuclear Safety Commission, is because management and human performance aspects are among the leading causes of unplanned events at licensed nuclear facilities, particularly in light of pressures such as deregulation of the electricity market. Finland specifically requires that nuclear power plants maintain an advanced safety culture and its inspections target the importance that has been embedded in factors affecting safety, including management. NRC had begun considering methods for assessing organizational factors, including safety culture, but in 1998, NRC's commissioners decided that the agency should have a performance-based inspection program of overall plant performance and should infer licensee management performance and competency from the results of that program. They chose this approach instead of one of four other options:

[41]The International Atomic Energy Agency is an international organization affiliated with the United Nations that provides advice and assistance to its members on nuclear safety matters.

- conduct performance-based inspections in all areas of facility operation and design, but not infer or articulate conclusions regarding the performance of licensee management;
- assess the performance of licensee management through targeted operations-based inspections using specific inspection procedures, trained staff, and contractors to assess licensee management—a task that would require the development of inspection procedures and significant training—and to document inspection results;
- assess the performance of licensee management as part of the routine inspection program by specifically evaluating and documenting management performance attributes—a larger effort that would require the development of assessment tools to evaluate safety culture as well as additional resources; or
- assess the competency of licensee management by evaluating management competency attributes—an even larger effort that would require that implementation options and their impacts be assessed.

When adopting the proposal to infer licensee management performance from the results of its performance-based inspection program, NRC eliminated any resource expenditures specifically directed at developing a systematic method of inferring management performance and competency. NRC stated that it currently has a number of means to assess safety culture that provide indirect insights into licensee safety culture. These means include, for example, (1) insights from augmented inspection teams, (2) lessons-learned reviews, and (3) information obtained in the course of conducting inspections under the Reactor Oversight Process. However, insights from augmented inspection teams and lessons-learned reviews are reactionary and do not prevent problems such as those that occurred at Davis-Besse. Further, before the Davis-Besse incident, NRC assumed its oversight process would adequately identify problems with licensees' safety culture. However, NRC has no formalized process for collectively assessing information obtained in the course of its problem identification and resolution inspection to ensure that individual inspection results would identify poor management performance. NRC stated that its licensee assessments consider inputs such as inspection results and insights, correspondence to licensees related to inspection observations, input from resident inspectors, and the results of any special investigations. However, this information may not be sufficient to inform NRC of problems at a plant in advance of these problems becoming safety significant.

In part because of Davis-Besse, NRC's Advisory Committee on Reactor Safeguards[42] recommended that NRC again pursue the development of a methodology for assessing safety culture. It also asked NRC to consider expanding research to identify leading indicators of degradation in human performance and work to develop a consistent comprehensive methodology for quantifying human performance. During an October 2003 public meeting of the advisory committee's Human Performance Subcommittee, the subcommittee's members again reiterated the need for NRC to assess safety culture. Specifically, the members recognized that certain aspects of safety culture, such as beliefs, perceptions, and management philosophies, are ultimately the nuclear power industry's responsibility but stated that NRC should deal with patterns of behavior and human performance, as well as organizational structures and processes. At this meeting, NRC officials discussed potential safety culture indicators that NRC could use, including, among other things, how many times a problem recurs at a plant, timeliness in correcting problems, number of temporary modifications, and individual program and process error rates. Committee members recommended that NRC test various safety culture indicators to determine whether (1) such indicators should ultimately be incorporated into the Reactor Oversight Process and (2) a significance determination process could be developed for safety culture. As of March 2004, NRC had yet to respond to the advisory committee's recommendation.

Despite the lack of action to address safety culture issues, NRC's concern over FirstEnergy's safety culture at Davis-Besse was one of the last issues resolved before the agency approved Davis-Besse's restart. NRC undertook a series of inspections to examine Davis-Besse's safety culture and determine whether FirstEnergy had (1) correctly identified the underlying causes associated with its declining safety culture, (2) implemented appropriate actions to correct safety culture problems, and (3) developed a process for monitoring to ensure that actions taken were effective for resolving safety culture problems. In December 2003, NRC noted significant improvements in the safety culture at Davis-Besse, but expressed concern with the sustainability of Davis-Besse's performance in this area. For example, a survey of FirstEnergy and contract employees conducted by FirstEnergy in November 2003 indicated that about 17

[42]The Advisory Committee on Reactor Safeguards is an independent committee comprising nuclear experts that advises NRC on matters of licensing and safety-related issues, and provides technical advice to aid the NRC commissioners' decision-making process.

percent of employees believed that management cared more about cost and schedule than resolving safety and quality issues—again, production over safety.

NRC's Task Force Recommendations Did Not Address NRC's Decision-Making Process

NRC's task force also did not analyze NRC's process for deciding not to order a shutdown of the Davis-Besse plant. It noted that NRC's written rationale for accepting FirstEnergy's justification for continued plant operation had not yet been prepared and recommended that NRC change guidance requiring NRC to adequately document such decisions. It also made a recommendation to strengthen guidance for verifying information provided by licensees. According to an NRC official on the task force, the task force did not assess the decision-making process in detail because the task force was charged with determining why the degradation at Davis-Besse was not prevented and because NRC had coordinated with NRC's Office of the Inspector General, which was reviewing NRC's decision making.

NRC's Failure to Track the Resolution of Identified Problems May Allow the Problems to Recur

The NRC task force conducted a preliminary review of prior lessons-learned task force reports to determine whether they suggested any recurring or similar problems. As a result of this preliminary review, the task force recommended that a more detailed review be conducted to determine if actions that NRC took as a result of those reviews were effective. These previous task force reports included: Indian Point 2 in Buchanan, New York, in February 2000; Millstone in Waterford, Connecticut, in October 1993; and South Texas Project in Wadsworth, Texas, from 1988 to 1994.[43] NRC's more detailed review, as of May 2004, was still under way. We also reviewed these reports to determine whether they suggested any recurring problems and found that they highlighted broad areas of continuing programmatic weaknesses, as seen in the following examples:

- *Inspector training and information sharing.* All three of the other task forces also identified inspector training issues and problems with information collection and sharing. The Indian Point task force called

[43]NRC formed the Indian Point lessons-learned task force in response to a steam-generator-tube rupture that forced a reactor shutdown. NRC formed the Millstone lessons-learned task force because the plant operated outside its design standards while refueling. NRC formed the South Texas task force in response to concerns about the effectiveness of NRC's inspection program and the adequacy of the licensee's employee concerns program.

upon NRC to develop a process for promptly disseminating technical information to NRC inspectors so that they can review and apply the information in their inspection program.

- *Oversight of licensee corrective action programs.* Two of the three task forces also identified inadequate oversight of licensee corrective action programs. The South Texas task force recommended improving assessments of licensees' corrective action programs to ensure that NRC identifies broader licensee problems.
- *Better identification of problems.* Two of the three task force reports also noted the need for NRC to develop a better process for identifying problem plants, and one report noted the need for NRC inspectors to more aggressively question licensees' activities.

Over the past two decades, we have also reported on underlying causes similar to those that contributed, in part, to the incident at Davis-Besse. (See Related GAO Products.) For example, with respect to the safety culture at nuclear power plants, in 1986, 1995, and 1997, we reported on issues relevant to NRC assessing plant management so that significant problems could be detected and corrected before they led to incidents such as the one that later occurred at Davis-Besse. Regardless of our 1997 recommendation that NRC require that the assessment of management's competency and performance be a mandatory component of NRC's inspection process, NRC subsequently withdrew funding to accomplish this. In terms of inspections, in 1995 we reported that NRC, itself, had concluded that the agency was not effectively integrating information on previously identified and long-standing issues to determine if the issues indicated systemic weaknesses in plant operations. This report further noted that NRC was not using such information to focus future inspection activities. In 1997 and 2001, we reported on weaknesses in NRC's inspections of licensees' corrective action programs. Finally, with respect to learning from plants' operating experiences, in 1984 we noted that NRC needed to improve its methods for consolidating information so that it could evaluate safety trends and ensure that generic issues are resolved at individual plants. These recurring issues indicate that NRC's actions, in response to individual plant incidents and recommendations to improve oversight, are not always institutionalized.

NRC guidance requires that resolutions to action plans be described and documented, and while NRC is monitoring the status of actions taken in response to Davis-Besse task force recommendations and preparing quarterly and semiannual reports on the status of actions taken, the Davis-Besse action plan does not specify how long NRC will monitor them. It also does not describe how long NRC will prepare quarterly and semiannual status reports, even though, according to NRC officials, these semiannual status reports will continue until all items are completed and the agency is required to issue a final summary report. The plan also does not specify what criteria the agency will use to determine when the actions in response to specific task force recommendations are completed. Furthermore, NRC's action plan does not require NRC to assess the long-term effectiveness of recommended actions, even though, according to NRC officials, some activities already have an effectiveness review included. As in the past and in response to prior lessons-learned task force reports and recommendations, NRC has no management control in place for assessing the long-term effectiveness of efforts resulting from the recommendations. NRC officials acknowledged the need for a management control, such as an agencywide tracking system, to ensure that actions taken in response to task force recommendations effectively resolve the underlying issue over the long term, but the officials have no plans to establish such a system.

Conclusions

It is unlikely, given the actions that NRC has taken to date, that extensive reactor vessel corrosion will occur any time soon at another domestic nuclear power plant. However, we do not yet have adequate assurances from NRC that many of the factors that contributed to the incident at Davis-Besse will be fully addressed. These factors include NRC's failure to keep abreast of safety significant issues by collecting information on operating experiences at plants, assessing their relative safety significance, and effectively communicating information within the agency to ensure that oversight is fully informed. The underlying causes of the Davis-Besse incident underscore the potential for another incident unrelated to boric acid corrosion or cracked control rod drive mechanism nozzles to occur. This potential is reinforced by the fact that both prior NRC lessons-learned task forces and we have found similar weaknesses in many of the same NRC programs that led to the Davis-Besse incident. NRC has not followed up on prior task force recommendations to assess whether the lessons learned were institutionalized. NRC's actions to implement the Davis-Besse lessons-learned task force recommendations, to be fully effective, will require an extensive effort on NRC's part to ensure that these are effectively incorporated into the agency's processes. However, NRC has not estimated the amount of resources necessary to carry out these recommendations, and we are concerned that resource limitations could constrain their effectiveness. For this reason, it is important for NRC to not only monitor the implementation of Davis-Besse task force recommendations, but also determine their effectiveness, in the long term, and the impact that resource constraints may have on them. These actions are even more important because the nation's fleet of nuclear power plants is aging.

Because the Davis-Besse task force did not address NRC's unwillingness to directly assess licensee safety culture, we are concerned that NRC's oversight will continue to be reactive rather than proactive. NRC's oversight can result in NRC making a determination that a licensee's performance is good one day, yet the next day NRC discovers the performance to be unacceptably risky to public health and safety. Such a situation does not occur overnight: Long-standing action or inaction on the part of the licensee causes unacceptably risky and degraded conditions. NRC needs better information to preclude such conditions. Given the complexity of nuclear power plants, the number of physical structures, systems, and components, and the manner in which NRC inspectors must sample to assess whether licensees are complying with NRC requirements and license specifications, it is possible that NRC will not identify licensees that value production over safety. While we recognize the difficulty in assessing licensee safety culture, we believe it is sufficiently important to develop a means to do so.

Given the limited information NRC had at the time and that an accident did not occur during the delay in Davis-Besse's shutdown, we do not necessarily question the decision the agency made. However, we are concerned about NRC's process for making that decision. It used guidance intended to make decisions for another purpose, did not rigorously apply the guidance, established an unrealistically high standard of evidence to issue a shutdown order, relied on incomplete and faulty PRA analyses and licensee evidence, and did not document key decisions and data. It is extremely unusual for NRC to order a nuclear power plant to shut down. Given this fact, it is more imperative that NRC have guidance to use when technical specifications or requirements may be met, yet questions arise over whether sufficient safety is being maintained. This guidance does not need to be a risk-based approach, but rather a more structured risk-informed approach that is sufficiently flexible to ensure that the guidance is applicable under different circumstances. This is important because NRC annually makes about 1,500 licensing decisions relating to operating commercial nuclear power plants. While we recognize the challenges NRC will face in developing such guidance, the large number and wide variety of decisions strongly highlight the need for NRC to ensure that its decision-making process and decisions are sound and defensible.

Recommendations for Executive Action

To ensure that NRC aggressively and comprehensively addresses the weaknesses that contributed to the Davis-Besse incident and could contribute to problems at nuclear power plants in the future, we are recommending that the NRC commissioners take the following five actions:

- Determine the resource implications of the task force's recommendations and reallocate the agency's resources, as appropriate, to better ensure that NRC effectively implements the recommendations.

- Develop a management control approach to track, on a long-term basis, implementation of the recommendations made by the Davis-Besse lessons-learned task force and future task forces. This approach, at a minimum, should assign accountability for implementing each recommendation and include information on the status of major actions, how each recommendation will be judged as completed, and how its effectiveness will be assessed. The approach should also provide for regular—quarterly or semiannual—reports to the NRC commissioners on the status of and obstacles to full implementation of the recommendations.

- Develop a methodology to assess licensees' safety culture that includes indicators of and inspection information on patterns of licensee performance, as well as on licensees' organization and processes. NRC should collect and analyze this data either during the course of the agency's routine inspection program or during separate targeted assessments, or during both routine and targeted inspections and assessments, to provide an early warning of deteriorating or declining performance and future safety problems.

- Develop specific guidance and a well-defined process for deciding on when to shut down a nuclear power plant. The guidance should clearly set out the process to be used, the safety-related factors to be considered, the weight that should be assigned to each factor, and the standards for judging the quality of the evidence considered.

- Improve NRC's use of probabilistic risk assessment estimates in decision making by (1) ensuring that the risk estimates, uncertainties, and assumptions made in developing the estimates are fully defined, documented, and communicated to NRC decision makers; and (2) providing guidance to decision makers on how to consider the relative importance, validity, and reliability of quantitative risk estimates in conjunction with other qualitative safety-related factors.

Agency Comments and Our Evaluation

We provided a draft of this report to NRC for review and comment. We received written comments from the agency's Executive Director for Operations. In its written comments, NRC generally addressed only those findings and recommendations with which it disagreed. Although commenting that it agreed with many of the report's findings, NRC expressed an overall concern that the report does not appropriately characterize or provide a balanced perspective on NRC's actions surrounding the discovery of the Davis-Besse reactor vessel head condition or NRC's actions to incorporate the lessons learned from that experience into its processes. Specifically, NRC stated that the report does not acknowledge that NRC must rely heavily on its licensees to provide it with complete and accurate information, as required by its regulations. NRC also expressed concern about the report's characterization of its use of risk estimates—specifically the report's statement that NRC's estimate of risk exceeded the risk levels generally accepted by the agency. In addition, NRC disagreed with two of our recommendations: (1) to develop specific guidance and a well-defined process for deciding on when to shut down a plant and (2) to develop a methodology to assess licensees' safety culture.

With respect to NRC's overall concern, we believe that the report accurately captures NRC's performance. Our draft report, in discussing NRC's regulatory and oversight role and responsibilities, stated that according to NRC, the completeness and accuracy of the information provided by licensees is an important aspect of the agency's oversight. To respond further to NRC's concern, we added a statement to the effect that licensees are required under NRC's regulations to provide the agency with complete and accurate information. While we do not want to diminish the importance of this responsibility on the part of the licensees, we believe that NRC also has a responsibility, in designing its oversight program, to implement management controls, including inspection and enforcement, to ensure that it has accurate information on and is sufficiently aware of plant conditions. In this respect, it was NRC's decision to rely on the premise that the information provided by FirstEnergy was complete and accurate. As we point out in the report, the degradation of the vessel head at Davis-Besse occurred over several years. NRC knew about several indications that problems were occurring at the plant, and the agency could have requested and obtained additional information about the vessel head condition.

We also believe that the report's characterization of NRC's use of risk estimates is accurate. The NRC risk estimate that we and our consultants found for the period leading up to the December 2001 decision on Davis-Besse's shutdown, including the risk estimate used by the staff during key briefings of NRC management, indicated that the estimate for core damage frequency was $5.4x10^{-5}$, as used in the report. The $5x10^{-6}$ referenced in NRC's December 2002 safety evaluation is for core damage probability, which equates to a core damage frequency of approximately $5x10^{-5}$—a level that is in excess of the level generally accepted by the agency. The impression of our consultants is that some confusion about the differences in these terms may exist among NRC staff.

Concerning NRC's disagreement with our recommendation to develop specific guidance for making plant shutdown decisions, NRC stated that its regulations, guidance, and processes are robust and do provide sufficient guidance in the vast majority of situations. The agency added that from time to time a unique situation may present itself wherein sufficient information may not exist or the information available may not be sufficiently clear to apply existing rules and regulations definitively. According to NRC, in these unique instances, the agency's most senior managers, after consultation with staff experts and given all of the information available at the time, decide whether to require a plant shutdown. While we agree that NRC has an array of guidance for making decisions, we continue to believe that NRC needs specific guidance and a well-defined process for deciding when to shut down a plant. As discussed in our report, the agency used its guidance for approving license change requests to make the decision on when to shut down Davis-Besse. Although NRC's array of guidance provides flexibility, we do not believe that it provides the structure, direction, and accountability needed for important decisions such as the one on Davis-Besse's shutdown.

In disagreeing with our recommendation concerning the need for a methodology to assess licensees' safety culture, NRC said that the Commission, to date, has specifically decided not to conduct direct evaluations or inspections of safety culture as a routine part of assessing licensee performance due to the subjective nature of such evaluations. According to NRC, as regulators, agency officials are not charged with managing licensees' facilities, and direct involvement with organizational structure and processes crosses over to a management function. We understand NRC's position that it is not charged with managing licensees' facilities, and we are not suggesting that NRC should prescribe or regulate the licensees' organizational structure or processes. Our recommendation is aimed at NRC monitoring trends in licensees' safety culture as an early warning of declining performance and safety problems. Such early warnings can help preclude NRC from assessing a licensee as being a good performer one day, and the next day being faced with a situation that it considers a potentially significant safety risk. As discussed in the report, considerable guidance is available on safety culture assessment, and other countries have established safety culture programs.

NRC's written response also contained technical comments, which we have incorporated into the report, as appropriate. (NRC's comments and our responses are presented in app. IV.)

As arranged with your staff, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from its issue date. At that time, we plan to provide copies of this report to the appropriate congressional committees; the Chairman, NRC; the Director, Office of Management and Budget; and other interested parties. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at http://www.gao.gov. If you or your staff have any questions, please call me at (202) 512-3841. Key contributors to this report are listed in appendix V.

Jim Wells

Jim Wells
Director, Natural Resources
and Environment

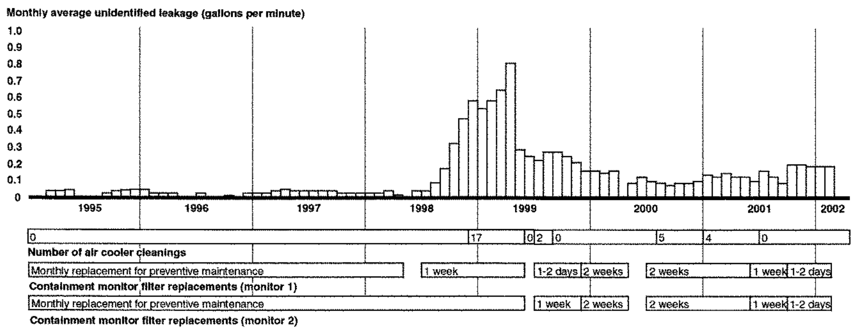
List of Congressional Requesters

The Honorable George V. Voinovich
United States Senate

The Honorable Dennis J. Kucinich
House of Representatives

The Honorable Steven C. LaTourette
House of Representatives

Time Line Relating Significant Events of Interest



Source: GAO analysis of FirstEnergy, Electric Power Research Institute, and Dominion Engineering data.

Analysis of the Nuclear Regulatory Commission's Probabilistic Risk Assessment for Davis-Besse

Report of the Committee to Review the NRC's Oversight of the Davis-Besse Nuclear Power Station

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Report of the Committee to Review the NRC's Oversight of the Davis-Besse Nuclear Power Station

1. Scope of the Review

The U. S. General Accounting Office formed a committee in September-October 2003 to review the oversight that the U. S. Nuclear Regulatory Commission provided on matters related to the pressure vessel head corrosion at the Davis-Besse (DB) Nuclear Power Station. The GAO charge to the committee was to respond to the questions:

(1) What probabilistic risk assessment model did NRC use and is it an appropriate model?
(2) What was the source of key data used to run NRC's probabilistic risk assessment and were these data valid?
(3) What key assumptions implicit in the model did NRC use to govern the estimated risk of different scenarios and were these reasonable?
(4) Is probabilistic risk assessment an appropriate tool for making such decision in these instances?
(5) How could NRC improve its use of probabilistic risk assessment to make more informed decisions?

The committee was initially provided with a set of 53 documents, which included GAO's preliminary analysis of the issues involved and chronology of the DB events during 2001 and 2002. The GAO reports summarized NRC-DB interactions in fall 2001 related to NRC Bulletin 2001-01 on control rod drive mechanism (CRDM) nozzle cracking, the eventual shutdown of the plant on 16 February 2002, and the subsequent discovery of pressure vessel head corrosion. Included also were:

(1) Official NRC documents, Generic Letters, Bulletins, and Information Notices transmitted to licensees including Davis-Besse,
(2) DB reports submitted to NRC related to the CRDM nozzle issues,
(3) NRC documents summarizing the staff's positions and discussions,
(4) Summaries of NRC staff presentations to NRC's Advisory Committee on Reactor Safeguards (ACRS) and to the Commission Technical Assistants,
(5) Event inquiry report of the NRC Office of Inspector General (OIG) and response from the NRC Chair,
(6) Redacted transcripts of OIG interviews of NRC staff, and
(7) Transcripts of GAO interviews with NRC staff.

The committee reviewed the initial set of documents received from GAO and conducted discussion on the phone and quite frequently via email. One member (GSW) provided a set of initial questions, which GAO used in a meeting with the NRC staff in October 2003. Another member (JCL) met with Mark Reinhart of NRC at the November American Nuclear Society meeting to discuss relevant technical issues and to prepare for a meeting of the review committee with NRC staff, which took place on December 11, 2003. At the meeting, two members (GSW, JCL) discussed technical and management issues with a total of nine NRC officials.

The review committee also consulted a number of experts from the industry and national laboratories, and reviewed a number of additional materials including:

(1) Several NRC Regulatory Guides,
(2) NRC Augmented Inspection Report and Lessons-Learned Task Force Report,

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(3) Additional NRC reports on significance assessment of the DB CRDM degradations and the October 2003 OIG review of NRC's oversight on DB,
(4) Reports (including one proprietary version) from Electric Power Research Institute and Nuclear Energy Institute,
(5) Notes from William Shack, Argonne National Laboratory (ANL), describing his calculation of CRDM nozzle failure probability,
(6) DB probabilistic risk assessment (PRA) study performed for NRC by the Idaho National Engineering and Environmental Laboratory,
(7) Transcripts of several ACRS meetings during 2001–2003, and
(8) Select papers in engineering journals and proceedings.

The committee conducted an extensive review and discussion on the probabilistic risk calculations performed both by the FirstEnergy Nuclear Operating Company (FENOC) and NRC for Davis-Besse. One committee member (JCL) also developed a simplified analytical model to determine the CRDM failure probability, which provided a rough check on numerical calculations performed at ANL.

Following the 11 December 2003 meeting with the NRC staff, the committee made an effort to follow up on a number of questions that required additional information or clarifications. One essential piece of information is the core damage probability due to the postulated CRDM failure and ejection that NRC actually used in connection with the decision to allow continued DB operation until February 16, 2002. After a long wait, finally on February 24, 2004, the committee received a response from Jin Chung, Richard Barrett, and Gary Holahan, summarizing, to the extent they could reconstruct, how NRC arrived at key quantitative risk estimates in November 2001.

We present in Section 2 key findings of the committee on NRC's oversight related to the DB issues. We provide responses to the first four GAO charges in Sections 3 through 6, in a slightly restructured format, covering (a) PRA methodology and data used in NRC's risk assessment, (b) assumptions and uncertainties in the risk assessment, (c) relevant regulations and guidelines, and (d) November 2001 NRC decision. Our response to the fifth GAO charge is finally presented in Section 7.

2. Key Findings of the Committee

The committee presents key findings of its review on NRC's oversight on Davis-Besse and related safety and regulatory issues:

(1) <u>NRC's Risk Analysis for Davis-Besse</u>

(a) To guide a risk-informed decision on whether to grant an extension beyond its December 31, 2001 date for shutdown of Davis-Besse for nozzle inspection, NRC relied on its PRA of risks from crack-induced failure of control-rod housing nozzles. The calculated risk was incorrectly small because the calculations did not consider corrosion of the reactor vessel due to boric acid in coolant leaking through the cracks. The calculated risk was also subject to large uncertainties. As a result, NRC staff found it difficult to balance results of quantitative risk calculations against qualitative considerations. Regulatory Guide 1.174 provided little help in this regard.

(b) NRC did not perform uncertainty analysis in applying PRA in the DB decision-making process and there was confusion regarding the interpretation of core damage frequency (CDF) and core damage probability (CDP) as risk attributes within the framework of RG 1.174. NRC staff should have recognized large uncertainties associated with the CDF estimated for CRDM nozzle failures

(c) NRC's risk analysis was poorly documented and inadequately understood by NRC staff.

(d) Even now, NRC is unable to provide estimates of the risk from continued operation of Davis-Besse from December 31, 2001 to February 16, 2002, taking into account the large corrosion cavity in the reactor vessel head found in March 2002. The risks from that operation prior to shutdown are likely to have been unacceptably large. Thus, with proper risk analysis, quantified risk calculations would have provided clear guidance for prompt shutdown.

(2) Relevant Regulations and Guidelines

(a) Coolant leakage through flanges and valves was allowed under the DB Technical Specifications, leading the DB personnel and NRC resident inspectors to treat boric acid deposits in various locations in the containment as routine events, and hence not risk significant.

(b) NRC has no predetermined methodology to weigh PRA against deterministic factors. NRC needs to develop a set of guidelines for the use of PRA in decision-making.

(3) November 2001 Davis-Besse Decision

(a) The proposed shutdown date of 31 December 2001 was arbitrary. There was significant pressure from DB to delay the shutdown for financial reasons, but no cost-benefit analysis was presented.

(b) Communication was seriously lacking between NRC headquarters and Region III and also between resident inspectors and Region III administrators regarding the extent of coolant leakage and boric-acid corrosion.

(c) NRC staff incorrectly assumed that the visible white deposits of anhydrous boric acid resulted entirely from rapid evaporation and drying of the leaking coolant and were not associated with corrosion.

(d) The transparency of the decision-making process within NRC is not uniform. The NRC lacks an established and well-defined process for decision-making.

(4) General Safety and Regulatory Issues

(a) How to ensure safety from corrosion by leaking coolant is generic to all pressurized water reactors (PWRs). There is no evidence that it has been evaluated as such by NRC's Advisory Committee on Reactor Safeguards.

(b) The root cause of this near miss of a serious accident at Davis-Besse is human error: inadequate evaluation of the effect of simplifying assumptions in the risk analysis and inadequate perception and understanding of the many clues that challenged those assumptions.

(c) NRC is slow to integrate new safety information into its programs, and to share that information with its licensees.

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3. NRC Probabilistic Risk Assessment Model and Database

3.1 Basic PRA Methodology and Data Used for the DB Risk Analysis

The NRC staff relied on a Standardized Plant Analysis Risk (SPAR) study [Sat00] for Davis-Besse that Idaho National Engineering and Environmental Laboratory performed. The Saphire code [Sap98] provided the PRA tools and database for key system failure rates and human error probabilities in the SPAR study. The PRA methodology combines semi-pictorial structures of event and fault trees to estimate the probability of occurrence of rare events, in particular, the core damage frequency (CDF) and large early release frequency (LERF) of radioactivity associated with the operation of a nuclear power plant. An event tree is constructed for each major sequence of events beginning with an initiating event, e.g., a medium-break loss-of-coolant accident (MBLOCA), and following through multiple stages of safety systems to be activated. The probability of failure or unreliability of a safety system that is called upon to function is determined as the probability of the top event of a fault tree, which is determined through Boolean logic representing failure probabilities of components making up the top event. Uncertainties in the CDF and LERF are then obtained by a Monte Carlo convolution of probability density functions representing failure rates of components in fault trees and of safety systems in event trees.

The MBLOCA, which is assumed to occur following the failure and ejection of CRDM nozzles at Davis-Besse, is analyzed in the SPAR report [Sat00] as one of 12 major internal events postulated to lead to core damage and radioactivity release. A baseline CDF of 1.0×10^{-7}/year for MBLOCA results from a generic value [Pol99] of the initiating event frequency of 4.0×10^{-5}/year for the MBLOCA combined with the failure probabilities of a number of engineered safety features, including high- and low-pressure injection systems. This results in an estimate of 2.5×10^{-3} for the conditional core damage probability (CCDP) for MBLOCA. The CCDP of 2.5×10^{-3} is almost entirely due to the failure of low-pressure recirculation pumps, which in turn depends heavily on the ability of the operator to properly align and start the pumps. Based on human factor analysis, an estimate of 1.0×10^{-3} for the operator error is included in determining the CCDP of 2.5×10^{-3}. The baseline or point-estimate CDF of 1.0×10^{-7}/year for MBLOCA contributes 0.5% toward the total baseline CDF of 2.0×10^{-5}/year, with uncertainties represented as CDF = {5th percentile, median, mean, 95th percentile | 6.3×10^{-6}, 1.6×10^{-5}, 5.1×10^{-5}, 9.6×10^{-5}} per year. The SPAR report for Davis-Besse provides only baseline CDF estimates for individual core damage events; hence no uncertainty estimates are available for the MBLOCA event. The mean overall CDF = 5.1×10^{-5}/year for Davis-Besse compares well with the those for internal initiating events for three PWR plants analyzed extensively as part of NRC's severe accident evaluation project in NUREG-1150 [Nrc90]: Surry Unit 1, 4×10^{-5}/year; Sequoyah Unit 1, 6×10^{-5}/year; and Zion Unit 1, 6×10^{-5}/year. The CDF estimates for the four PWRs are, however, an order of magnitude larger than those for two boiling water reactors analyzed in NUREG-1150: Peach Bottom Unit 2, 5×10^{-6}/year, and Grand Gulf Unit 1, 4×10^{-6}/year.

3.2 DB Calculation of Risk due to CRDM Nozzle Failures

The DB calculation of the nozzle failure probability consisted of the following steps [Cam01c]. The nozzles were divided into three groups based on the extent of visual inspection possible during refueling outage (RFO) 10, 11 and 12. Group 1 consisted of 15 nozzles that were not inspected during RFO 10 and 11. Group 2 consisted of 5 additional nozzles that were not inspected during RFO 12. Group 3 consisted of 45 nozzles, all of which were inspected during all outages. This analysis accounts for 65 nozzles, four short of the total number of nozzles on the DB head. The four nozzles not included in this analysis are at the center of the head. They were determined by a Structural Integrity Associates analysis [Cam01d] to have no demonstrable annular gaps, and therefore, were considered as not susceptible to circumferential cracking and were excluded from the calculation. This particular assumption turned out to be quite inappropriate, since the February-March 2002 inspection revealed that three central nozzles (Nos. 1, 2, 3) had developed through-wall axial cracks and that nozzle 2 also had a circumferential crack.

Leak frequencies were determined for each group according to the equation: leak frequency = 1.1/year × F_i, where F_i is the fraction of the total nozzles (65) in group i, and the value of 1.1 is the estimated frequency of CRDM leaks per reactor year based on observations on 5 other Babcock and Wilcox (B&W) plants. Data on CRDM cracking noted in the 2001-01 NRC Bulletin were incorporated into the PRA analysis [Cam01c] in calculating the leak frequency. Specifically, recent inspections had revealed that there were sixteen leaking nozzles identified in the B&W plants, Arkansas Nuclear One Unit 1 (ANO-1), Crystal River Unit 3 (CR-3), Oconee Nuclear Station Unit 1 (ONS-1), ONS-2 and ONS-3. The assumption was made that all leaks appeared during the most recent two fuel cycles. Assuming 1.5 years per fuel cycle, 2 cycles per plant and 5 plants, a product of these three values yields 15 reactor years of operation. Sixteen leaking nozzles over 15 years of operation yields a leak frequency of about 1.1 leaks per reactor year. This value then incorporated the most recent data on CRDM cracking at other B&W plants.

An event tree was constructed for each CRDM group, beginning with the CRDM leak frequency, accounting for crack growths and failures during subsequent operation and CRDM nozzle inspection failures, and culminating with a total CDF. The event tree analysis included CCDP = 2.7×10^{-3} for all groups. The resulting total CDF summed over all three groups was 6.97×10^{-6}/year. Dividing by the CCDP yielded a value of the initiating event (IE) frequency of 2.58×10^{-3}/year representing an MBLOCA due to CRDM nozzle ejection. Using the IE frequency, one would then calculate an IE probability of 3.4×10^{-4} for continued DB operation for another 0.13 year, representing the period between 31 December 2001 and 16 February 2002. We note here also that the DB estimation of CCDP = 2.7×10^{-3} agrees closely with the SPAR estimate of 2.5×10^{-3} discussed in Section 3.1.

The probability of missing a leak in an inspection was estimated by Framatome [Cam01b] using human reliability analysis. Their estimates [Cam01d] indicated that the probability of missing a leak was 0.06 in the first inspection (RFO 10), 0.065 in the second inspection (RFO 11) and 0.11 in subsequent inspections. Davis-Besse's analysis [Cam01c], however, uses a single probability of value 0.05 applied to all of the nozzles covered in RFO 10, 11 and in subsequent inspections. The document [Cam01c] references the Framatome analysis [cam01b], but does not indicate why a different value was used and why a single, lower value was applied for all inspections. Correcting, however, the calculation to account for the three separate failure detection probabilities results in an IE frequency of 2.64×10^{-3}/year vs. 2.58×10^{-3}/year assumed [Cam01c].

3.3 NRC Calculation of Risk due to CRDM Nozzle Failures

Although documents provided to the review committee do not provide sufficient details on how NRC arrived at the incremental CDF or core damage probability (CDP), it appears that the NRC staff used the DB estimate of CCDP = 2.7×10^{-3} for the MBLOCA initiated by CRDM nozzle failure and ejection. The NRC did not have the in-house expertise to determine the nozzle ejection probability for Davis-Bessie. They had two sources for estimates of the nozzle ejection probability. One source was Dr. William Shack at Argonne National Laboratory (ANL). Dr. Shack conducted a rather extensive analysis of the failure probability consisting of 5 steps: 1) the number of cracked nozzles, 2) the crack size distribution, 3) the crack growth rate, 4) a time to failure based on initial crack size and crack growth rate, and 5) a probability of failure, based on a Monte Carlo analysis of failure times. The end result was a plot and a table with failure probability vs. time that was provided to NRC and is described in several references [Sha01, Sha03, Nrc01a]. The second source of information on the MBLOCA frequency was the DB estimate [Cam01c] for IE frequency of 2.58×10^{-3}/year, discussed in Section 3.2.

Documents provided to the review committee [Rei03, Chu04] list the IE probability of 2.0×10^{-3} for continued operation for another 0.13 year, representing the period between 31 December 2001 and 16 February 2002, but reference Dr. Shack as the source. However, the values provided by Shack to the NRC [Sha01] do not agree with this number and apparently NRC decided not to use the ANL analysis, as it was viewed as preliminary, and a work in progress.

In a final response [Chu04] to questions the review committee raised following the 11 December 2003 meeting with nine NRC staff, Jin Chung, Richard Barrett, and Gary Holahan confirmed that NRC used the DB estimate of CCDP = 2.7×10^{-3}, coupled with the IE frequency of 2.0×10^{-2}/year, to obtain an incremental CDF = 5.4×10^{-5}/year, associated with the postulated CRDM failure and ejection leading to an MBLOCA. They indicate that, instead of allowing for the inspection failure probability of 0.05 for RFO 10, assumed in the Framatome risk calculation [Cam01c], NRC allowed no credit to discover the nozzle cracking. NRC, however, used the same crack growth and failure rates as in the Framatome PRA submittal to arrive at the IE frequency of 3.4×10^{-2}/year, which is an order of magnitude larger than the Framatome estimate of 2.58×10^{-3}/year. Dr. Chung then decided to reduce the IE frequency to 2.0×10^{-2}/year to "reflect best estimate rather than 75 percentile fracture mechanics," which is the best description of the adjustment that NRC is able to present in February 2004. The adjusted value of IE frequency = 2.0×10^{-2}/year is then used together with CCDP = 2.7×10^{-3} to yield the incremental CDF = 5.4×10^{-5}/year. Finally, to convert the incremental CDF to an incremental CDP, associated with the continued DB operation for 0.13 year, NRC again rounded off the resulting CDP = 7.0×10^{-6} to 5.0×10^{-6}. In the deliberations leading to the 28 November 2001 DB decision, NRC apparently used the adjusted, rounded-off risk estimates: incremental CDF = 5.4×10^{-5}/year and incremental CDP = 5.0×10^{-6}.

The conclusion of the review committee is that the determination of IE probability is questionable, and that the error or uncertainty associated with this probability is likely to be very high, rendering it of questionable value. In the February 2004 response [Chu04] to the review committee questions, NRC confirms that no uncertainty analysis was performed on the incremental CDF and CDP estimates they used in November 2001. Furthermore, NRC proposes an unusual use of the incremental CDF and CDP values to compare with the quantitative guidelines given in RG 1.174 [Nrc02a]. This will be discussed further in Section 5.1.

4. Assumptions and Uncertainties in NRC Risk Analysis

4.1 The Discovery of Massive Corrosion Wastage at Davis-Besse

The most serious shortcoming in NRC's risk analysis was the complete neglect of any consideration of corrosion of the reactor vessel by boric acid in reactor coolant known to be leaking from the high-pressure cooling system. After finally shutting down the reactor and inspecting the control housing nozzles, Davis-Besse discovered extensive corrosive wastage of the steel pressure vessel. Boric acid in leaking coolant had reacted with iron to form a mass of corrosion products which, when removed, left a cavity the size of a

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pineapple. Corrosion had penetrated the 6-inch thick steel head of the reactor vessel and exposed the thin corrosion-resistant vessel liner, found to be only about 0.2 inches thick at that location.

The reactor had been operating for months, maybe years, perilously close to rupture of the vessel liner and rapid loss of reactor coolant. In response to our repeated requests to NRC to share with us what it has learned about the risks from corrosion-induced failure of the coolant pressure boundary, NRC states that such analysis has not been completed, awaiting completion of laboratory tests on relevant failure mechanics at the Oak Ridge National Laboratory. That answer is most disappointing.

An earmark of a responsive safety program is prompt incorporation of new safety information, by undertaking new risk analysis, whether deterministic, probabilistic, or both, to guide new procedures that would avoid such a potential accident and to guide research and testing necessary for proper risk-informed decision making. Now, some two years since the discovery of massive and dangerous corrosion wastage at Davis-Besse, NRC seems unable to supply even preliminary analysis of the magnitude of potential safety problems arising from coolant leakage and corrosion. This harks back to the 1977-79 era, when NRC failed to recognize the implications of a near miss of a serious reactor accident at Davis-Besse, discussed further in Section 6.6. If NRC had made a prompt analysis of Davis-Besse's 1977 operator errors and the implications for a more serious accident if not corrected, and if that analysis had been communicated to other licensees, the tragic accident at Three Mile Island could have been avoided. It appears that NRC has not fully recovered from its mistakes in 1977-79.

4.2 Assumption that Boric Acid in Hot Escaping Coolant Will Not Corrode

Apparently all NRC staff who were involved in the November 2001 decision on Davis-Besse were aware that high-pressure coolant was leaking from valves, flanges, and possibly from cracks, but they evidently thought that the hot coolant, at 600 °F, would immediately flash into steam and non-corrosive anhydrous compounds of boric acid. As evidence, they referred to the readily visible deposits of white fluffy anhydrous boric acid observed on plant equipment. But evaporation concentrates boric acid in the remaining liquid, which becomes far more corrosive. Its vapor pressure decreases and slows further evaporation. Thus, one should expect that some of the boric acid in the escaping coolant can reach the metal surfaces as wet or moist highly corrosive material underlying the white fluffy surface layers. That is evidently what happened. It should have been anticipated.

Also the geometry of a cracked nozzle was not considered in NRC's thoughts about boric acid corrosion. NRC was focused on the metal surface because they were convinced that the boric acid they saw came from "dripping" from the leaky valves above the head. However, in a leaking nozzle, the escape path of the water is some 6-8 inches – from the clad to the vessel surface. Such a long crevice provides considerably greater opportunity for concentration of the liquid behind the evaporation front at or near the vessel head surface where the steam escapes.

NRC staff should also have been aware of experience at the French nuclear plants, where boric acid corrosion from leaking reactor coolant had been identified during the previous decade, the safety significance had been recognized, and safety procedures to mitigate the problem had been implemented. Keeping abreast of safety issues at similar plants, whether domestic or abroad, and conveying relevant safety information to its licensees is an important function of NRC's safety program.

NRC staff were involved a few years earlier in discussions regarding boric acid deposits on the reactor pressure vessel head [Epr01]. Boric-acid corrosion programs were initiated. But to the NRC staff involved in the November 2001 decision on Davis-Besse, boric-acid corrosion was not viewed as a significant safety concern; rather, there was concern that the anhydrous crystals could obscure indication of leakage from the nozzles above the reactor head. But already several tests of boric acid corrosion had been underway in industry and government laboratories. Representative tests of nozzle leakage showed that corrosion rates from boric acid solutions dripping onto carbon steel at 600 °F can be in the range of four inches per year [Nrc02b]. Drip tests sponsored by the Electric Power Research Institute [Sri98, Epr01] showed that the corrosion rate is much higher for carbon-steel surfaces at 600 °F than at lower temperature. Only at temperatures much higher than 600 °F is the vaporization rate high enough to produce anhydrous boric acid crystals with little corrosion.

NRC personnel involved in the November 2001 safety review evidently were not aware of these corrosion tests or else they had forgotten about them. An NRC resident inspector at Davis-Besse was shown, by a Davis-Besse engineer, a photograph that revealed streaks of rust-colored corrosion products on the head of the reactor vessel, in the midst of the expected white crystals. But the inspector was not aware of the significance of these rust streaks, and he did not report this information to other NRC personnel. At other times, Davis-Besse reported the presence of airborne rust particles that had lodged on the surveillance filters, but the significance of this information was not recognized.

After the discovery of the corrosion wastage in 2002, an NRC official was asked about the corrosion data reported by the Electric Power Research Institute (EPRI). He replied that those data were not considered in the discussions with Davis-Besse because EPRI had not "submitted" the report of those data to NRC. EPRI points out that the corrosion data had been published in 1998 in a widely available technical report, well known to industry and NRC. EPRI had not formally "submitted" the report because NRC charges a fee for the submittal process.

4.3 Control Rod Ejection and Reactivity Transient

In discussions related to the consequences of CRDM nozzle ejections at Davis-Besse, NRC duly considered the effects of the control rods ejected, thereby made inoperable, in the resulting LOCA. They apparently concluded before the 28 November 2001 Davis-Besse decision that the negative reactivity feedback resulting from the overheating and boiling of coolant in a LOCA would easily overshadow any potential decrease in the amount of subcritical reactivity that would ensure safe shutdown of the reactor. Furthermore, a more recent NRC report [Dye03] evaluating the significance of the Davis-Besse CRDM penetration cracking and pressure vessel head degradation presents a similar conclusion. Here, a combined thermal-hydraulic and reactivity transient analysis performed with the RELAP code indicates that the boiling of the reactor coolant coupled with the addition of boric acid in the emergency coolant water injected is sufficient to maintain the shutdown condition, thereby obviating the concern for an anticipated transient without scram (ATWS).

One consequence of the CRDM nozzle ejection that has not been, however, analyzed is the positive reactivity inserted into the reactor core when the control rod ejection occurs in a hot zero power (HZP) rather than a hot full power (HFP) condition. The consequences of postulated control rod ejection accidents are generally more severe, if initiated in a HZP condition when the system is fully pressurized but at low power. This is because at HZP the control rods would be inserted deeply into the core, thereby adding a larger positive reactivity when the rods are ejected, than that resulting in a HFP rod ejection accident. Thus, a HZP CRDM nozzle ejection could result in a power level above rated power before a significant coolant heating or boiling occurs. This combination of postulated accidents requires an integrated analysis of two PWR design basis accidents, LOCA and rod ejection accident, and should be performed for a complete evaluation of CRDM nozzle ejection consequences.

4.4 Need to Account for Corrosion in Risk Analysis

NRC's analysis of risks from nozzle cracking was concerned only with the formation and propagation of circumferential cracks that could result in nozzle failure, loss of coolant, and even control rod ejection. The formation of axial cracks was neglected in the risk analysis. There is less chance of axial cracks causing complete failure of a nozzle but they do open additional pathways for coolant leakage. Leakage from axial cracks is believed to have been the main source for the massive corrosion wastage at Davis-Besse.

Neglecting axial cracking and corrosion wastage that could result in rupture of the reactor vessel and a more serious loss-of-coolant accident was a principal deficiency in NRC's risk assessment.

NRC has not described to us any plans for extensions to its risk analysis that would predict the dangers of corrosion wastage. In our view, the necessary additional ingredients of the probabilistic risk analysis must include:

- Formation and growth of axial cracks in control-rod-housing nozzles,
- Flow of leaking coolant from cracks,
- Evaporation of leaking coolant and concentration of boric acid,
- Corrosion of the steel pressure vessel,
- Time-dependent penetration of the corrosion front into the pressure vessel,
- Corrosion and stress-corrosion cracking of the vessel liner,
- Time-dependent calculation of stress on the vessel and its failure if ruptured, and
- Loss-of-coolant analysis of reactor core damage if rupture occurs.

Some of the possible parameters for such an analysis were developed for this report from sources other than NRC, as outlined in the next section. The wide variations in some of the key parameters illustrate uncertainties that must be resolved to make accurate predictions of risk and its uncertainty.

4.5 Uncertainties in Predicting Risks from Nozzle Cracking

For risk-informed decision making, it is important to include calculation of uncertainties in the predicted risks. NRC informs us that it has not calculated uncertainties in its present risk assessments of nozzle cracking. It does believe that its present results on core-damage risks are accurate "to within a factor of 2 or 3". NRC did not provide the basis for their belief. The information necessary for probabilistic risk calculation should include enough data for uncertainty analysis. NRC should perform uncertainty calculations.

A major uncertainty arises in attempting to predict the corrosion wastage that would rupture the reactor vessel, particularly after boric-acid-induced corrosion has penetrated all the way through the carbon steel and exposed the thin stainless steel liner that would serve as the reactor coolant system pressure boundary, as occurred at Davis-Besse. From other sources [Pin03a,b], we are informed that in early 2003 an internal NRC memo concluded that there was no danger of imminent rupture of the Davis-Besse reactor prior to its shutdown in February 2002. The memo cited calculations by the Oak Ridge National Laboratory that the as-discovered cavity could have supported twice the operating pressure of 2185 psia before rupturing and that, "had the cavity enlarged under continued operation, at least twelve months remained before the cavity would reach a size that rupture would occur at normal operating temperature and pressure." It was assumed that "the wastage cavity was actively growing at a maximum rate of seven inches per year" [Pin03a], much greater than the 4 inches per year quoted earlier by NRC. The NRC memo stated that the need for more accurate data on the morphology and depth of cladding cracks necessitates a revision of these calculations and expects a possible reduction in the amount of margin that was originally calculated.

A report by Structural Integrity Associates [Sia02], commissioned by FirstEnergy, calculated that the cladding could withstand pressures of more than 5000 psia. Davis-Besse concluded that vessel rupture "was therefore considered not to be a credible event". Later in 2003, an Oak Ridge National Laboratory study, conducted on a spare reactor-vessel head with a machined-out cavity simulating wastage, reported two rupture tests, one occurring at 2000 psia, the other at 2700 psia. If these two results are applicable, Davis-Besse had been operating at 2185 psia with significant probability of vessel rupture. NRC's project manager for these tests stated in October 2003 that the Oak Ridge test results would be made public "probably within weeks." The report is not yet released.

An important feature of the Oak Ridge tests was taking into account the "dissimilar weld" between the carbon-steel vessel head and the stainless steel cladding. The Union of Concerned Scientists pointed out that the Oak Ridge tests revealed that the weld overlay process used for the Davis-Besse vessel left a thin interface that was not as strong as either of the adjoining layers. Also, the tests were conducted quasi-statically, whereas pressure transients during reactor operation must be considered [Pin03b].

These are examples of crucial data uncertainties that need to be resolved. Such uncertainties must be considered in reporting probabilistic risks.

It is not enough to finesse such uncertainties by instituting new procedures intended to eliminate the possibility of operator error. The near accident at Davis-Besse resulted from human error, errors by reactor operators, by NRC on-site inspectors and by the staffs at Davis-Besse and NRC. The experience at Three Mile Island has taught us that human errors can occur and must be included in responsible risk analysis.

4.6 Lack of Uncertainty Analysis in DB Risk Estimation

As discussed in Section 4.5, an important issue regarding the application of quantitative guidelines for risk management and regulatory decisions, as in the Davis-Besse case under review, is the need to account for uncertainties in risk values determined through PRA techniques. It was noted in Sections 3.1 and 3.3 that we are unable to obtain any uncertainty estimates for the SPAR baseline CDF of 1.0×10^{-7}/year for Davis-Besse MBLOCA, without CRDM nozzle failures, or the NRC estimate of 5.4×10^{-5}/year for the corresponding MBLOCA CDF accounting for CRDM nozzle failures. It is well known among the PRA community that all quantitative risk estimates for nuclear power plants are subject to significant uncertainties and that it is imperative that proper uncertainty analysis be performed for any PRA study for nuclear power plants. This point was made abundantly clear in a recent NRC report [Fle03], prepared at the request of NRC's Advisory Committee on Reactor Safeguards (ACRS), for the purpose of evaluating practices and issues regarding PRA applications. The need to understand and characterize uncertainties in PRA and risk-informed regulatory activities was also emphasized in both RG 1.174 [Nrc02a] and RG 1.200 [Nrc03]. Furthermore, it was primarily for the purpose of duly accounting for uncertainties in the calculated risks of postulated severe accidents that NRC and its contractors had to go through two draft versions of the massive volumes of the severe accidents risk study of NUREG-1150 [Nrc90] before releasing the final version in 1990. Nonetheless, it is rather clear to the review committee that the NRC staff and management did not give due considerations to the impact of large uncertainties, in particular, in the frequency of MBLOCA initiated by the postulated Davis-Besse CRDM nozzle ejection in their Davis-Besse deliberations in November 2001. In addition, the SPAR calculation of CCDP = 2.5×10^{-3} is subject to significant uncertainties associated with human errors and common cause failures represented in the fault tree analysis. Questions were also raised in GAO interviews with the NRC staff if the staff had the proper understanding of the impact on the CCDP estimate of the compensatory measures proposed by Davis-Besse before the November 2001 decision.

During the 11 December 2003 meeting with the NRC staff, we got the indication that several NRC staff felt that Regulatory Guide 1.174 [Nrc02a], with its PRA framework, does account for uncertainties in risk estimates including the effects of unknown events, e.g., the Davis-Besse pressure vessel head wastage, through the defense-in-depth philosophy. As discussed in detail in the February 2003 NRC Region III report [Dye03], it is very much doubtful how the system modeling uncertainties and unknown events could possibly have been represented through a simple application of RG 1.174. It is noteworthy that the ACRS, at its first full committee meeting [Acr02] after the Davis-Besse cavity findings, repeatedly criticized the NRC staff for not having performed any uncertainty analysis for the CRDM nozzle failure issues and suggested that the staff had drifted away from the RG 1.174 guidelines. Had the staff gone through even a simple analysis, without any detailed uncertainty calculations or invoking RG 1.174, they should have realized that the *incremental* CDF of 5.4×10^{-5}/year would result in doubling the total CDF for Davis-Besse, even with the mean SPAR value of 5.1×10^{-5}/year. Note furthermore that the SPAR baseline CDF is 1.6×10^{-5}/year. Thus, the staff should have readily recognized the risk significance of the incremental CDF = 5.4×10^{-5}/year estimated in November 2001 for the CRDM nozzle failure event.

One regulatory decision-making case where PRA applications were questioned is the ATWS issue. A recent review [Rau03] emphasizes that the uncertainty in the calculated values of the reactor scram system reliability requires maintaining defense in depth regarding ATWS, rather than relying heavily on PRA results. Thus, despite small values of scram failure probabilities calculated in the early 1980s, system changes, including improved reactor shutdown systems and circuits, were implemented but only after incipient ATWS events had occurred at the Salem Unit 1 plant in 1983 [Sci83]. We suggest that the NRC staff should have applied the lessons learned from the ATWS rulemaking case to the DB case, which would have reduced the NRC staff's heavy reliance on the quantitative risk. Although we will never be able to determine the extent by which the incremental CDF or CDP values influenced the decision making, it is rather apparent to the review committee that the quantitative risk values, without due considerations for uncertainties, did play an important role in the 28 November 2001 decision.

5. Relevant Regulations and Guidelines

5.1 Use of Regulatory Guide 1.174 and Other Guidelines in the DB Decision

One key set of guidelines discussed extensively among the NRC staff and management before the 28 November 2001 DB decision is RG 1.174 [Nrc02a], which is intended to promote risk-informed decisions on plant-specific changes. Included in RG 1.174 is one particular quantitative metric in the form of incremental CDF. According to Figure 3 illustrating acceptance guidelines, any plant-specific changes resulting in an incremental CDF of 1×10^{-5}/year or higher should not be allowed. In addition, there apparently was considerable discussion and lack of unanimity among the NRC staff prior to the 28 November 2001 decision if the other four safety principles of RG 1.174 were satisfied. The February 2003 NRC Region III report [Dye03] documenting the significance of the Davis-Besse CRDM penetration cracking and pressure vessel head degradation leaves, however, no question that all five safety principles of REG 1.174 were violated at Davis-Besse in November 2001. Included in this report is a revised estimate of incremental MBLOCA frequency of 3.0×10^{-2}/year, yielding estimates of incremental CDF in the range of [1×10^{-5}, 1×10^{-4}] per year, due to the ejection of three central CRDM nozzles. These estimates of incremental CDF bracket the value of 5.4×10^{-5}/year presented to the review committee [Rei03] and would have clearly resulted in violation of the sole quantitative metric of RG 1.174.

Although the February 2003 findings of NRC rendering Davis-Besse in the "red" status are attained certainly with the benefits of hindsight, it is worth summarizing the reasoning presented in the report, rather than presenting the review committee's evaluations:

(1) Principle 1: *Regulations were not met*, because reactor coolant system (RCS) pressure boundary leakage occurred over an extended period of time and the RCS was not inspected and maintained properly. This resulted in violation of the General Design Criteria.
(2) Principle 2: Performance and maintenance deficiency *degraded the level of defense in depth* required for safe operation of the plant.
(3) Principle 3: *Safety margins were not maintained* because the integrity of the RCS pressure boundary relied solely on the vessel lining, which was not designed for this purpose.
(4) Principle 4: *Calculated risk violated the quantitative guideline.*
(5) Principle 5: There was *no basis for assuring that degradations* due to CRDM leaks *would be properly monitored and managed.*

It goes without saying that nobody anticipated in November 2001 the severe vessel wastage that was uncovered in March 2002, which resulted in an unambiguous verdict regarding Principle 3 above. Nonetheless, there were sufficient indications in November 2001 to question if safety margins were not violated, as voiced by a number of the NRC staff before the 28 November 2001 decision. This in turn raises questions if NRC made proper application of RG 1.174 in arriving at the decision to allow a delay of the shutdown of Davis-Besse for the pressure vessel head inspection required in NRC Bulletin 2001-01 [Nrc01c].

During the 11 December 2003 meeting with the NRC staff, the review committee was offered a number of other NRC and industry guidelines that the NRC staff apparently used for the Davis-Besse decision. A review of these additional guidelines further suggests that the NRC value for the incremental CDF = 5.4×10^{-5}/year for seven weeks of additional Davis-Besse operation could not have satisfied these guidelines either. To clarify the point here, we follow the process NRC used to convert the incremental CDF = 5.4×10^{-5}/year to the incremental core damage probability (CDP) for seven weeks or 0.13 year: incremental CDP = 5.4×10^{-5}/year × 0.13 year = 7.0×10^{-6}, rounded off to 5.0×10^{-6}, which is roughly equivalent to approximating 7 weeks as 0.1 year. We may now compare this incremental CDP estimate with three additional guidelines for risk-informed decision-making processes:

(1) RG 1.177 [Nrc98] intended for evaluating Technical Specification changes suggests that an incremental CDP of 5×10^{-7} is acceptable for relaxation of allowed outage time or surveillance test intervals.
(2) PSA Applications Guidelines [Tru95] proposed by the Electric Power Research Institute indicates that an incremental CDP in the range of [1×10^{-6}, 1×10^{-5}] requires assessment of non-quantifiable factors.
(3) NUMARC 93-01 [Nei96] suggests that an incremental CDP in the range of [1×10^{-6}, 1×10^{-5}] requires risk management actions, adding further that any decisions resulting in an incremental CDP greater than 1×10^{-5} should not be allowed.

Thus, NRC's incremental CDP value of 5×10^{-6} would have resulted in violation of RG 1.177 and would have required risk management actions according to both the EPRI and Nuclear Energy Institute guidelines. In addition, during the 11 December 2003 meeting with the NRC staff, Richard Barrett insisted that the quantitative RG 1.174 guidelines are supposed to be applied in terms of incremental CDP, not incremental CDF as stipulated clearly in the Regulatory Guide. In the February 2004 response [Chu04] to the review committee questions, NRC now proposes that the incremental CDF used as a key metric in RG 1.174 is meant to be an annual average. Thus, NRC now suggests that the incremental CDF = 5.4×10^{-5}/year for 13% of a year should be combined with CDF = 0.0 for the remaining 87% of the year to yield an annual-average incremental CDF = 5×10^{-6}/year. This new interpretation is at best unusual and certainly is inconsistent with clear RG 1.174 guidelines regarding the use of incremental CDF. This reinforces the impression of the review committee that perhaps there was in November 2001 and possibly is still some confusion among the NRC staff regarding basic quantitative metrics that should be considered in evaluating regulatory and safety issues.

A recent release of RG 1.200 [Nrc03] is intended to provide guidance for determining the technical adequacy of PRA results in regulatory decision making. The Regulatory Guide discusses various technical characteristics and attributes that should be included in PRA, and highlights the importance of capturing system dependencies in risk evaluations. RG 1.200 also emphasizes that understanding uncertainties in PRA is an essential aspect of risk characterization and refers to RG 1.174 for guidance on how to address the uncertainties. As reviewed in connection with the DB decision-making process, however, we feel that the guidelines in RG 1.174 are not specific enough, especially for PRA results subject to large uncertainties and for representing events not well understood.

5.2 Technical Specifications and General Design Criteria Regarding Coolant Leak

Davis-Besse technical specification 3.4.6.2 requires that no reactor coolant pressure boundary (RCPB) leakage is allowed. The General Design Criteria, 10 CFR 50 Appendix A, addresses reactor coolant pressure boundary leakage in GDC 14, GDC 31, and GDC 32. GDC 14 specifies that the RCPB have an extremely low probability of abnormal leakage, or rapidly propagating failure, and of gross rupture. GDC 31 specifies that the probability of rapidly propagating fracture of the RCPB be minimized. GDC 32 specifies that components which are part of the RCPB have the capability of being periodically inspected to assess their structural and leaktight integrity.

The FENOC response [Cam01a] to the NRC Bulletin 2001-01 applies the GDC against the situation of potentially cracked nozzles at Davis-Besse. Specifically the following points were made:

- The presence of cracked and leaking vessel head penetration (VHP) nozzles is not consistent with GDC14 or GDC 31.
- Inspection practices that do not permit reliable detection of VHP nozzle cracking are not consistent with GDC 32.

The situation regarding primary coolant leakage can be summarized as follows. The Davis-Besse technical specifications (TS) present a definitive criterion that allows no RCPB leakage. The GDC are not as definitive by virtue of their reference to *probability* of occurrence, which is not an absolute or definitive condition. GDC 14 and 31 are in agreement with the TS in principle, but not in their level of definitiveness. Therefore, there exists the possibility that a specific condition can be considered to satisfy the GDC but not the TS. Furthermore, the GDC implemented in the TS for DB allows for 1 gpm of unidentified reactor coolant system (RCS) leakage and 10 gpm of identified RCS leakage, with the interpretation that leakage past seals, flanges, and gaskets is not pressure boundary leakage.

GDC 32 refers to the capability to inspect the leaktight integrity of the nozzles. Inspections were acknowledged to be incomplete because of failure to inspect all nozzles. They were insufficient because it was acknowledged that visual inspection may be inadequate in detecting cracks. By virtue of the inadequacy of the inspections in achieving their intended purpose, GDC 32 was largely not satisfied.

According to the 2002 OIG Event Inquiry [Bel02], FENOC's own risk-informed evaluation estimated that Davis-Besse had between one and nine leaking CRDM nozzles, depending on the analysis used. According to the NRC, FENOC reported [Nrc02c] an estimate of 8.8 leaking nozzles to ACRS. From the results and analysis of the inspection data from five other B&W plants that revealed 16 cracked nozzles in 15 reactor years of operation [Cam01c] there should be 1-2 leaking nozzles since the last outage (RFO 12 in April 2000). So from the available data, it was *highly likely* that there were leaks in the pressure boundary. These data were circumstantial as there was no direct evidence of the leaks, in part due to the inadequacy of the visual inspection techniques.

Given that positive identification of nozzle leakage was not obtainable because of the nature and capability of the inspections, and given that multiple analyses show that as many as 9 leaking nozzles were likely, it can be concluded that Davis-Besse was *likely* in violation of their Technical Specifications. This point was further discussed in the NRC Significance Assessment Report [Dye03].

The incorporation of PRA into the decision-making process at NRC should have compelled the NRC to consider the likelihood of leaking nozzles in the decision on whether to allow Davis-Besse to continue to operate. However, "the NRR Director told OIG that from a legal point of view, there was an issue about constructing an order without knowing with *certainty* that there were cracks" [Bel02]. This position had a significant impact on the NRC decision as the key decision-maker in this case, Brian Sheron, believed that NRC had no case to shut down the plant based on the technical specification that there be no RCPB leakage. The potential conflict between PRA and legal considerations must be resolved for PRA to play any role in the decision-making process of the NRC.

5.3 Balance between Probabilistic and Deterministic Indicators for Risk Assessment

NRC management is responsible for decision-making. The technical staff is responsible for providing the technical case that serves as the foundation for decisions by management. The technical case includes both deterministic and PRA analysis that both involve models, data and calculations.

NRC has adopted "risk-informed" decision-making. However, the process is ill-defined and lacks guidelines as to exactly how it is supposed to work. The management does not have a set formula, process or procedure for incorporating PRA into its decision-making process. Brian Sheron was the key decision-maker in the Davis-Besse case. He stated in the December 11 interview with the review team that the PRA analysis was used as a "calibration point" that gives NRC a ballpark figure of the risk. He indicated that the PRA value is not of much consequence unless it is of a "wildly" extreme value. He also indicated that there is little clear guidance on the use of PRA in the decision-making process. This point was supported by comments from Jack Strosnider and Gary Holahan who confirmed in their December 11 interview with the review team that there is no documentation or guidance that outlines to what extent or how the NRC should weigh the resultant risk number and uncertainty with respect to the ultimate decision.

This viewpoint indicates that NRC has no predetermined methodology to weigh the PRA result against a deterministic result or other factors. That is, the value assigned to the PRA analysis is largely at the discretion of the decision-maker and there is no guidance as to the weight to assign to this result. Such a process can result in a decision in which PRA plays a role anywhere from 0 to 100%. Clearly, there is need for the NRC to provide guidance for the use of PRA in decision-making.

6. Review of the November 2001 NRC Decision Regarding Davis-Besse

6.1 Involvement of NRC Staff and Management in the DB Decision

The basis of the November 28 decision to allow Davis-Besse to operate until February 16 was a meeting involving both technical staff and management. The meeting was called by Brian Sheron and was held on November 28, 2001. Following discussion of the various issues regarding Davis-Besse, Brian Sheron asked the staff if they could accept an extension of operation of the plant until February 16, 2002. Three staff members had objections. Mr. Sheron then reframed the question and asked the staff if any of them thought that Davis-Besse was not safe to operate until that date. None thought that this was the case. Based on this result, NRC accepted the February 16, 2002 date proffered by FENOC.

During the discussion, both deterministic analyses and PRA results were considered. However, a cost-benefit type of analysis of the situation was not performed. In an interview with the review team, Richard Barrett explained that NRC followed the RG 1.174 and RIS 2001-02 [Nrc01b] argument, based on a "special circumstance." This special circumstance was that the regulations (ASME inspection codes) at the time were not adequate to detect cracked and/or leaking nozzles and thus NRC had to take special action to address the special circumstance. Once the existence of a special circumstance was established, NRC used RG 1.174 to determine if the problem was risk significant enough. NRC determined that the problem was not risk significant, per RG 1.174, because "defense-in-depth" was preserved. Therefore, NRC did not consider the third factor, which would have been "higher level NRC management thoughts," such as a "cost-benefit" analysis or impact/burden on license.

However, as noted by several staff, there was pressure on the NRC from industry, Congress and the NRC Commissioners to keep plants running. It is not clear how much influence this pressure had on the decision-making process.

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The transparency of the decision-making process within NRC is not uniform. In the case of a shutdown order, the Executive Director for Operations (Office Director) would be the official responsible for signing the order. If the issue does not involve an order, the process is less clear. The specification of decision-maker appears to depend on the importance of the issue. There does not appear to be a policy that identifies what individuals are empowered to make what decisions. Strosnider and Holahan indicated that a routine response to a generic letter may be handled by a project manager, or perhaps by the Divisions of Licensing Project Management, with the concurrence of the involved sections or other divisions. NRC has no standard process or guidelines for decision-making. Sometimes the decision process involves a memo describing the licensee's request and NRC's response that is routed around and signed off on by relevant NRC staff. Other times, NRC will pull together a meeting of decision stakeholders.

The lack of an established and well-defined process for decision-making within the agency is a significant problem that needs to be addressed.

6.2 Coordination among NRR, RES, and Inspectors

The analysis and decision-making process for the Davis-Besse case involved numerous individuals and offices. Included in the consideration of issues regarding Davis-Besse were the Directorate for Project Licensing & Technical Analysis, the Division of Engineering, and Division of System Safety and Analysis and the technical staff of the several Branches that report to those Division Directors of the Office of Nuclear Reactor Regulation (NRR). In addition, the Office of Research (RES) and ACRS played roles, as did the regional office and the regional inspector at Davis-Besse.

While there were a number of individuals and offices involved in the technical assessment of nozzle cracking, the interplay between offices and individuals is impossible to reconstruct. However, there are two cases that highlight problems with communication between offices and between individuals. The first is in the assessment of the initiating event probability. Based on interviews with some 12 different individuals, all significantly involved in the Davis-Besse issue and analysis, and spanning two Offices, one Directorate, two Divisions and several Branches, there was no sense of understanding about how the initiating event probability used in the PRA analysis was determined and by whom. In fact, the origin of the value for the initiating event probability that appears to have been used in the PRA analysis was variously ascribed to Bill Shack at ANL, FENOC, Framatome and EMC[5]. Further, the perception of who within NRC was responsible for establishing this quantity was not consistent. This situation indicates a very uneven understanding of one of the key underlying quantities for the entire PRA analysis. The origin of this term remains an outstanding issue, even with the February 2004 NRC response [Chu04]. It was clear that there was substantial interaction among offices and individuals during the period of intense analysis in the Fall of 2001. However, communication did not appear to be well structured, complete or effective in establishing a value for the initiating event probability.

A second problem was evident in the communication between the various components (headquarters, regional office, regional inspector at Davis-Besse) of the NRC. The resident inspector appears to have played little or no role in providing information relevant to the issues being analyzed at NRC HQ. Further, there appears to have been no communication between the resident inspector and HQ. In the December 11th interview with the review team, Mr. Strosnider stated that it was rare one would think a resident inspector would offer substantive help. He did not believe that the resident inspector at Davis-Besse was, in fact, contacted. He also believed that the resident inspector is busy with other things, and that he probably had not been part of the vessel head inspections, and that he lacked the technical aptitude needed to contribute to the issue.

There were several indications of operational irregularities that should have been noted by an inspector in residence at the plant. These include: 1) radiological surveys showing a contamination plume effect originating from the service structure ventilation exhaust over the East D-ring [Dye02], 2) significant increase in the cleaning of containment air coolers, 3) the removal of fifteen, 5-gallon buckets of boric acid from the ductwork and plenum of the containment air coolers and the discovery of significant boric acid elsewhere in the containment, such as service water piping, stairwells, and other areas of low ventilation, and 4) the sudden change to rust-colored boric acid in June of 1999. That these events were occurring without the knowledge or appreciation of the resident NRC inspector highlights a major weakness of the role of the resident inspector in helping to ensure safe operation of the plant at which he/she is stationed.

6.3 Arbitrariness of the Requested Shutdown Date

The 12/31/01 date for completing inspections of reactor vessel head nozzles imposed on licensees by the NRC was arbitrarily set. The arbitrariness of the 12/31/01 date was confirmed by Brian Sheron in his interview with the review committee in which he stated that there was nothing magical about the December 31st date, and that it just as easily could have been February 28th or March 31st.

The arbitrariness of the date caused difficulty for the NRC when challenged by FENOC. The challenge resulted in a perceived reversal of the burden of proof from the licensee to the NRC. NRC believed that they needed to make a case in order to force a shutdown of DB to look for cracks. Unfortunately, their authority to act was perceived to be undermined by the lack of a defensible rationale for the selection of the inspection date.

NRC has been encouraging the use of risk analysis as part of the risk-informed decision-making process. Yet NRC did not consider including risk analysis in the original call for inspection. The inclusion of risk analysis in the formulation of the inspection date could have provided the NRC with the justification for enforcement that they lacked under the present circumstances. If the call for inspection were based on a risk-informed decision-making strategy, then the calculations of the likelihood of nozzle failure and LOCA would have provided the support they needed to call for an inspection. The practical considerations in this strategy are not trivial. Yet had NRC followed its commitment to incorporate risk analysis in its decision-making process at the outset, the decision regarding Davis-Besse may have been much more straightforward.

6.4 The Role of NRC's Advisory Committee on Reactor Safeguards

Although we recognize that ACRS does not provide routine guidance on plant-specific issues, we feel that NRC staffs should have recognized the CRDM nozzle failures as a generic issue and should have solicited in-depth assistance from ACRS before the 28 November 2001 decision. Thus, relying on a narrow interpretation of the CRDM nozzle failure issues, the staff missed an opportunity to obtain important expert perspectives on the issues. We recommend that the NRC staff make more direct use of ACRS to augment in-house expertise on the staff, which may be limiting at times.

6.5 NRC Staff Workload Affecting Its Ability for Detailed Risk Assessment

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An NRC manager raised the question if NRC had sufficient personnel, given the workload, to perform detailed studies on complex regulatory or licensing issues such as the Davis-Besse case. Although the upper level management seems to be satisfied with the overall staff performance, we recommend a review of the workload and technical competence of the staff required to provide licensing and regulatory support in a timely manner.

6.6 Davis-Besse, NRC, and Three Mile Island

The human errors on the parts of Davis-Besse and NRC, resulting in a near miss of a serious accident, echo a similar chain of events that originated at Davis-Besse in 1977 and culminated in America's most serious reactor accident at Three Mile Island in 1979. It began in September 1977 at Davis-Besse when a relief valve on the reactor coolant pressurizer stuck open. The coolant pressure fell but the water level in the pressurizer increased, the result of an anomaly in the pressurizer piping. Thinking that the reactor was getting too much water, the operator improperly interfered with the high-pressure injection system. Fortunately, a supervisor recognized what was happening and closed the relief valve twenty minutes later and re-admitted coolant. No damage was done to the reactor because it had been operating at only 9 percent power.

The incident was investigated by both NRC and by B&W, the reactor supplier, but no information calling attention to the correct operating actions was provided to other utilities. A B&W engineer had stated in an internal memorandum that if the Davis-Besse event had occurred in a reactor operating at full power, "it is quite possible, perhaps probable, that core uncovering and possible fuel damage would have occurred."

In 1978 an NRC official pointed out the likelihood of erroneous operator action in B&W reactors. The NRC did not notify utilities about the lessons learned at Davis-Besse and the pressing need for new training to avoid the confusing interpretation of water level indicators at B&W plants. Fourteen months later the core-melt accident happened at Three Mile Island.

In March 1979, a similar B&W reactor was operating at full power at Three Mile Island in Pennsylvania. Again, the pressure relief valve stuck open, reactor coolant escaped, coolant pressure fell and the operators made the same mistake as had the operators two years earlier at Davis-Besse. They turned off the high-pressure coolant injection. Unfortunately, the ensuing control room confusion did not lead to early diagnosis and restoration of reactor water. With the high-pressure injection water incorrectly turned off, the reactor continued to generate heat and boil coolant, ultimately uncovering the reactor core and melting a substantial portion of the reactor fuel. When a supervisor finally diagnosed the problem and restored high-pressure injection water, some two hours later, enormous fuel damage had been done and considerable radioactivity released to the reactor building.

The President's Commission on the Accident at Three Mile Island [Kem79] concluded that the major factor that turned the TMI incident into a serious accident was inappropriate operator action, deficiencies in training and failure of responsible organizations, especially the NRC, to learn the proper lessons from previous incidents. There was a serious lack of recognition of the safety implications of new information and there was serious lack of questioning of the adequacy of assumptions made in the reactor design, in the operating procedures, and in the follow up of events. The Commission concluded that, starting with the Davis-Besse 1977 event and given all the deficiencies of the safety system and its regulation, an accident like Three Mile Island was eventually inevitable.

For many months and even years it was not realized that the TMI accident had resulted in such extensive core damage. More responsive earlier analyses by NRC of the 1977 Davis-Besse precursor event and its potential consequences would have alerted NRC to forewarn the utilities of the incipient danger. Similarly, the seeming lack of aggressive followup by NRC and industry to understand the risks from the recent near miss at Davis-Besse is a serious concern. History should not be allowed to repeat itself.

7. Recommendations for Improved Use of Probabilistic Risk Assessment

There are several ways in which NRC can improve the use of PRA in its decision-making process:

(1) Establish an appreciation for PRA across the spectrum of NRC technical and managerial personnel. There is great divergence in the appreciation for, and understanding of PRA and its value in the decision-making process. In a sense, NRC needs to get their staff "on the same page" with regard to PRA applications in regulatory and licensing issues.

(2) Establish a set of guidelines for the use of PRA in decision-making. No guidelines currently exist for how PRA should be incorporated into the decision-making process other than the general philosophy that risk analysis should be part of a risk-informed decision-making process. A set of guidelines that establishes the level and nature of consideration of PRA is needed. In particular, guidance should be provided on how to balance PRA results against deterministic or qualitative evaluations, especially when the PRA results are subject to large uncertainties.

(3) Establish a set of guidelines for how decisions are made at NRC and by whom. This is a necessary precursor to the success of recommendation 2. The decision-making process must be defined in order to incorporate risk analysis into that process. Further, the offices and individuals responsible for making decisions need to be defined in order to successfully determine who needs to be aware of and familiar with PRA as discussed in recommendation 1.

(4) Establish a better protocol for estimating and incorporating uncertainties in PRA. PRA results without associated uncertainties are of little value. As a result, it is difficult to incorporate results of an analysis into a decision strategy without an understanding of the bounds of the validity of the result.

(5) Provide for unanticipated events. Corrosion of the Davis-Besse pressure vessel head was not an anticipated event. As put by NRC personnel, it was not even on the radar screen. As such, it was not incorporated into the event tree analysis in PRA. However, PRA needs to be able to anticipate the consequences of such oversight.

(6) Establish a better system at NRC for recognizing generic problems and transmitting information and concerns about these potential problems to other plants.

(7) NRC should issue preliminary analyses of risks from nozzle cracking that include leakage through axial cracks, evaporation of leaking coolant, concentration of and corrosion by boric acid, corrosion of the carbon-steel vessel and the vessel liner, the time-dependent probability of rupture of the corroded vessel, core damage resulting from loss of coolant, and the effects of human failure to make and interpret surveillance inspections. The results and possible interpretations of the recent Oak Ridge tests of vessel failure should be made known to the safety community.

References

[Acr02] Transcript of the 491st Meeting of the Advisory Committee on Reactor Safeguards, U. S. Nuclear Regulatory Commission (2002).

[Bar03] R. Barrett. "Note for GAO Meeting on Dec 1, 2003," private communication to the review committee (2003).

[Bel02] H. T. Bell, "NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head (Case No. 02-03S)," U. S. Nuclear Regulatory Commission (2002).

[Cam01a] G. G. Campbell, "Response to NRC Bulletin 2001-01, *Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles*," FirstEnergy Nuclear Operating Company, Docket Number 50-346, License Number NPF-3, Serial Number 2731 (2001).

[Cam01b] G. G. Campbell, "Response to Requests for Additional Information Concerning NRC Bulletin 2001-01, *Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles*," FirstEnergy Nuclear Operating Company, Docket Number 50-346, License Number NPF-3, Serial Number 2741 (2001).

[Cam01c] G. G. Campbell, "Transmittal of Davis-Besse Nuclear Power Station Risk Assessment of Control Rod Drive Mechanism Nozzle Cracks," FirstEnergy Nuclear Operating Company, Docket Number 50-346, License Number NPF-3, Serial Number 2745 (2001).

[Cam01d] G. G. Campbell, "Supplemental Information in Response to NRC Bulletin 2001-01, Circumferential *Cracking of Reactor Pressure Vessel Head Penetration Nozzles*," FirstEnergy Nuclear Operating Company, Docket Number 50-346, License Number NPF-3, Serial Number 2735 (2001).

[Chu04] J. Chung, R. Barrett, and G. Holahan, "Response to GAO Questions," communication to M. B. McWreath, February 24, 2004.

[Dye02] "Davis-Besse Nuclear Power Station NRC Augmented Inspection Team – Degradation of the Reactor Pressure Vessel Head, Report No. 50-346/02-03(DRS)," U. S. Nuclear Regulatory Commission (2002).

[Dye03] J. E. Dyer, "Davis-Besse Control Rod Drive Mechanism Penetration Cracking and Reactor Pressure Vessel Head Degradation Preliminary Significance Assessment, Report No. 50-346/2002-08(DRS)," U. S. Nuclear Regulatory Commission (2003).

[Epr01] "Boric Acid Corrosion Handbook, Revision 1," Report 1000975, Electric Power Research Institute (2001).

[Fle03] K. N. Fleming, "Issues and Recommendations for Advancement of PRA Technology in Risk-Informed Decision Making," NUREG/CR-6813, U. S. Nuclear Regulatory Commission (2003).

[Hub03] "NRC's Oversight of Davis-Besse Boric Acid Leakage and Corrosion During the April 2000 Refueling Outage (Case No. 03-02S)," Memorandum from H. T. Bell,

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Inspector General, to Chairman Diaz, U. S. Nuclear Regulatory Commission, October 17, 2003.

[Kem79] J. G. Kemeny, B. Babbitt, P. E. Haggerty, C. Lewis, P. A. Marks, C. B. Marrett, L. McBride, H. C. McPherson, R. W. Peterson, T. H. Pigford, T. B. Taylor, A. D. Trunk, "The Need For Change: The Legacy of TMI," Report of the Presidential Commission on The Accident at Three Mile Island (1979).

[Nei96] "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," NUMARC 93-01, Rev. 2, Nuclear Energy Institute (1996).

[Nrc01a] "Preliminary Staff Technical Assessment for Pressurized Water Reactor Vessel Head Penetration Nozzles Associated with NRC Bulletin 2001-01, *Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles*," U. S. Nuclear Regulatory Commission (2001).

[Nrc01b] "Guidance on Risk-informed Decisionmaking in License Amendment Reviews," Regulatory Issue Summary (RIS) 2001-02, U. S. Nuclear Regulatory Commission (2001).

[Nrc01c] "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," U. S. Nuclear Regulatory Commission (2001).

[Nrc02a] "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Regulatory Guide 1.174, U. S. Nuclear Regulatory Commission (2002).

[Nrc02b] "Davis-Besse Reactor Vessel Head Degradation Lessons-Learned Task Force Report," U. S. Nuclear Regulatory Commission (2002).

[Nrc02c] Transcript of the 20 August 2002 Interview, Office of Investigations, U. S. Nuclear Regulatory Commission (2002).

[Nrc03] "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Regulatory Guide 1.200, U. S. Nuclear Regulatory Commission (2003).

[Nrc90] "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, U. S. Nuclear Regulatory Commission (1990).

[Nrc98] "An Approach for Plant-Specific Risk-Informed Decisionmaking: Technical Specifications," Regulatory Guide 1.177, U.S. Nuclear Regulatory Commission (1998).

[Pin03a] Platts: *Inside NRC*, McGraw-Hill Companies, February 16, 2003.

[Pin03b] Platts: *Inside NRC*, McGraw-Hill Companies, November 3, 2003.

[Pol99] J. P. Poloski, et al., "Rates of Initiating Events at U. S. Nuclear Power Plants: 1987–1995," NUREG/CR-5750, U. S. Nuclear Regulatory Commission (1999).

[Rau03] W. S. Raughley and G. F. Lanik, "Regulatory Effectiveness of the Anticipated Transient Without Scram Rule," NUREG-1780, U. S. Nuclear Regulatory Commission (2003).

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[Rei03] "Jin Chung's email dated May 29, 2003 and subsequent discussion," email communication from M. Reinhart, November 25, 2003.

[Sap98] "Systems Analysis Program for Hands-On Integrated Reliability Evaluations (SAPHIRE)," Technical Reference Manual, Version 6, NUREG/CR-6116, U. S. Nuclear Regulatory Commission (1998).

[Sat00] M. B. Sattison, J. K. Knudsen, L. M. Wolfram, and S. T. Beck, "Standardized Plant Analysis Risk Model for Davis-Besse," ASP PWR D, Rev. 3i, Idaho National Engineering and Environmental Laboratory (2000).

[Sci83] "The Salem Case: A Failure of Nuclear Logic," *Science, 220*, 280 (1983).

[Sha01] W. Shack, DavisBesseANL.pdf file, October 27, 2001.

[Sha03] W. Shack, Integrated model outline.pdf file, private communication to G. S. Was, 2003.

[Sia02] "Elastic-Plastic Finite Element Stress Analysis of Davis-Besse RPV Head Wastage Cavity with Different Enlarged Areas and Thicknesses," Non-Proprietary Version, Structural Integrity Associates, Inc. (2002).

[Sri98] "Boric Acid Corrosion Evaluation (BACE) Corrosion Program -- Phase II Corrosion Testing," Topical Report, Southwest Research Institute (1998).

[Tru95] D. True, K. Fleming, G. Parry, B. Putney, and J-P Sursock, "PSA Applications Guide," TR-105396, Electric Power Research Institute (1995).

Davis-Besse Task Force Recommendations to NRC and Their Status, as of March 2004

Recommendation	NRC actions and status as of March 2004
Completed recommendations	
Either fully implement or revise guidance to manage licensee commitments. Determine whether the periodic report on commitment changes submitted by licensees should continue.	Revised instructions for these submittals and reviews to ensure that these tasks are accomplished. Completed in May 2003.
Determine if stress corrosion cracking models are appropriate for predicting susceptibility of vessel head penetration nozzles to pressurized water stress corrosion cracking. Determine if additional analysis and testing is needed to reduce modeling uncertainties for their continued applicability in regulatory decision making.	Evaluated existing stress corrosion cracking models for their continuing use in determining susceptibility. Completed in July 2003.
Revise the problem identification and resolution approach so that safety problems noted in daily licensee reports are reviewed and assessed. Enhance guidance to prescribe the format of information that is screened when deciding which problems to review.	Revised inspection procedure for determining licensee ability to promptly identify and resolve conditions adverse to quality or safety. Completed in September 2003.
Provide enhanced inspection guidance to pursue issues and problems identified during reviews of plant operations.	Revised inspection procedure for determining licensee capability to promptly identify and resolve conditions adverse to quality or safety. Completed in September 2003.
Revise inspection guidance to provide for longer-term follow-up of previously identified issues that have not progressed to an inspection finding.	Revised inspection procedure for determining licensee capability to promptly identify and resolve conditions adverse to quality or safety. Completed in September 2003.
Revise inspection guidance to assess (1) the safety implications of long-standing unresolved licensee equipment problems, (2) the impact of phased in corrective actions, and (3) the implications of deferred plant modifications.	Revised inspection procedure for determining licensee capability to identify and resolve conditions adverse to quality or safety. Completed in September 2003.
Revise inspection guidance to allow for establishing reactor oversight panels even when a significant performance problem, as defined under NRC's Reactor Oversight Process, does not exist.	Revised inspection guidance for establishing reactor oversight panels. Completed in October 2003.
Assess the scope and adequacy of requirements for licensees to review operating experience.	Included in NRC's recommendation to develop a program for collecting, analyzing, and disseminating information on experiences at operating reactors. Completed in November 2003.
Ensure inspector training includes (1) boric acid corrosion effects and control, and (2) pressurized water stress corrosion cracking of nickel-based alloy nozzles.	Developed and implemented Web-based training and a means for ensuring training is completed. Completed in December 2003.
Provide training and reinforce expectations to managers and staff to (1) maintain a questioning attitude during inspection activities, (2) develop inspection insights from Davis-Besse on symptoms of reactor coolant leakage, (3) communicate expectations to follow up recurring and unresolved problems, and (4) maintain an awareness of surroundings while conducting inspections. Establish mechanisms to perpetuate this training.	Developed Web-based inspector training and a means for ensuring that training has been completed. NRC headquarters provided an overview of the training to NRC regional offices. (Training modules will be added and updated as needed.) Completed in December 2003.
Reinforce expectations that regional management should make every effort to visit each reactor at least once every 2 years.	Discussed at regional counterparts meeting. Completed in December 2003.
Develop guidance to address impacts of regional oversight panels on regional resource allocations and organizational alignment.	Evaluated past and present oversight panels. Developed enhanced inspection approaches for oversight panels and issued revised procedures. Completed in December 2003.

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Recommendation	NRC actions and status as of March 2004
Evaluate (1) the capacity to retain operating experience information and perform long-term operating experience reviews; (2) thresholds, criteria, and guidance for initiating generic communications; (3) opportunities for more gains in effectiveness and efficiency by realigning the organization (i.e., feasibility of a centralized operating experience "clearinghouse"); (4) effectiveness of the generic Issues program; and (5) effectiveness of internal dissemination of operating experience information to end users.	Developed program objectives and attributes and obtained management endorsement of a plan to implement the recommendation. Developed specific recommendations to improve program. Evaluation completed in November 2003. (Implementation of recommendations resulting from this evaluation expected to be completed in December 2004.)
Ensure that generic requirements or guidance are not inappropriately affected when making unrelated changes to other programs, processes, guidance, etc.	Revised inspection guidance. Completed in February 2004.
Develop inspection guidance to assess scheduler influences on amount of work performed during refueling outages.	Revised the appropriate inspection procedure. Completed in February 2004.
Establish guidance to ensure that NRC decisions allowing licensees to deviate from guidelines and recommendations issued in generic communications are adequately documented.	Update guidance to address documentation. Develop training and distribute to NRC offices and regions to emphasize compliance with the updated guidance. Follow up to assess the effectiveness of the training. Completed follow-up in February 2004.
Develop or revise inspection guidance to ensure that NRC reviews vessel head penetration nozzles and the reactor vessel head during licensee inspection activities.	Develop or revise inspection guidance to ensure that nozzles and the vessel head are reviewed during licensee inspection. Issued interim guidance in August 2003 and a temporary inspection procedure in September 2003. Additional guidance expected in March 2004.
Develop inspection guidance to assess (1) repetitive or multiple technical specification actions in NRC inspection or licensee reports, and (2) radiation dose implications for conducting repetitive tasks.	Revise the appropriate inspection procedure to reflect this need. Completion expected in March 2004.
Develop guidance to periodically inspect licensees' boric acid corrosion control programs.	Issued temporary guidance in November 2003. Completion of further inspection guidance changes expected in March 2004.
Reinforce expectations for managers responsible for overseeing operations at nuclear power plants regarding site visits, coordination with resident inspectors, and assignment duration. Reinforce expectations to question information about operating conditions and strengthen guidance for reviewing license amendments to emphasize consideration of current system conditions, reliability, and performance data in safety evaluation reports. Strengthen guidance for verifying licensee-provided information.	Update project manager handbook that provides guidance on activities to be conducted during site visits and interactions with NRC regional staff. Also, revise guidance for considering plant conditions during licensing action and amendment reviews. Completion expected in March 2004.
Assemble and analyze foreign and domestic information on Alloy 600 nozzle cracking. If additional regulatory action is warranted, propose a course of action and implement a schedule to address the results.	Assemble and analyze alloy 600 cracking data. Completion expected in March 2004.
Recommendations due to be completed between April and December 2004	
Conduct an effectiveness review of actions taken in response to past NRC lessons-learned reviews.	Review past lessons-learned actions. Completion expected in April 2004.
Provide inspection and oversight refresher training to managers and staff.	Develop a training module. Completion expected in June 2004.

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Recommendation	NRC actions and status as of March 2004
Establish guidance for accepting owners group and industry recommended resolutions for generic communications and generic issues, including guidance for verifying that actions are taken.	Revise office instructions to provide recommended guidance. Completion expected in June 2004.
Review inspection guidance to determine the inspection level that is sufficient during refueling outages, including inspecting reactor areas inaccessible during normal operations and passive components.	Revised an inspection procedure to reflect these changes. Some inspection procedure changes were completed in November 2003, and additional changes are expected in August 2004.
Evaluate, and revise as necessary, guidance for proposing candidate generic issues.	Evaluate and revise guidance. Completion expected in October 2004
Assemble and analyze foreign and domestic information on boric acid corrosion of carbon steel. If additional regulatory action is warranted, propose a course of action and implement a schedule to address the results.	Review Argonne National Laboratory study on boric acid corrosion. Analyze data to revise inspection requirements. Completion expected in October 2004.
Conduct a follow-on verification of licensee actions to implement a sample of significant generic communications with emphasis on those that are programmatic in nature.	Screen candidate generic communications to identify those most appropriate for follow-up using management-approved criteria. Develop and approve verification plan. Completion expected in November 2004.
Strengthen inspection guidance for periodically reviewing licensee operating experience.	Incorporated into the recommendation pertaining to NRC's capacity to retain operating experience information. Completion expected in December 2004.
Enhance the effectiveness of processes for collecting, reviewing, assessing, storing, retrieving, and disseminating foreign operating experience.	Incorporated into the recommendation pertaining to NRC's capacity to retain operating experience information. Completion expected in December 2004.
Update operating experience guidance to reflect the changes implemented in response to recommendations for operating experience.	Incorporated into the recommendation pertaining to NRC's capacity to retain operating experience information. Completion expected in December 2004.
Review a sample of NRC evaluations of licensee actions made in response to owners groups' commitments to identify whether intended actions were effectively implemented.	Conduct the recommended review. Completion expected in December 2004.
Develop general inspection guidance to periodically verify that licensees implement owners groups' commitments.	Develop inspection procedure to provide a mechanism for regions to support project managers' ability to verify that licensees implement commitments. Completion expected in December 2004.
Conduct follow-on verification of licensee actions pertaining to a sample of resolved generic issues.	No specific actions have been identified. Completion expected in December 2004.
Review the range of baseline inspections and plant assessment processes to determine sufficiency to identify and dispose of problems like those at Davis-Besse.	No specific actions have been identified. Completion expected in December 2004.
Identify alternative mechanisms to independently assess licensee plant performance for self-assessing NRC oversight processes and determine the feasibility of such mechanisms.	No specific actions have been identified. Completion expected in December 2004.
Establish measurements for resident inspector staffing levels and requirements, including standards for satisfying minimum staffing levels.	Develop standardized staffing measures and implement details. Metrics were developed in December 2003. Completion expected in December 2004.
Structure and focus inspections to assess licensee employee concerns and a "safety conscious work environment."	No specific actions have been identified. Completion expected in December 2004.

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Recommendation	NRC actions and status as of March 2004
Recommendations due to be completed in calendar year 2005	
Develop inspection guidance and criteria for addressing licensee response to increasing leakage levels and/or adverse trends in unidentified reactor coolant system leakage.	Develop recommendations for guidance with action levels to trigger greater NRC interaction with licensees in response to increased leakage. Completion expected in January 2005.
Reassess the basis for the cancellation, in 2001, of certain inspection procedures (i.e., boric acid control programs and operational experience feedback) to assess if these procedures are still applicable.	Review revised procedures and reactivate as necessary. Completion expected in March 2005.
Assess requirements for licensee procedures to respond to plant alarms for leakage to determine whether requirements are sufficient to identify reactor coolant pressure boundary leakage.	Review and assess adequacy of requirements and develop recommendations to (1) improve procedures to identify leakage from boundary, (2) establish consistent technical specifications for leakage, and (3) use enhanced leakage detection systems. Completion expected in March 2005.
Determine whether licensees should install enhanced systems to detect leakage from the reactor coolant system.	Re-evaluate the basis for current leakage requirements and assess the capabilities of current leakage detection systems. Develop recommendations to (1) improve procedures for identifying leakage, (2) establish consistent technical specifications, and (3) use enhanced leakage detection systems. Completion expected in March 2005
Inspect the adequacy of licensee's programs to control boric acid corrosion, including effectiveness of implementation.	Develop guidance to assess adequacy of corrosion control programs, including implementation and effectiveness, and evaluate the status of this effort after the first year of inspections. Guidance expected to be developed by March 2004. Follow-up scheduled for completion in March 2005.
Continue ongoing efforts to review and improve the usefulness of barrier integrity performance indicators and evaluate the use of primary system leakage that licensees have identified but not yet corrected as a potential indicator.	Develop and implement improved performance indicators based on current requirements and measurements. Explore the use of additional performance indicators to track the number, duration, and rate of system leakage. Determine the feasibility of establishing a risk-informed performance indicator for barrier integrity. Completion expected in December 2005.
Recommendations whose completion dates have yet to be determined	
Encourage the American Society of Mechanical Engineers to revise inspection requirements for nickel-based alloy nozzles. Encourage changes to requirements for nonvisual, nondestructive inspections of vessel head penetration nozzles. Alternatively, revise NRC regulations to address the nature and scope of these inspections.	Monitor and provide input to industry efforts to develop revised inspection requirements. Participate in American Society of Mechanical Engineers' meetings and communicate with appropriate stakeholders. Decide whether to endorse the revised American Society of Mechanical Engineers' code requirements. These actions parallel a larger NRC rulemaking effort. Completion date yet to be determined.
Revise processes to require short- and long-term verification of licensee actions to respond to significant NRC generic communications before closing out issues.	Target date to be set upon completion of review of NRC's generic communications program. Completion date yet to be determined.
Determine whether licensee reactor vessel head inspection summary reports should be submitted to NRC and, if so, revise submission requirements and report disposition guidance, as appropriate.	Will be included as part of revised American Society of Mechanical Engineers' requirements for inspection of reactor vessel heads and vessel head penetration nozzles. Completion date yet to be determined.

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Recommendation	NRC actions and status as of March 2004
Evaluate the adequacy of methods for analyzing the risk of passive component degradation and integrate these methods and risks into NRC's decision-making processes.	No specific actions have been identified. Completion date yet to be determined.
Review pressurized water reactor technical specifications to identify plants that have nonstandard reactor coolant pressure boundary leakage requirements and change specifications to make them consistent among all plants.	Assessed plants for nonstandard technical specifications. Completed in July 2003. Change leakage detection specifications in coordination with other changes in leakage detection requirements. Completion date yet to be determined.
Improve requirements for unidentified leakage in reactor coolant system to ensure they are sufficient to (1) discriminate between unidentified leaks from the coolant system and leaks from the reactor coolant pressure boundary and (2) ensure that plants do not operate with pressure boundary leakage.	Issue regulations implementing the improved requirements when these requirements are determined. Completion date yet to be determined.
NRC should review a sample of plant assessments conducted between 1998 and 2000 to determine if any identified plant safety issues have not been adequately assessed.	No specific actions have been identified. Completion expected in March 2004.
Recommendations rejected by NRC management	
Review industry approaches licensees use to consider economic factors for inspection and repair and consider this information in formulating future positions on the performance of non-visual inspections of vessel head penetration nozzles.	Recommendation rejected by NRC management. No completion date.
Revise the criteria for review of industry topical reports to allow for NRC staff review of safety-significant reports that have generic implications but have not been formally submitted for NRC review in accordance with the existing criteria.	Recommendation rejected by NRC management. No completion date.

Source: GAO analysis of NRC data.

Appendix IV

Comments from the Nuclear Regulatory Commission

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 5, 2004

Mr. James Wells, Director
Natural Resources and Environment
United States General Accounting Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Wells:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am responding to your letter of April 2, 2004, requesting the NRC's review of the draft report entitled "Nuclear Regulation: NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown" (GAO-04-415). I appreciate the opportunity to provide comments to the General Accounting Office (GAO) on this report.

I am concerned that the draft report does not appropriately characterize or provide a balanced perspective on the NRC's actions surrounding the discovery of the Davis-Besse reactor vessel head condition or NRC's actions to incorporate the lessons learned from that experience into our processes. The NRC also does not agree with two of the report's recommendations, as discussed in the following paragraphs.

See comment 1.

The first sentence of the draft report states: "...oversight did not generate accurate, complete information on plant conditions." I agree that our oversight program should have identified certain evolving plant conditions for regulatory follow-up. This was also identified in the report of the Davis-Besse Lessons Learned Task Force (LLTF) that the NRC formed to ensure that lessons from the Davis-Besse experience are learned and appropriately captured in the NRC's formal processes. However, the draft report does not acknowledge that the NRC, in carrying out its safety responsibilities, must rely heavily on our licensees to provide us with complete and accurate information. In fact, Title 10 of the Code of Federal Regulations Section 50.9 requires that information provided to the NRC by a licensee be complete and accurate in all material respects. The report should clearly indicate that NRC's licensees are responsible for providing us with accurate and complete information. While the NRC's Davis-Besse LLTF concluded that the NRC, the Davis-Besse licensee (FirstEnergy), and the nuclear industry failed to adequately review, assess, and follow up on relevant operating experience, they also noted that the information that FirstEnergy provided in response to Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles" was inconsistent with information identified by the task force. Further, the LLTF report stated that had this information been known in the fall of 2001, "...the NRC may have identified the VHP [vessel head penetration] nozzle leaks and RPV [reactor pressure vessel] head degradation a few months sooner than the March 2002 discovery by the licensee." As you are aware, there is an ongoing investigation by the Department of Justice regarding the completeness and accuracy of information that FirstEnergy provided to the NRC on the condition of Davis-Besse.

See comment 2.

The NRC is particularly concerned about the draft report's characterization of the NRC's use of risk estimates. The statement in the report that the NRC's "estimate of risk exceeded the risk

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levels generally accepted by the agency" is not factually correct. NRC officials pointed out to GAO and GAO's consultants, both in interviews and in written responses to GAO questions, that our estimate of delta core damage frequency was $5x10^{-6}$ per reactor year, not $5x10^{-5}$ per reactor year as indicated in the report. In fact, the NRC staff safety evaluation (attached to a December 3, 2002, letter to FirstEnergy) stated that the change in core damage frequency due to the potential for control rod drive mechanism nozzle ejection was consistent with the guidelines of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." The enclosure to this letter provides detailed comments on issues of correctness and clarity in the report, many of which are related to the NRC's estimate of risk at Davis-Besse.

See comment 3.

We disagree with the finding that the NRC does not have specific guidance for deciding on plant shutdowns and with the report's related recommendation identifying the need for NRC to develop specific guidance and a well-defined process for deciding when to shut down a nuclear power plant. We believe our regulations, guidance, and processes that cover whether and when to shut down a plant are robust and do, in fact, provide sufficient guidance in the vast majority of situations. Plant technical specifications, as well as many other NRC requirements and processes, provide a spectrum of conditions under which plant shutdown would be required. Plants have shut down numerous times in the past in accordance with NRC requirements. From time to time, however, a unique situation may present itself wherein sufficient information may not exist or the information available may not be sufficiently clear to apply existing rules and regulations definitively. In these unique instances, the NRC's most senior managers, after consultation with staff experts and given all of the information available at the time, will decide whether or not to require a plant shutdown. Risk information is used in accordance with Regulatory Guide 1.174. This process considers deterministic factors as well as probabilistic factors (i.e., risk information). We regard the combined use of deterministic and probabilistic factors to be a strength of our decision-making process.

See comment 4.

Another issue identified in the draft report as a systemic weakness is that the NRC has not proposed specific actions to address a licensee's commitment to safety, also known as safety culture. We disagree with the report's recommendation that NRC should develop a methodology to assess licensees' safety culture that includes indicators of and/or information on patterns of licensee behavior, as well as on licensee organizational structures and processes. To date, the Commission has specifically decided not to conduct direct evaluations or inspections of safety culture as a routine part of assessing licensee performance due to the subjective nature of such evaluations. As regulators, we are not charged with managing our licensees' facilities. Direct involvement with safety culture, organizational structure, and processes crosses over to a management function. The NRC does conduct a number of assessments that adequately evaluate how effectively licensees are managing safety. These include an inspection procedure for assessing licensees' employee concerns programs, the NRC allegation program, enforcement of employee protection regulations, and safety-conscious work environment assessments during problem identification and resolution (PI&R) inspections. In addition, the NRC's LLTF made several recommendations (which are being addressed) to enhance the NRC's capability in this area. The NRC does not assess, nor does it plan to assess, licensee management competence, capability, or optimal organizational structure as part of safety culture.

See comment 5.

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While there are a number of factual errors in the draft report, as noted in the enclosure, we agree with many of the findings in the draft report. Most of GAO's findings are similar to the findings of the NRC's Davis-Besse LLTF. The NRC staff has made significant progress in implementing actions recommended by the LLTF and expects to complete implementation of more than 70 percent of them, on a prioritized basis, by the end of calendar year 2004. Reports tracking the status of these actions are provided to the Commission semiannually and will continue until all items are completed, at which time a final summary report will be issued.

I have enclosed the NRC's detailed comments on the draft report. If you have any questions, please contact Stacey L. Rosenberg, of my staff, at (301) 415-3868.

Sincerely,

William D. Travers
Executive Director
for Operations

Enclosure:
1. NRC Comments on GAO Draft Report on Davis-Besse
2. Memorandum from EDO to OIG dated April 19, 2004

See comment 1.

See comment 2.

NRC Comments on Draft Report, GAO-04-415

1. The draft report does not speak to a key issue, the responsibility of licensees to provide complete and accurate information to the NRC. In carrying out its safety responsibilities, NRC must rely heavily on our licensees to provide us with complete and accurate information. Title 10 of the Code of Federal Regulations Section 50.9 requires that information provided to the NRC by a licensee be complete and accurate in all material respects. By not recognizing this explicitly and its role in this matter, the draft report conveys the expectation that the NRC staff should have known about the thick layer of boron on the reactor vessel head. The Davis-Besse Lessons Learned Task Force (LLTF), which NRC formed to ensure that lessons from the Davis-Besse experience are learned and appropriately captured in the NRC's formal processes, noted that the information that FirstEnergy provided in response to Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles" was inconsistent with information identified by the task force. Further, the LLTF report stated that had this information been known in the fall of 2001, the NRC may have identified the vessel head penetration (VHP) nozzle leaks and reactor pressure vessel (RPV) head degradation a few months sooner than the March 2002 discovery by the licensee. See also the related information in response #2.

2. Page 7, first sentence of the last paragraph states: ***"NRC should have but did not identify or prevent the vessel head corrosion at Davis-Besse because both its inspections at the plant and its assessments of the operator's performance yielded inaccurate and incomplete information on plant safety conditions."***
Response: This statement is misleading. We agree that our oversight program should have identified certain evolving plant conditions for regulatory follow-up. This was also

Enclosure 1

identified in the report of the Davis-Besse Lessons LLTF. It is the responsibility of licensees to provide the NRC with complete and accurate information. In fact, Title 10 of the Code of Federal Regulations Section 50.9 requires that information provided to the NRC by a licensee be complete and accurate in all material respects. The report should clearly indicate that NRC's licensees are responsible for providing us with accurate and complete information. While the NRC's Davis-Besse LLTF concluded that the NRC, the Davis-Besse licensee (FirstEnergy), and the nuclear industry failed to adequately review, assess, and follow up on relevant operating experience, the LLTF also noted that the information that FirstEnergy provided in response to Bulletin 2001-01 was inconsistent with information identified by the task force. Further, the LLTF report stated that had this information been known in the fall of 2001, the NRC may have identified the vessel head penetration nozzle leaks and the reactor vessel head degradation a few months sooner than the March 2002 discovery by the licensee. As you are aware, there is an ongoing investigation by the Department of Justice regarding the completeness and accuracy of information that FirstEnergy provided to the NRC on the condition of Davis-Besse.

See comment 3.

3. Page 8, last sentence states: ***"Further, the risk estimate indicated that the likelihood of an accident occurring at Davis-Besse was greater than the level of risk generally accepted as being reasonable by NRC."***

Response: This is incorrect. NRC staff explained to the GAO consultants that NRC guidance produces an estimate for the change in core damage frequency of $5x10^{-6}$ per year, not $5x10^{-5}$ as indicated in the GAO report. According to Regulatory Guide (RG) 1.174, for Davis-Besse, this estimate is within acceptable bounds. NRC specifically documented the acceptability of the estimate in the December 2002 assessment. Thus, the December 3, 2002, safety evaluation concluded that the delta core damage frequency was consistent with the guidelines of RG 1.174.

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See comment 6.

4. Page 15 states that borax (i.e., sodium borate) is dissolved in the water. This is incorrect. Please replace the word "borax" with "boric acid crystals."

See comment 7.

5. Page 18, first full paragraph states: ***"NRC, in deciding on when FirstEnergy had to shutdown Davis-Besse for the inspection,..."***
Response: In addition, the staff relied upon information provided by the licensee regarding the condition of the vessel head (i.e., previous leakage and action taken to repair leaks and clean the vessel head).

See comment 8.

6. Page 26, beginning on line 4, states: ***"According to the NRC regional branch chief—who supervised the staff responsible for overseeing FirstEnergy's vessel head inspection activities during the 2000 refueling outage—he was unaware of the boric acid leakage issues at Davis-Besse, including its effects on the containment air coolers and the radiation monitor filters."***
Response: According to the individual to whom this statement is attributed, the statement would be correct if the phrase, "he was unaware...filters" is changed to "he was unaware that boric acid was found on the reactor vessel head during the outage."

See comment 9.

7. Page 27, first sentence states: ***"Similarly, NRC officials said that NRC headquarters had no systematic process for communicating information in a timely manner to its regions or on-site inspectors."***
Response: If the "information" in question refers to issues of potential safety significance into which inspectors should look, then this statement is inaccurate. The systematic process for temporarily focusing inspection activity in a coordinated program-wide manner on high-priority issues is the "Temporary Instruction" (TI) process, which is well established within the NRC Inspection Manual and frequently used. The legitimate point

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to be made is that until the Davis-Besse event, the NRC had not concluded that boric acid corrosion was a sufficient safety concern that reached the threshold for using the TI process.

See comment 10.

8. Page 33, middle paragraph states: ***"For example, concern over alloy 600 cracking led France, as a preventive measure, to develop plans for replacing all of its reactor vessel heads and installing removable insulation to better inspect for cracking."***
Response: French regulators instituted requirements for an extensive, non-visual nondestructive examination inspection program for vessel head penetration nozzles that resulted in plant operators deciding, on the basis of economic considerations, to replace vessel heads in lieu of conducting such examinations.

See comment 11.

9. Page 34, last paragraph states: ***"If such small leakage can result in such extensive corrosion..."***
Response: Small leakage alone was not the cause of the corrosion. It was a combination of prolonged leakage in conjunction with allowing caked-on boron to remain on the vessel head.

See comment 12.

10. Page 36, middle paragraph states: ***"However, NRC decided that it could not order Davis-Besse to shut down on the basis of other plants' cracked nozzles and identified leakage or the manager's acknowledgment of a probable leak. Instead, it believed it needed more direct, or absolute, proof of a leak to order a shutdown."***
Response: As discussed at the NRC-GAO exit conference, plant Technical Specifications, as well as many other NRC requirements and processes, provide a number of circumstances in which a plant shutdown would or could be required, including the existence of reactor coolant pressure boundary leakage while operating at power.

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Please note that there was no legal objections to the draft order and the stated basis for deciding to not issue the order was not an insufficient legal basis.

11. Page 36, last paragraph states: ***"...NRC does not have specific guidance for shutting down a plant when the plant may pose a risk to public health and safety even though it may be complying with NRC requirements."***

See comment 4.

Response: We disagree with this finding and with the report's related recommendation on Page 63 identifying the need for NRC to develop specific guidance and a well-defined process for deciding when to shut down a nuclear power plant. We believe our regulations, guidance, and processes that cover whether and when to shut down a plant are robust and do, in fact, provide sufficient guidance in the vast majority of situations. Plant technical specifications, as well as many other NRC requirements and processes, provide a spectrum of conditions under which plant shutdown would be required. Plants have shut down numerous times in the past in accordance with NRC requirements. From time to time, however, a unique situation may present itself wherein sufficient information may not exist or the information available may not be sufficiently clear to apply existing rules and regulations definitively. In these unique instances, the NRC's most senior managers, after consultation with staff experts and given all of the information available at the time, will decide whether or not to require a plant shutdown. Risk information is used in accordance with RG 1.174. This process considers deterministic factors as well as probabilistic factors (i.e., risk information). We regard the combined use of deterministic and probabilistic factors to be a strength of our decisionmaking process.

See comment 13.

12. Page 38, third paragraph states: ***"At some point during this time, NRC staff also concluded that the first safety principle was probably not being met, although the basis for this conclusion is not known."***

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Response: The report should clarify GAO's basis for this statement. NRC staff believed that the regulations were met.

13. Page 40, last paragraph states: ***"However, NRC did not provide the assessment until a full year later—in December 2002. In addition, the December 2002 assessment, which includes a 4-page evaluation, does not fully explain how the safety principles were used or met—other than by stating that if the likelihood of nozzle failure were judged to be small, then adequate protection would be ensured."***

See comment 14.

Response: The attachment to the December 3, 2002, letter is an 8-page evaluation, not 4 pages. We note this to make sure GAO is referring to the same document. The assessment addresses four of the five safety principles. In the NRC's December 2002 safety evaluation, the staff stated that the criterion related to compliance with the regulations was being met because the inspections performed by the licensee were in conformance with the ASME Code. In addition, the safety evaluation stated that Davis-Besse met the criterion related to defense-in-depth because all three barriers against release of radiation were intact and reliable; they met the margin criterion because even the largest circumferential cracks found in pressurized-water reactors had considerable margin to structural failure, and they met the low-risk impact criterion based on a comparison of delta core damage frequency estimates with the guidelines of RG 1.174. The fifth safety principle, requiring a monitoring program, was not relevant to a decision that lasted only 6 weeks.

14. Page 42, first paragraph states: ***"Multiplying these two numbers, NRC estimated that the potential for a nozzle to crack and cause a loss-of-coolant accident would increase the frequency of core damage at Davis-Besse by about $5.4x10^{-5}$ per year, or about 1 in 18,500 per year. Converting this frequency to a probability, NRC***

See comment 15.

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calculated that the increase in probability of core damage was approximately 5.0x10^{-6}, or 1 chance in 200,000. While NRC officials currently disagree that this was the number it used, this is the number that it included in its December 2002 assessment provided to FirstEnergy. Further, we found no evidence in the agency's records to support NRC's current assertion."

Response: These statements mischaracterize the facts. NRC estimated that the probability of nozzle cracking leading to a loss-of-coolant accident during the first 6 weeks in 2002 would increase the annual core damage frequency (CDF) by about 5.4x10^{-6} per year, or about 1 in 185,000 per year. The estimate of 5x10^{-5} was an intermediate step in our calculation. The estimate of 5x10^{-5} represents the change in CDF if Davis-Besse were allowed to operate for one year without shutting down for inspection of the vessel head. Allowing Davis-Besse to continue to operate for one year was never a consideration. Thus, multiplying by the fraction of time in one year under consideration (in this case 7 weeks) was the final step in the calculation of delta CDF. The confusion about the estimate NRC used in the decisionmaking process may be due to NRC's method of calculating delta CDF for plant conditions which do not persist for the entire year. If this final step (the fraction of the year the plant is allowed to operate) were not part of the calculation, then the risk estimate of allowing the licensee to continue to operate for 7 weeks, as compared to one year, would be the same. Logically, this does not make sense. Therefore, the estimate of 5x10^{-5} does not automatically convert to a probability, as GAO's statement implies. Because the period of operation under consideration was approximately 0.13 years, the annual average change in CDF was about 5x10^{-6} per year, and the increase in the probability of core damage was about 5x10^{-6} as well. NRC officials **agree** that 5x10^{-6} was the estimate used in the decisionmaking process and is the estimate provided in the December 2002 assessment.

15. Page 42, second paragraph states: ***"For example, the consultants concluded that NRC's estimate of risk was incorrectly too small, primarily because the calculation did not consider corrosion of the vessel head."***

See comment 16.

Response: An underlying assumption in any risk assessment is that you have complete and accurate information from the licensee. NRC staff was of the understanding that efforts had been made to remove boric acid accumulation from the vessel head during previous outages. For all six B&W plants that found signs of penetration leakage, the leakage manifested itself in the form of small amounts of dry boron crystals on the vessel head, which are not corrosive, and did not produce any corrosion on the vessel heads of these six B&W plants. Boron leaking onto a clean vessel head does not cause corrosion. Therefore, corrosion this extensive was not anticipated at the time. Also, it is important to note that had Davis-Besse shut down on December 31, 2001, the same corrosion would have been found.

16. Page 43, first full paragraph discusses the experience at French nuclear power plants.

See comment 17.

Response: The NRC staff was aware of the issue as illustrated in an internal memorandum dated December 15, 1994, from Brian Grimes to Charles Rossi.

17. Page 44, first full paragraph states: ***"Third, NRC's analysis was inadequate because the risk estimates were higher than generally considered acceptable under NRC guidance. Despite PRA's [probabilistic risk assessment's] important role in the decision, our consultants found that NRC did not follow its guidance for ensuring that the estimated risk was within levels acceptable to the agency.*** Page 45, first paragraph states: ***"...NRC's PRA estimate for Davis-Besse resulted in an increase in the frequency of core damage of $5.4x10^{-5}$ or 1 chance in about 18,500 per year was higher than the acceptable level."***

See comment 18.

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Response: This conclusion is not supported by the facts and it is misleading. The estimate referenced by GAO is an intermediate calculation in our process, and was not used, and should not be used, in the decisionmaking process. NRC staff explained to the GAO consultants that NRC guidance produces an estimate for the change in core damage frequency of $5x10^{-6}$ per year, not $5x10^{-5}$ as indicated in the GAO report. According to RG 1.174, for Davis-Besse, this estimate is within acceptable bounds. NRC specifically documented the acceptability of the estimate in the December 2002 assessment. Thus, the December 3, 2002, safety evaluation concluded that the delta CDF was consistent with the guidelines of RG 1.174.

See comment 19.

18. Page 45, first paragraph states: ***"NRC's guidance for evaluating requests to relax NRC technical specifications suggests that a probability increase higher than*** $5x10^{-7}$ ***or 1 chance in 2 million is considered unacceptable for relaxing the specifications. Thus, NRC's estimate would not be considered acceptable under this guidance."***
Response: This criterion in RG 1.177 is not relevant to the Davis-Besse decision. It is confined to decisions on allowed outage times (AOT) for equipment, and is defined to avoid very high instantaneous risks (CDF > 10^{-3}) for very short periods (5 hours).

See comment 20.

19. Page 46, first full paragraph states: ***"Lastly, NRC's analysis was inadequate because the agency does not have clear guidance for how PRA estimates are to be used in the decision-making process."***
Response: The NRC's process for risk-informed decision-making is considerably more robust than characterized in this section. Regulatory Guide 1.174 comprises 40 pages of guidance on how to use risk in decisions of this type, and it is backed up by equally detailed guidance for specific types of decisions such as technical specifications, in-service inspection programs, in-service testing, and quality assurance. The NRC has

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amassed a great deal of experience in application of the guidance. Risk assessment is a tool to help better inform decisions that are based on engineering judgements.

20. Page 46, last paragraph states: ***"It is not clear how NRC staff used the PRA risk estimate in the Davis-Besse decision-making process."***
Response: The December 3, 2002, safety evaluation clearly states how the PRA estimate was used in the decisionmaking process; the estimate was compared with the guidelines of RG 1.174. The safety evaluation also points out that NRC staff who are expert in non-PRA disciplines such as probabilistic fracture mechanics, gave more weight to deterministic factors, such as the structural margin that remains in the nozzles with circumferential cracks. The NRC considers the combined use of deterministic and probabilistic factors to be a strength of our decisionmaking process.

See comment 21.

21. Page 48, last paragraph states: ***"...NRC had made progress in implementing the recommendations, although some completion dates have slipped."***
Response: The schedules for implementation of all high priority recommendations have not slipped. The implementation schedule for certain low or medium priority recommendations slip only in accordance with NRC's Planning, Budgeting and Performance Management (PBPM) process, which explicitly considers safety significance when making budget priority decisions.

See comment 22.

22. Page 51, top of page, first full bullet states: ***"One recommendation is directed at improving NRC's generic communications program. NRC is..."***
Response: We recommend re-wording this as follows: "One recommendation is directed at improving follow up of licensee actions taken in response to NRC generic communications. A Temporary Instruction (Inspection Procedure) is currently being

See comment 23.

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developed to assess the effectiveness of licensee actions taken in response to generic communications. Additionally, improvements in the verification of effectiveness of generic communications are planned as a long-term change in the operating experience program."

See comment 24.

23. Page 51, last paragraph states: ***"...NRC's revised inspection guidance for more thorough examinations of reactor vessel heads and nozzles, as well as new requirements for NRC oversight of licensees' corrective action programs, will require at least an additional 200 hours of inspection per reactor per year."***
Response: It is unclear where this number comes from, but the changes to the corrective action program procedure require only about 16 hours per reactor year for the trend review.

See comment 25.

24. Page 53, first paragraph discusses the NRC's Office of the Inspector General's (OIG's) findings on communications.
Response: The NRC's actions are not limited primarily to improving communication about boric acid corrosion and cracking. There are multiple task force recommendations, and other NRC initiatives, that are aimed at addressing the broader implications stemming from communication lapses noted by the task force and the OIG. For example, actions have been implemented to more effectively disseminate operating experience to end users, reenforce a questioning attitude in the inspection staff, and discuss Davis-Besse lessons learned at various forums.

NRC's initial response to the OIG did not directly address the broader actions we are taking to improve communications. Our response to the OIG only indirectly addressed this by discussing the operating experience program enhancements. Part of the

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enhancements to the operating experience program is the expectations for improved communications. In addition, communication improvement initiatives with internal and external stakeholders are in progress to address shortcomings in this critical area. Our revised response to the OIG on this issue, dated April 19, 2004, is provided as Enclosure 2.

25. Page 53, second paragraph states: ***"NRC's Davis-Besse task force did not make any recommendations to address two systemic problems: evaluating licensees' commitment to safety and improving the agency's process for deciding on a shutdown."***

See comment 26.

Response: The LLTF did not make a recommendation for improving the agency's process for deciding on a shutdown. This area was not reviewed in detail by the task force because of coordination with the OIG. Moreover, the task force review efforts were focused on why the degradation cavity was not prevented. While related, the shutdown issue had little to do with the degradation cavity.

See comment 5.

The task force made multiple recommendations aimed at enhancing NRC's capability to evaluate the licensees' commitment to safety, by indirect means. Refer to task force recommendations: 3.2.5(1), 3.2.5(2), 3.3.2(2), 3.3.4(5), and Appendix F.

26. Page 54, last paragraph states: ***"This problem identification and resolution inspection procedure is intended to assess the end-results of management's safety commitment rather than the commitment itself."***

See comment 5.

Response: This statement is inaccurate. Regarding its accuracy, the PI&R inspection procedure (IP 71152) actually has six stated inspection objectives (refer to section 71152-01) including: (1) provide for early warning of potential performance issues that could

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See comment 5.

result in crossing threshold in the action matrix and (2) to provide insights into whether licensees have established a safety-conscious work environment. Using this IP, inspectors seek factual evidence of the licensee's assumed commitment to safety (by reviewing their identification and correction of actual problems). Inspection issues routinely are raised with regard to a licensee's weakness in correcting recurrent problems or in adequately addressing issues that could become a future significant safety concern. The statement on Page 55 of the report, ***"Furthermore, because NRC directs its inspections at problems that it recognizes as being more important to safety, NRC may overlook other problems until they develop into significant and immediate safety problems"*** does not accurately reflect the stated objectives and demonstrable implementation of IP 71152.

27. Pages 55-56, discuss safety culture.
Response: To a significant degree, the areas referenced in this draft report are addressed either by NRC requirements or inspection activities. For example, the NRC has requirements limiting work hours for critical plant staff members such as security officers and plant operators. The NRC has requirements governing operator training. Inspectors routinely monitor various licensee meetings and job briefings to evaluate the licensee's emphasis on safety.

Moreover, the NRC has a number of other means to indirectly assess safety culture. Other NRC tools that provide indirect insights into licensee safety culture include:

- inspection procedure for assessing the licensee's employee concerns program,
- NRC's allegation program,
- enforcement of employee protection regulations,

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- Safety-Conscious Work Environment (SCWE) assessments during problem identification and resolution inspections,
- lessons-learned reviews such as the one conducted for the Davis-Besse reactor pressure vessel head degradation; and
- Reactor Oversight Process cross-cutting issues of human performance, problem identification and resolution, and SCWE.

28. Page 58, paragraph under the first header states: ***"It recognized that NRC's written rationale for accepting FirstEnergy's justification for continued plant operation was not prepared until 1 year after its decision..."***

See comment 27.

<u>Response</u>: For clarification, the documentation of the decision about one year later was corrective action from a task force finding.

29. Page 58, paragraph under second header states: ***"The NRC task force did not address NRC's failure to learn from previous incidents at power plants and prevent their recurrence."***

See comment 28.

<u>Response</u>: This sentence is factually inaccurate. The task force performed a limited review of past lessons-learned reports and actually identified many more potentially recurring programmatic issues as a result of that review than the three examples cited by the GAO in this section of the draft report. As discussed during the NRC-GAO exit conference, the task force made a recommendation to perform a more detailed effectiveness review of the actions stemming from other past NRC lessons learned reviews (Appendix F). This review is currently in progress.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 19, 2004

MEMORANDUM TO: Hubert T. Bell
Inspector General

FROM: William D. Travers ***/RA Carl J. Paperiello Acting For/***
Executive Director for Operations

SUBJECT: FEBRUARY 2, 2004, OFFICE OF INSPECTOR GENERAL (OIG) MEMORANDUM CONCERNING AGENCY RESPONSE TO OIG EVENT INQUIRY CASE NO. 03-02S (NRC'S OVERSIGHT OF DAVIS-BESSE BORIC ACID LEAKAGE AND CORROSION DURING THE APRIL 2000 REFUELING OUTAGE)

This memorandum responds to your memorandum to Chairman Diaz, dated February 2, 2004, concerning the Nuclear Regulatory Commission (NRC) staff's response of January 12, 2004, to OIG Event Inquiry 03-02S. The referenced OIG event inquiry was initiated in response to a Congressional request that OIG determine how the NRC staff handled Davis-Besse Condition Report (CR) 2000-0782 at the time of discovery in refueling outage (RFO) 12 (2000) and whether the CR was considered in the November 2001 decision to allow Davis-Besse to continue to operate to February 16, 2002. The NRC staff's previous response to OIG (January 12, 2004) regarding this issue provided a matrix of those recommendations from the Davis-Besse Lessons Learned Task Force (DBLLTF) report that specifically addressed the event inquiry findings and referenced the report for a complete picture of the staff's efforts. The OIG response of February 2, 2004, stated that the NRC staff had not addressed the problem of communications as an underlying cause of the findings of the OIG event inquiry and that the agency should include an expectation of improved communication between and among NRC Headquarters and regional staff and should outline specific guidance to achieve this goal. In addition, OIG specifically concluded that "had the [Davis-Besse Nuclear Power Station] DBNPS inspectors been better informed of ongoing NRC industry-wide efforts to address coolant pressure boundary leakage and the effects of boric acid corrosion, they would have recognized the significance of Condition Report 2000-0782 and highlighted the information to regional management."

The DBLLTF report discusses the NRC's and industry's failure to understand the significance of boric acid corrosion of the reactor vessel head. The NRC staff believes that this failure caused the underlying communications lapses. Although the potential for this type of degradation existed previously, the significance of boric acid deposits was not understood by the staff. The assumption throughout NRC was that the boric acid deposits would be in a dry, powder-like form that could easily be removed and would not accumulate in a condition that would be corrosive to the reactor vessel head. As identified in the event inquiry, the inspectors did communicate a substantial amount of information to the region and the NRR Project Manager, particularly regarding the fouling of the containment air coolers and radiation monitor filter

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415-1485

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elements; however, the significance of this information was also not appreciated at the time. This same failure to understand the significance of the situation was the cause of the lack of communication from Headquarters to the regions. Several elements of the matrixed DBLLTF Action Plans address this underlying issue of lack of recognition of the significance of the evidence. The desired outcome for these actions is for all NRC staff to maintain a questioning attitude and lower thresholds for communications concerning materials degradation corrosion.

More broadly, the NRC staff agrees that communications are of critical importance in all aspects of NRC activities and particularly important as an underlying cause for issues discovered at DBNPS. The corrective actions outlined in the DBLLTF Action Plans address communications beyond the topic of boric acid corrosion control. For example, corrective actions in the area of operating experience development and use are focused on enhancing communications. The recommendations to strengthen inspection guidance, institute training to reinforce a questioning attitude on the part of management and staff, and change the Inspection Manual to provide guidance for the staff to pursue issues identified during plant status reviews are intended to establish more definitive expectations for improved communications of operating experience. As discussed in the February 23, 2004, semiannual update report and at the February 26, 2004, Commission meeting, implementation plans for this area are still under development and may significantly influence the way the agency does business in the future. Developing the most effective and efficient communications channels will be key to the successful implementation of an effective operating experience program.

Beyond the DBLLTF Action Plan, the agency has several ongoing initiatives that provide examples of efforts to more broadly improve intra-agency communications. These examples include establishment of a Communication Council reporting to the Executive Director for Operations and the creation of a communications specialist position reporting to the Office of Nuclear Reactor Regulation (NRR) Associate Director for Inspections and Programs. NRR also continues to improve and enhance its Web site as a focused means of communicating with both internal and external stakeholders. From a regional perspective, examples of communication enhancements include lowering the threshold for communication of plant issues on morning status calls, devoting additional time to discussing lessons learned from plant events and inspection findings during counterpart meetings, and developing enhanced guidance for documenting significant operational event followup decisions. Collectively, these examples provide a strong indication that NRC Headquarters and regional staff have begun to internalize two of the most important lessons from the Davis-Besse event. These are that on occasion, information initially considered to have low significance by the first NRC recipient is later found to be of greater significance once the information is shared and evaluated more collegially; and with regard to the complex nature of commercial nuclear power operations, no one person can be aware of all aspects of an issue. As a result, the more information that is shared, the more likely significant problems will be identified and appropriate action(s) taken.

In summary, the NRC staff recognizes that communication failures were an underlying cause of the agency's problems concerning the delayed discovery of the boric acid corrosion at DBNPS. Our January 12, 2004, response to the event inquiry specifically addressed what we considered to be the root cause of the event-specific communication failures, namely that the entire staff did not recognize the potential significance of boric acid corrosion. Expectations for improved communications will be developed as an integral part of our operating experience program enhancements. More broadly, communication improvement initiatives with internal and external

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stakeholders are in progress to enhance agency performance in this critical area of our responsibilities. We regret that our initial response did not clearly address the broader actions we are taking to improve communications and appreciate the opportunity to clarify our response.

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY
LReyes

The following are GAO's comments on the Nuclear Regulatory Commission's letter dated May 5, 2004.

GAO Comments

1. We agree with NRC that 10 C.F.R. § 50.9 requires that information provided to NRC by a licensee be complete and accurate in all material respects, and we have added this information to the report. NRC also states that in carrying out its oversight responsibilities, NRC must "rely heavily" on licensees providing accurate information. However, we believe that NRC's oversight program should not place undue reliance on applicants providing complete and accurate information. NRC also recognizes that it cannot rely solely on information from licensees, as evidenced by its inspection program and process for determining the significance of licensee violations. Under this process, NRC considers whether there are any willful aspects associated with the violation—including the deliberate intent to violate a license requirement or regulation or falsify information. We believe that management controls, including inspection and enforcement, should be implemented by NRC so as to verify whether licensee-submitted information considered to be important for ensuring safety is complete and accurate as required by the regulation. In this regard, as stated in NRC's enforcement policy guidance, NRC is authorized to conduct inspections and investigations (Atomic Energy Act § 161); revoke licenses for, among other things, a licensee's making material false statements or failing to build or operate a facility in accordance with the terms of the license (Atomic Energy Act § 186); and impose civil penalties for a licensee's knowing failure to provide certain safety information to NRC (Energy Reorganization Act § 206).

   With regard to the draft report conveying the expectation that NRC should have known about the thick layer of boron on the reactor vessel head, we note in the draft report that since at least 1998, NRC was aware that (1) FirstEnergy's boric acid corrosion control program was inadequate, (2) radiation monitors within the containment area were continuously being clogged by boric acid deposits, (3) the containment air cooling system had to be cleaned repeatedly because of boric acid buildup, (4) corrosion was occurring within containment as evidenced by rust particles being found, and (5) the unidentified leakage rate had increased above the level that historically had been found at the plant. NRC was also aware of the repeated but ineffective attempts by FirstEnergy to correct many of these recurring problems—evidence that the licensee's programs to identify and correct problems were not effective. Given these indications at Davis-Besse, NRC could have taken more aggressive follow-up action to determine the underlying causes. For example, NRC could have taken action during the fuel outage in 1998, the shutdown to repair valves in mid-1999, or the fuel outage in 2000 to ensure that staff with sufficient knowledge appropriately investigated the types of conditions that could cause these indications, or followed up to ensure that FirstEnergy had fully investigated and successfully resolved the cause of the indications.

2. With respect to the responsibility of the licensee to provide complete and accurate information, see comment 1. As to the Davis-Besse lessons-learned task force finding, we agree that some information provided by FirstEnergy in response to Bulletin 2001-01 may have been inconsistent with some information subsequently identified by NRC's lessons-learned task force, and that had some of this information been known in the fall of 2001, the vessel head leakage and degradation may have been identified sooner than March 2002. This information included (1) the boric acid accumulations found on the vessel head by FirstEnergy in 1998 and 2000, (2) FirstEnergy's limited ability to visually inspect the vessel head, (3) FirstEnergy's boric acid corrosion control procedures relative to the vessel head, (4) FirstEnergy's program to address the corrosive effects of small amounts of reactor coolant leakage, (5) previous nozzle inspection results, (6) the bases for FirstEnergy's conclusion that another source of leakage—control rod drive mechanism flanges—was the source of boric acid deposits on the vessel head that obscured multiple nozzles, and (7) photographs of vessel head penetration nozzles. However, various NRC officials knew some of this information, other information should have been known by NRC, and the remaining information could have been obtained had NRC requested it from FirstEnergy. For example, according to the senior resident inspector, he reviewed every Davis-Besse condition report on a daily basis to determine whether the licensee properly categorized the safety significance of the conditions. Vessel head conditions found by FirstEnergy in 1998 and 2000 were noted in such condition reports or in potential-condition-adverse-to-quality reports. According to a FirstEnergy official, photographs of the pressure vessel head nozzles were specifically provided to NRC's resident inspector, who, although he did not specifically recall seeing the photographs, stated that he had no reason to doubt the FirstEnergy official's statement. NRC had been aware, in 1999, of limitations in FirstEnergy's boric acid corrosion control program and, while it cited FirstEnergy for its failure to adequately implement the program, NRC officials did not

follow up to determine if the program had improved. Lastly, while NRC questioned the information provided by FirstEnergy in its submissions to NRC in response to Bulletin 2001-01 (regarding vessel head penetration nozzle inspections), NRC staff did not independently review and assess information pertaining to the results of past reactor pressure vessel head inspections and vessel head penetration nozzle inspections. Similarly, NRC did not independently assess the information concerning the extent and nature of the boric acid accumulations found on the vessel head by the licensee during past inspections.

On page 2 of the report, we note that the Department of Justice has an ongoing investigation concerning the completeness and accuracy of information that FirstEnergy provided to NRC on the conditions at Davis-Besse. The investigation may or may not find that FirstEnergy provided inaccurate or incomplete information. While NRC notes that it might have detected something months earlier if information had been known in the fall of 2001, we would also note that the degradation of the reactor vessel head likely took years to occur.

3. We believe that the statement is correct. NRC produced an estimate of $5x10^{-5}$ per year for the change in core damage frequency, as we state in the report. NRC specifically documented this calculation in its December 2002 assessment:

"The NRC staff estimated that, giving credit only to the [FirstEnergy] inspection performed in 1996, the probability of a [control rod drive mechanism] nozzle ejection during the period of operation from December 31, 2001, to February 16, 2002, was in the range of 2E-3 and was an increase in the overall [loss of coolant accident] probability for the plant. The increase in core damage probability and large early release probability were estimated as approximately 5E-6 and 5E-08, respectively."[1]

The probability of a large early release—5E-6—equates to a frequency of $5x10^{-5}$ per year.[2] As we note in the report, according to NRC's

[1]The numbers 2E-3, 5E-6, and 5E-8 can also be written as $2x10^{-3}$, $5x10^{-6}$, and $5x10^{-8}$.

[2]The probability of an event occurring is the product of the frequency of an event and a given time period. In this case, the time period—7 weeks—was approximated as one-tenth of the year. Thus, $5.4x10^{-5}$ per year multiplied by 0.10 equates to a probability of $5.4x10^{-6}$. According to NRC, it revised $5.4x10^{-6}$ to $5.0x10^{-6}$ to account for uncertainties.

regulatory guide 1.174, this frequency would be in the highest risk zone and NRC would generally not approve the requested change.

On several occasions, we met with the NRC staff that developed the risk estimate in an attempt to understand how it was calculated. We obtained from NRC staff the risk estimate information provided to senior management in late November 2001, as well as several explanations of how the staff developed its calculations. We were provided with no evidence that NRC estimated the frequency of core damage as being $5x10^{-6}$ per year until February 2004, after our consultants and we had challenged NRC's estimate as being in the highest risk zone under NRC's regulatory guide 1.174. Furthermore, several NRC staff involved in deciding whether to issue the order to shut down Davis-Besse, or to allow it to continue operating until February 16, 2002, stated that the risk estimate they used was relatively high.

4. We agree that existing regulations provide a spectrum of conditions under which a plant shutdown could occur and that could be interpreted as covering the vast majority of situations. However, we continue to believe that NRC lacks sufficient guidance for making plant shutdown decisions. We disagree on two grounds: First, the decision-making guidance used by NRC to shut down Davis-Besse was guidance for approving license change requests. This guidance provides general direction on how to make risk-informed decisions when licensees request license changes. It does not address important aspects of decision-making involved in deciding whether to shut down a plant. It also does not provide direction on how NRC should weigh deterministic factors in relation to probabilistic factors in making shutdown decisions. Secondly, while NRC views the flexibility afforded by its existing array of guidance as a strength, we are concerned that, even on the basis of the same information or circumstances, staff can arrive at very different decisions. Without more specific guidance, NRC will continue to lack accountability and the degree of credibility needed to convince the industry and the public that its shutdown decisions are sufficiently sound and reasoned for protecting public health and safety.

5. We are aware that the commissioners have specifically decided not to conduct direct evaluations or inspections of safety culture. We agree that as regulators, NRC is not charged with managing licensees' facilities, but disagree that any direct NRC involvement with safety culture crosses over to a management function. Management is an

embodiment of corporate beliefs and perceptions that affect management strategies, goals, and philosophies. These, in turn, impact licensee programs and processes and employee behaviors that have safety outcomes. We believe that NRC should not assess corporate beliefs and perceptions or management strategies, goals, or philosophies. Rather, we believe that NRC has a responsibility to assess licensee programs and processes, as well as employee behaviors. We cite several areas of safety culture in the report as being examples of various aspects of safety culture that NRC can assess which do not constitute "management functions." The International Atomic Energy Agency has extensive guidance on assessing additional aspects of licensee performance and indicators of safety culture.[3] Such assessments can provide early indications of declining safety culture prior to when negative safety outcomes occur, such as at Davis-Besse.

We also agree that NRC has indirect means by which it attempts to assess safety culture. For example, NRC's problem identification and resolution inspection procedure's stated objective is to provide an early warning of potential performance issues and insight into whether licensees have established safety conscious work environments. However, we do not believe that the implementation of the inspection procedure has been demonstrated to be effective in meeting its stated objectives. The inspection procedure directs inspectors to screen and analyze trends in all reported power plant issues. In doing so, the procedure directs that inspectors annually review 3 to 6 issues out of potentially thousands of issues that can arise and that are related to various structures, systems, and components necessary for the safe operation of the plant. This requires that inspectors judgmentally sample 3 to 6 issues on which they will focus their inspection resources. While we do not necessarily question inspector judgment when sampling for these 3 to 6 issues, NRC inspectors stated that due to the large number of issues that they can sample from, they try to focus on those issues that they believe have the most relevance for safety. Thus, if an issue is not yet perceived as being important to safety, it is less likely to be selected for follow up. Further, even if an issue were selected for follow up and this indicated that the licensee did not properly identify and resolve underlying problems that contributed to the issue, according to NRC officials, it is highly unlikely

[3]The International Atomic Energy Agency, International Nuclear Safety Advisory Group, *Safety Culture* (Vienna, Austria: February 1991).

that this one issue would rise to a high enough level of significance for it to be noted under NRC's Reactor Oversight Process. Additionally, the procedure is dependant on the inspector being aware of, and having the capability to, identify issues or trends in the area of safety culture. According to NRC officials, inspectors are not trained in what to look for when assessing licensee safety culture because they are, by and large, nuclear engineers. While they may have an intuition that something is wrong, they may not know how to assess it in terms of safety culture.

Additional specific examples NRC cites for indirectly assessing a selected number of safety culture aspects have the following limitations:

- NRC's inspection procedure for assessing licensees' employee concerns program is not frequently used. According to NRC Region III officials, approval to conduct such an inspection must be given by the regional administrator and the justification for the inspection to be performed has to be based on a very high level of evidence that a problem exists. Because of this, these officials said that the inspection procedure has only been implemented twice in Region III.

- NRC's allegation program provides a way for individuals working at NRC-regulated plants and the public to provide safety and regulatory concerns directly to NRC. It is a reactive program by nature because it is dependent upon licensees' employees feeling free and able to come forward to NRC with information about potential licensee misconduct. While NRC follows up on those plants that have a much higher number of allegations than other plants to determine what actions licensees are taking to address any trends in the nature of the allegations, the number of allegations may not always provide an indication of a poor safety culture, and in fact, may be the reverse. For example, the number of allegations at Davis-Besse prior to the discovery of the cavity in the reactor head in March 2002 was relatively small. Between 1997 and 2001, NRC received 10 allegations from individuals at the plant. In contrast, NRC received an average of 31 allegations per plant over the same 5-year period from individuals at other plants.

- NRC's lessons-learned reviews, such as the one conducted for Davis-Besse, are generally conducted when an incident having potentially serious safety consequences has already occurred.

- With respect to NRC's enforcement of employee protection regulations, NRC, under its current enforcement policy, would normally only take enforcement action when violations are of very significant or significant regulatory concern. This regulatory concern pertains to NRC's primary responsibility for ensuring safety and safeguards and protecting the environment. Examples of such violations would include the failure of a system designed to prevent a serious safety incident not working when it is needed, a licensed operator being inebriated while at the control of a nuclear reactor, and the failure to obtain prior NRC approval for a license change that has implications for safety. If violations of employee protection regulations do not pose very significant or significant safety, safeguards, or environmental concerns, NRC may consider such violations minor. In such cases, NRC would not normally document such violations in inspection reports or records, and would not take enforcement action.

- NRC's Reactor Oversight Process, instituted in April 2000, focuses on seven specific "cornerstones" that support the safety of plant operations to ensure reactor safety, radiation safety, and security. These cornerstones are: (1) the occurrence of operations and events that could lead to a possible accident if safety systems did not work, (2) the ability of safety systems to function as intended, (3) the integrity of the three safety barriers, (4) the effectiveness of emergency preparedness, (5) the effectiveness of occupational radiation safety, (6) the ability to protect the public from radioactive releases, and (7) the ability to physically protect the plant. NRC's process also includes three elements that cut across these seven cornerstones: (1) human performance, (2) a licensee's safety-conscious work environment, and (3) problem identification and resolution. NRC assumes that problems in any of these three crosscutting areas will be evidenced in one or more of the seven cornerstones in advance of any serious compromise in the safety of a plant. However, as evidenced by the Davis-Besse incident, this assumption has not proved to be true.

NRC also cites lessons-learned task force recommendations to improve NRC's ability to detect problems in licensee's safety culture, as a means to achieve our recommendation to directly assess licensee safety culture. These lessons-learned task force recommendations include (1) developing inspection guidance to assess the effect that a licensee's fuel outage shutdown schedule has on the scope of work conducted during a shutdown; (2) revising inspection guidance to provide for assessing the safety implications of long-standing, unresolved problems; corrective actions being phased in over the course of several years or refueling outages; and deferred plant modifications; (3) revising the problem identification and resolution inspection approach and guidance; and (4) reviewing the range of NRC's inspections and assessment processes and other NRC programs to determine whether they are sufficient to identify and dispose of the types of problems experienced at Davis-Besse. While we commend these recommendations, we do not believe that revising such guidance will necessarily alert NRC inspectors to early declines in licensee safety culture before they result in negative safety outcomes. Further, because of the nature of NRC's process for determining the relative safety significance of violations under NRC's new Reactor Oversight Process, we do not believe that any indications of such declines will result in a cited violation.

6. We have revised the report to reflect that boron in the form of boric acid crystals is dissolved in the cooling water. (See p. 13.)

7. On page 41 of the report, we recognize that NRC also relied on information provided by FirstEnergy regarding the condition of the vessel head. For example, in developing its risk estimate, NRC credited FirstEnergy with a vessel head inspection conducted in 1996. However, NRC decided that the information provided by FirstEnergy documenting vessel head inspections in 1998 and 2000 was of such poor quality that it did not credit FirstEnergy with having conducted them. As a result, NRC's risk estimate was higher than had these inspections been given credit.

8. The statement made by the NRC regional branch chief was taken directly from NRC's Office of the Inspector General report on NRC's oversight of Davis-Besse during the April 2000 refueling outage.[4]

9. We agree that up until the Davis-Besse event, NRC had not concluded that boric acid corrosion was a high priority issue. We clarified the text of the report to reflect this comment. (See p. 25.)

[4]NRC, Office of the Inspector General, *NRC's Oversight of Davis-Besse during the April 2000 Refueling Outage* (Washington, D.C.: Oct. 17, 2003).

10. We agree that plant operators in France decided to replace their vessel heads in lieu of performing the extensive inspections instituted by the French regulatory authority. The report has been revised to add these details. (See p. 31.)

11. We agree that caked-on boron, in combination with leakage, could accelerate corrosion rates under certain conditions. However, even without caked-on boron, corrosion rates could be quite high. Westinghouse's 1987 report on the corrosive effects of boric acid leakage concluded that the general corrosion rate of carbon steel can be unacceptably high under conditions that can prevail when primary coolant leaks onto surfaces and concentrates at the temperatures that are found on reactor surfaces. In one series of tests that it performed, boric acid solutions corroded carbon steel at a rate of about 0.4 inches per month, or about 4.8 inches a year. This was irrespective of any caked-on boron. In 1987, as a result of that report and extensive boric acid corrosion found at two other nuclear reactors that year—Salem unit 2 and San Onofre unit 2—NRC concluded that a review of existing inspection programs may be warranted to ensure that adequate monitoring procedures are in place to detect boric acid leakage and corrosion before it can result in significant degradation of the reactor coolant pressure boundary. However, NRC did not take any additional action.

12. We agree that NRC has requirements and processes that provide a number of circumstances in which a plant shutdown would or could be required. We also recognize that there were no legal objections to the draft enforcement order to shut down the plant, and that the basis for not issuing the order was NRC's belief that the plant did not pose an unacceptable risk to public health and safety. The statement in our report that NRC is referring to is discussing one of these circumstances—the licensee's failure to meet NRC's technical specification—and whether NRC believed that it had enough proof that the technical specification was not being met. The statement is not discussing the basis for NRC issuing an enforcement order. We revised the report to clarify this point. (See p. 34.)

13. The basis for our statement that NRC staff concluded that the first safety principle was probably not met was its November 29, 2001, briefing to NRC's Executive Director's Office and its November 30, 2001, briefing to the NRC commissioners' technical assistants. These briefings, the basis for which are included in documented briefing

slides, took place shortly before NRC formally notified FirstEnergy on December 4, 2001, that it would accept its compromise shutdown date.

14. We are referring to the same document that NRC is referring to—NRC's December 3, 2002, response to FirstEnergy (NRC's ADAMS accession number ML023300539). The response consists of a 2-page transmittal letter and an 7.3-page enclosure. The 7.3-page enclosure is 3 pages of background and 4.3 pages of the agency's assessment. The assessment includes statements that the safety principles were met but does not provide an explanation of how NRC considered or weighed deterministic and probabilistic information in concluding that each of the safety factors were met. For example, NRC concluded that the likelihood of a loss-of-coolant accident was acceptably small because of the (1) staff's preliminary technical assessment for control rod drive mechanism cracking, (2) evidence of cracking found at other plants similar to Davis-Besse, (3) analytical work performed by NRC's research staff in support of the effort, and (4) information provided by FirstEnergy regarding past inspections at Davis-Besse. However, the assessment does not explain how these four pieces of information successfully demonstrated if and how each of the safety principles was met. The assessment also states that NRC examined the five safety principles, the fifth of which is the ability to monitor the effects of a risk-informed decision. The assessment is silent on whether this principle is met. However, in NRC's November 29, 2001, briefing to NRC's Executive Director's Office and in its November 30, 2001, briefing to the NRC commissioners' technical assistants, NRC concluded that this safety principle was not met. As noted above, NRC formally notified FirstEnergy on December 4, 2001, that it would accept FirstEnergy's February 16, 2002, shutdown date.

15. See comment 3. We do not agree that the report statements mischaracterize the facts. Rather, we are concerned that NRC is misusing basic quantitative mathematics. In addition, with regard to NRC's concept of an annual average change in the frequency of core damage, NRC stated that the agency averaged the frequency of core damage that would exist for the 7-week period of time (representing the period of time between December 31, 2001, and February 16, 2002) over the entire 1-year period, using the assumption that the frequency of core damage would be zero for the remainder of the year—February 17, 2002, to December 31, 2002. According to our consultants, this calculation *artificially* reduced NRC's risk estimate to a level that is acceptable under NRC's guidance. By this logic, our consultants stated,

risks can always be reduced by spreading them over time; by assuming another 10 years of plant operation (or even longer) NRC could find that its calculated "risks" are completely negligible. They further stated that NRC's approach is akin to arguing that an individual, who drives 100 miles per hour 10 percent of the time, with his car otherwise garaged, should not be cited because his time-average speed is only 10 miles per hour.

Further, our consultants concluded that the "annual-average" core damage frequency approach was also clearly unnecessary, since one need only convert a core damage frequency to a core damage probability to handle part-year cases like the Davis-Besse case. Lastly, we find no basis for the calculation in any NRC guidance. According to our consultants, this new interpretation of NRC's guidance is at best unusual and certainly is inconsistent with NRC's guidelines regarding the use of an incremental core damage frequency. This interpretation also reinforces our consultants' impression that perhaps there was, in November 2001 and possibly is still today, some confusion among the NRC staff regarding basic quantitative metrics that should be considered in evaluating regulatory and safety issues. As noted in comment 3, we found no evidence of this calculation prior to February 2004.

16. While we agree that vessel head corrosion as extensive as later found at Davis-Besse was not anticipated, NRC had known that leakage of the primary coolant from a through-wall crack could cause boric acid corrosion of the vessel head, as evidenced by the Westinghouse work cited above. Regardless of information provided to NRC by individual licensees, such as FirstEnergy, NRC's model should account for known risks, including the potential for corrosion.

17. We agree that NRC was aware of control rod drive mechanism nozzle cracking at French nuclear power plants. NRC provided us additional information consisting of a December 15, 1994, internal memo, in which NRC concluded that primary coolant leakage from a through-wall crack could cause boric acid corrosion of the vessel head. However, because some analyses indicated that it would take at least 6 to 9 years before any corrosion would challenge the structural integrity of the head, NRC concluded that cracking was not a short-term safety issue. We revised the report to include this additional information. (See p. 40.)

18. See comment 15.

19. We agree that while not directly relevant to the Davis-Besse situation, NRC uses regulatory guide 1.177 to make decisions on whether certain equipment can be inoperable while a nuclear reactor is operating, which can pose very high instantaneous risks for very short periods of time. However, we include the reference to this particular guidance in the report because it was cited by an NRC official involved in the Davis-Besse decision-making process as another piece of guidance used in judging whether the risk that Davis-Besse posed was acceptable.

20. While regulatory guide 1.174 comprises 25 pages of guidance on how to use risk in making decisions on whether to allow license changes, it does not lay out how NRC staff are to use quantitative estimates of risk or probabilistic factors, or how robust these estimates must be in order to be considered along with more deterministic factors. The regulatory guide, which was first issued in mid-1998, had been in effect for only about 1.5 years when NRC staff was tasked with making their decision on Davis-Besse. According to the Deputy Executive Director of Nuclear Reactor Programs at the time the decision was being made, the agency was trying to bring the staff through the risk-informed decision-making process because Davis-Besse was a learning tool. He further stated that it was really the first time the agency had used the risk-informed decision-making process on operational decisions as opposed to programmatic decisions for licensing. At the time the decision was made, and currently, NRC has no guidance or criteria for use in assessing the quality of risk estimates or clear guidance or criteria for how risk estimates are to be weighed against other risk factors.

21. The December 3, 2002, safety assessment or evaluation did state that the estimated increase in core damage frequency was consistent with NRC's regulatory guidelines. However, as noted in comment 3, we disagree with this conclusion. In addition, while we agree that NRC has staff with risk assessment disciplines, we found no reference to these staff in NRC's safety evaluation. We also found no reference to NRC's statement that these staff gave more weight to deterministic factors in arriving at the agency's decision. While we endorse NRC's consideration of deterministic as well as probabilistic factors and the use of a risk-informed decision-making process, we continue to maintain that NRC needs clear guidance and criteria for the quality of risk estimates, standards of evidence, and how to apply deterministic as well as probabilistic factors in plant shutdown decisions. As the agency continues to incorporate a risk-informed process into much of its regulatory guidance and programs, such criteria will be increasingly

important when making shutdown as well as other types of decisions regarding nuclear power plants.

22. The information that NRC provided us indicates that completion dates for 2 of the 22 high priority recommendations have slipped.[5] One, the completion date for encouraging the American Society of Mechanical Engineers to revise vessel head penetration nozzle inspection requirements or, alternatively, for revising NRC's regulations for vessel head inspections has slipped from June 2004 to June 2006. Two, the completion date for assessing NRC's requirements that licensees have procedures for responding to plant leakage alarms to determine if the requirements are sufficient for identifying reactor coolant pressure boundary leakage has slipped from March 2004 to March 2005.

23. We agree with this comment and have revised the report to reflect this clarification. (See p. 49.)

24. Our estimate of at least an additional 200 hours of inspection per reactor per year is based on:

    - NRC's new requirement that its resident inspectors review all licensee corrective action items on a daily basis (approximately 30 minutes per day). Given that reactors are intended to operate continuously throughout the year, this results in about 3.5 hours per week for reviewing corrective action items, or about 182 hours per year. In addition, resident inspections are now required to determine, on a semi-annual basis, whether such corrective action items reflect any trends in licensee performance (16 to 24 hours per year). The total increase for these new requirements is about 198 to 206 hours per reactor per year.

    - A new NRC requirement that its resident inspectors validate that licensees comply with additional inspection commitments made in response to NRC's 2002 generic bulletin regarding reactor pressure vessel head and vessel head penetration nozzles. This requirement results in an additional 15 to 50 hours per reactor per fuel outage.

[5] Of NRC's 21 high priority recommendations, we categorized 1 recommendation as 2 so that we could better track actions taken to implement it. Thus, we have 22 recommendations categorized as high priority.

25. Our draft report included a discussion that NRC management's failure to recognize the scope or breadth of actions and resources necessary to fully implement task force recommendations could adversely affect how effective the actions may be. We made this statement based on NRC's initial response to the Office of the Inspector General's October 2003 report on Davis-Besse.[6] That report concluded that ineffective communication within NRC's Region III and between Region III and NRC headquarters contributed to the Davis-Besse incident. NRC, in its January 2004 response to the report, stated that among other things, it had developed training on boric acid corrosion and revised its inspection program to require semi-annual trend reviews. In February 2004, the Office of the Inspector General criticized NRC for limiting the agency's efforts in responding to its findings. Specifically, it stated that NRC did not address underlying and generic communication failures identified in the Office's report. In response to the criticism, on April 19, 2004 (while our draft report was with NRC for review and comment), NRC provided the Office of the Inspector General with additional information to demonstrate that its actions to improve communication within the agency were broader than indicated in the agency's January 2004 response. Based on NRC's April 19, 2004, response and the Office's agreement that NRC's actions appropriately address its concerns about communication within the agency, we deleted this discussion in the report.

26. We recognize that the lessons-learned task force did not make a recommendation for improving the agency's decision-making process because the task force coordinated with the Office of the Inspector General regarding the scope of their respective review activities and because the task force was primarily charged with determining why the vessel head degradation was not prevented. (See p. 55.)

27. We agree that NRC's December 3, 2002, documentation of its decision was prepared in response to a finding by the Davis-Besse lessons-learned task force. We revised our report to incorporate this fact. (See p. 55.)

28. We agree that NRC's lessons-learned task force conducted a preliminary review of reports from previous lessons-learned task forces

[6]NRC, Office of the Inspector General, *NRC's Oversight of Davis-Besse during the 2000 Refueling Outage* (Washington, D.C.: Oct. 17, 2003).

and, as a result of that review, made a recommendation that the agency perform a more detailed effectiveness review of the actions taken in response to those reviews. We revised the report to reflect that NRC's detailed review is currently underway. (See p. 55.)

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Related GAO Products

Management Weaknesses Affect Nuclear Regulatory Commission Efforts to Address Safety Issues Common to Nuclear Power Plants. GAO-RCED-84-149.Washington, D.C.: September 19, 1984.

Probabilistic Risk Assessment: An Emerging Aid to Nuclear Power Plant Safety Regulation. GAO-RCED-85-11. Washington, D.C.: June 19, 1985.

The Nuclear Regulatory Commission Should Report on Progress in Implementing Lessons Learned from the Three Mile Island Accident. GAO-RCED-85-72. Washington, D.C.: July 19, 1985.

Nuclear Regulation: Oversight of Quality Assurance at Nuclear Power Plants Needs Improvement. GAO-RCED-86-41.Washington, D.C.: January 23, 1986.

Nuclear Regulation: Efforts to Ensure Nuclear Power Plant Safety Can Be Strengthened. GAO-RCED-87-141. Washington, D.C.: August 13, 1987.

Nuclear Regulation: NRC's Restart Actions Appear Reasonable—but Criteria Needed. GAO-RCED-89-95.Washington, D.C.: May 4, 1989.

Nuclear Regulation: NRC's Efforts to Ensure Effective Plant Maintenance Are Incomplete. GAO-RCED-91-36. Washington, D.C.: December 17, 1990.

Nuclear Regulation: NRC's Relationship with the Institute of Nuclear Power Operations. GAO-RCED-91-122. Washington, D.C.: May 16, 1991.

Nuclear Regulation: Weaknesses in NRC's Inspection Program at a South Texas Nuclear Power Plant. GAO-RCED-96-10. Washington, D.C.: October 3, 1995.

Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action. GAO-RCED-97-145. Washington, D.C.: May 30, 1997.

Nuclear Regulatory Commission: Preventing Problem Plants Requires More Effective Action by NRC. GAO-T-RCED-98-252. Washington, D.C.: July 30, 1998.

Nuclear Regulatory Commission: Strategy Needed to Develop a Risk-Informed Safety Approach. GAO-T-RCED-99-71. Washington, D.C.: February 4, 1999.

Nuclear Regulation: Strategy Needed to Regulate Safety Using Information on Risk. GAO-RCED-99-95. Washington, D.C.: March 19, 1999.

Nuclear Regulation: Regulatory and Cultural Changes Challenge NRC. GAO/T-RCED-00-115. Washington, D.C.: March 9, 2000.

Major Management Challenges and Performance Risks at the Nuclear Regulatory Commission. GAO-01-259. Washington, D.C.: January 2001.

Nuclear Regulation: Progress Made in Emergency Preparedness at Indian Point 2, but Additional Improvements Needed. GAO-01-605. Washington, D.C.: July 30, 2001.

Nuclear Regulation: Challenges Confronting NRC in a Changing Regulatory Environment. GAO-01-707T. Washington, D.C.: May 8, 2001.

Nuclear Regulatory Commission: Status of Achieving Key Outcomes and Addressing Major Management Challenges. GAO-01-760. Washington, D.C.: June 29, 2001.

Managing for Results: Efforts to Strengthen the Link between Resources and Results at the Nuclear Regulatory Commission. GAO-03-258. Washington, D.C.: December 10, 2002.

Nuclear Regulatory Commission: Oversight of Security at Commercial Nuclear Power Plants Needs to Be Strengthened. GAO-03-752. Washington, D.C.: September 4, 2003.

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STATEMENT OF MARVIN FERTEL, SENIOR VICE PRESIDENT OF NUCLEAR GENERATION, NUCLEAR ENERGY INSTITUTE

Chairman Voinovich, Ranking Member Carper and distinguished members of the subcommittee, I am Marvin Fertel, senior vice president and chief nuclear officer at the Nuclear Energy Institute (NEI). I am honored to represent NEI's member companies before this subcommittee today. Nuclear energy is vitally important to our environment, particularly in meeting the nation's clean air goals, and to our nation's energy security. It is also necessary that the nuclear industry has a Federal regulatory agency that is stable, effective and efficient.

NEI is responsible for developing policy for the United States nuclear industry. NEI's 270 corporate and other members include every United States energy company that operates a nuclear plant, as well as a wide variety of organizations and businesses involved in the use of radioisotopes for beneficial purposes. NEI's membership also includes nuclear fuel cycle companies, suppliers, engineering and consulting firms, national research laboratories, and manufacturers of radiopharmaceuticals, universities, labor unions and law firms.

The 103 reactors in the United States are among the world's most efficient and reliable. Nuclear energy is the largest source of emission-free electricity in the United States and the nation's second-largest source of electricity after coal. The U.S. nuclear energy sector is also the world's largest, generating more electricity than the nuclear sectors of France and Japan-the next two largest-combined. On a percentage basis, nuclear energy provides electricity for 20 percent of American homes and businesses. Globally, 18 nations generate a higher percentage of electricity from nuclear energy that the United States, including France at 78 percent, Japan at 35 percent. Nuclear energy is growing rapidly in the burgeoning economics like China and India.

This testimony addresses:

(1) actions needed to preserve this vital energy resource

(2) essential steps needed to enhance progress toward a long-term, stable regulatory approach in the United States

(3) essential Nuclear Regulatory Commission funding issues

(4) changes needed in the Atomic Energy Act

(5) industry initiatives toward preserving the integrity of materials, including metals that comprise components and equipment used in nuclear power plants

(6) the need for resolution of conflicting radiation protection policies

(7) advances in nuclear power plant security.

NUCLEAR POWER PLANTS CONTINUE TO OPERATE AT RECORD SAFETY AND PERFORMANCE LEVELS

During the past decade, U.S. nuclear power plants have achieved record levels of production and efficiency while maintaining the highest levels of safety in the electricity sector. U.S. nuclear power plants produced 767 billion kilowatt-hours of electricity in 2003, a 25 percent increase compared to 1993 output and the third best production year ever. Although no new U.S. plants have been built during this period, this increased production is equivalent to adding 19 new 1,000-megawatt (MW) plants over the 10-year period.

U.S. nuclear plants achieved a capacity factor of about 90 percent in 2003. This average is approximately double the capacity factors of 20 years ago and is the highest of any generating source in the United States. In 2002, coal-fired power plants had a capacity factor of about 69 percent; combined-cycle natural gas power plants, 40 percent; hydropower, 35 percent; and wind, 29 percent. Overall nuclear plant performance has been increasing steadily over the past decade as measured by the Institute of Nuclear Power Operations.

Nuclear energy continues to be the most affordable baseload source of electricity for businesses and consumers. Average production costs in 2002 of 1.71 cents per kilowatt-hour (kWh) were lower than those for coal (1.85 cents per kWh), natural gas (4.06 cents per kWh) and oil (4.41 cents per kWh). Preliminary production costs for 2003 show that low-cost trend continuing.

Throughout this period of record production and efficiency, the industry has maintained a steadfast commitment to safety. The level of significant events equipment malfunctions or operational anomalies is 30 times lower than it was at the end of the 1980's. The industry average is currently 0.03 annual events per reactor, which is equivalent to three reportable events per year.

With productivity and reliability on the rise and production costs falling, the profitability of nuclear plants also is improving. The industry expects incremental gains in profitability to continue for several more years. In addition to improving profitability, companies plan to increase revenue through power uprates. With these uprates and the restart of the Browns Ferry reactor in Alabama, the industry expects to add approximately 10,000 megawatts to the U.S. electricity system over the next decade.

The efficiency and competitiveness of nuclear power plants are driving factors in the decision by U.S. energy companies to seek renewal of operating licenses from the Nuclear Regulatory Commission. One-quarter of U.S. reactors already have been approved by the NRC to extend their reactor operating licenses from 40 to 60 years. Seventeen other reactors are in the queue for NRC review of their license renewal applications, and the industry expects that nearly all reactors will pursue license extensions. The Department of Energy's Energy Information Agency is recognizing this trend in its most recent energy forecast.

NUCLEAR ENERGY: AN ESSENTIAL COMPONENT OF OUR NATION'S CLEAN AIR GOALS

Nuclear energy plays a vital role in U.S. energy security and diversity, producing electricity safely and cleanly for one of every five U.S. homes and businesses. Before the oil shocks of the early 1970's, nuclear power provided just 4 percent of our electricity supply, and oil provided about 20 percent. The situation is now reversed, as nuclear energy essentially has phased out oil use in the electricity sector.

This steady growth of nuclear power over the past three decades has produced enormous environmental and clean air benefits. Nuclear energy now generates three-fourths of all emission-free electricity generation in the United States and is making significant reductions in harmful emissions into the atmosphere from the industrial sector. Between 1973 and 2001, U.S. nuclear power plants avoided the emission of 70.3 million tons of sulfur dioxide (SO_2) and 35.6 million tons of nitrogen oxide (NOx), compared to fuels that otherwise would have produced electricity.

The value of the emissions prevented by using nuclear power is essential in meeting clean air regulations. In 2002, U.S. nuclear power plants avoided the emission of about 3.4 million tons of sulfur dioxide and about 1.4 million tons of nitrogen oxide. The requirements imposed by the 1990 Clean Air Act Amendments reduced SO_2 emissions from the electric power sector between 1990 and 2002 by 5.5 million tons per year and NOx emissions by 2.3 million tons per year. Thus, in a single year, using nuclear power plants to generate electricity has eliminated nearly as much in emissions than has been achieved over a 12-year period by all other sources combined.

To put these numbers into perspective further, the NOx emissions prevented by U.S. nuclear power plants are the equivalent of eliminating the NOx emissions from 6 of every 10 passenger cars on our roads today. The carbon emissions prevented by U.S. nuclear power plants are equivalent to eliminating the carbon emissions from nine of every 10 passenger cars on our roads.

According to a report issued last year by the U.S. Environmental Protection Agency and the Ozone Transport Commission, nuclear energy was one of the most significant compliance tools for reducing NOx emissions in Northeastern and mid-Atlantic states. The EPA assessment found that energy companies have been shifting electricity production from fossil-fueled power plants to emission-free nuclear power plants to help comply with Federal air pollution laws.

Nuclear energy also is an environmental imperative for reducing greenhouse gases. New York is a good example of this phenomenon. New York's greenhouse gas emissions from fuel combustion have decreased 1 percent from 1990 to 2002, despite a growth in population and the number of automobiles on the road. The increased production from the state's six nuclear power plants offset the need for electricity production at other power plants and therefore reduced greenhouse gas emissions during that period.

In 1990, the FitzPatrick, Ginna, Indian Point and Nine Mile Point nuclear power plants generated more than 24 billion kilowatt-hours of electricity in New York. By 2000, nuclear energy production increased by 60 percent to more than 40,000 billion kilowatt-hours. This increase in nuclear production allowed for a decrease in the use of other fuels and offset an increase in emissions from the rising use of natural gas. The result is an overall 23 percent reduction in greenhouse gas emissions from the electricity sector.

Two reactors at the Indian Point Energy Center near New York City produced 15.7 billion kilowatt-hours of electricity in 2003, approximately 11 percent of New York's power and enough for 1.5 million households. Some are recommending closure of the Indian Point Energy Center because of security concerns, but such a move would sacrifice a critical source of power for the state and needlessly reverse progress that New York has made in reducing greenhouse gas emissions. EPA has determined that all five counties that surround Indian Point already do not comply with Federal air rules. Taking Indian Point off the New York electricity grid would worsen air quality and unnecessarily drive up the cost of electricity to consumers and businesses.

As the New York example shows, nuclear energy is vital to our nation's clean air programs. Expanding nuclear energy production through continued efficiency gains and building new nuclear plants would further enhance the role of nuclear energy in our environmental goals. Recent studies by the Earth Institute at Columbia University and the Massachusetts Institute of Technology underscore the importance of nuclear energy and renewable energy sources in meeting energy and environmental goals that are inextricably linked.

A STABLE, EFFECTIVE, EFFICIENT NRC IS VITAL TO THE OPERATION OF EXISTING REACTORS AND THE FUTURE EXPANSION OF NUCLEAR POWER

Nuclear power plants are a strategic national asset that contribute the fuel and technology diversity that is the foundation of our electric supply system. Together, large coal and nuclear power plants produce 70 percent of our nation's electricity, with a mix of hydroelectric, natural gas and renewables providing the balance. But this energy diversity is at risk because today's business and market conditions hamper investment in new large capital-intensive technologies, such as advanced design nuclear power plants and clean coal power plants. Although the industry expects that most reactors will be relicensed, the nuclear industry's potential obviously is severely limited if new nuclear plants cannot be financed.

The United States faces a critical need for investment in energy infrastructure, including advanced nuclear designs. Nuclear plants are the most reliable of our sources of electricity and offer the greatest degree of price stability. Yet, since the passage of the Energy Policy Act of 1992, our Nation has built approximately 284,000 megawatts (MW) of natural gas-fired generating capacity more than 90 percent of the new capacity added during this period. Only 4,355 MW of new nuclear capacity and 9,500 MW of new coal-fired capacity have been added to the electricity grid during that same period.

The nuclear energy industry is committed to the construction of new nuclear plants when the business conditions are appropriate. However, most of the factors involved in building new reactors the structure of the industry and markets, the technology itself and the Federal licensing process have changed since the last nuclear power plants were built.

The industry has been working for several years on regulatory, financial and legislative initiatives that encourage investment in new nuclear plants. For example, recognizing that the construction of large power plants has a high degree of business risk, the industry proposed legislative initiatives that provide Federal financial support for the first few new nuclear plant designs. In addition, the industry supports the DOE's Nuclear Power 2010 program aimed at developing, in partnership with companies, detailed design and engineering on advanced reactor designs and demonstrate the early site permit and combined construction and operating license process.

More pertinent to the jurisdiction of this subcommittee is the prospect that companies would pursue new nuclear plants would be greatly enhanced by continuity and stability in the regulatory processes and regulatory environment at the NRC. Regulatory uncertainty is the largest perceived risk with new nuclear plant construction, so any reduction in stability of the regulatory process will damage industry and financial community prospects for new nuclear plants.

Regulatory stability and continuity also are vital for the continued success of current nuclear plants. As I have previously noted, that fleet continues to operate at high levels of safety and efficiency, and the NRC should regulate the industry commensurate to this excellent record of performance.

THE NRC REACTOR OVERSIGHT PROCESS HAS PROVEN SUCCESSFUL

The NRC now has 4 years of experience with its revised reactor oversight process, first launched in April 2000. The new oversight process focuses on those areas of the plant that are most important to safety. The new approach is successful in improving the transparency, objectivity and efficiency of regulatory oversight. It is an enormous improvement over the agency's previous approach to evaluating nuclear plant safety.

The revised oversight process combines the results of performance indicators in 18 key areas and findings from an average of 2,500 hours of inspections per reactor to determine the appropriate allocation of inspection resources across the fleet of operating plants. The results among the nations 103 operating reactors after the first quarter of 2004 were as follows:

• Seventy-seven reactors had all green performance indicators and inspection findings and will receive the baseline level of NRC inspection (approximately 2,500 hours per year).

• Twenty reactors had a single white performance indicator or inspection finding and will receive supplemental inspection beyond the baseline effort.

• Five reactors had more than one single white indicator or finding in a performance area or had white indicators or findings in different performance areas and will receive more in-depth inspection.[1]

During the past 4 years, there have been 83 performance indicators and 114 inspection findings across the industry that are less than the highest NRC level. Given that the 4-years encompass about 400 reactor operating years and over 1 million hours of NRC inspection, these results demonstrate that the industry continues to operate at excellent levels of safety. Although an internal NRC report expressed concern about the declining number of "non-green" performance indicators, the industry views this trend as achieving success and a strong example of the soundness of performance-based regulation.

THE NEED FOR CONTINUED REGULATORY CHANGE

The NRC, however, has struggled to implement safety-focused insights into Federal regulation fully. The agency has made admirable progress in employing safety-focused principles that properly apply probabilistic risk assessment to apply regulation where it is needed. Although the NRC has applied the safety-focused approach to the reactor oversight process, it has yet to incorporate this into the actual regulations. This would result in a vastly more effective and efficient regulatory process, but much work remains to codify the safety-focused principles as part of the rules themselves.

Rulemaking initiatives have been under way for several years to apply the safety-focused principles to 10 CFR Part 50, which deals with regulation of nuclear facilities. Successful promulgation of these rules is critical to the effective and efficient regulation of nuclear facilities. These rules also could aid in establishing a more stable and predictable regulatory process that supports both current and future nuclear plants.

This approach is particularly necessary to address issues such as the integrity of plant materials—metals and alloys used in plant components and equipment. In addition, the application of the safety-focused principles is essential to the regulation of programs related to the structural integrity of reactor systems and components.

The NRC also has undertaken other projects of concern to the industry. With congressional approval of Yucca Mountain as the site of a national repository for used nuclear fuel, DOE in December is scheduled to submit a license application to the NRC for the construction of that facility. Having one Federal agency review and approve the actions of another is relatively unique and represents a major challenge for both agencies. The NRC has been actively engaged with DOE in prelicensing activities. The industry supports the efforts of the NRC to date and believes that it is providing sound oversight of the project. It is in the interest of all parties that the repository be built and operated safely.

In reviewing the Yucca Mountain license application, the NRC will create multiple licensing boards. Creating and coordinating these various bodies will test the agency's management. The industry strongly urges continued oversight by this and other congressional committees to assure efficient management of resources and to hold the NRC to its timetable of acting on the license application within 3 years of receipt.

The NRC also is active in licensing new nuclear facilities. Louisiana Energy Services (LES) submitted an application for the licensing of a new enrichment facility in January, and a similar license application is expected from the U.S. Enrichment Company within the next few months. The NRC responded to the LES application with an order that the application review be completed within 30 months, and the NRC appears to be keeping to that schedule.

The industry is following the management of the LES applications closely, given that prior efforts by the NRC to review applications for new facilities have taken many years to resolve. Unnecessary delays in the licensing process for nuclear facilities add significant business risk and hamper the development of the nuclear industry. The industry encourages congressional oversight of these license applications to ensure that they are processed in a timely and thorough manner.

[1] The Davis-Besse plant is receiving special inspection outside of the normal regulatory framework.

NRC BUDGET AND STAFFING LEVELS REQUIRE REVIEW

The NRC's budget has increased significantly over the past 5 years. The NRC's proposed fiscal 2005 budget totals $670.3 million, an increase of $44.2 from the fiscal 2004 budget, and the highest ever for this agency. This is, in large part, due to expanded security programs and staffing for those programs. However, the industry believes that the NRC has failed to leverage opportunities to become more efficient.

Just as consolidation within the industry resulted in more nuclear plants being operated by a smaller number of companies, the NRC should review its regional structure and determine if changes are needed to respond to the new industry structure. In addition to the implementation of the revised reactor oversight process, the natural consolidation of the industry provides an opportunity for the NRC to reallocate existing resources.

About 4 years ago, the Environment and Public Works Committee approved legislation that renewed the NRC's authority to collect user fees to offset its budget. That proposal was eventually passed into law in a slightly modified form. As a result, general revenues will be used to fund 10 percent of the NRC's budget in the coming fiscal year. That legislation expires at the end of the fiscal year 2005, and the NRC's budget again will be fully funded by user fees despite many programs that do not benefit the industry.

As some form of reauthorization of the user fee is likely to be passed next year, the industry urges the committee to review the current fee structure and to identify improvements for the NRC. The industry believes that the NRC should tie activities and fees together. We believe it is inappropriate to categorize about 75 percent of the agency's budget in one "general" account (part 171). In addition, the committee's action 4 years ago that resulted in 10 percent of the agency's budget coming from general revenues was based upon a calculation of those services that do not directly benefit NRC licensees. The percentage of these services that do not benefit licensees should be reviewed, particularly in light of increased national security expenses that should be funded through general revenues. The industry supports legislative efforts that call for much of the security program at the NRC to be funded from general revenues and appreciates the committee's support of that proposal.

THE INDUSTRY RECOMMENDS CHANGES TO THE ATOMIC ENERGY ACT

The industry continues to support several proposed changes to the Atomic Energy Act. These proposals will facilitate reform of the NRC and its regulatory processes to ensure the effective and efficient regulation of the industry.

- In order to provide the commission with the flexibility and discretion to manage and organize the NRC in the most appropriate manner, Sections 203, 204 and 205 of the Atomic Energy Act should be repealed.
- Congress should remove the restriction on foreign ownership of commercial nuclear facilities.
- When a combined construction and operating license is issued by the NRC for a new nuclear power plant, Congress should clarify that the license term begins when the plant commences operation rather than when the license is issued.
- Congress should remove the requirement that the NRC conduct antitrust reviews as other Federal agencies, notably the Securities and Exchange Commission, the Federal Trade Commission, the Justice Department, and the Federal Energy Regulatory Commission, conduct such reviews.

The industry is aware of and appreciates the efforts of the committee to pass several of these proposals into law. In addition, the industry strongly supports, and also appreciates, efforts of this committee to ensure that Price-Anderson Act coverage will be available to companies that are considering building new nuclear power plants and other nuclear facilities. The industry supports the Price-Anderson Act reauthorization language included in the energy bill conference report.

RADIATION PROTECTION POLICY MUST BE SCIENCE-BASED AND CONSISTENT

As the industry works to increase energy production, it remains committed to maintaining the highest priority on safety. Achieving this goal depends in large part on the Federal Government's setting a uniform radiation protection policy. The policy should be based on the best available science and should be applied equitably and consistently by every Federal agency across all programs.

Duplicative and conflicting regulation by different agencies, using different criteria, must be eliminated. In this area, Federal radiation protection policy falls short. Senator Pete Domenici requested in 2000 that the General Accounting Office (GAO) produce a report on this issue. The report—"Radiation Standards: Scientific

Basis Inconclusive, and the EPA and NRC Disagreement Continues" (GAO/RCED00–152)—concluded that U.S. radiation protection standards "lack a conclusively verified scientific basis," involve "differing exposure limits" due to policy disagreements between Federal agencies, and "raise questions of inefficient, conflicting dual regulation." A troubling conclusion of the GAO report is that the costs related to complying with such standards "will be immense, likely in the hundreds of billions of dollars" of private and public funds.

This situation has persisted for years, without any substantial resolution. For example, Senator John Glenn, as chairman of the Senate Committee on Governmental Affairs, asked the GAO to report on this issue in 1994. The GAO report, "Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public is Lacking" (GAO/RCED–94–190), concluded that "differences exist in the limits on human exposure to radiation set by Federal agencies, raising questions about the precision, credibility, and overall effectiveness of Federal radiation standards and guidelines affecting public health."

What is particularly troubling is that the 2000 report requested by Senator Domenici, issued 6 years after the report requested by Senator Glenn, reflected that the situation was essentially unchanged. Now 4 years later, the nuclear energy industry still notes little substantive progress in resolving the issue of duplicative and conflicting radiation standards.

Although Federal regulatory agencies contend this protects public health, it discourages enhancements to public health protection and the cost-effectiveness of doing so. In addition, this situation undermines public confidence in regulatory activities and, in the end, inhibits the availability the vast health and quality-of-life benefits from commercial applications of nuclear technology. This situation also creates significant uncertainties in projecting costs and schedules of licensing and building of new plants, the decommissioning of facilities that are no longer operational, and the disposal of radioactive waste.

Federal radiation protection policy must provide a foundation to protect public health and safety, make the best use of public funding and resources, and help build public trust and confidence in Federal decisions. The current conflicting radiation standards and duplicative regulation work against those principles.

Recently, the NRC and EPA have pursued initiatives to resolve duplication and conflict in their regulatory programs for radiation safety. The NRC and EPA have agreed on a communication process that addresses their conflicting standards for decommissioning site cleanups. Also, the agencies are coordinating efforts to create a more integrated framework for regulating the safe disposition of low-activity radioactive material and mixed (radiological and chemical) waste.

However, the greatest impediment to resolving issues of duplicative authority and conflicting standards are the various laws that mandate the respective agencies' regulatory programs. Congress should resolve the policy issues that the agencies cannot resolve on their own. We encourage this committee to provide appropriate, continued oversight to ensure that consistent radiation policy is established through legislation.

INDUSTRY HAS LAUNCHED A PROACTIVE, COMPREHENSIVE MATERIALS MANAGEMENT PROGRAM

The nuclear industry has long known that radiation could have effects on metals and other structural materials previously unknown to scientists or engineers. Because commercial nuclear reactors operate at high temperatures and pressures, it had to find materials able to withstand radiation, stress, wear and corrosion. Through experience, it has.

Some of the initial materials used to fabricate reactor and power generation components did not perform as well as predicted. In response, the industry, over the past 20 years, has formed four major programs related to boiling water reactor vessel internals, steam generator management, pressurized water reactor materials reliability, and robust fuels. Working with EPRI and the Institute of Nuclear Power Operators (INPO), these efforts have been successful in addressing many materials issues.

Despite these efforts, an inspection at the Davis-Besse nuclear plant in 2002 identified component damage stemming from two issues: reactor vessel nozzle cracking and boric acid leakage. Since 1988, all U.S. pressurized water reactors have had programs for preventing boric acid leakage. In the early 1990's, the NRC and the industry began examining the potential for reactor vessel nozzle cracking, after tiny cracks were found in nozzles at a French reactor.

Nozzle cracking and boric acid leakage at Davis-Besse combined to create a problem that the nuclear industry had not experienced before: significant corrosion on a reactor vessel head. The corrosion was caused by water that contains boric acid. The cracks developed over several years, ultimately permitting a small amount of water containing boric acid to leak and come into contact with the reactor vessel head.

As a result of this corrosion, the Davis-Besse plant was shut down for corrective measures. In March, the NRC approved FirstEnergy's corrective actions and ongoing plant maintenance changes and permitted Davis-Besse to restart. FirstEnergy replaced the reactor vessel head at Davis-Besse and the NRC conducted a thorough inspection of the reactor. In addition, the company implemented, with NRC oversight, an overhaul of its management and management practices at the site.

The nuclear industry and the NRC have responded quickly and responsibly to the Davis-Besse event. As the NRC has also been invited to testify, the commissioners can best detail actions taken by the agency. However two of these actions merit special attention: additional inspections of all U.S. pressurized water reactors and changes in the agency's oversight process to facilitate early detection of the type of corrosion that occurred at Davis-Besse.

The nuclear industry has also responded to the event. INPO investigated the event and issued a report with recommendations aimed at preventing a similar event. EPRI, the industry's research organization, had previously developed a technical document on boric-acid corrosion inspection and leakage detection. The owners of pressurized water reactors have completed inspections recommended by the NRC. There are no indications at any other plant of corrosion on reactor vessel heads similar to that found on Davis-Besse. Small cracks were found on the nozzles at several plants and reactor owners have scheduled replacement of 30 vessel heads by 2007. To date, vessel heads have been replaced at eleven nuclear plants. In the meantime, all of these reactors will continue to operate safely.

Perhaps more importantly, the nuclear industry has also developed a integrated, coordinated, and proactive nuclear plant materials program. In 2003, a task force composed of senior industry executives with broad experience in materials issues, working with materials experts, completed a broad assessment of industry programs. Although materials integrity has long been a part of the industry's research and maintenance programs, companies are now replacing more equipment and components more rapidly than expected. The task force found that the industry would benefit from a proactive program to assess and, when needed, replace plant components and materials.

Among the findings of the industry assessment is the recognition that when significant materials issues become known, they quickly consume all the attention, personnel and funding of diverse current materials groups. Current programs differ in levels of funding, scope, assessment processes, executive involvement, personnel resources and other areas. No industry group had looked holistically at the management of nuclear materials issues.

The recent industry assessment stressed the importance of funding and organizational commitment to oversee materials issues. The assessment concluded that consistent funding at the level required to resolve current materials issues is a prerequisite to remaining an effective nuclear plant operator. As a result, the industry will spend nearly $65 million annually on this effort. We have put new inspection protocols in place and have developed techniques to anticipate and detect potential problems.

NEI also has taken proactive action to address materials degradation at our nation's nuclear power plants. With the unanimous support of the chief nuclear officer of each company that operates a nuclear power plant, NEI has established an industry wide initiative to integrate materials programs and to establish ongoing, comprehensive management of materials issues. This approach integrates existing activities by INPO, EPRI and reactor owners' groups and refocuses them for future efforts. An executive-level oversight structure is in place to ensure appropriate resources and attention is given to ensure effective management of materials issues.

The Davis-Besse event prompted the NRC and the nuclear industry to reexamine its programs for materials management issues. The industry is committed to detecting and resolving materials issues before they challenge the safe operation of our facilities. The industry believes that the NRC has taken appropriate steps to address these issues. Additionally, the industry believes that a proactive industry-led program, supported with appropriate resources, is the preferred approach.

U.S. NUCLEAR POWER PLANTS ARE THE MOST SECURE INDUSTRIAL FACILITIES BEFORE 9/11 AND EVEN MORE SECURE TODAY

NEI has not had the opportunity, since the tragic attack of Sept. 11, 2001, to review with this subcommittee the actions that the industry has taken in response to increased security concerns created by that event. The nuclear industry fully recognizes that the health, economic and national security benefits from nuclear energy easily could be overruled if our plants cannot be operated safely, even in the current environment of concern over terrorism.

Even prior to Sept. 11, 2001, our nuclear power plants were the most secure industrial facilities in the United States. They were built to withstand extreme natural events, such as earthquakes and hurricanes, and the NRC has for more than 20 years required that private security forces defend against an attacking force of saboteurs intent on causing a release of radiation. The facilities are even more secure today, with voluntary and NRC-required security and emergency response implemented since 2001.

In analyzing this changing global environment, the nuclear industry started with the firm knowledge that nuclear power plants although robust and difficult targets to penetrate nonetheless are considered by some to be potential terrorist targets. However, as stated by former NRC Chairman Richard Meserve:

> It should be recognized that nuclear power plants are massive structures with thick exterior walls and interior barriers of reinforced concrete. The plants are designed to withstand tornadoes, hurricanes, fires, floods, and earthquakes. As a result, the structures inherently afford a measure of protection against deliberate aircraft impacts. In addition, the defense-in-depth philosophy used in nuclear facility design means that plants have redundant and separated systems in order to ensure safety. That is, active components, such as pumps, have backups as part of the basic design philosophy. This provides a capability to respond to a variety of events including aircraft attack.

As former Chairman Meserve noted, the industry's "defense-in-depth" philosophy includes protection by well-trained, heavily armed security officers, fortified perimeters and sophisticated detection systems. The industry also assumes that potential attackers may attempt to achieve the help of a sympathetic insider, so the companies that operate nuclear plants conduct extensive background checks before hiring employees. Even then, to be conservative, our security plans assume that attackers are successful in obtaining insider help.

SECURITY AT NUCLEAR FACILITIES HAS INCREASED SIGNIFICANTLY SINCE SEPT. 11, 2001

Nuclear power plants were our nation's most secure industrial facilities before Sept. 11, 2001, but new threats required the industry to take action to bolster security even more. The industry has increased well-trained, paramilitary security forces at the plants by one-third, to some 7,000 officers at 67 sites. The industry also has worked with the NRC to implement the security improvements mandated both in 2002 and 2003. Overall, the industry has invested more than $500 million in security-related improvements since September 2001, and the industry will invest another $500 million in security enhancements by the end of this year.

The industry's security has been recognized as excellent in independent assessments conducted by the Progressive Policy Institute, a panel of security and infrastructure experts for The Washington Post and by current and former law enforcement officials. The Progressive Policy Institute, in a report issued last summer, gave nuclear plant security its only A rating. When The Washington Post reviewed security in several U.S. private and government sectors a year after Sept. 11, a panel of experts gave the nuclear industry a rating of "A-/B+" the second-highest rating in the survey. More recently, the National Journal, in a bipartisan survey, gave nuclear plant security its third-highest ranking.

A copy of an NEI publication entitled "Post-Sept. 11 Improvements in Nuclear Plant Security Set U.S. Industry Standard" is attached. It provides additional detail regarding the many security changes that have been made at our plants since September 2001.

The nuclear industry has cooperated and worked with the NRC to review nuclear plant security completely, and many improvements have been implemented as a result. Changes include measures to provide additional protection against vehicle bombs, as well as additional protective measures against water- and land-based assaults. The industry has increased security patrols, augmented security forces, added more security posts, increased vehicle standoff distances, tightened access controls, and enhanced coordination with state and local law enforcement.

In April 2003, the NRC issued new security requirements that effectively revised the agency's "design basis threat," which defines the characteristics of the threat against which a plant must defend and is the foundation for the industry's security programs. Since then, the nuclear industry has been working in cooperation with the NRC to resolve issues related to the new orders and in late April of this year, every company that operates a nuclear power plant submitted revised security plans to the NRC. These plans determine how each plant will be able to meet the new standards by the NRC-imposed deadline of October 29.

Regarding an issue that received a considerable amount of congressional concern, the industry has worked with the NRC to develop a revised program to constantly test the security at our facilities. This program includes "force-on-force" drills using advanced equipment. Although the tests were suspended for several months after Sept. 11, they are being conducted at plants throughout the nation. Every plant will conduct NRC-evaluated force-on-force exercises at least once every 3 years, in addition to exercises conducted by energy companies on a more frequent basis.

It is highly unlikely that attackers could successfully breach security at a nuclear power plant and produce a release of radiation that would endanger the residents near the plant. NRC Chairman Nils Diaz on May 15 said that facilities that shield reactor fuel the containment building, spent fuel pools or dry storage containers are protected from scenarios as extreme as an aircraft crashing into a nuclear power plant. "The NRC has conducted an extensive analysis of the potential vulnerability of nuclear power plants to aircraft attacks," Diaz said. "While the analysis is classified, the NRC remains convinced that nuclear power plants are the most heavily protected civilian facilities in the United States." Diaz noted that the possibility that such an attack would result in a radiological release is low.

Even so, we recognize that the security programs at our nuclear power plants must not be static. We are constantly reviewing and reevaluating our security programs. In that regard, the industry is ready to work with this subcommittee to help you and the American public better understand our industry's strong commitment to security and protecting public safety.

Mr. Chairman, the nuclear energy industry is proud of our efforts in security and emergency preparedness. We believe that no other industry can match or even approach the level of sophistication and commitment that the nuclear industry has exhibited in operating safe and secure power plants.

We have enhanced security significantly since the Sept. 11 terrorist attacks and we continue to work with Federal, state and local officials to ensure there is a seamless shield of protection at our facilities both for our workers and for residents who live near our facilities. The industry also needs regulatory stability during this period of complying with the most recent NRC security requirements and thereafter. The industry's plans to meet the new NRC requirements include costly physical improvements that will bolster plant security. Constantly changing the security requirements could delay current improvements or could result in the improvements being outdated even as they are being built.

NEI SUPPORTS NRC-ENDORSED LEGISLATIVE PROPOSALS AND URGES THE SUBCOMMITTEE TO SUPPORT COMPREHENSIVE ENERGY LEGISLATION

The nuclear energy industry has followed the legislative proposals of the Senate Environment and Public Works Committee closely over the past 2 years. The industry appreciates the cooperation that members and staff, on a bipartisan basis, have provided.

In general, the industry has supported several NRC proposals on security, and we appreciate the committee's efforts in including those initiatives in legislation approved last year and in agreeing to include those proposals as part of the comprehensive energy bill conference report still be considered by the Senate. We were disappointed that language was not agreed upon to resolve the issue regarding when our security personnel may use deadly force. We continue to support efforts to assure that they can use deadly force under appropriate circumstances. Although the industry still has concerns regarding the proposals in the energy bill conference report, it supports passage of the legislation, along with those proposals included in a broad energy package for America.

Mr. Chairman, the nuclear energy industry has responded to many of the concerns that the full committee voiced regarding security at our plants over the past 2 years. The NRC has created a new security division. The industry's security is being tested with force-on-force drills on a more frequent basis. The design basis threat has been increased to reflect today's potential security threats after the NRC conducted a review of the requirements with other Federal agencies. Our emergency response plans, already the gold standard for emergency planning, have been improved.

The industry remains hopeful that an energy bill, including nuclear security provisions, can be passed this year. Yet, we urge this subcommittee and the full committee to consider that this industry has maintained its long-standing commitment to security, is making the changes required to defend against new threats and is re-examining its emergency preparedness programs to ensure that our facilities continue to be the most secure in the nation.

By October 29, we will have spent approximately $1 billion industry wide on security enhancements, working with the NRC and Department of Homeland Security. The industry will continue its long-standing practice of re-examining security based on emerging global events. We take that initiative as an industry and we must do so in a climate of regulatory stability and certainty so that there is time to comply with the new requirements imposed by the NRC and bring stability to the programs that make America's nuclear power plants the most secure industrial facilities in the country.

CONCLUSION

America's 103 nuclear power plants comprise a critical element of our energy portfolio. Nuclear power is vital not only to our nation's energy security and economic future but also to our environmental and clean air goals. The industry continues to operate nuclear plants safely and efficiently. During the past decade, performance and safety have been consistently at, or near, record levels. In addition, nuclear power plants also are the most secure industrial facilities in the country.

The nuclear industry has significantly increased the amount of electricity that it generates over the past two decades. But for the nuclear industry to continue generating three-quarters of our nation's emission-free electricity, new nuclear plants must be built. The industry has made great strides toward its goal of constructing new nuclear plants and is committed to achieving this objective in the near term.

The NRC plays an important role in the nuclear energy sector. Achieving the goal of new plant construction depends on a stable regulatory environment, one that assures the safe operation of our plants. The NRC has made significant progress toward this end, yet more must be done. The NRC must continue to modernize its regulatory environment to incorporate safety-focused principles. For the nuclear industry to continue to play an important role in our nation's energy and environmental future, the NRC must be more effective and more efficient.

RESPONSES BY MARVIN FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

Question 1. In your opinion, with the resident inspectors, is it necessary today to continue having four NRC regions as well?

Response. We believe it is likely that the NRC could gain additional efficiencies and effectiveness by further consolidation of its regional offices. As noted in my testimony, the NRC's budget and overall staffing levels have increased significantly over the past several years. According to its budget request for fiscal year 2000, the NRC was to have 2,810 full time equivalent employees. But, by fiscal year 2005, that number had increased to 3,109. Most of this increase reflects efforts to address uprates, relicensing, new plant licensing, emergency preparedness and security. While these are areas the industry recognizes as priority activities requiring NRC resources, we believe the NRC has other areas where resource commitments could be decreased or reassigned to address the priority areas and where efficiencies could be gained-both improving NRC regulatory effectiveness and also decreasing licensee costs. Specifically, recognizing the extremely high level of plant performance in the industry, the more effective and safety-focused reactor oversight process, and the changes in ownership and management of operating plants in the industry, the NRC should be able to decrease resources committed to inspections and should seriously consider further consolidation of their regional offices.

With specific regard to the regional offices, a key factor that should be considered in evaluating the structure of the regional offices is the amount of industry consolidation that has taken place. When the regional offices were created, all of the operating units owned by an individual utility were located in the same NRC region and one regional office would interface with the utility management team. Today, we have individual utilities that own operating units in multiple regions, creating a situation where multiple regions are interacting with one utility management group. We don't believe this is necessarily the most effective way for the NRC to oversee company performance, or for licensees to effectively interact with the regulator.

The industry also believes that the NRC could become more efficient by eliminating, or consolidating its regional offices. Each regional office has approximately 65 positions that do not have any direct inspection responsibility. The functions of these individuals include management positions, administrative staff, public affairs offices, travel offices, etc. There are also considerable facility-related costs.

In assessing its overall organizational staffing levels, the NRC should also avoid creating large new permanent staff positions to handle short-term resource requirements. A specific example where this appears to be the case is in the area of security. With the changes to the regulatory requirements and to licensee plans and strategies, the NRC has faced a "bow-wave" of activities over the past 3 years. However, going forward, the industry, not the NRC, has the bulk of implementation requirements. NRC should assess their staffing needs, everywhere and particularly in the area of security, based upon a longer-term perspective of fulfilling their responsibilities and be careful to not establish large organizations that do not have relevant longer-term activities to fulfill.

In summary, the industry believes that the changing regulatory environment as well as the changing nature of the industry has provided opportunities for the NRC to review and evaluate its staffing levels and that the NRC has significant opportunities to increase both efficiency and effectiveness by both structural organizational changes and more focused staff assignments. Consolidating its regional offices is but one example of how legitimate increases in staffing levels in some areas could be offset by decreases elsewhere without diminishing NRC's effectiveness.

Question 2. Has NEI noticed a difference in the way the NRC conducts their enforcement actions since they have been moving toward risk-based decisionmaking?

Response. The enforcement program changes that were put in place coincident with the revised Reactor Oversight Process have resulted in enforcement actions that are much more closely tied to the significance of the performance issue. This is a much improved process and has led to a better safety focus on performance issues. However, further enhancements can be made.

In our view, there remain compliance requirements that have little or no safety significance. For example, over 98 percent of the NRC's inspection findings are determined to have little or no safety significance. The new enforcement policy appropriately defers these issues to licensee management for resolution as part of the plant's corrective action program, with follow-up from the resident inspector to ensure the issues are properly addressed. In many cases, these issues had already been identified by the licensee. What this result says is that significant NRC inspection resources are being committed to issues of low, or no safety significance.

While the output from the Reactor Oversight Process is successfully focusing NRC resources on safety-related issues, the fact that 98 percent of the inspection findings have little or no safety significance, is indictive of a situation where the inspectors are inspecting existing codified regulations which are not safety focused. In essence, while the oversight process and its enforcement process have been made safety-focused, many of the existing codified regulations are not safety-focused. This is a primary area where the NRC's inspection/enforcement requirements can be more risk-informed.

While the Commission is committed to addressing this issue, and while some progress is being made in revising outdated and ineffective regulatory requirements, the pace of change is far too slow to provide any significant improvement in the foreseeable future. The Commission should set a goal of eliminating or modifying those regulations that have little safety value within 5 years. In an attempt to facilitate such changes, the industry has provided the NRC with a white paper describing a new, risk-informed regulatory framework, which includes sample regulation language that is risk-informed and performance-based where appropriate. The new framework is technology neutral and could be applied to both current and future plants.

RESPONSE BY MARVIN FERTEL TO AN ADDITIONAL QUESTION FROM SENATOR JEFFORDS

Question. Mr. Fertel, in light of the consolidation in the nuclear industry you describe in your testimony, do you think the NRC should be doing more to track wastes and fuels?

Response. The industry fully recognizes and accepts its responsibility to safely and securely control and manage fresh nuclear fuel and all byproducts, including spent nuclear fuel generated at the plants. We find the recent, though very limited, incidents unacceptable from a credibility and public confidence perspective, though they posed no threat to public health and safety.

The NRC currently has strict regulatory requirements regarding the control and recordkeeping associated with special nuclear material, including new fuel, spent nuclear fuel, high-level wastes and low-level wastes. To meet these requirements, every commercial nuclear power plant utilizes computerized systems to track the movements and storage locations of all nuclear materials. Every delivery to the site and transports away from the site are tracked and recorded.

The industry recognizes that there have been three recent problems identified that raise questions regarding the effectiveness of the current regulations. However, events contributing to the recently identified concerns occurred decades ago. At the Vermont Yankee plant, the used fuel pieces that could not be properly accounted were subsequently found at the plant in the used fuel storage pool. In the Millstone event, fuel rods that were also unaccounted for were determined by the NRC to not be a public safety hazard and that they were most likely disposed of in a low-level waste facility and thus properly sequestered away from the public. The most recent problem is expected to result in finding the material in the pool.

The industry and the NRC have proactively investigated these circumstances to develop lessons learned and initiate corrective actions. In addition, the NRC has informed all licensees about these circumstances and expects the licensees to review the effectiveness of their individual material control and accounting programs in order to avoid similar problems at their facilities.

The consolidation of the industry, as described in my testimony, has little or no impact upon the NRC's ability to control and track nuclear materials at the sites owned by those companies. Regardless of the owner, the requirements are clear and the recordkeeping should be accurate. Also, with respect to consolidation, a valid argument could be made, for example, that the consolidation and thus shared management of several facilities will result in better and more uniform management practices.

In our view, these few incidents, while undesirable, did not pose a threat to health and safety. On the positive side, they demonstrated the value of the inspection and reporting requirements imposed by the NRC, illustrated the transparency of the NRC process to the public, resulted in a very systematic resolution of the identified problem, and provided lessons-learned to the NRC and he industry. As such, we believe the existing regulatory requirements are both adequate and effective. The strength of these tracking systems and the utilities commitment to safety have resulted in what in an excellent overall record of controlling and tracking nuclear material by the NRC.

RESPONSES BY MARVIN FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1a. What are the human capital needs in the nuclear industry?

Response. The nuclear energy industry recognizes that it faces a human resource challenge. It has an aging work force, which will require careful evaluation and comprehensive planning in order for the industry to meet its human resources needs over the next decade.

In 2003, NEI completed a comprehensive staffing study which indicated that nearly 28 percent of workers at generating stations and 35 percent of workers at key suppliers will be eligible to retire within the next 5 years. (A copy of the study is attached.) Further, significant skills shortages were identified in the 2001 NEI Staffing Study. Absent some proactive industry and government initiatives, we project that demand will exceed supply for nuclear engineers by 56 percent and health physicists by 63 percent. It is important to keep in mind that all of these assessments were based on the continued operation of the current fleet and have not considered the work force demands for the construction and operation of new plants, which could add thousands to the work force need in the latter part of the next decade.

We are particularly concerned that there are very few education and training programs available at universities or community colleges for health physicists, radiation protection technicians, chemistry technicians, instrumentation and control technicians (analogue) and non-destructive examination professionals.

Question 1b. What can be done to help human capital development in the industry?

Response. As result of our concerns in this area, NEI recommends continued support for University Programs in the Department of Energy's Office of Nuclear Energy at the $27.5 million level and expansion of these programs to include funding support for Health Physics programs. In addition, support for the development of e-learning and community college initiatives in a variety of fields including radiation protection, instrumentation and control, and non-destructive examination would greatly assist the industry to successfully tackle its work force challenges. In this area, NEI urges support for the Department of Labor's High Growth Job Training Initiative at the administration requested funding level of $250 million specifically for community college programs. Finally, NEI recommends that all of the agencies whose mandates encompass supporting education and training in this area, including the National Science Foundation, the Departments of Energy, Labor and Education work collaboratively with the industry in new program design and development to ensure that appropriate, seamless and adequate programs are supported and to avoid needless duplication of programs.

In addition to the broad-based industry activities, the Federal Government can play a large role in assisting the industry and the American worker in gaining the education and job skills necessary for employment in the nuclear industry. Furthermore, programs that build a competency in this area will also help ensure a pool of qualified candidates with nuclear and radiological skills for the Departments of Energy, Defense and Homeland Security, the Nuclear Regulatory Commission and the national laboratory system.

Question 2. Do you agree or disagree with GAO's recommendation that the NRC should develop a methodology to assess early indications of deteriorating safety at nuclear power plants? Why? What do you think the NRC should do to address safety culture at nuclear plants around the country?

Response. The NRC certainly has the responsibility to assess indications of deteriorating safety at nuclear plants and to take appropriate regulatory actions. They had that responsibility prior to Davis-Besse and the responsibility remains.

There is, however, single metric the NRC can use to effectively evaluate safety culture. Therefore, when the GAO says the NRC should develop a "methodology" to assess safety culture, I believe that the best manner for the NRC to achieve that goal is for the NRC to ensure that it is effectively integrating safety culture insights from all its activities. My following comments explain how I would implement such a "methodology".

The NRC has been very systematic in reviewing the Davis-Besse event to identify improvements in their assessment process. A lessons-learned task force (LLTF) was established by the NRC to develop recommendations from the Davis-Besse event to improve the NRC's regulatory process. I believe the actions taken are consistent with the industry's view of the event.

While the creation and maintenance of the desired safety culture is the responsibility of corporate and plant management, the NRC does have an important role to ensure that the desired safety culture exists. In 1989 the Commission issued a policy statement that outlined the expectation that the management of a nuclear plant has the duty and obligation to foster the development of a "safety culture" at each facility and provide a professional working environment that assures safe operations.

The NRC currently has many tools to assure that result. As there are generally two full time inspectors at every nuclear plant site, the NRC has a real-time view of the performance of every nuclear plant. The NRC also performs inspections of systems and components during operation and shutdown conditions. These inspections give the NRC the ability to make continuous observations of performance, including safety culture.

Following the Davis-Besse incident, the NRC through the LLTF, recognized several areas for improvement in observation training and questioning attitude of the resident inspectors regarding the maintenance of a safety culture at the plant and has improved its oversight by enhancing the recognition of safety culture concerns by the resident inspectors.

The reactor oversight process (ROP), through the performance indicators and cross-cutting issue inspections, provides a view of unit performance, material condition and culture at the plants. Complimentary to the ROP is the corrective action program at every nuclear plant. Not only does the NRC have real time access to the daily review of corrective action documents but they also perform periodic inspections of the performance indicators, corrective action programs and work activities. These inspections provide valuable insight into the way safety issues are identified, trended and resolved, all providing good indications of the safety culture at the plants.

The NRC should use all the program reviews, inspections and direct oversight by resident inspectors discussed above plus the allegation and employee concerns programs, which is a component of a safety conscious work environment, to review safety culture at nuclear plants.

In addition, the NRC has a memorandum of agreement with the Institute of Nuclear Power Operations (INPO) to allow them to place observers on the evaluation teams that perform the every 2 year plant evaluations for the industry. These teams specifically look at the safety culture of the plant and review the results of the evaluation directly with the company's chief executive officer. INPO has increased its focus on safety culture since the Davis-Besse incident.

The strength of safety culture can best be determined by a combination of direct contact with station personnel and management, reviewing results of plant performance, trending allegations resulting from the safety conscious work environment, routine inspections, and inspections of the corrective action process. The onsite resident inspectors along with the various visiting inspectors provide continuous, as well as, periodic sampling of the safety culture at a nuclear plant. The inspectors observe behavior during routine operation, refueling outages and special evolutions. They can determine, if properly trained, when there is a major shift in culture at a plant. This concept was recently demonstrated by the identification of a problem and the significant actions taken by the NRC at the Salem-Hope Creek nuclear plants.

Taking into consideration the changes the NRC has made based upon their Davis-Besse LLTF plus all the activities and opportunities to observe and evaluate safety culture, the NRC currently has the ability to effectively assure that every site maintains a safety culture. As part of its "methodology", the NRC should continue to integrate, and look for ways to improve, the input from its systematic oversight, inspections and safety conscious work environment related allegations to gather the complete picture of safety culture at a plant.

Question 3a. What has the industry learned from the Davis-Besse incident? What changes have been made across the industry?

Response. The industry recognizes that the Davis Besse incident was the result of a significant failure on the part of the company, the industry, as well as the NRC. As such, it has taken many actions to not only identify lessons-learned but also to assure that every plant has acted to implement changes and recommendations as a result.

The industry participated on many of the teams that were sent to Davis-Besse to help determine root cause and corrective actions. Due to this direct participation, several changes have occurred throughout the industry. As discussed, subsequently in this answer, INPO has been the major driver in changing its processes and in driving change in the industry.

One of the major lessons-learned was a heightened awareness of plant material condition and degradation mechanisms. To address this issue, senior industry leadership through NEI developed an initiative to address the material condition and degradation at nuclear plants. This initiative is more fully explained in my written testimony already submitted to the subcommittee. Because of this increased focus on materials, the industry has taken a very aggressive stance on inspections and repair/replacement of components susceptible to material degradation, e.g. steam generators and reactor vessel heads.

Question 3b. Please detail the work that Nuclear Energy Institute (NEI) and the Institute of Nuclear Power Operations (INPO) has done on safety culture and safety-conscious work environment.

Response. With respect to safety culture, NEI has played a role in activities relating to safety culture and safety conscious work environment (SCWE). NEI has sponsored forums and formed working groups to address safety culture and SCWE issues. NEI has assisted in the development of guidelines for principles associated with safety culture and guidelines for developing robust employee concerns programs which is an important aspect of SCWE. The latter guideline has been shared on our public web site so that all nuclear related industries can share our collective expertise and lessons learned.

Following the Davis-Besse event, major systematic changes were made to INPO's programs. From an industry perspective, the assessment and oversight of safety culture for the industry, falls directly within the domain of the INPO. INPO has significantly changed its oversight of nuclear plants, particularly in the area of safety culture, as a result of the Davis-Besse incident.

INPO established a very aggressive internal program review related to safety culture following the Davis-Besse incident in the fall 2002. This review developed recommendations that were acted upon by the INPO executives resulting in comprehensive and broad-based corrective actions that touched every cornerstone and technical employee. Many of the corrective actions were focused on the plant evaluation process and how INPO evaluates safety culture. Safety culture "touch points" were adopted from pre-evaluation analysis to preexit meeting to exit meeting with the utility CEO. Safety culture is now discussed with each utility CEO as part of the evaluation process.

INPO also conducted a series of workshops for the industry to cover the lessons learned from Davis-Besse and INPO. These work shops were regional throughout the United States and included participation by the Davis-Besse management team.

Along with the internal review and workshops, INPO also issued a Significant Operating Experience Report (SOER) in November 2002 to be implemented by every U.S. nuclear utility. The SOER contained three specific recommendations summarized as follows: (1) to discuss the Davis-Besse case study outline (provided with the SOER) with all nuclear organization managers and supervisors. Continue this effort periodically with all new managers and supervisors. Include a discussion of the technical and non-technical contributors to the event; (2) to conduct a self-assessment to determine to what degree your organization has a healthy respect for nuclear safety and that nuclear safety is not compromised by production priorities. The self-assessment should emphasize the leadership skills and approaches necessary to achieve and maintain the proper focus on nuclear safety. The components of this self-assessment should be included in the plants on-going self-assessment program; and (3) to identify and document abnormal plant conditions or indications at your station that cannot be readily explained. Pay particular attention to long-term unexplained conditions. Thoroughly investigate and evaluate each condition individually and in an aggregate to determine the causes and potential consequences and to ensure timely and effective resolution.

INPO members were asked to provide a copy of their internal self-assessment required by the SOER to be reviewed by INPO mangers and executives. The aggregate findings of the self-assessments were shared with the utility CEOs at the November 2003 CEO Conference. The discussion highlighted some of the industry's safety culture best practices, including how some CEOs were personally communicating their safety culture expectations.

In addition, INPO developed a principles document with the assistance of several prominent current and retired nuclear industry executives and a smaller number of culture experts. The document is titled, "Principles for a Strong Nuclear Safety Culture". (A copy is attached.)

The document was introduced at the November CEO Conference with the expectation that the CEOs will use the principles during discussions with utility senior management and that each utility will incorporate the principles into their nuclear program. As part of INPO's systematic evaluations of individual plants, the implementation of the principles will be assessed.

Safety culture discussions have been incorporated into the appropriate leadership courses and seminars offered through INPO. These seminars cover all levels of the nuclear plant management structure. Safety culture will also continue to be a primary theme at the Annual INPO-CEO Conferences.

In conclusion, the lessons-learned from the Davis-Besse event have resulted in major changes to almost all of the ongoing INPO programs, most prominently the evaluations program and its leadership training programs. Of equal significance, the importance of safety culture and its characteristics are now a fundamental theme in all interactions with CEO's, NEI, INPO and the leadership in the industry are committed to prevent events like what occurred at Davis-Besse. The increased focus on and to substantive programmatic changes made to address safety culture should result in success on that commitment.

Building on the Principles
for Enhancing Professionalism

Principles for a Strong Nuclear Safety Culture

(Preliminary)

November 2003

INPO®

Introduction

Principles for a Strong Nuclear Safety Culture describes the essential attributes of a healthy nuclear safety culture (hereafter "safety culture"), with the goal of creating a framework for open discussion and continuing evolution of safety culture throughout the commercial nuclear electric generating industry. The principles and associated attributes described have a strong basis in plant events.

Basic principles are addressed herein, rather than prescribing a specific program or implementing methods. These principles and attributes, if embraced, will influence values, assumptions, experiences, behaviors, beliefs, and norms that describe what it is like to work at a specific facility and how things are done there. Principles appear in boldface type. Attributes help clarify the intent of the principles.

Utility managers are encouraged to make in-depth comparisons between these principles and their day-to-day policies and practices, and to use any differences as a basis for improvement.

This document is complementary to, and should be used in conjunction with, previously published principles documents. It builds on and supports *Principles for Enhancing Professionalism of Nuclear Personnel*, March 1989. It contains concepts consistent with those described in *Management and Leadership Development*, November 1994; *Excellence in Human Performance*, September 1997; *Principles for Effective Self-Assessment and Corrective Action Programs*, December 1999; and *Principles for Effective Operational Decision-Making*, December 2001.

This initial version of the document is issued in preliminary form. Suggestions for improvement and comments from the industry are welcomed and encouraged. A final version will be published after industry suggestions and comments are incorporated.

This document was developed by an industry advisory group in conjunction with the staff of the Institute of Nuclear Power Operations (INPO) and with broad input from the U.S. nuclear industry.

Background

A variety of **watershed events** over the years have influenced the safety culture at U.S. nuclear electric generating plants. The industry had its first significant wake-up call in 1979 as a result of the accident at Three Mile Island Nuclear Station. Many fundamental problems involving hardware, procedures, training, and attitudes toward safety and regulation contributed to the event.

In 1986, the Chernobyl accident was a stark reminder of the hazards of nuclear technology. This accident resulted from many of the same weaknesses that led to the Three Mile Island accident. In addition, it highlighted the importance of maintaining design configuration, plant status control, line authority for reactor safety, and cultural attributes related to safety.

Response from industry and regulatory organizations to both these events was sweeping. Improvements were made in standards, hardware, emergency procedures, processes, training (including simulators), emergency preparedness, design and configuration control, testing, human performance, and attitude toward safety.

More recent events, such as the 2002 discovery of degradation of the Davis-Besse Nuclear Power Station reactor vessel head, have highlighted problems that develop when the safety environment at a plant receives insufficient attention. A theme common in these cases is that, over time, problems crept in, often related to or a direct result of the culture at the plant. Had these problems been detected and resolved, the events could have been prevented or their severity lessened.

These events and the notion that culture is a key ingredient in the overall success of the plant form the basis for this document.

Organizational culture is the shared basic assumptions that are developed in an organization as it learns and copes with problems. The basic assumptions that have worked well enough to be considered valid are taught to new members of the organization as the correct way to perceive, think, and feel. Culture is the sum total of a group's learning. ***Culture is for the group what character and personality are for the individual.***

In addition to a healthy organizational culture, each nuclear station, because of the special characteristics and unique hazards of the technology—radioactive byproducts, concentration of energy in the reactor core, and decay heat—needs a strong **safety culture**.

> ***Safety culture: An organization's values and behaviors—modeled by its leaders and internalized by its members—that serve to make nuclear safety the overriding priority.***

Implied in this definition is the notion that nuclear power plants are designed, built, and operated (and intended) to produce power in a safe, reliable, efficient manner; that the concept of safety culture applies to every employee in the nuclear organization, from the board of directors to the individual contributor; that the focus is on nuclear safety, although the same principles apply to radiological safety, industrial safety, and environmental safety; and that nuclear safety is the first value adopted at a nuclear station and is never abandoned.

The strength of a facility's safety culture could lie anywhere along a broad **continuum**, depending on the degree to which the attributes of safety culture are embraced. Even though safety culture is a somewhat intangible concept, it is possible to determine, based on observable attributes, whether a station tends toward one end of the continuum or the other.

A **safety-conscious work environment** (freedom to raise concerns without fear of retribution) is one, but only one, element of a strong nuclear safety culture.

Commercial nuclear electric generating plants are designed, built, and operated to produce electricity. **Safety, production, and cost control** are natural goals for the operation of such a plant. These outcomes are quite complementary, and most plants today achieve high levels of safety, impressive production records, *and* competitive costs, reinforced by decisions and actions made with a long-term view. This perspective keeps safety as the overriding priority for each plant and for each individual associated with it.

Principles for a Strong Nuclear Safety Culture

Safety culture: An organization's values and behaviors—modeled by its leaders and internalized by its members—that serve to make nuclear safety the overriding priority.

The following principles are described in this document:

1. Nuclear safety is everyone's responsibility.
2. Leaders demonstrate commitment to safety.
3. Trust permeates the organization.
4. Decision-making reflects safety first.
5. Nuclear is recognized as different.
6. A "what if" approach is cultivated.
7. Organizational learning is embraced.
8. Nuclear safety undergoes constant examination.

Principles and Their Attributes

1. Nuclear safety is everyone's responsibility.

Responsibility and authority for nuclear safety are well defined and clearly understood. Reporting relationships, positional authority, staffing, and financial resources are commensurate with and support nuclear safety responsibilities. Corporate policies emphasize the overriding importance of nuclear safety.

Attributes:

- The line of authority and responsibility for nuclear safety is defined from the board of directors to the individual contributor. Each of these positions has clearly defined roles, responsibilities, and authorities, designated in writing and understood by the incumbent.
- People and their professional capabilities, values, and experiences are regarded as the nuclear organization's most valuable asset. Staffing levels are consistent with the demands related to maintaining safety and reliability.
- Board members and corporate officers periodically take steps to reinforce nuclear safety, including site visits to assess management effectiveness first-hand.
- The line organization is the primary source of information and the only source of direction. Other parties, such as oversight organizations and committees, review boards, or outside advisors, that provide management information essential to effective self-evaluation are not allowed to dilute or undermine line authority and accountability.
- Relationships among utilities, operating companies, and owners are not allowed to obscure or diminish the line of responsibility for nuclear safety.
- The system of rewards and sanctions is aligned with strong nuclear safety policies and reinforces the desired behaviors and outcomes.
- All personnel understand the importance of adherence to nuclear safety standards. Healthy accountability is exercised at all levels of the organization for shortfalls in meeting standards.

2. Leaders demonstrate commitment to safety.

Executive and senior managers are the leading advocates of nuclear safety and demonstrate their commitment both in word and action. The nuclear safety message is communicated frequently and consistently, occasionally as a stand-alone theme. Leaders throughout the plant organization set an example for safety through their direct involvement in training and field oversight of important plant activities.

Attributes:

- Managers and supervisors practice visible leadership in the field by placing "eyes on the problem," coaching, mentoring, and reinforcing standards. Deviations from station expectations are corrected promptly.
- Continuous oversight is provided during safety-significant tests or evolutions.
- Managers and supervisors are personally involved in high-quality training that consistently reinforces expected worker behaviors.
- Leaders recognize that aggressive production goals can appear to send mixed signals on the importance of nuclear safety. Managers are sensitive to detect and avoid these misunderstandings.
- The bases, expected outcomes, potential problems, planned contingencies, and abort criteria for important operational decisions are communicated promptly to workers.
- Informal opinion leaders in the organization are encouraged to model safe behavior and influence peers to meet high standards.

3. Trust permeates the organization.

A high level of trust is established in the organization. There is a free flow of information in which issues are raised and addressed. Employees are informed of steps taken in response to their concerns.

Attributes:

- A variety of methods are available by which personnel can raise nuclear safety concerns, without fear of retribution.
- Employees are expected and encouraged to offer innovative ideas to help solve problems.
- Differing opinions are welcomed and respected. When needed, fair and objective methods are used to resolve conflict and unsettled differing professional opinions.
- Supervisors are skilled in responding to employee questions in an open, honest manner. They are recognized as an important part of the management team, crucial to translating safety culture into practical terms.
- Impacts of impending organizational changes (such as those caused by sale or acquisition, bargaining unit contract renegotiations, and economic restructuring) are anticipated and managed such that trust in the organization is maintained.
- Complete, accurate, and forthright information is provided to oversight, audit, and regulatory organizations.

4. Decision-making reflects safety first.

Plant personnel are systematic and rigorous in making decisions that support safe, reliable plant operation. Operators are vested with the authority and understand the expectation, when faced with unexpected or uncertain conditions, to place the plant in a safe condition. Senior leaders support and reinforce conservative decisions.

Attributes:

- The organization maintains a knowledgeable workforce to support a broad spectrum of operational and technical decisions. Outside expertise is employed when necessary.
- Plant personnel apply a rigorous approach to problem-solving. Conservative actions are taken when understanding is incomplete.
- Single-point accountability is maintained for important safety decisions, allowing for ongoing assessment and feedback as circumstances unfold.
- Managers regularly communicate to the workforce important decisions and their bases as a way of demonstrating and reinforcing a healthy safety culture.
- Candid dialogue and debate are encouraged when safety issues are being evaluated. Robust discussion and healthy conflict are recognized as a natural result of diversity of expertise and experience.
- Decision-making practices reflect the ability to distinguish between "allowable" choices and prudent choices.

5. Nuclear is recognized as different.

The special characteristics of nuclear technology are taken into account in all decisions and actions. Reactivity control, continuity of core cooling, and safety margin management are valued as essential, distinguishing attributes of the nuclear station work environment.

Attributes:

- Activities that could affect core reactivity are conducted with particular care and caution.
- Features designed to maintain critical safety functions, such as core cooling, are recognized as particularly important.
- Design and operating margins are carefully guarded and changed only with great thought and care. Special attention is placed on maintaining defense-in-depth.
- Equipment is meticulously maintained well within design requirements.
- Insights from probabilistic risk analyses are considered in daily plant activities and plant change processes.
- Plant activities are governed by comprehensive, high-quality processes and procedures.
- Employee mastery of reactor and power plant fundamentals, as appropriate to the job position, establishes a solid foundation to support sound decisions and behaviors.

6. A "what if" approach is cultivated.

Individuals demonstrate a questioning attitude by challenging assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. All employees are watchful for conditions or activities that can have an undesirable effect on plant safety.

Attributes:

- While individuals expect successful outcomes of daily activities, they recognize the possibility of mistakes and worst-case scenarios. Contingencies are developed to deal with these possibilities.
- Anomalies are thoroughly investigated, promptly mitigated, and periodically analyzed in the aggregate. Personnel do not proceed in the face of uncertainty.
- Workers do not live with conditions or behaviors that have the potential to reduce operating or design margins. These circumstances are promptly identified and corrected.
- Group-think is avoided through diversity of thought and intellectual curiosity. Opposing views are encouraged and considered.

7. Organizational learning is embraced.

Operating experience is highly valued, and the capacity to learn from experience is well developed. Training, benchmarking, and self-assessments are used to stimulate learning and improve performance.

Attributes:

- The organization avoids complacency and cultivates a continuous learning environment. The attitude that "it can't happen here" is not allowed in the organization.
- Training effectively upholds management's standards and expectations. Beyond teaching knowledge and skills, trainers are adept at instilling nuclear safety values and beliefs.
- Individuals are well informed of the underlying lessons learned from significant industry and station events, and they are committed to not repeating these mistakes.
- Expertise in root cause analysis is applied effectively to examine events and improve safety focus.
- Processes are established to identify and resolve latent organizational weaknesses that can aggravate relatively minor events if not corrected.

8. Nuclear safety undergoes constant examination.

Oversight is used constructively to strengthen safety and improve performance. Nuclear safety is kept under constant scrutiny through a variety of monitoring techniques, some of which provide an independent "fresh look."

Attributes:

- A mix of self-assessment and independent oversight reflects an integrated and balanced approach. This balance is periodically reviewed and adjusted as needed.
- Periodic safety culture assessments are conducted and used as a basis for improvement.
- The pitfalls of overfocusing on a narrow set of performance indicators are recognized. The organization is alert to detect and respond to indicators that may signal declining performance.
- The insights and fresh perspectives provided by quality assurance, assessment, and independent oversight personnel are valued.
- Senior executives and board members are periodically briefed on results of oversight group activities to gain insights into station safety performance.

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Safety Culture Advisory Group

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NEI Work Force Survey

May 2004

NEI
NUCLEAR ENERGY INSTITUTE

NEI Work Force Survey

May 2004

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Contents

Section I: Executive Summary

The nuclear energy industry faces a human resources challenge that will require careful evaluation and comprehensive planning: an aging work force.

The industry isn't alone in addressing this challenge. Overall, the median age of the U.S. labor force is rising, according to the U.S. Department of Labor's Bureau of Labor Statistics. By 2008, the median age will reach 40.7 years, reflecting the aging of the baby boomer generation—persons born between 1946 and 1964. Worker median age has risen steadily from 35.9 in 1988.

This report, compiled by the Nuclear Energy Institute,[1] examines the results of a survey undertaken by the NEI Work Force Issues Task Force in December 2003 to get a clearer picture of the future work force. The survey contains data from 20 owners or operators representing 84 of the nation's 103 operating commercial reactors. Other participants include major staffing augmentation firms, original equipment manufacturers, fuel suppliers and universities. The survey's findings reveal the extent of the challenge ahead.

Nuclear power generators may experience up to 46 percent attrition over the next five years, representing an estimated 26,000 workers leaving the industry. The survey found that approximately 16,000 workers will retire and 10,000 will be lost because of general attrition.

More than 60 percent of the projected attrition is expected to come from retirement, nearly two and one half times the current portion of attrition generated by retirement. Within the nuclear energy industry, retirements generally occur around age 55. Currently, half of the industry's workers are 48 and over. Fewer than 7 percent of the industry's workers are over 57 years of age, 17 percent of workers are between 53 and 57 years of age, and nearly 26 percent are between 48 and 52 years of age.

Further, the industry may be unprepared for the level of general attrition in the next three to five years. Historic non-retirement attrition is more than 4.5 percent annually, based on empirical rates for the past three years. In June 2003, many companies in the nuclear energy industry calculated future non-retirement attrition that could range between 1.8 percent and 2.4 percent annually—which may underestimate future behavior. Although several nuclear generators reported reductions in forces during the study period, the overall impact on general attrition rates was not significant.

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[1] The Nuclear Energy Institute is the policy organization of the nuclear energy and technologies industry and participates in both the national and global policymaking process.

If the economy improves and the labor market tightens, general and retirement attrition may rise significantly. For instance, total attrition of more than 7 percent occurred during the technology boom in 2000.

During the past two years, many workers postponed retirement because of lack of confidence in the economy and declining personal investment values. As investment portfolio values increase and consumer confidence rebounds, retirement rates may accelerate.

On the other side of the age spectrum, the industry has not invested in developing a staffing "pipeline" to replace future retirees. Only 7 percent of nuclear power generation employees are 32 and younger—3 percent are under 27 years of age, while 4 percent are between 28 and 32 years of age.

Additionally, the industry continues to face recruiting challenges in the areas of ethnic diversity, women candidates, nuclear engineering and health physics.

Nuclear power generators are not alone in facing the challenges of an aging work force. Other segments also are feeling the personnel pinch.

Key suppliers anticipate that 35 percent of their workers will be eligible to retire through 2008, while another 18 percent are likely to leave through general attrition. On a positive note, the pipeline for key supplier employees is significantly better than that of power generators. Although workers who are 32 and younger make up 7 percent of the nuclear power generation work force, they comprise 14 percent of the supplier work force.

The study also found that peak worker demand to support outages in some fields, such as radiation protection, soon may exceed supply. Approximately 4 percent of outage support workers will retire through 2008, according to the survey. Because of the temporary nature of work related to outage support, 24 percent of the workers are expected to leave through general attrition during the next four years.

As for universities, the survey showed that a relatively high percentage of employees are 42 and younger, although many may represent graduate students who are employed by university nuclear engineering departments in non-tenure-track teaching or non-faculty positions while pursuing their degrees. However, nearly 33 percent of current faculty received their doctorates more than 30 years ago, according to the 2003 American Nuclear Society's Nuclear Engineering Sourcebook. This distribution indicates that the junior faculty may be insufficient to fill senior faculty positions of those who will soon retire.

Key Recommendations

Staffing concerns in the nuclear energy industry are critical, but not a crisis. The industry has many tools available to address this issue, including:

- improving retention of new employees, which has the added benefit of reducing recruiting and training costs
- delaying retirement for older staff, which will temporarily reduce the replacement pressure
- increasing the number of "pipeline" employees, which will increase headcount and payroll in the short run, but is the only long-term solution
- continuing to improve work processes and management practices to increase productivity and function with reduced headcount.

NEI and the Work Force Issues Task Force also recommend a renewed focus on training and apprenticeship programs to reduce the amount of time an employee needs to acquire skills and competencies. Equally important, accurate and realistic staff planning must be developed that looks at a longer time horizon (five to 10 years) and includes issues such as employee development plans, succession planning and knowledge transfer.

Further, the task force suggests investments in expanding the labor pool to reduce pressure on recruiting, additional nuclear career branding to attract young people to the industry, and continued recruiting efforts for underrepresented communities. Demographers expect women and minorities to become substantially larger proportions of the future work force.

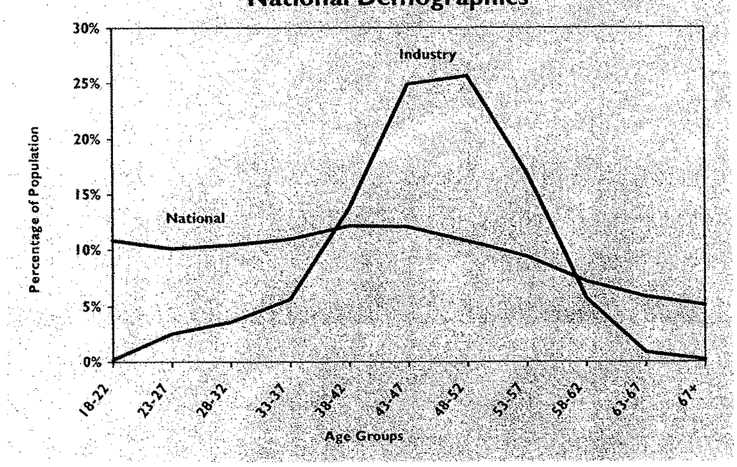
Section 2: Introduction

The purpose of this report is to help the nuclear energy industry identify specific challenges that will be encountered over the next five years and to recommend actions that will help mitigate adverse effects of the changing work force.

An aging work force is not unique to the nuclear industry, the electric power industry or the energy sector broadly. Across the United States, someone turns 50 approximately every seven seconds.[2] By some estimates, half of the nearly 80 million baby boomers are expected to retire by 2010, while the remainder is expected to leave the labor market by 2020. At the same time, fewer students plan to study math, science and engineering, which will lead to a decline in the labor pool available for technology-based industries like nuclear power generation.

In the nuclear energy industry, this aging trend is made even more pronounced by the hiring and retention practices of the industry over the past two decades. Although many technology-oriented companies hired continuously during the 1980s and 1990s, the nuclear industry hired staff largely at the time of plant construction and commissioning.

Figure 2-1.
National Demographics



Sources: NEI 2003 Work Force Survey,
2000 Census by U.S. Bureau of Labor Statistics

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[2] Washington State Department of Personnel, "Impact of Aging Trends on the State Government Work Force," June 2000.

During the late 1980s and early 1990s, many in the nuclear energy industry expected plants to operate only for the term of their original 40-year license. With dramatic improvements in economic performance and the renewal of licenses for existing facilities, many nuclear generating stations are now expected to operate for an additional 20 years.

Further compounding the nuclear industry's demographic trend were the consolidation of the nuclear generating sector and growing economic pressures. With the advent of electric deregulation and the decoupling of generation and transmission systems, additional emphasis was placed on economic performance.

Nearly 70 percent of non-fuel operations and maintenance costs are labor-related.[3] This prompted nuclear generators to seek ways to increase worker productivity, improve work management practices and reduce unnecessary on-site headcount.

These realities led to a period within the nuclear energy industry where hiring, when it did occur, centered on seasoned professionals from within the industry rather than younger staff entering the industry. Generally, this trend led to today's demographic picture—a bubble in the work-force population between 38 and 52.

[3] Data provided by the Electric Utility Cost Group.

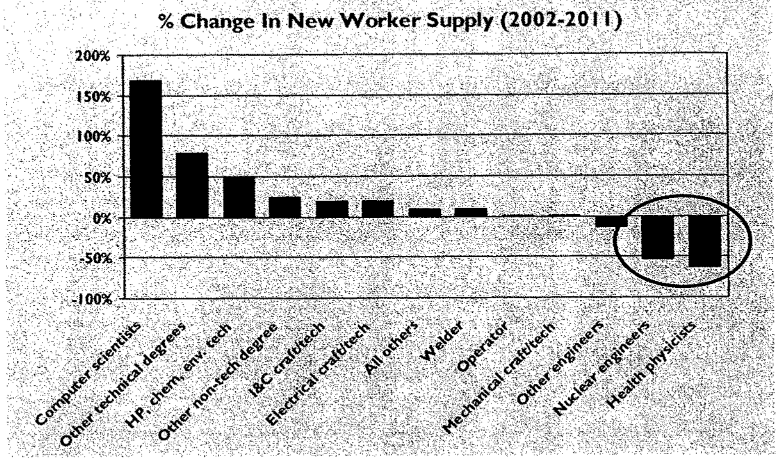
Section 3: Survey Background

In 2001, NEI formed a Recruiting and Staffing Task Force (later renamed the Work Force Issues Task Force) at the instruction of the Nuclear Strategic Issues Advisory Committee. The task force had multiple missions, including:

- maximizing industry, government and academic approaches focused on meeting the nation's nuclear technology staffing needs
- articulating policy on the national imperative to meet these staffing demands
- enhancing existing programs aimed at retaining current staff and recruiting new staff, and establishing new programs, where needed
- setting nationwide priorities and coordinating activities among all participants.

As part of its charter, the task force launched an industrywide staffing survey that looked at the entire nuclear industry, including power generation, outage support, front- and back-end fuel cycle, architectural and engineering firms, universities, government, and national labs. The survey was designed to examine the supply and demand for individuals with specific skills needed to staff the industry in the following decade (2001-2011). The poll identified significant staffing challenges in nuclear engineering, health physics and skilled crafts.

Figure 3-1.
Worker Supply Projected to Decrease in Key Areas



Source: NEI 2001 Work Force Survey

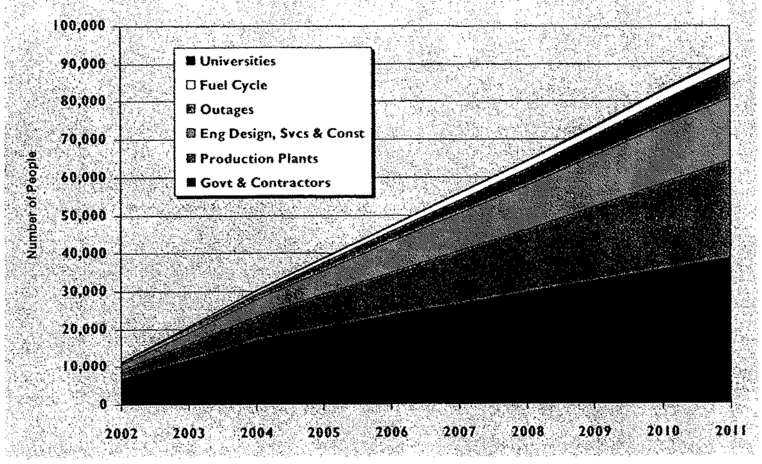
The survey's findings galvanized industry, government and nonprofit support for nuclear engineering programs. Since the release of the 2001 survey, the industry has witnessed increased university enrollments in nuclear engineering programs, significant rises in funding for university programs in nuclear engineering, and renewed support for test and training reactors located at many institutions of higher learning.

Federal government support for university programs in nuclear engineering increased from $12 million in 2000 to $22.9 million in 2004. Additionally, industry matching grants have supported numerous programs.

"The Energy Department is very pleased with the progress we have made in reversing the decline in nuclear engineering in the United States," William Magwood, director of DOE's Office of Nuclear Energy, Science and Technology told the Senate Appropriations Energy and Water Development Subcommittee earlier this year.

In 1998, approximately 500 students were enrolled as nuclear engineering students in U.S. universities—down from almost 1,500 in 1992. "After several years of focused effort, the United States now has over 1,300 students studying nuclear engineering," Magwood said. "That number is set to increase further, as strong programs—such as those at Purdue and Texas A&M—continue to grow, and we see new programs start at schools such as South Carolina State University, the University of South Carolina, and the University of Nevada-Las Vegas."

Figure 3-2.
Cumulative Demand for New Workers



Source: NEI 2001 Work Force Survey

In February 2004, Rep. Judy Biggert (R-Ill.), chairwoman of the House Science Subcommittee on Energy, introduced legislation designed to ensure the future of university programs in nuclear engineering and health physics, as well as the continued operation of university test and training reactors.

In addition, numerous new programs in nuclear science and technology have been developed at the associate's and baccalaureate degree levels.

The 2001 NEI Staffing Survey looked at a broad industry segment over a time period. Although this was useful for the purpose of identifying skill shortages, it was not helpful in identifying the time horizon for retirement and other attrition that will affect staffing at nuclear power plants and key suppliers. Further, in a time when reducing excessive headcount at power plants is still an economic reality for efficient business operation, understanding the types and timeframe of retirement and non-retirement attrition is increasingly necessary.

2003 Staffing Survey

In June 2003, the NEI Work Force Issues Task Force discussed the current status of the nuclear work force. The group recognized the impending retirement of a significant portion of the industry's employees and the lack of new and mid-career workers to replace them. Many individuals noted that they planned to replace departing workers with trained workers from other nuclear generating facilities or from vendors. As the discussion evolved, the group realized that they would attempt to recruit from the same small pool of skilled workers.

With this realization, the 2003 staffing survey was launched. The survey collected industry data from roughly 85 percent of the operating reactors based on demographic characteristics of onboard staff as of June 30, 2003. The survey utilized demographic profiles, empirical "survivor" models, historic attrition rates and independent data verification to reach its conclusions. The results were peer reviewed by the NEI Work Force Issues Task Force.

The survey contains data from 20 owners or operators representing 84 of the nation's 103 operating commercial reactors. Other participants include major staffing augmentation firms, original equipment manufacturers and universities.

Staffing data was collected based on the categories set forth in the Standard Nuclear Performance Model-Revision 3.[4] The first data collection tool identified the age, years of service and job category for each individual included in the survey. This information was

[4] NEI/Electric Utility Cost Group Task Force Report, "The Standard Nuclear Performance Model—A Process Management Approach—Revision 3," Electric Utility Cost Group Data Template, December 2002.

then compared with headcount data collected by the Electric Utility Cost Group to verify accuracy and to allow the data to be inflated to represent the total employment characteristic for the 103 operating commercial reactors.

In addition, a second data collection tool was used to identify historic and projected rates for retirement and non-retirement attrition. The tool also collected information on retirement savings and pension programs, major recruiting challenges, staffing plan details, and the number of positions left unfilled at survey respondent organizations.

Survey Analysis

Analysis of the survey's data was completed by members of the Work Force Issues Task Force during December 2003 and January 2004. This task force is comprised of professionals from a variety of disciplines within the nuclear industry, including engineering, human resources, organizational development and recruiting. The task force also includes representatives from government, key suppliers, nuclear industry organizations, nuclear licensees and organized labor.

Approach

The task force adopted a career-ladder approach to analyze data from the survey. This approach recognized that because of the high level of training required for employment in the nuclear industry, many of the specialized positions at generating stations and at key suppliers are filled by long-time employees who have advanced through various positions within the industry.

Further, many on the task force noted that senior positions are most often filled through internal promotion. In this sense, internal promotion is not necessarily promotion within the same company, but promotion within the nuclear industry. Finally, the demographics indicated by the survey responses showed few individuals in pipeline or mid-career positions. Many employees at generating stations have been employed in the industry for a significant period of time.

The career-ladder approach identifies typical sources of supply for employees within each identified career ladder. It also recognizes that typical career paths exist for employees and that, as workers progress through this career ladder, they have the opportunity for advancement into a variety of specialized positions within the industry. Additionally, this approach acknowledges that a training and employee development pipeline exists for each distinct career ladder.

Based on the survey findings, the task force identified four distinct career ladders within the generating stations: engineering, operations, skilled crafts and radiation protection. The task force also examined other industry segments, including key suppliers, outage support firms and universities.

Each of these career ladders has distinct entrance and training requirements. They often include a number of job titles with similar attributes; however, the ladders are aligned functionally. The approach also allowed the group to examine the number of individuals who could be promoted from their specific career group to fill senior positions.

Besides using a career-ladder approach to examine industry demographic trends, the task force asked the following questions for each career ladder:

- How many positions will need to be filled in the next five years?
- Where do we typically recruit for these positions?
- What is the training pipeline for these groups, specifically regarding education, on-the-job training, certification and proficiency?
- What are the risks of inaction?

Section 4: Work Force Survey Results

The aging work force is a topic of national interest. Numerous organizations have examined the issue and its effects on employment trends in both the public and private sectors. For the nuclear industry, these demographic trends, coupled with the hiring practices of the past decade, have skewed the demographic makeup of the industry's work force. The major issues affecting the nuclear work force are: an aging population, attrition rates, employee benefits and recruitment trends and challenges.

Aging Population

Within the nuclear industry, and specifically the power generation sector, the average age of employees is nearing 50. With retirement typically occurring around age 55, this poses very real, near-term challenges to the industry that will affect workplace culture, organizational development, recruiting, staffing, staff planning and training.

Table 4-1 compares the nuclear plant workers who are under 32 with those over 48. The imbalance between younger and older employees is stark: 44 percent of nuclear plant workers are 48 years old or older, while just 7 percent are 32 and younger. Total direct employment is about 58,400.

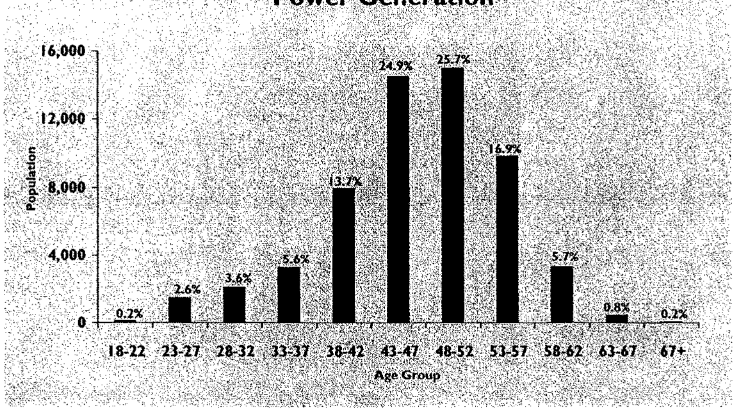


Figure 4-1.
2003 Survey Findings
Power Generation

Source: NEI 2003 Work Force Survey

Table 4-1. Category Comparison of Nuclear Plant Workers 32 and Under/48 and Over

Category/Subcategory	*32 and Under*	*48 and Over*
Configuration Management		
Administrative Support	10%	52%
Computer Engineering	4%	41%
Management	0%	53%
Design/Mods/Tech. Eng.	7%	50%
Nuclear Fuels/Reactor Eng.	13%	39%
Project Management	3%	54%
Equipment Reliability		
Administrative Support	10%	42%
Equipment Reliability Mgt.	12%	36%
Non-Destructive Examination	24%	34%
Plant Engineering	14%	42%
Loss Prevention		
Administrative Support	5%	44%
Emergency Preparedness	3%	52%
Fire Protection	5%	44%
Licensing	2%	55%
Loss Prevention Management	0%	52%
QA/Corrective Action Prog.	1%	66%
Safety/Health	6%	49%
Security	23%	30%
Maintenance-Construction		
Electrical	4%	45%
I and C	5%	38%
Mechanical	3%	50%
Other*	7%	43%
Support**	7%	57%
Management/Support Services		
Administrative Support	3%	45%
Communications	14%	36%
Document Control/Records	4%	51%
Facilities	9%	48%
Financial Services	6%	46%
Human Resources	8%	36%
Information Services	11%	36%
Management Assistance	1%	60%
Support Services Mgt.	3%	51%

Category/Subcategory	*32 and Under*	*48 and Over*
Materials and Services		
Administrative Support	5%	53%
Contracts and Purchasing	5%	56%
Materials/Services Mgt.	1%	50%
Materials Mgt./Warehouse	2%	56%
Procurement Engineering	3%	56%
Officers/Executive		
Officers/Executives	0%	64%
Operate Plant		
Administrative Support	12%	47%
Chemistry	8%	36%
Environmental	11%	44%
Operations	14%	24%
Operations Management	2%	37%
Operations Support	15%	33%
Training		
Administrative Support	8%	41%
Training	2%	49%
Training Management	0%	41%
Work Management		
Administrative Support	10%	41%
Outage Management	2%	51%
Planning	2%	55%
Quality Control	2%	63%
Radwaste and RP Direct	5%	38%
RP-Support	3%	43%
Scheduling	1%	52%
Management	0%	49%
TOTAL	7%	44%

** Includes utility workers, painters, heating-ventilation-air conditioning workers, crane operators and insulators*

*** Includes procedure writers and metrology personnel*

Historic Recruitment Trends

During the 1970s and 1980s, many nuclear power plants were hiring new employees for their new facilities. This was a time when the industry saw tremendous growth. Although some facilities hired more staff to meet regulatory requirements, many were being staffed for the first time. At the same time, the federal government was expanding its nuclear programs and oversight functions. The combination of public- and private-sector growth created job opportunities unmatched in recent years.

This growth opportunity created the base for universities to increase their programs in engineering, health physics, nuclear technologies and related math and science education. In turn, this growth provided qualified candidates for new positions within the nuclear energy industry.

The availability of resources from the government, industry-related contractors, military and universities provided employers with a large pool of highly qualified candidates. As such, many nuclear power plants were able to meet their staffing needs without significant delays. Many candidates came from contactors that helped build the plants or from unions that supported those efforts.

The operations area of these facilities was generally staffed by former military personnel who sought employment opportunities in the industry after leaving the armed services. Many radiological and chemistry workers and other plant personnel came from the military or government. Engineering positions were generally filled by contractors and craft personnel.

These traditional sources of labor continued to meet the industry's needs until the early 1990s. Then, the industry began consolidating, which resulted in increased efficiencies and fewer personnel. From 1993 to 2003, total nuclear generation staffing fell from 81,108[5] to 58,400.[6] With reduced plant staff, a downsized military and government cancellation of several nuclear programs, traditional labor sources began to fade.

The trend had a domino effect. Universities discontinued many of their nuclear engineering and technology programs, the availability of nuclear workers from the military slowed, and contractors supporting the industry consolidated or changed business lines. All of this affected the ability of many employers to find adequate staff from traditional sources. When jobs did open, they were typically filled by older, more experienced workers who left one plant or company to join another. When employers experienced recruitment difficulties,

[5] Institute of Nuclear Power Operations, "1993 Survey of Nuclear-Related Employment in United States Electric Utilities," November 1993.

[6] In 1993, 108 commercial reactors were operating in the United States. In 2003, there were 103 operating reactors.

some established nontraditional recruiting practices, including internships, joint union-management training programs and school-to-work programs.

These opportunities presented additional challenges to training new personnel. Traditionally, personnel hired by the industry received extensive training through the new hire's primary source—contractors, government, military and universities. Consequently, training programs provided by utilities tended to focus on specific plant operational and regulatory needs. The nuclear energy industry's unique cultural orientation had been part of that training. However, using nontraditional sources of labor presented greater challenges to such important training topics as workplace culture.

Defined Benefit Plans and Other Retirement Savings Programs

The nuclear industry, unlike many other U.S. industries, offers generous retirement plans, including defined benefit plans, as well as 401(k) and other employee- and employer-funded programs. Seventy-six percent of the nuclear generating companies responding to the survey offer defined benefit plans. These plans and their related benefit trigger points have had a significant effect on retirement attrition. Survey results indicate that many of the defined benefit plans in the nuclear industry allow for trigger points when an individual reaches 55 years of age and has met a service requirement of between 10 and 25 years, depending on benefit levels.

National surveys show that individuals 50 and older have decided to delay retirement because of poor economic performance of investments in stocks and mutual funds. In 2002, the AARP's annual report, "The State of 50+ America," found that 20 percent of those surveyed planned to delay retirement as a result of poor financial investment performance. In 2003, that total increased to 21 percent.

The study indicated that "low interest rates on assets, combined with low equity returns, were a 'double whammy' that depleted the retirement nest eggs of both those retired and those nearing retirement. Thirty percent of respondents who had interest-earning assets said that they earned less than 2 percent on their interest-bearing accounts." [7]

Defined benefits programs can increase the likelihood of retirement since the programs are not dependent on the economic performance of investments in stocks and mutual funds.

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[7] AARP, "The State of 50+ America," Feb. 18, 2004.

Historic Attrition Rates

Historic attrition rates in the nuclear industry have been very low, compared with attrition rates in other industries. Since 1999, total attrition has ranged from 4.8 percent to 7.3 percent, with non-retirement attrition accounting for 3.6 percent to 6.1 percent each of the past four years. Earlier this decade, the industry observed a significant increase in retirement attrition, from 1.1 percent in 2000 to about 2.8 percent in 2002. Some of the increase has been attributed to voluntary separation programs and early retirement incentives, while the remainder is attributable to the aging nuclear work force.

Table 4-2. Attrition Rates (1999-2002)

Year	*Non-Retirement Attrition*	*Retirement Under 57*	*Retirement 57-62*	*Retirement After 62*	*Total Attrition*	*Replacement*
1999	3.57%	0.34%	0.74%	0.27%	4.83%	2.16%
2000	6.16%	0.19%	0.69%	0.27%	7.30%	5.94%
2001	4.46%	0.20%	0.73%	0.36%	5.76%	4.59%
2002	4.36%	1.16%	0.91%	0.22%	7.20%	4.76%

Expected Future Attrition Rates

Estimates have varied from respondent to respondent, but the average projected attrition rates from year to year are significantly less than past rates. Some of this variance can be attributed to involuntary separations and downsizing.

Table 4-3. Anticipated Attrition Rates (2003-2012)

Year	*Retirement*	*Non-Retirement*	*Total Attrition*
2003	1.79%	2.10%	4.28%
2004	2.03%	2.38%	4.83%
2005	2.37%	1.90%	4.62%
2006	3.02%	1.77%	5.31%
2007	3.42%	1.76%	5.54%
2008	3.65%	1.71%	5.64%
2009	3.28%	1.78%	5.26%
2010	3.65%	1.78%	5.57%
2011	3.49%	1.79%	5.16%
2012	3.60%	1.79%	5.11%

The non-retirement component of attrition projected for the next decade is less than half the historic rate. Based on empirical survivor models, non-retirement attrition for new employees, especially those in the first few years of their careers, is significantly higher than that of seasoned employees. This, coupled with the need to replace a significant number of retiring employees in the coming years, may lead to higher attrition rates than expected.

Although historic attrition rates have been fairly low, the trend has occurred during an economic recession. Further, labor markets and investment performance have been weak. As the economy rebounds, labor markets strengthen and financial performance of investments improves, a higher attrition rate in both retirement and non-retirement categories could occur. During the technology and stock market boom of 2000, the industry noted total attrition rates of more than 7 percent.

Recruiting Challenges

As part of the survey, respondents were asked to identify their greatest recruiting challenges. Overwhelmingly, work-force diversity and recruitment of women were identified as top issues. A total of 63 percent mentioned recruiting minority candidates as a top challenge, while 60 percent cited women candidates. Other challenges noted were nuclear engineers, 37 percent; health physicists, 23 percent; experienced engineers, 20 percent; and operators, 17 percent.

In response to this finding, NEI launched a diversity recruiting initiative designed to improve industry branding in targeted communities. The program aims to bring the most skilled and talented workers to the industry.

Section 5: Nuclear Power Generation Career Ladders

The next four segments contain information on four key career ladders within the nuclear power generation sector:

- engineering
- operations
- radiation protection
- skilled crafts.

Engineering Career Ladder

The career ladder for engineering typically begins with the direct hire of an individual with a bachelor's or master's degree from an accredited university in chemical, civil, electrical, mechanical, nuclear or systems engineering. In most cases, these individuals are hired directly upon graduation from their university program. Many nuclear employers prefer cooperative education or internship experience; however, they are not prerequisites for employment in this group. In some cases, individuals enter this career ladder by completing an engineering degree program while employed in another career ladder, through an internal transfer from a non-nuclear group within a utility, or as a newly hired, experienced engineer from another industry.

The core of the engineering career ladder contains the following job categories:[8]

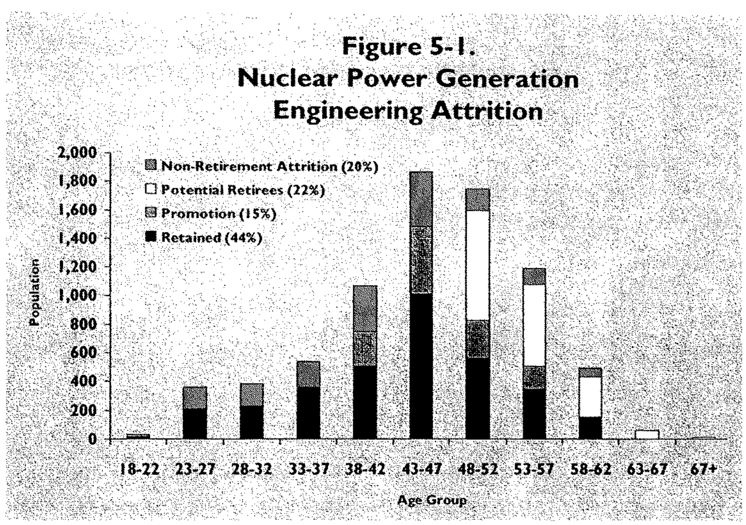
- Configuration management
  - computer engineering
  - configuration management
  - design, modification and engineering
  - nuclear fuels and reactor engineering
- Equipment reliability
  - plant engineering.

The core of the engineering career ladder is often used as a staffing source for a variety of management and specialty functions. Senior engineering staff is often promoted to fill roles throughout the operating station.

[8] Detailed descriptions of these positions can be found in Appendix B.

The engineering staff typically is drawn to fill these functions:[9]

- Configuration management
  - project management
  - equipment reliability
  - nondestructive examination
- Loss prevention
  - fire protection
  - licensing
  - loss prevention management
  - quality assurance and corrective action
  - quality control
- Materials and services
- Operations site technical adviser
- Other management
- Procurement engineering.



[9] Detailed descriptions of these functions can be found in Appendix B.

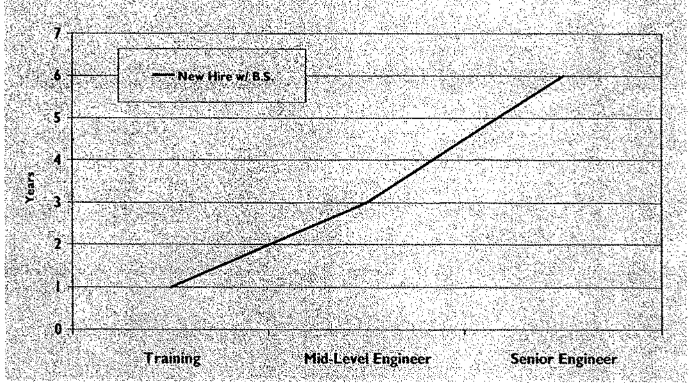
When considering the career ladder for engineering and the draw that will pull engineers into other positions, the survey found that non-retirement attrition will reduce the ranks of engineers by about 20 percent. Another 22 percent of current engineers will retire, while approximately 15 percent will be promoted to fill other positions. This leaves only 43 percent of current engineers available after five years. The total current population for this group is about 7,775, which means that keeping engineering employment levels stable will require the industry to hire and train more than 4,660 new engineers over the same five-year period.

A number of factors will affect the engineering career ladder and will need to be considered by the industry as plans are made to deal with the changing work force. First, the development time for engineers is lengthy. After completion of a four-year degree program, it often takes six months to a year to complete a basic training and orientation program. An additional two years of training are needed to qualify as a mid-level engineer, while another three years are necessary to become a seasoned engineer. Replacing a seasoned engineer may require up to six years of advance planning.

Fortunately, most firms in the industry have junior engineers who will be ready to replace senior engineers in less time, but there may be insufficient numbers of these junior engineers to fully replace the staff that will leave the industry or be promoted.

A second consideration is the engineer's high degree of "skill portability." Many in the engineering career ladder are able to seek employment in other industries or within non-nuclear units of utilities. Their education and skills have applicability in many settings. This can lead to attrition from the nuclear energy industry because engineers can earn comparable salaries in other fields.

Figure 5-2.
Engineering Training



Source: NEI 2003 Work Force Survey

Finally, increasing diversity within the engineering career field was identified as a challenge. Many human-resources professionals indicated their desire to increase the diversity of the engineering work force. Recruitment of minority and female candidates was sited in the survey as a particular challenge.

Operations Career Ladder

Individuals enter the operations career ladder in several ways. In some cases, the industry promotes employees from security or facilities functions into this career track. In other cases, individuals are hired from the U.S. Navy after gaining reactor operating experience during their military service. A few individuals are hired directly into this career track after completing a bachelor of science degree from an accredited university in an engineering discipline or graduating from a technical program, such as earning an associate's degree from a community college.

The core of the operations career ladder contains the following job categories:[10]

- Operations
  - chemistry
  - environmental
  - operations
  - operations management
  - operations support.

The core of the operations career ladder is often used as a staffing source for management and specialty functions. Senior operations employees are often promoted to fill roles throughout the operating station. This staff typically is drawn to fill these functions:[11]

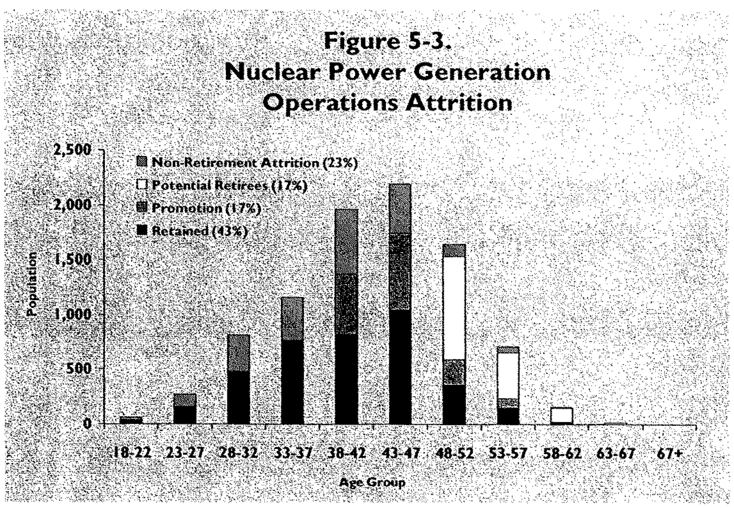
- Configuration management
  - outage management
  - planning
  - project management
  - scheduling
  - work management
- Loss prevention
  - quality assurance and corrective action
  - licensing
- Other management
- Training.

[10] Detailed descriptions of these positions can be found in Appendix B.
[11] Detailed descriptions of these functions can be found in Appendix B.

When considering the career ladder for operations and the draw that will pull core members of this career ladder into other positions, the survey found that non-retirement attrition will reduce operations staff by approximately 23 percent. Another 17 percent of current operators will retire and about 17 percent will be promoted to fill other positions. This leaves only 43 percent of current operations employees available after five years. The total current population for this group is approximately 8,970. The industry will need to hire and train more than 5,110 new operators over the period in order to keep operations employment levels stable.

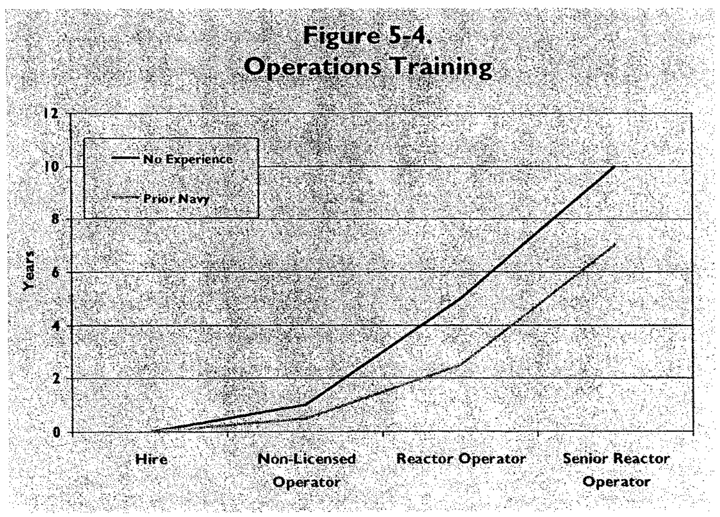
Operations employees at nuclear plants participate in rigorous training, qualification and re-qualification programs. After completing initial operations training, these individuals are required to complete extensive recurrent or refresher training and at various stages are subject to re-licensing or re-qualification testing.

The training program to elevate nonlicensed operators to senior reactor operators can take up to 10 years to complete. This training is very expensive because it is conducted in-house through the use of classroom, full-scope simulation and job-performance measures. Additionally, the amount of training and qualification time required by this process mandates that a nuclear utility invest hundreds of thousands of dollars to move a newly hired individual along this career track and receive a senior reactor operator license.



Potential retirees are defined as employees who will be older than 53 with 25+ years of service, older than 63 with 20 years of service, or older than 67 within the next five years.

Source: NEI 2003 Work Force Survey



Source: NEI 2003 Work Force Survey

Another consideration in the operations career ladder is the increasing competitiveness of a key traditional recruiting source for operators: the U.S. Navy, which is expending significant resources to attract and retain nuclear-trained sailors. According to U.S. Navy publications, the service is paying as much as $12,000 for enlistment in the nuclear field training program and re-enlistment bonuses that reach $60,000. Compounding this, the Naval Nuclear Propulsion Program plans to increase its staffing level throughout 2005, and the current estimate of non-retirement attrition from the Navy program is significantly less than the demand for new commercial reactor operators.

Responding to this challenge, the study indicated that the industry is hiring and training operators. When examining the number of operators who are younger than age 32, the survey found that this population represents more than 12 percent of the current operations staff. Further, the industry has an ongoing interest in finding efficient ways to recruit from the military and develop local work forces.

Radiation Protection Career Ladder

Individuals begin their radiation protection careers in several ways: the industry promotes workers from other facilities functions into this career track; individuals are hired into this track from the U.S. Navy, after gaining radiation protection experience during their military service; and experienced health physics staff are hired from the pool of vendor company outage support staff. A few individuals are hired directly into this career ladder after completing an associate's degree from a community college, or in some cases, a bachelor's or master's degree in biology, chemistry, health physics, medical physics or physics.

Minimum training and experience criteria are spelled out in a standard published by the American National Standards Institute (ANSI) for two positions in this career track: radiation protection technician and radiation protection manager. The ANSI standard is endorsed by the Nuclear Regulatory Commission and is commonly incorporated as a commitment in a facility's operating license. Professional certification is offered by the National Registry of Radiological Protection Technicians for radiation protection technicians and the American Board of Health Physics for health physicists.

Unlike the other career ladders examined, the core of the radiation protection career ladder contains only the radiation protection direct category.[12]

Radiation protection employees often serve as a staffing source for a variety of management and specialty functions. These workers are frequently promoted to fill roles within the generating station. The functions[13] that radiation protection staff typically are drawn to fill include:

- other management
- radiation protection support
- safety and health
- training.

When considering the career ladder for radiation protection and the draw that will pull core members of this career ladder into other positions, the survey found that approximately 21 percent of current radiation protection employees will leave because of non-retirement attrition. About 15 percent of current workers will retire and another 21 percent will be promoted to other positions. This leaves only 43 percent of current radiation protection employees available after five years. The current population for this group is approximately 1,781. If the industry intends to maintain a constant level of staffing in radiation protection, it will need to hire and train more than 1,015 new radiation protection staff over the next five years.

Radiation protection employees at nuclear power plants typically use two training routes. The first, for new hires or others without prior radiation protection experience in the U.S. military (typically the U.S. Navy), requires a combination of approximately two years of training and on-the-job experience to qualify as a radiation protection technician.

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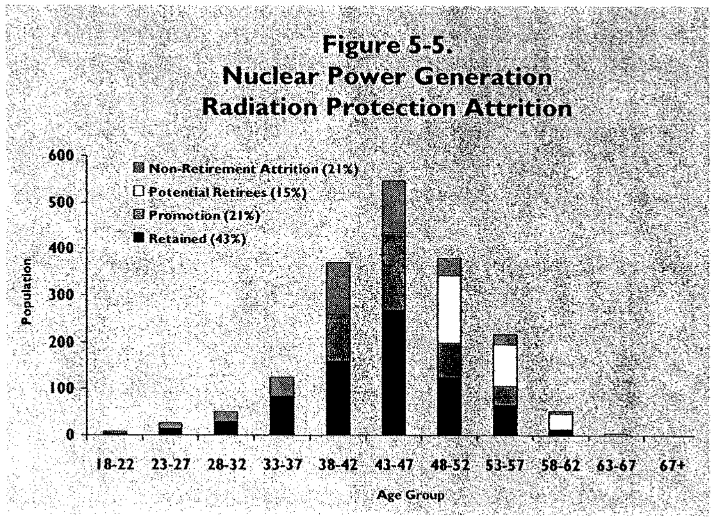
[12] Detailed position and function descriptions can be found in the Work Management section of Appendix B.

[13] Detailed position descriptions can be found in Appendix B.



Potential retirees are defined as employees who will be older than 53 with 25+ years of service, older than 63 with 20 years of service, or older than 67 within the next five years.

Source: NEI 2003 Work Force Survey.

An additional two years of on-the-job experience is needed to advance to the level of senior radiation protection technician. These requirements stem from the ANSI criteria.

Personnel hired from the U.S. Navy or contractor work force with significant radiation protection experience generally require one year of site-specific, on-the-job training to become a senior radiation protection technician.

A radiation protection technician generally requires the supervision of a senior radiation protection technician for many job tasks, while a senior radiation protection technician can perform most job tasks independently.

As with recruitment for operations, an additional consideration in the radiation protection career ladder is that a desired recruiting source for radiation protection, the U.S. Navy, is becoming significantly more competitive. The Navy is expending substantial resources to attract and retain nuclear-trained sailors. According to the Navy, only 380 radiation protection technicians are trained through their program each year, and significant re-enlistment bonuses are paid to retain them.

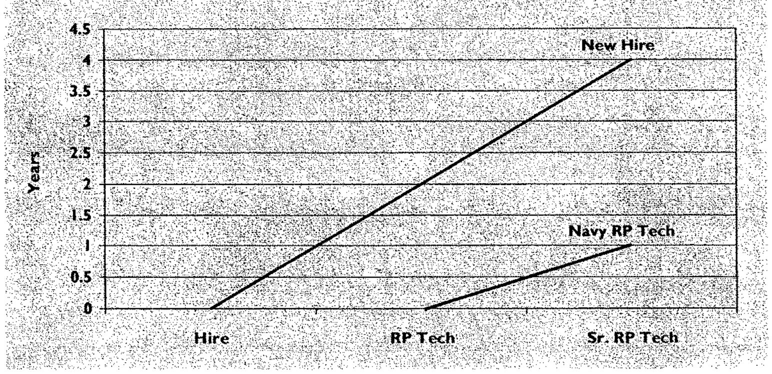
This is leading several nuclear utilities to search for alternative sources of labor for this career ladder. After a steady decline in training programs during the past decade, several community college programs have been developed in the past two years.

Several industry sources indicated that radiation protection staff is in short supply. Existing staff is often very lean, because of several rounds of headcount reductions at generating stations. The Health Physics Society, a professional society for degreed health physicists, recently concluded that a shortage of degreed health physicists exists today. And the nuclear power industry is not alone in experiencing a shortage in radiation protection specialties. The medical and manufacturing sectors also are feeling the pinch.

This shortage has been noted in H.R. 3828, the Department of Energy University Nuclear Science, Engineering and Health Physics Act. The bill seeks to increase the supply of health physicists by funding scholarships and fellowships, as well as supporting university programs.

Radiation protection technicians are employed in many industries, leading to significant competition in recruiting and retention. The most competitive sector is the medical community, where a radiation protection technician often works in an office setting and is offered a very competitive salary and benefits package. As positron emission tomography and computer tomography diagnostic techniques increase in popularity, experts anticipate that this competition will increase. Additionally, it should be noted that several health physics bachelor's degree programs have shifted their focus from power technologies to medical applications.

Figure 5-6.
Radiation Protection Training



Source: NEI 2003 Work Force Survey

The impact of this impending shortage is significant for the nuclear power sector.

Radiation protection staff is crucial during outages. The industry has often relied on outage support temporary staffing companies to supply this expertise. In their survey responses, the firms indicated they are experiencing increasing difficulty in hiring radiation protection staff as well.

The outcome of these factors may lead to increased outage duration and scheduling outages when staff is available, rather than when power pricing permits. New technologies and work processes could be introduced to ease the effects of the shortage.

Skilled Craft Career Ladder

The career ladder for skilled craft begins in several ways. In some cases, the industry promotes individuals from security or facilities functions into this career track. In other cases, individuals are hired into this track from the U.S. Navy, vocational schools, community colleges and other industries. Additionally, the nuclear energy industry sometimes hires skilled craft workers who support outage work as a contractor employee or union hall.

The skilled craft career ladder consists of the following job categories:[14]

- Maintenance/construction
  - electrical
  - instrumentation & control
  - mechanical
  - other.

[14] Detailed position descriptions can be found in Appendix B.

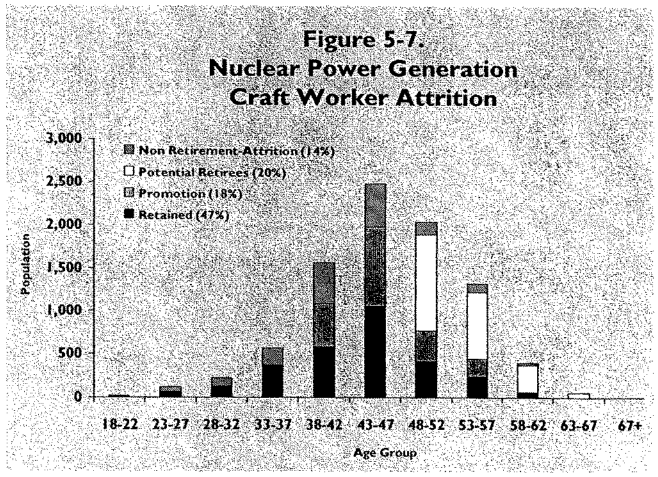
The core of the skilled craft career ladder is often used as a source of staff for a variety of management and specialty functions. Skilled craft workers are often promoted to fill other roles within the generating station. The functions[15] that skilled craft staff typically is drawn to fill include:

- Configuration management
- Loss prevention
  - quality assurance and corrective action
- Maintenance/construction
  - support
- Other management
- Project management
- Safety and health
- Training
- Work management
  - planning
  - scheduling.

When considering the career ladder for skilled craft and the draw that will pull core members of this career ladder into other positions, the survey found that non-retirement attrition will lead approximately 14 percent of current craft workers to leave the industry. About 20 percent of the current skilled craft career pool will retire, while nearly 18 percent will be promoted to fill other positions. This leaves only 48 percent of current skilled craft workers after five years. Today's total population for this group is approximately 11,010. If the industry intends to keep skilled craft employment levels stable, it will need to hire and train more than 5,835 new craft workers over the five-year period.

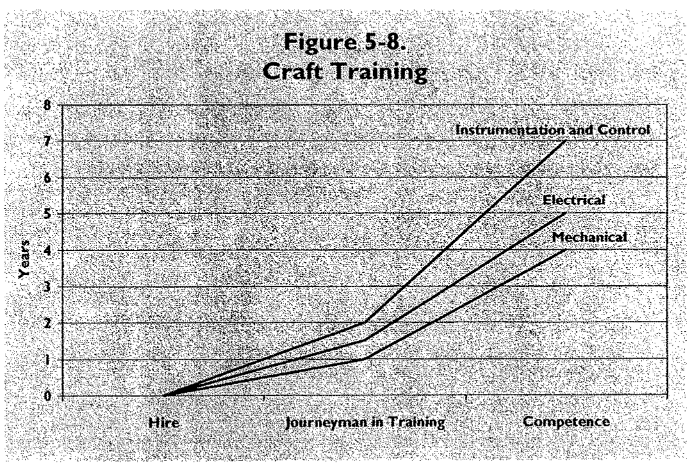
Skilled craft workers perform a variety of functions within a nuclear generating station. As a result, a variety of specialties are encompassed in this group. Each of the specialties has its own training schedule. For example, an electrician typically needs 1½ years of training and on-the-job experience to earn the rank of journeyman. Another three to four years may be needed to complete an apprenticeship program and perform at a level where most job tasks can be completed without significant supervision.

[15] Detailed function descriptions can be found in Appendix B.



Potential retirees are defined as employees who will be older than 53 with 25+ years of service, older than 63 with 20 years of service or older than 67 within the next five years.
Source: NEI 2003 Work Force Survey

Training can be shorter for mechanical craft workers, with one year to achieve journeyman status and an additional three years to complete an apprenticeship program that would allow them to work largely unsupervised. However, some skilled crafts require significantly longer training programs. An instrumentation-and-control technician may need two years of training and on-the-job experience to qualify as a journeyman and an additional five years to complete an apprenticeship.



Source: NEI 2003 Work Force Survey

Several additional factors should be considered when examining the staffing of skilled craft positions. First, many systems at nuclear power plants are older technologies. In many cases, these technologies are no longer taught in vocational or trade schools. Even if individuals had prior training in their craft, they may need to be retrained on the specific systems and technologies used at the plant site.

Second, some knowledge that skilled craft workers need requires mentoring and other informal means of knowledge transfer. Another consideration: Skilled craft staff levels at most plants are already very lean, which means opportunities for mentoring and informal knowledge transfer are limited. As retirements and other attrition decrease staff levels, increasing pressure will be placed on this staff to do more with less, making current opportunities for knowledge transfer even rarer.

It is also important to recognize that many employees in the skilled craft career ladder are represented by unions. Depending on the union-management relationship, this may complicate hiring, promotion and training of skilled craft workers.

Finally, the nature of the work that many in the skilled craft career ladder perform also should be considered in any analysis. Most of the work is physically demanding. This consideration, coupled with the fact that many of the licensees offer defined benefit packages, may lead many skilled craft workers to depart as soon as they reach the threshold requirements for retirement benefits.

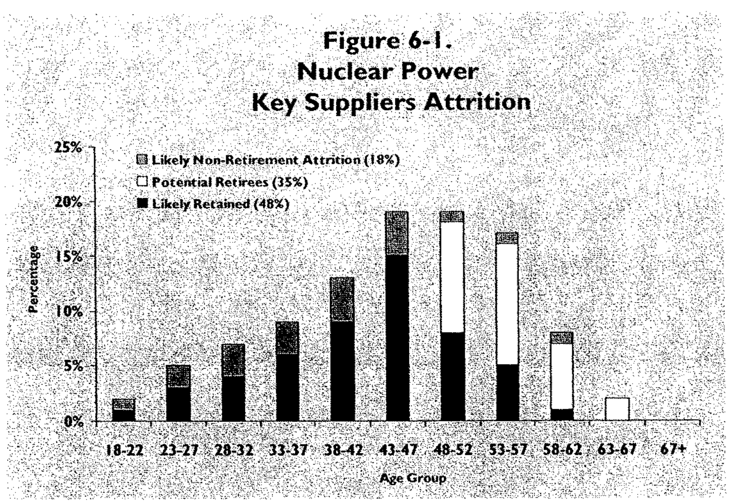
Section 6: Other Industry Segments

Key Suppliers

Key suppliers of equipment and services are a critical component in the nuclear industry. These firms supply fuel and critical plant components, as well as provide architecture and engineering services. The companies also may supply personnel who provide specific services to refuel reactors or maintain specific equipment supplied by the firm.

Experts anticipated that retirement and non-retirement attrition may have significant impacts on the work force at these firms. Based on available attrition information, 18 percent of workers in this category may leave because of non-retirement attrition, and 35 percent will be eligible to retire over the next five years.

Although those figures seem daunting, these workers typically stay with their employers beyond the retirement thresholds of their defined benefit plans at a higher rate than those who work for power generators. Simply put, although these workers are eligible to retire earlier, some may elect to work longer.



Potential retirees are defined as employees who will be older than 53 with 25+ years of service, older than 63 with 20 years of service, or older than 67 within the next five years.

Source: NEI 2003 Work Force Survey

The pipeline for employees in the supplier category is significantly better than that of power generators. Although workers who are 32 or younger make up 7 percent of the nuclear power work force, 14 percent of supplier employees are 32 or younger. According to the survey, 2 percent are 18-22, 5 percent are 23 to 27, and 7 percent are 28 to 32. However, as a result of the higher percentage of younger employees, suppliers may experience increased levels of attrition.

The percentage of potential retirees for this group is higher than those for the power generation sector, largely because current supplier employees who are age 53 and older (27 percent) is higher than staff in this category for power generation (24 percent). Additionally, employees in this category typically have worked longer with their firms than those in the power generation sector.

Since many workers at supply firms have highly specialized skills, these companies must ensure that worker knowledge, both explicit and tacit, is passed to the employees who will replace them. This challenge is being actively addressed by several firms in this category, and several projects are under way at supplier companies to ensure that corporate knowledge is retained.

Another factor brings additional challenges to recruiting and retaining key supplier employees. The international nature of this work force can be affected by visa and nonproliferation treaty compliance considerations.

Outage Support

Firms that supply personnel for outage support[16] face a variety of pressures on staffing, including an aging work force. More importantly, the structure of outage support work has changed so that jobs in this sector are less desirable to many craft and technician workers.

Outage work at nuclear power plants draws additional staff to complete unit refueling, as well as the maintenance or replacement of major station components, which cannot be done when the reactor is operating.

The primary change in outage work over the past decade has been the duration and scheduling of outages for refueling and other maintenance. In the early 1990s, it was not unusual for an outage to last 100 days or more. Today, many operating units target refueling outages of 21 days or less.

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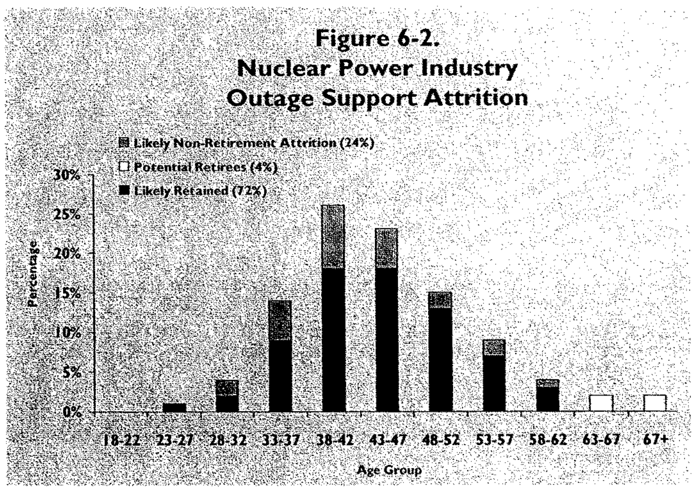
[16] Staffing augmentation services primarily supply technicians or skilled craft for outages. These firms also may provide limited supervisory personnel or project managers, but the personnel supplied are not associated with the supply of equipment, fuel fabrication or architectural and engineering services.

These outages are concentrated into two seasons—spring, which generally begins in January and continues through June, and fall, which begins in September and runs through December. Peak staffing is generally required in March and October.

Peak worker demand to support outages in some fields may soon exceed supply. For example, radiation protection technicians are a key resource in outage support. In the spring 2003 refueling outage season, peak demand was 750. For the fall 2003, that demand was expected to rise to more than 800.[17] The spring 2004 season will again require in excess of 700 radiation protection technicians, and the fall 2004 season is expected to require more than 800.

The current available supply of 800 to 850 radiation protection workers is not sufficient to meet this growing demand because these workers also are required in other areas. For example, the Department of Energy and the national laboratories also require radiation protection technicians and the work at these facilities is year-round. This may be more attractive to radiation protection workers since they are permanent or long-term job opportunities that do not require as much travel.



Potential retirees are defined as employees who will be older than 53 with 25+ years of service, older than 63 with 20 years of service or older than 67 within the next five years.

Source: NEI 2003 Work Force Survey

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[17] Information supplied by Jerry Hiatt, president of Bartlett Services, in a presentation to the Health Physics Forum, August 2003.

In 2003, more than 15 million man-hours were worked by skilled craft at nuclear power plants for outage support. While this number may be significant, the nuclear industry must compete with other construction projects in the local market. The duration of outages affects the ability of outage support organizations to supply skilled craft personnel. While an outage may be lucrative work, skilled craft workers also are employed in other construction projects that may last longer.

Although the age of outage workers may become an issue in the next few years, non-retirement attrition will have a much larger impact on staff availability. Using historic attrition data and the empirical survivor model used to analyze the power generation sector, the task force found that roughly 24 percent of outage support workers are expected to leave the industry in the next five years.

Because of the temporary nature of the work involved in outage support, only 4 percent of the workers are expected to retire. This retirement number may be misleading because the number of employees captured by this survey does not represent the skilled craft personnel employed by staff augmentation organizations. Further, non-retirement attrition numbers may be underestimated if large long-term projects, which compete for the same workers, are initiated or if workers can no longer find sufficient amounts of work because of shortening outage periods.

Training efforts for this employment segment can be affected by the compressed outage structure. As a result, support workers are developed more slowly since fewer hours are available for qualification and training.

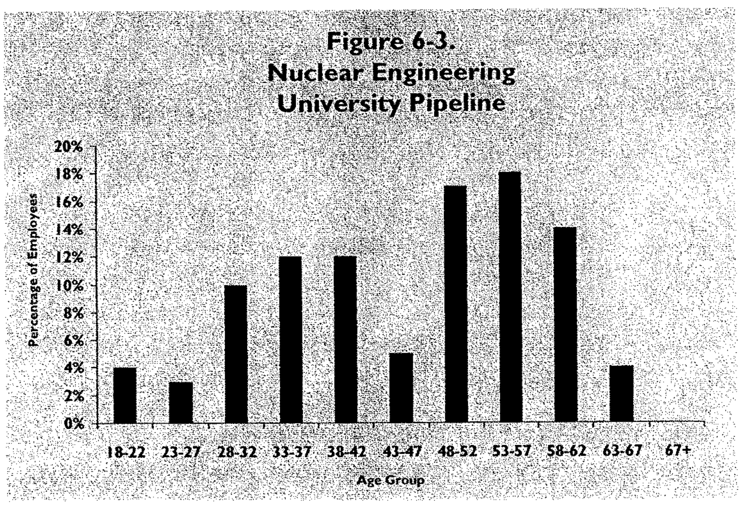
University Pipeline

The faculty at universities is critical to maintaining the nuclear work force. Although the faculty in nuclear engineering departments is not directly linked to the commercial power sector, these educators form the foundation of a training infrastructure, ensuring that nuclear engineers can be educated at the baccalaureate and graduate levels.

The 2001 NEI Staffing Survey identified nuclear engineers as a key skill shortage in the next decade. Although recognizing that enrollments are increasing, the earlier study indicated concern about the nuclear industry's ability to recruit nuclear engineers in the future.

Without a suitable training pipeline, it may become increasingly difficult to produce the future nuclear engineers that the nuclear energy industry needs. It is encouraging that a relatively high percentage of employees in university nuclear engineering departments are younger than 42. Many may be graduate students who are employed by university nuclear engineering departments in non-tenure-track teaching or non-faculty positions while pursuing their degrees.

The American Nuclear Society's 2003 Nuclear Energy Sourcebook indicated that, on average, tenured or tenure-track faculty received doctorates in 1979 and that these professors are more than 24 years into their career. This same survey showed that only 10 percent of the current faculty received their doctorates within the last decade and nearly 33 percent received them more than 30 years ago. This distribution, which can be seen in the NEI survey data, indicated that insufficient junior faculty may exist to fill senior faculty positions as they retire.



Source: NEI 2003 Work Force Survey

Appendix A: NEI 2003 Work Force Survey

INDUSTRY SITUATION

Because of the demographics in the nuclear industry, many companies anticipate that a significant number of experienced employees may retire in the next 10 years. In addition, several segments of the industry are losing employees to other non-nuclear industries. Since many workers in the nuclear industry are highly trained and skilled, industry leaders question whether there will be enough new nuclear workers in the industry to meet staffing needs and whether those workers will remain.

This Survey

To better understand this issue, NEI is sponsoring a study of the nuclear staffing situation to determine whether there will be sufficient staff available to the industry over the next 10 years. As part of the study, a survey is being conducted that is compatible with the Electric Utility Cost Group (EUCG) nuclear staffing headcount survey and NEI entry and exit surveys. Information from this survey will be used to analyze the nuclear industry staffing situation. Your cooperation on the survey is very much appreciated. Separately, information is being collected about the supply of new workers for the nuclear industry.

Depending on the size of your company and the availability of data, it should take you between eight and 40 hours to assemble the needed information and complete this survey form. Company information will be kept confidential and released only in aggregate or back to the company supplying the data.

Instructions

1. All responses are due no later than Sept. 12, 2003.

2. To avoid double counting, exclude baseline and other contractors and non-exempt (hourly) craft workers hired by companies that specialize in providing these temporary workers to power plants ***unless you are one of the companies that directly hires these temporary workers.***

3. This survey is intended to capture data from the nuclear industry. If your company is involved in several sectors, include only data relevant to the nuclear portions of your operations. This includes electrical production operations at nuclear power plants; outage support for nuclear operations; engineering design, services and construction support to nuclear generating facilities; the front- and back-end of the nuclear fuel cycle; regulation of nuclear power plants; universities; and Department of Energy environmental site cleanup and laboratories.

4. Data collected for this survey can be input at *http://survey.nei.org*.

5. If you have questions about this survey, please contact Carol Berrigan at NEI at 202.739.8050 or *clb@nei.org*.

Survey Starts Here

Question 1: Who is the person and company responding to this survey?

Name:

Title/Department:

Company Name:

Telephone Number:

Fax Number:

E-mail Address:

Company Code: (assigned and included in cover letter)

Question 2: Does your organization have a long-term staffing plan?

A long-term staffing plan is defined as an assessment of organizational staffing needs that includes anticipation of retirement and other attrition.

- ☐ Yes
- ☐ No

If NO, skip to Question 3.

If YES, continue to Question 2a.

a. If yes, what time period does it cover?

- ☐ 1-2 years
- ☐ 3-5 years
- ☐ 6-9 years
- ☐ 10 years+

b. If yes, how often do you update this plan?

- ☐ Annually
- ☐ Every 1-3 years
- ☐ Every 3-5 years
- ☐ It was a one-time plan

c. If yes, what level of detail does this plan include?

- ☐ To the division level
- ☐ To the plant level
- ☐ To the department level
- ☐ To the position level

d. If yes, is the staffing plan aligned with the EUCG/NEI model?

- ☐ Yes, it is aligned.
- ☐ No, it is not aligned, but we are planning to align it in its next revision.
- ☐ No, it is not aligned, and we have no current plans to align it.

Question 3: What was your attrition of full-time staff for the following years?
Please provide data in total headcount of full-time equivalent positions. All data should be for the specified year end.

Attrition is defined as leaving the nuclear portion of the company for which you are responding, e.g., transferring to a fossil position would count as attrition, moving from one nuclear plant site to another should not be counted.

New Hires are employees who have been hired from outside the company or have transferred internally within the company from a non-nuclear to a nuclear portion of the company.

Note: The sum of columns A, B, C and D should equal column E.

	A	B	C	D	E	F	G
Year	*Non-Retirement Attrition*	*Retirement Less Than Age 57*	*Retirement Ages 57-62*	*Retirement Above Age 62*	*Total Attrition*	*Total New Hires*	*Total Population*
1999							
2000							
2001							
2002							

Question 4: What is your expected attrition for the following years?
Please provide data in total headcount of full-time equivalent positions. All data should be projections for the specified year end.

Attrition is defined as leaving the nuclear portion of the company for which you are responding, e.g., transferring to a fossil position would count as attrition, moving from one nuclear plant site to another should not be counted.

Note: The sum of columns A and B should equal column C.

	A	B	C	D
Year	*Retirement*	*Non-Retirement Attrition*	*Total Attrition*	*Total Population*
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				

Question 5: What is the total number of current vacancies within the group for which you are reporting?

Vacancies should be defined as vacancies approved by management to be filled.

____

Question 6: Please describe your pension/retirement plan profile.

Please check all that apply.

- ☐ Defined benefit plan
- ☐ 401(k) plan with employer contributions
- ☐ 401(k) plan without employer contributions
- ☐ Company stock option plan
- ☐ Employee stock ownership program

Please provide any additional information:

Examples

1. Defined benefit plan applied to employees hired before January 1, 1985; 401(k) offered to newer employees.
2. Employees have both a defined benefit plan and access to a 401(k) plan.

Question 7: Please describe any plans in place for phased-in or managing retirement.

Examples

1. Employees have a one-year notice period for retiring and participate in a part-time mentoring program during the first year of retirement.

Question 8: Please provide a headcount for each of the following positions.
Headcount is separated into job category by age and years of service (YOS) for highly trained and licensed positions and headcount for all others.

Please provide information for full-time employees only.
Data should reflect employees as of June 30, 2003.

Below is an example of the headcount chart used for the officers and executives category:

Activity	*Age*	*1-5 YOS*	*6-10 YOS*	*11-15 YOS*	*16-20 YOS*	*21-25 YOS*	*26-30 YOS*	*30+ YOS*	*Total*
Officers/Executive									
	18-22								0
	23-27								0
	28-32								0
	33-37								0
	38-42								0
	43-47								0
	48-52								0
	53-57								0
	58-62								0
	63-67								0
	67+								0
	Total	0	0	0	0	0	0	0	0

Question 9: Please identify the areas in which you are experiencing the biggest challenges in recruiting. Please check all that apply.

- ☐ Electrical engineers
- ☐ Mechanical engineers
- ☐ System engineers
- ☐ Nuclear engineers
- ☐ Chemical engineers
- ☐ Maintenance technicians
- ☐ Field service engineers
- ☐ Experienced engineers (eight to 10 years of experience)
- ☐ Health physicists
- ☐ Nondestructive examination technicians
- ☐ Operators
- ☐ Chemical technicians
- ☐ Minority candidates
- ☐ Female candidates

Other ______________________

Appendix B: Staffing Definitions and Groups

These staffing definitions and groups, which were used in the NEI 2003 Work Force Survey, have changed significantly from the Standard Nuclear Performance Model Revision 2 Electric Utilities Cost Group Staffing Reporting. Please review these definitions prior to inputting data into the survey.

STAFFING DEFINITIONS

The following definitions should be used for employees and contractors:

Employees

- On-site utility employees: All individuals who are direct employees of the utility and perform core or baseline activities at the plant.
- Off-site/corporate support: All individuals assigned to multiple locations, such as off-site utility staff and/or corporate headquarter activities.
- Full time equivalent (FTE): This data element accounts for the total number of regular full- or part-time positions that are not temporary or contract.

Note: Initially, both on-site and off-site FTE positions should be included, as well as the best estimates in either one-quarter, one-half, three-quarter or one employees. After the first year, the NEI Work Force Issues Task Force will critique the process to determine whether a more detailed accounting process is needed.

Contractors

- Baseline contractors are contractors who perform a core or recurring function. (A core function is routine to an organization's operations.) A baseline contractor also could perform activities that have been proven to be best managed by contracting, based on a thorough cost-benefit analysis. This category could include administrative support, engineering consulting work, facility upkeep, labor tasks or security work. For example, you would include security activities being performed by the National Guard or local law enforcement agencies that are compensated by the utility. Do not include contractors brought in for outage support activities.
- Other contractors perform non-baseline functions or activities, including initiatives, modifications or projects. Other contractors are more likely to be used on a short-term basis. Do not include contractors who are brought in for outage support activities.

STAFFING GROUPS

The following groups will be utilized in the Nuclear Staffing and Reporting process and are linked to the NEI Standard Nuclear Performance Model. Group codes help show a process relationship to the model, where applicable.

Operate the Plant

Operations *(OP001A)*

All activities associated with preparing and placing systems and components in and out of service (e.g., tag-outs and clearances) to support normal and off-normal system operations and actions required to maintain the plant in a safe operating condition in all modes of operation. This category includes:

- plant walkdowns and inspections
- plant problem identification (generation of a trouble ticket)
- maintenance of operations logs, reports and records regarding equipment performance
- routine system and component lineup changes
- actions required to address abnormal occurrences (including reducing power or removing and restoring the unit to service)
- routine actions required for fuel burnup (i.e., dilution at a pressurized water reactor or control rod sequence exchanges at a boiling water reactor)
- fuel shuffling and actions required to maintain the plant in a safe operating condition in all modes of operation
- on-shift staff and supervisors responsible for operating primary, secondary and liquid radwaste systems
- preparation or review of responses to operating events and associated inquiries from other organizations, if performed by shift staff
- shift technical advisers.

Operations Support *(OP001B)*

All activities associated with functions to support plant operations. This function includes non-shift personnel supporting the operations staff, such as functions supporting work control through operations; dedicated procedure writers; personnel handling ops/work-control clearance orders; training coordinators; corrective action program coordinators; root-cause investigators; non-modification project managers; and technical specialists. This category also includes workers attending licensed operator training classes.

***Environmental** (OP002)*
All activities associated with establishing and maintaining environmental programs and monitoring the environment. Also includes employees responsible for non-radiological environmental monitoring programs and related requirements, audits, and thermal monitoring.

***Chemistry** (OP003)*
All activities associated with establishing and maintaining a chemistry program, monitoring and controlling plant chemistry, and managing chemical use and safety programs to maintain component integrity and optimize plant efficiency. Also includes collecting and processing analytical chemistry samples and preparing reports. Chemistry technicians for normal and emergency shift functions, such as chemical additions and chemical/radiochemical analyses, are included in this category. Others are employees who coordinate all aspects of a plant's chemistry program and provide guidance on chemistry standards; conduct evaluations of plant chemistry programs; and address and resolve chemistry operating problems. Also includes staff responsible for radioactive effluents program.

Operations Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks and clerical pools, including clerical pool supervisors who support operations. Among their duties are performing administrative support functions, such as meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical data analysis.

Operations Management
All activities associated with management personnel above first-line supervisors managing operations of the plant.

Work Management

***Radwaste & RP Direct** (WM008)*
All activities associated with providing contamination control, including:

- the control and monitoring of contaminated areas of plant
- decontamination services
- waste and decontamination radiation protection services
- treatment, measurement, control, minimization, collection, compaction, storage, filtration, ion exchange and other processing, reporting, handling, shipping, disposing of low-level waste and effluents
- liquid radwaste, gaseous radwaste, dry active radwaste, hazardous waste, mixed waste, industrial solid waste, industrial air emissions and non-radioactive liquid effluents.

Employees include radiation protection technicians involved with routine and special surveys, data reading and analysis, as well as the collection and analysis of radiation system samples.

***RP Support** (WM007)*

All activities associated with providing radiation exposure control, including:

- establishing and monitoring health physics program
- controlling and monitoring personnel work and their work locations
- performing activities necessary to maintain radiation levels that are as low as reasonably possible (shielding, respiratory protection, calculations, stay times, radiation work permits, etc.).

Personnel responsible for technical oversight of health physics program are included in this category, as are employees involved with respiratory protection, radiological environmental and dosimetry programs.

***Outage Management** (WM001, 002)*

All activities associated with planning and coordinating all outage activities, such as serving as the central contact point for refueling and maintenance outage planning and management, and forced outage managers. Dedicated outage work window managers also are included.

***Planning** (WM002)*

All activities associated with work order planning (outage and non-outage), including job package development; assemblage, completion and review of documentation associated with the maintenance effort; detailed planning required to maintain all structures, systems and components in optimum condition; and any formal evaluations required to support this activity.

***Scheduling** (WM002)*

All activities associated with scheduling, such as scheduling of outages; corrective, preventive and plant improvement maintenance; and surveillance and performance testing. This activity also includes the scheduling of all related supporting tasks, such as clearance application/ removal, scaffold erection/removal, radiological protection and industrial safety; and coordinating with maintenance, construction management, and engineering for daily schedule review and update. Employees who schedule non-refueling outage work activities are included in this category.

***Quality Control** (WM003, 004)*

All activities associated with quality control for preventive and corrective maintenance, such as ensuring and verifying component integrity, performing quality inspections and quality monitoring, reviewing safety-related work orders, and implementing the inspection hold point program. This category does not include implementing a nondestructive examination program.

Work Management Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors supporting work management. Administrative support functions including coordinating meetings and conferences, word processing, developing and maintaining spreadsheets and graphic/presentation materials, and analyzing non-technical data.

Work Management - Management
All activities associated with management personnel above first-line supervisors handling work management tasks at the plant.

Electrical Maintenance *(WM003, 004, 005, 006, 009)*
All activities associated with electrical maintenance and construction work within the power block, such as routine electrical preventive maintenance, as well as corrective, predictive and fix-it-now maintenance activities on plant components. It also includes major and minor modifications, the staging/acquiring of parts, actual performance of the work, pre- and post-maintenance testing, cleanup of the job site during and after work, and documentation closeout (signatures and delivery for storage).

I&C Maintenance *(WM003, 004, 005, 006, 009)*
All activities associated with instrumentation and control (I&C) maintenance and construction work within the power block, including routine I&C preventive, corrective, predictive and fix-it-now maintenance activities on plant components. Major and minor modifications also are found in this category. Other activities are staging and acquiring parts, performance of the work, pre- and post-maintenance testing, job site cleanup during and after work, and documentation closeout (signatures and delivery for storage).

Mechanical Maintenance *(WM003, 004, 005, 006, 009)*
All activities associated with electrical maintenance and construction work within the power block, such as routine mechanical preventive maintenance, as well as corrective, predictive and fix-it-now maintenance activities on plant components. It also includes major and minor modifications, parts staging and acquisition, performance of the work, pre- and post-maintenance testing, job-site cleanup during and after work, and documentation closeout (signatures and delivery for storage).

***Maintenance/Construction Support** (WM001, 002, 005)*
All activities associated with supporting the work of maintenance/construction craft/non-engineering-degreed maintenance technical experts; non-engineering-degreed persons developing maintenance strategies and resolving maintenance rules issues; personnel coordinating the development of corrective maintenance procedures and other technical matters with plant engineers; and maintenance procedure writers. This category also includes personnel who support plant modification work, such as coordination of contract laborers, cost and scheduling estimates and workers performing metrology activities.

***Maintenance/Construction Other** (WM003, 004)*
All activities associated with utility, painting, heating-ventilation-air conditioning, cranes, insulators and coaters.

Equipment Reliability

***Plant Engineering** (ER001, 002, 003, 004)*
All activities associated with development of a long-term planning and life-cycle management strategy and maintenance plan to establish, maintain and analyze information related to the condition and efficiency of structures, systems and components; the administration of preventive, predictive maintenance programs; and thermal performance monitoring program. These include:

- performing surveillance testing programs, in-service inspections and in-service tests
- calibrating, cataloging and maintaining/testing equipment and any engineering evaluations in support of testing requirements or evaluating results
- conducting post-maintenance testing
- writing procedures
- maintaining documentation closeout logs, reports and records regarding equipment performance to determine conditions adverse to quality
- reporting the system health assessment.

***Non-Destructive Examination-NDE** (ER002)*
All activities associated with the nondestructive examination program in support of engineering, maintenance and modifications. Examples include radiography, ultrasonic, eddy current, liquid penetrant and magnetic particle examinations to identify, ensure and verify component and/or equipment integrity. This includes American Society of Mechanical Engineers-code, safety-related and balance-of-plant activities.

Equipment Reliability Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors in equipment reliability. Among the administrative support functions performed are meeting and

conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Equipment Reliability Management
All activities associated with management personnel above the level of first-line supervisor in equipment reliability functions

Configuration Management

Design/Modification/Technical Engineering *(CM001, CM002, CM003)*
All activities associated with design/modification/technical engineering services, and ensuring design integrity for:

- Civil/structural engineering, including site buildings, roads, bridges and waterfront structures. Employees also perform soils and foundations analyses; review and approve hanger and support locations; and provide stress analysis, evaluation services, as well as architecture and site layout services.
- Electrical/I&C engineering, including high-, medium- and low-voltage distribution systems (including DC and instrument power), related components (such as motors, circuit breakers, transformers, batteries, chargers and inverters) and instrumentation and control systems and components.
- Mechanical engineering such as primary, secondary and auxiliary systems, and associated components, including piping, insulation and hangers.

Other associated activities are:

- developing design changes
- performing manual and computer-aided design engineering functions
- resolving field questions
- maintaining piping and instrument diagrams and electric power line diagrams
- preparing stress isometrics
- working on technical engineering issues, such as providing technical support to modification engineers and plant/system engineers, research and analysis of technical engineering issues
- disposing of non-conformances and other assigned items
- responding to design basis and configuration control issues and questions
- serving as technical consultants on engineering issues
- answering technical inquiries and information requests from internal and external sources
- ensuring design integrity for assigned specialized areas.

These employees are also responsible for engineering services and key programs in specialized technical areas not included in other engineering functions, such as equipment qualification, configuration management, in-service inspection, fire protection engineering and probabilistic risk assessment.

Nuclear Fuels/Reactor Engineering *(CM001, CM002, CM003, CM004, MS007, MS008)*
All activities associated with performing and/or reviewing reload safety evaluations; reload design analyses; and thermal, hydraulic and transient analyses. Employees also provide support to operations staff for core analysis, as well as fuel licensing and fuel management activities. Personnel who manage and monitor the nuclear fuel acquisition process are included in this category.

Other activities are those associated with analyzing fuel performance, handling core performance monitoring and trending, and providing support and technical direction to operations during refueling, startup and shutdown. This includes developing core designs, providing safety analysis calculations and support, monitoring fuel performance, and devising strategies for reactivity management.

Computer Engineering *(CM002, SS001)*
All activities associated with hardware and software engineering for supporting plant process computers, radiation monitoring systems and other operational/support computers and systems. Personnel who provide similar services for training simulators also are included in this category. This function does not include those positions supporting operation and maintenance of the supporting network and mainframe infrastructure, such as resource management, telecommunications, network services, mainframe, desktop services and enterprise applications.

Project Management *(CM002)*
All activities associated with direct control and monitoring of contractors and in-house design packages, as well as other work in support of engineering functions, including processes required to ensure design changes are justified based on efficiency, reliability, safety and value.

Project management employees review products to ensure high-quality work, participate in developing bid packages, establish and monitor milestone schedules for assigned work, assist in reviewing contractor proposals and recommending contract award, and coordinate resolution of technical questions directed to, or originated by, contractors.

Configuration Management Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors in configuration

management. Administrative support functions are meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Configuration Management (Management)
All activities associated with all management personnel above the level of first-line supervisor in configuration management functions.

Materials and Services

Contracts/Purchasing *(MS002, MS003)*
All activities associated with contract services and the evaluation and procurement of materials and services, including:

- developing, negotiating and monitoring service contracts from outside agencies/vendors
- processing and administering purchase requisitions, purchase orders and internal supply request, contracts and leases
- expediting materials
- filing claims for damage
- resolving shipping discrepancies
- participating in life-cycle cost planning, decisions to make/buy, the standardization of materials/variety reduction and customer contact/service
- planning and developing contracting and leasing strategies, market intelligence and performance, and strategic sourcing of materials and services
- supporting procurement (e.g., commercial grade dedication, procurement engineering and quality-related receipt inspection) and periodic nuclear vendor qualification and oversight related to procurement.

Procurement Engineering *(MS002, MS003)*
Includes all activities associated with qualification and technical specifications of plant materials, parts and equipment, including parts substitution, identification and resolution of supplier nonconformance, commercial parts dedication testing, and like-for-like replacement analysis.

Materials Management/Warehouse *(MS001, MS004, MS005, MS006)*
All activities associated with on-site receipt, inspection and reservation, warehouse storage (identification, tracking and stock-level maintenance), and distribution of materials prior to use. This includes receipt/dispatch of materials; warehouse operation handling and storage; packaging reduction; initial issuance of equipment and materials; handling and storage of nuclear grade materials, bulk gases and chemicals. Other activities are inventory planning, control and optimization; tool control and tool-room activities; consumable/free issue

management; records maintenance; development of inventory management control policies/procedures; and identification of unneeded inventory and scrap materials.

Materials and Services Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors in materials and services. Administrative support functions include meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Materials and Services Management
All activities associated with management personnel above the level of first-line supervisor in materials and services functions.

Training

Training *(Technical/Non-Technical T001, T002)*
All activities associated with program development, support and implementation of technical training functions. These individuals provide or coordinate all formal technical training for nuclear staff, including all programs accredited by the Institute of Nuclear Power Operations and Nuclear Regulatory Commission licensing programs. These employees also coordinate training schedules; produce training reports; provide for instructor training and development; and instructional system design and implementation; and operate simulators. This category includes all activities associated with non-technical training and employee development programs, such as management/supervisor, leadership development, cultural and programmatic training.

Training Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors in training. Administrative support functions include meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Training Management
All activities associated with management personnel above the level of first-line supervisor in training functions.

Loss Prevention

Emergency Preparedness *(LP005)*

All activities associated with emergency preparedness that provides technical direction and support to nuclear sites, state and local governments, and directly implements plans to minimize risks to both the general public and company employees. These employees also coordinate and establish priorities for the nuclear power emergency communication and data transmission programs.

Fire Protection *(LP006)*

All activities associated with developing, conducting and supporting fire protection, including support and implementation of fire protection (fire brigade) programs. These workers administer plant fire protection programs in accordance with applicable codes and technical specifications, as well as such requirements as control of temporary structures, welding permit systems and general area fire watches not associated with a specific project. Maintenance of fire protection equipment (fixed and portable) is included in the appropriate maintenance process.

Licensing *(LP004)*

All activities associated with managing regulatory (NRC and non-NRC) relationships; obtaining and maintaining the operating license; providing regulatory guidance and interpretation; monitoring and evaluating regulatory and industry trends; and evaluating, assessing and negotiating current and future commitments. This category includes supporting the following activities: license event reports, notices of violation, 50.59 evaluations, license and final safety analysis report amendments, NRC user fees, and U.S. Department of Energy high-level waste fee. These workers respond to generic letters; obtain and maintain environmental permits; review and evaluate proposed legislation, rulemaking and industry issues; and handle required regulatory insurance costs and inspection fees for personal and public liability (American Nuclear Insurers) and nuclear mutual limited insurance premiums.

QA and Corrective Action Program *(LP002)*
Activities associated with verifying the effectiveness of plant programs and compliance with regulations and codes. These include:

- self-assessments, root-cause determination, as well as implementation of the corrective action program and associated trending activities
- human performance/human factors/error prevention and reduction
- knowledge management activities
- required audits and inspections that verify regulatory compliance and conformance, excluding nuclear vendor qualification
- nuclear quality assurance program implementation and maintenance activities.
- vendor quality audits are included in contracts and purchasing.

Safety/Health *(LP003)*
All activities associated with the implementation of requirements of the Occupational Safety and Health Administration, such as industrial hygiene. The category also includes responsibility for safety program design and implementation, as well as the provision of medical services and other loss-prevention strategies (e.g., cost management of a worker compensation program).

Security *(LP001)*
All activities associated with providing security for nuclear plants, including manning security posts and operating security systems. Individuals in this category are responsible for the development of security plans and procedures. These employees also address technical issues pertaining to security regulations and requirements. This category includes all personnel responsible for site access control and fitness-for-duty programs.

Loss Prevention Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks, and clerical pools, including clerical pool supervisors in loss prevention. Administrative support functions include meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Loss Prevention Management
All activities associated with management personnel above the level of first-line supervisor in loss prevention functions.

Management and Support Services

Financial Services *(SS002)*

All activities associated with the operation of financial services, such as budgeting and cost control, accounting, payroll, treasury and time-reporting. Activities related to political action committee and governmental affairs, such as filing reports and information requests, are in this category.

Communications *(SS006)*

All activities associated with company involvement in the community for the betterment of the community and the economic well-being of the company, such as visitor center functions and public communications. This category includes individuals involved in media relations.

Document Control/Records *(SS003)*

All activities associated with processing records to ensure they are legible, identifiable and retrievable by establishing and complying with procedures that provide for their collection, review, indexing, protection and disposition. Among the activities are publishing and maintaining guidelines, approval documents, processes, programs, procedures and manuals, as well as maintaining revisions, files and distribution lists. Functions include typing, word processing, using various software applications, keying, filing, recordkeeping, providing copy and fax services, as well as graphics and typing pool functions related to document control/records support.

Facilities *(SS005)*

All activities associated with planning, administering and maintaining buildings, facilities, utilities and grounds. This includes activities associated with providing transportation services and maintaining company vehicles.

Human Resources *(SS004)*

All activities associated with providing employee/labor relations, organization and human-resources development, staffing, performance management guidelines, compensation, benefits and other related services. Employee concern and ombudsman programs are part of this category.

Information Services *(SS001)*
All activities associated with planning, developing, maintaining and operating the company's information systems (enterprise, departmental and individual). This includes the operation and maintenance of the supporting network, applications and mainframe infrastructure. Other activities are associated with operating and maintaining telecommunications facilities and equipment, electronic mail, and paging/radio services.

Training associated with information systems (e.g., Word, Excel, Access and PowerPoint) is included in the process, but specific operational plant computer training is not. Other activities may include oversight of plant process computer and digital embedded devices. Activities associated with software and hardware engineering for plant process computers and digital embedded devices are not part of this category.

Management Assistance
All activities associated with assisting management positions not included in any other activity, such as directors, managers, assistant managers, executive assistants/secretaries, business planning coordinators and legal consultants.

Support Services Administrative Support
All activities associated with secretaries, administrative assistants who are not functional professionals, clerks and clerical pools, including clerical pool supervisors in support services. Administrative support functions include meeting and conference coordination, word processing, spreadsheet development and maintenance, graphic/presentation material creation, and non-technical analysis of data.

Support Services Management
All activities associated with management personnel above the level of first-line supervisor in support services functions.

Officers and Executives

This category includes all officers and executives.

Additional Categories for Non-Utility Respondents

Many employees in non-utility environments do not fit easily into the categories described earlier. They may fit better in the categories below.

Non-Utility Degreed Positions

These categories describe individuals who hold degrees (either bachelor's or advanced) in the following fields and perform job functions associated with these degrees:

- health physicist
- nuclear engineer
- electrical engineer
- civil engineer
- mechanical engineer
- chemical engineer
- structural engineer.

Non-Utility Functional Positions

These categories describe individuals who perform functional tasks in project management and construction management.

Appendix C: NEI Work Force Issues Task Force Members

Mark Antoine, Entergy Operations (South)
Mary Ellen Beach, Nuclear Regulatory Commission
Paul Bird, Nuclear Regulatory Commission
James Boyles, Tennessee Valley Authority
Steven Bylow, Nuclear Management Co.
Dan Culliton, FirstEnergy/Perry plant
Gerald Ellis, Exelon Nuclear
John Erickson, Nuclear Management Co.
Lynn Fieldman, International Brotherhood of Electrical Workers
Meghan Firster, Westinghouse Electric Co.
John Gutteridge, U.S. Department of Energy
Amy Hanse, AREVA
Jack Haugh, EPRI
David Heler, Arizona Public Service Co./ Palo Verde
William Illing, Institute of Nuclear Power Operations
Walter Johansen, Fluor Corp.
Sharon Kerrick, American Nuclear Society
Brian Kremer, National Aeronautics and Space Administration
Michael Monfalcone, Dominion Nuclear
Cindy Nelson, Southern Nuclear Operating Co.
Kevin Nelson, Health Physics Society
Kirk Newell, American Electric Power/ D.C. Cook Plant
Will Paul, International Brotherhood of Electrical Workers
Lynn Pressey, Southern California Edison
Larry Taylor, STP Nuclear Operating Co.
Nancy Winters, Constellation Nuclear
Angie Howard, Nuclear Energy Institute
Carol Berrigan, Nuclear Energy Institute

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STATEMENT OF DAVID LOCHBAUM, NUCLEAR SAFETY ENGINEER, ON BEHALF OF UNION OF CONCERNED SCIENTISTS

On behalf of the Union of Concerned Scientists (UCS), it is my pleasure to appear before this subcommittee. My name is David Lochbaum. After obtaining a degree in nuclear engineering from The University of Tennessee in 1979, I spent more than 17 years in the nuclear industry, mostly at operating power reactors in Georgia, Alabama, Mississippi, Kansas, New Jersey, Pennsylvania, New York, Ohio, and Connecticut, before joining UCS in October 1996 as their nuclear safety engineer. UCS, established in 1969 as a non-profit, public interest group, seeks to ensure that people have clean air, energy and transportation, as well as food that are produced in a safe and sustainable manner. UCS has monitored nuclear plant safety issues for over 30 years.

LESSONS FROM THE PAST

Twenty five years ago this past March, the Three Mile Island Unit 2 reactor outside Harrisburg, Pennsylvania experienced the worst nuclear plant accident in U.S. history. The 25th anniversary of that meltdown got considerable media attention. One reporter asked me how the nuclear industry would be different today had the Three Mile Island accident not happened. "There would be no difference," I answered him, "because that accident was bound to happen—if not at Three Mile Island, then at some other reactor." One-of-a-kind design flaws, isolated operator training deficiencies, or unique equipment failures did not cause the accident. Degraded conditions prevalent at and tolerated on all reactor sites ultimately produced a meltdown at one site—Three Mile Island. The many post-mortem inquiries into that accident resulted in extensive changes in the organization and management of the nuclear industry and its regulator, the Nuclear Regulatory Commission (NRC).

This history is relevant to today's hearing because compelling evidence suggests that extensive, degraded conditions at reactor sites are once again being tolerated. The NRC's response to these warning signs have amounted to little more than rearranging the deck chairs on the *Titanic*. Fortunately, there is still time for the NRC to plot a different course so as to avoid the icebergs looming on the horizon.

WARNING SIGNS IN THE PRESENT

The Davis-Besse nuclear plant in Ohio recently restarted after being shut down more than 2 years for repairs to emergency equipment. The NRC concluded that deteriorating conditions at Davis-Besse had, over a period of nearly 6 years, reduced safety margins to the point where the reactor was within two to 13 months of having an accident like Three Mile Island. The NRC identified more than four-dozen flaws in its regulatory oversight processes that allowed Davis-Besse to flirt with disaster. Many of those regulatory flaws remain uncorrected and are not even scheduled for correction.

Davis-Besse is not an isolated case. It is the twenty-eighth (28th) nuclear power reactor to be shut down for a year or longer for safety repairs since September 1984. In fact, there has not been a single minute in the past two decades without at least one reactor mired in a year-plus outage.

A year-plus outage adversely affects the reliability of the electrical power grid. It adversely affects the costs paid by ratepayers for electricity and the returns received by stockholders. It adversely affects safety levels exposing workers and the public to undue hazards. Twenty-eight year-plus outages in 20 years is an extremely poor report card for both the nuclear industry and its regulator. Nuclear safety problems must be found and fixed before they grow to epidemic proportions.

The NRC's report cards from internal and external auditors are equally bad, especially since so many of yesterday's problems still factor into today's problems. Very little is getting fixed. A review of reports issued by NRC Lessons Learned Task Forces, the NRC Office of the Inspector General (OIG), and the U.S. General Accounting Office (GAO) over the past 8 years shows the same regulatory problems contributing again and again to unacceptable safety levels. Examples of these recurring, uncorrected findings are:

Auditor – Date	Verbatim Auditor Findings & UCS Comments
US NRC OIG – 10/2003[1]	*"OIG found that NRC Headquarters did not integrate the issues raised in Generic Letters 88-05 and 97-01 into NRC's inspection program."* **UCS Comment: NRC Headquarters issued the generic letters to require owners to take steps to avoid safety problems encountered at other nuclear plants, but failed to follow-up to verify that the owners actually took those steps.**
	"OIG determined that there was ineffective communication among [NRC] Region III managers concerning boric acid leakage and corrosion at Davis-Besse."
	"OIG determined that the [NRC] Senior Resident Inspector, Resident Inspector, and possibly the ISI Inspector reviewed Davis-Besse CR 2000-0782 [containing the infamous Red Photo] during 12 RFO [the 12th refueling outage, April 2000]. These inspectors did not recognize the significance of the boric acid corrosion described in CR 2000-0782." **UCS Comment: In 1999, the NRC sanctioned Davis-Besse's owner for a safety problem caused by boric acid corrosion, but that lesson was soon forgotten by the owner and the NRC.**
US GAO – 09/2003[2]	*"NRC's Inspection Practices Minimize the Significance of Some Security Problems"*
	"NRC Does Not Systematically Collect, Analyze, and Disseminate Information That May Improve Security at All Plants" **UCS Comment: A major contributor to the 1979 meltdown at Three Mile Island was NRC's failure to disseminate known safety problems to plant owners. The NRC developed a system for sharing safety information, but did not – even in the wake of 09/11 – extend this system to cover security problems.**
	"NRC's Force-on-Force Exercises Are Limited in Their Usefulness"
	"[Security force-on-force] *Exercises Did Not Test the Full Extent of the Design Basis Threat*" **UCS Comment: The NRC's Design Basis Threat is not established at such a lofty level that testing shy of it is justified.**

[1] U.S. Nuclear Regulatory Commission Office of the Inspector General, Case No. 03-02S, "NRC's Oversight of Davis-Besse Boric Acid Leakage and Corrosion During the April 2000 Refueling Outage," October 17, 2003.
[2] U.S. General Accounting Office, GAO-03-752, "Nuclear Regulatory Commission: Oversight of Security at Commercial Nuclear Power Plants Needs to Be Strengthened," September 2003.

Auditor – Date	Verbatim Auditor Findings & UCS Comments
US NRC OIG – 05/2003[3]	*"NRC performs limited inspections of licensees' MC&A [materials control and accountability] activities, and cannot assure the reliability of the SNM [special nuclear material] tracking system."* **UCS Comment: The SNM tracking system is one of the barriers against "dirty bombs." This barrier must be as effective as possible.**
US NRC OIG – 12/2002[4]	*"NRR [NRC's Office of Nuclear Reactor Regulation] staff described to the technical assistants [of the Commissioners] ...how NRR's decision to allow Davis-Besse to operate ... comported with the five safety principles outlined in the NRC's risk-informed decisionmaking guidelines. NRR staff noted that although four out of five safety principles were not explicitly met, the staff concluded that Davis-Besse could operate safely until February 16, 2002."* **UCS Comment: 20% cannot be a passing grade when it comes to nuclear plant safety. NRC must abide by its safety principles, not generate excuses for ignoring them.**
	"An NRR manager stated that from the perspective of external stakeholders, the need for a shutdown order is not a positive indicator for the nuclear industry and would destabilize confidence in the nuclear industry's ability to make the right decisions." **UCS Comment: The NRC's poor performance at Davis-Besse destabilized confidence in its ability to make the right decisions. The NRC must worry more about safety and less about the nuclear industry's public relations.**
US NRC OIG – 12/2002[5]	*"Less than half (48%) of NRC employees feel that management actually trusts the judgment of employees at their level in the organization."*
	"Slightly more than half (53%) of the employees feel that it is "safe to speak up in the NRC."" **UCS Comment: It is simply unacceptable for half of the NRC work force to fear speaking up. The NRC would not tolerate such a large 'fear factor' at nuclear plant sites and must not tolerate such a condition internally.**
	"In comparison with 1998 survey data, the only item that shows a significant decrease (-5 percentage points) in favorability is "I believe NRC's commitment to public safety is apparent in what we do on a day-to-day basis.""

[3] U.S. Nuclear Regulatory Commission Office of the Inspector General, OIG-03-A-15, "Audit of NRC's Regulatory Oversight of Special Nuclear Materials," May 23, 2003.
[4] U.S. Nuclear Regulatory Commission Office of the Inspector General, Case No. 02-03S, "NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head," December 30, 2002.
[5] U.S. Nuclear Regulatory Commission Office of the Inspector General, OIG-03-A-03, "2002 Survey of the NRC's Safety Culture and Climate," November 2002.

Auditor – Date	Verbatim Auditor Findings & UCS Comments
US NRC – 09/2002[6]	*"The NRC failed to integrate known or available information into its assessments of DBNPS's [Davis-Besse Nuclear Power Station's] safety performance."* **UCS Comment: Like NASA's failure to properly evaluate available information on the insulation striking the *Columbia*'s wing during launch, NRC failed to properly evaluate available information about Davis-Besse.**
	"The NRC failed to adequately review, assess, and followup on relevant operating experience to bring about the necessary industry and plant specific actions to prevent this event."
	"The NRC accepted industry positions regarding the nature and significance of VHP nozzle cracking without having independently verified a number of key assumptions, including the implementation effectiveness of boric acid corrosion control programs and enhanced visual inspections of RPV [reactor pressure vessel] heads."
	"During the period in which the symptoms and indications of RCS [reactor coolant system] leakage were visible, the managers and staff members of the NRC's regional office responsible for DBNPS oversight were more focused on other plants that were the subject of increased regulatory oversight. This distracted management attention and contributed to staffing and resource challenges impacting the regulatory oversight of DBNPS." **UCS Comment: During this very same time period, the NRC did not permit 'distractions' from keeping the agency from meeting scheduler goals for license renewal and power uprate approvals. The NRC had sufficient resources but applied them with poor safety focus. This lack of proper focus must be remedied as soon as possible.**
US NRC OIG – 08/2002[7]	*"The agency has not developed guidance for an independent verification process to provide assurance that licensee risk assessment results are acceptable for SDP [significance determination process] purposes and provide a sound basis for regulatory decisions."*
	"Senior NRC officials confirmed that the agency is highly reliant on information from licensee risk assessments. Agency officials also noted that there are no PRA [probabilistic risk assessment] standards, no requirements for licensees' PRAs to be updated or accurate, and that the quality of the assessments varies considerably among licensee." **UCS Comment: "Garbage in, garbage out" is imprudent regulatory practice and must cease. The NRC must either establish minimum standards or stop relying on obsolete, inaccurate information.**

[6] U.S. Nuclear Regulatory Commission Lessons Learned Task Force, "Degradation of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report," September 2002.
[7] U.S. Nuclear Regulatory Commission Office of the Inspector General, OIG-02-A-15, "Review of NRC's Significance Determination Process," August 21, 2002.

Auditor – Date	Verbatim Auditor Findings & UCS Comments
US NRC OIG – 08/2000[8]	*"OIG learned that, although historically Region I has provided IP2 with enhanced oversight, the Region did not focus specifically on the plant's steam generators. According to the Region I Administrator, the Region did not view steam generators as significant in the overall oversight and regulation of IP2."* **UCS Comment: Indian Point Unit 2 (IP2) had the oldest steam generators of this type still in service. All other steam generators of this vintage had been replaced due to safety problems. The NRC had no credible reason for excluding the steam generators from its oversight at Indian Point Unit 2.**
	"OIG noted that in July 1997, the same month that the IP2 steam generator inspector report was received by NRR, the NRC Office of Public Affairs issued "NRC Technical Issues Papers and Fact Sheets: Steam Generator Tube Issues" ...: *These [steam generator] tubes play an important safety role because they stand between the radioactive and nonnuclear sides of the plant. The integrity of the tubing is instrumental in minimizing leakage of water between the two sides. There is the potential that if reactor fuel is damaged and several tubes were to burst at once, it could lead to a fairly significant release of radioactive steam."*
	"OIG learned that neither the Region I nor NRR staff conducted a technical review of IP2's 1997 steam generator tube inservice inspection report when it was submitted in July 1997."
	"The [NRC] junior engineer [reviewing IP2's request to defer steam generator inspections] added that she had concerns regarding the steam generators crack growth rates that were not addressed in the original license amendment submittal. ... OIG learned that the junior engineer did not ask additional questions of the licensee, although she believed the responses to the RAI [NRC's request for additional information] could have been more robust. The junior engineer stated that a second request of questions was "frowned upon" by NRR management. ... The junior engineer stated "I felt like we were stuck" with the IP2 responses to the RAI." **UCS Comment: The NRC demands that its licensees encourage "questioning attitudes" by plant workers, yet places impediments to its own staff asking questions about safety levels. These impediments must be eliminated.**
	"NRC Has Not Resolved Many Issues Needed to Implement a Risk-Informed Regulatory Approach"
	"Utilities Do Not Have Accurate and Reliable Design Information for Some Plants"

[8] U.S. Nuclear Regulatory Commission Office of the Inspector General, Case No. 00-03S, "NRC's Response to the February 15, 2000, Steam Generator Tube Rupture at Indian Point Unit 2 Power Plant," August 29, 2000.

[9] U.S. General Accounting Office, Testimony before the Subcommittee on Clean Air, Wetlands, Private Property, and Nuclear Safety, Committee on Environment and Public Works, U.S. Senate, GAO/T-RCED-99-71, "Nuclear Regulatory Commission: Strategy Needed to Develop a Risk-Informed Safety Approach," February 2, 1999.

Auditor – Date	Verbatim Auditor Findings & UCS Comments
US GAO – 02/1999[9]	*"NRC Does Not Have Confidence That Safety Analysis Reports Reflect Current Plant Designs"*
	"Erroneous Evaluations Can Erode Design and Safety Margins" **UCS Comment: Davis-Besse demonstrated that this problem still exists.**
	"NRC Does Not Have a Standard for the Content of Risk Assessments"
	"NRC Has Not Determined Whether Compliance With Risk-Informed Regulations Would Be Mandatory or Voluntary"
US GAO – 01/1999[10]	*"NRC Lacks Assurance of Nuclear Plants' Safety"*
	"NRC Is Slow to Require Corrective Action" **UCS Comment: The NRC initiated Generic Safety Issue No. 191 in September 1996. It involves known deficiencies in vital safety systems at most of the nation's power reactors that increases the likelihood of meltdown by as much as a factor of 100. The NRC's current 'schedule' calls for this problem to be resolved sometime in 2007.**
	"NRC's Culture and Organizational Structure Impede Effective Actions"
US GAO – 07/1998[11]	*"NRC Does Not Precisely Define Nuclear Plant Safety"*
	"NRC Is Not Effectively Overseeing Problem Plants"
	"Management Competency Is Critical to Safety"
	"Early Intervention Could Result in Fewer Problem Plants"
US NRC OIG – 06/1998[12]	"[NRC] *Employees report that communicating problems results in a "shoot-the-messenger" syndrome.*" **UCS Comment: NRC management simply must not impede the free communication about nuclear safety problems.**
	"More than half of the employees (53%) say the management style at NRC does not encourage employees to give their best."
	"Fifty-two percent (52%) of employees do not feel the NRC has a climate where one can challenge the traditional ways of doing things."
US GAO – 05/1997[13]	*"NRC Is Not Effectively Overseeing the Plants That Have Problems"*
	"NRC Is Not Getting Licensees to Fix Deficiencies in a Timely Manner"
	"Relying on Plant Managers to Fix Problems Is Not Always Effective"
	"NRC Enforcement Actions Are Too Late to Be Effective" **UCS Comment: On May 7, 2004, the NRC announced that it was not imposing sanctions on Davis-Besse's owner for having provided false information to the agency because, in part, the five-year statute of limitations had expired.**
	"The Senior Management Meeting Needs Revamping to Aid Early Intervention"
	"Increased Trend Analyses Could Identify Weak Areas"
US GAO – 01/1996[14]	**UCS Comment: On March 28, 1999, the NRC disbanded its office for the Analysis and Evaluation of Operational Data (AEOD) which effectively conducted trend analyses.**

[10] U.S. General Accounting Office, GAO/OCG-99-19, "Major Management Challenges and Program Risks: Nuclear Regulatory Commission," January 1999.
[11] U.S. General Accounting Office, Testimony before the Subcommittee on Clean Air, Wetlands, Private Property, and Nuclear Safety, Committee on Environment and Public Works, U.S. Senate, GAO/T-RCED-252, "Nuclear Regulatory Commission: Preventing Problem Plants Requires More Effective Action by NRC," July 30 1998.
[12] U.S. Nuclear Regulatory Commission Office of the Inspector General, "NRC Safety Culture and Climate Survey," June 1998.
[13] U.S. General Accounting Office, GAO/RCED-97-145, "Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action," May 1997.
[14] U.S. General Accounting Office, GAO/RCED-96-41, "Nuclear Regulation: Oversight of Quality Assurance at Nuclear Power Plants Needs Improvement," January 1996.

The NRC attempted to remedy the shortcomings identified by its auditors. However, these efforts failed to achieve the necessary outcome of preventing recurrence. The NRC's current regulatory processes rated Davis-Besse in 2002 as one of the best performing reactors in the U.S.—it now appears that Davis-Besse was the worst performer. Obviously, the NRC failed to correct enough of its many shortcomings. If the agency corrected its regulatory impairments, it would be able to detect declining safety levels sooner and intervene long before year-plus outages are needed to restore the necessary safety margins.

ROADBLOCKS TO NRC REFORMS

The NRC has many talented and capable employees committed to the agency's vital mission of protecting public health and safety. But as NASA learned with the *Challenger* tragedy and re-learned with the *Columbia* tragedy, technologies where risk is dominated by high-consequence, low-probability events require much more than the commitment of talented, capable workers. They require an unrelenting, uncompromising approach to safety.

The NRC strives to provide that level of oversight, but falls short too often as demonstrated by the 28 year-plus reactor outages in the past 20 years. The agency's efforts are stymied by its hiring and promotion policies. Very few of the NRC's senior technical managers are new to the agency. The majority worked their way up through the ranks. Consequently, NRC's managers come from the same mold and have the same habits. Retirements and reorganizations at NRC merely put new faces on the same management style. Reform efforts fail because merely re-packaging and re-applying that management style cannot yield substantive changes.

The aforementioned 28 reactors that endured lengthy outages shared the common trait of bringing in new—really new—management to direct the restart and recovery efforts. New management is the fastest way to meaningful and lasting reforms. New managers can assess policies and practices unencumbered by "traditions." New managers can stake out a new path with implicitly conceding it led troops down old paths. New management is a tried and true method for bringing about needed reforms in a timely manner. Yet it is an untried method at NRC, which desperately needs reform at any pace.

UCS is not advocating a massive infusion of new managers at NRC. This would be the fastest and surest way to the much-needed reforms, but it would be unfair to many fine public servants who have devoted many years of hard work on nuclear safety issues. Instead, we urge Congress to work with the NRC to revamp the agency's hiring and promotion policies. Retirements and other voluntary departures should provide opportunities for finding the most qualified replacements—not just the most qualified replacements from within the NRC. The salaries and benefits for NRC managers must be sufficient to attract and retain qualified candidates from inside and outside the agency.

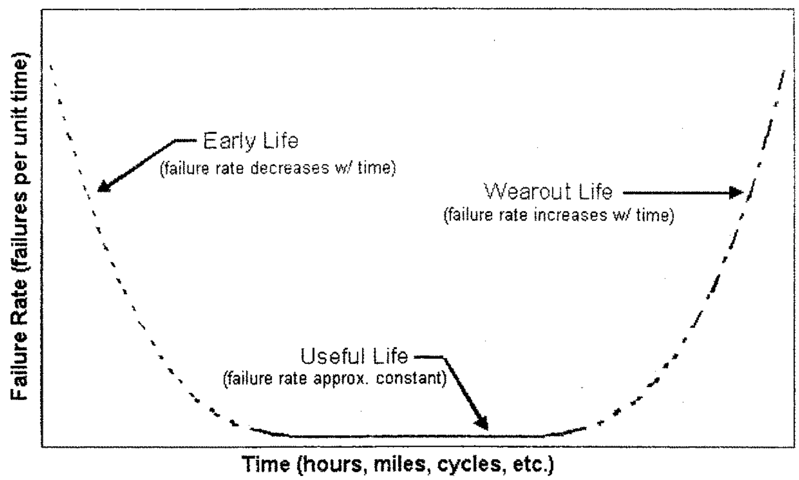
NUCLEAR CROSSROADS

The future of nuclear power in the United States depends on decisions made now. The NRC's regulatory impairments make nuclear power's cost and risks higher than is necessary. Left unchecked, the only question is whether economics or disaster will bring down the curtain on nuclear power in America.

Whatever role nuclear power plays in our energy future, the NRC must become an effective regulator. To hasten that transformation, the agency needs fresh perspectives from outside managers. One of the NRC's strengths is its work force of talented, capable, and dedicated employees. Properly led, they can make sure that nuclear power's costs are not too high or its safety levels too low.

The NRC is like NASA in that both agencies struggle with complex technologies where risk is dominated by low probability, high consequence events. We hope NRC is unlike NASA in not needing a tragic reminder to trigger the reform efforts that are so desperately needed.

The time for NRC to reform is running out. The Three Mile Island meltdown and other nuclear accidents at Chernobyl, Browns Ferry, St. Laurent, Fermi Unit 1, SL–1, and Sodium Reactor Experiment occurred in the first year or two of the plant's lifetime—during the break-in phase. As indicated in the figure of what is called the "bathtub curve" due to its distinctive shape, risk of failure is highest early and late in life. The 104 nuclear power reactors in the U.S. are heading toward, if not already within, the wear-out phase of life where risk once again rises. The NRC recurring, chronic problems must be fixed if the American public is to be adequately protected from the hazards of aging nuclear power plants.



On behalf of UCS, I wish to thank the subcommittee for conducting this hearing on nuclear plant security and for considering our views on the matter.

RESPONSES BY DAVID LOCHBAUM TO ADDITIONAL QUESTIONS FROM SENATOR JEFFORDS

Question 1. How can NRC enhance its enforcement efforts? In your view, is the issue a lack of personnel, or is additional training needed?

Response. The two major problems with the NRC's enforcement efforts are timeliness and clarity of communications. Based on the NRC's ability to meet schedule goals in other areas—such as reviewing license amendment requests—we believe that timeliness in enforcement actions can be achieved without additional staffing. The clarity of NRC's communications about enforcement actions can be improved by a combination of training and process refinements.

The NRC's enforcement actions on nuclear plant safety issues since spring of 2000 fall into two categories: willful violations and non-willful violations. Willful violations involve determinations by the NRC that plant personnel and/or management knowingly and deliberately violated regulations. Such determinations can prompt the NRC into enforcement actions such as fines against the individuals involved and the company. Non-willful violations involve determinations by the NRC that companies unknowingly or inadvertently failed to comply with regulations. Both categories suffer from lack of timely NRC decisions that harm plant owners and the public. When the NRC ultimately determines that no violations occurred, clouds of suspicion hung longer than necessary over suspected individuals and companies. On the other hand, when the NRC ultimately determines that violations occurred, individuals and companies remained at the controls of nuclear power plants unaccountable longer than necessary.

The fix is simple—the NRC must establish schedule goals for enforcement decisions and abide by them. The NRC established goals for decisions involving license renewal requests and has met every single deadline to date despite some involving intervenor action. Likewise, the NRC established goals for decisions involving other licensing requests by plant owners and it meets those deadlines over 95 percent of the time. By applying this proven management control to its enforcement decisions, the NRC should be able to achieve the similar on-time performance.

Regarding clarity of communications about enforcement actions, I began engaging the NRC in 1997 in a continuing series of discussions and correspondence about inconsistent enforcement actions. Many of those discussions occurred during public meetings conducted by NRC where representatives of the Nuclear Energy Institute (NEI), the nuclear industry's trade group, expressed similar comments about the vagueness of NRC's communications. By procedure, the NRC's communications about enforcement actions use templates where blanks for specific information (i.e., who, when, where) are filled in. This 'boilerplate' approach to communications force-fits varying reasons into the same messages. When queried by me or NEI, the NRC promptly reveals the true reasons why enforcement actions were or were not taken. Obviously, the true reasons had not been withheld for privacy or legal reasons or the NRC could not have divulged them so freely during public meetings and in public correspondence.

Again, the fix is simple—the NRC must publicly divulge the true reasons for its enforcement decisions. The current procedure that makes the NRC issue trite communications must be revised. Training on the revised procedure should be given to NRC staffers.

Question 2. Nuclear plants that are seeking license renewal may not always conform to current safety standards, but to a number of regulations dating back 40 years with exemptions, deviations, and waivers granted along the way. While each individual exemption or waiver may be justified and not reducing safety margins, the cumulative effective of so many exceptions can adversely affect safety. What should NRC be doing to properly manage the risk at aging reactors? Is having all plants meet current standards the appropriate solution?

Response. Having all nuclear plants conform to current standards before being granted permission to operate for up to 20 additional years would solve the problem. But that solution poses an undue burden on plant owners, their ratepayers and stockholders. Therefore, UCS advocates that the NRC adopt a more practical and reasonable solution.

The NRC's license renewal process assumes that nuclear power plants have adequate safety margins today and focuses the license renewal review efforts on aging mechanisms with the potential for eroding those safety margins. UCS feels strongly that this license renewal process must also include the NRC's verification that today's safety margins are indeed adequate.

The adequacy of safety margins is established by the NRC's regulations. UCS is not aware of a single U.S. nuclear power plant that meets today's regulations. Instead, U.S. nuclear power plants are supposed to meet (a) the regulations in effect when the NRC initially licensed them to operate, and (b) regulations subsequently adopted by the NRC that the agency specifically applied to existing plants (otherwise, the new regulations only applied to reactors licensed thereafter by the NRC). In addition, the NRC approved literally thousands of waivers, deviations, and exemptions to the regulations.

A prime purpose of the NRC's reactor oversight process is to determine if the reactors meet their applicable regulations (not today's regulations, but the hodge-podge of old regulations, new regulations, and hundreds of approved waivers, deviations, and exemptions).

Collectively, the NRC's reactor oversight process and its license renewal process seek to assure that a reactor has the safety margins provided by applicable regulations and that aging of structures and equipment throughout two more decades of operation will not erode those safety margins. The vital missing link is a verification that the reactor's safety margins provide the public with protection comparable to that afforded by today's regulations.

Before the NRC grants a license renewal, the NRC should verify the adequacy of today's safety margins by formally reviewing the regulations applicable to a reactor and all the approved waivers, deviations, and exemptions from those applicable regulations against the agency's current regulations. [NOTE: Wherever possible, the NRC's review should be streamlined by limiting its scope to only a comparison of regulations having a safety nexus. For example, regulations involving merely the frequency and content of reports to be submitted to the NRC by licensees could be excluded.]

UCS believes that it is necessary, practical, and prudent for the NRC to verify the adequacy of today's safety margins before granting a 20-year extension to the original 40-year license. After all, an option to extending the life of the 40-year old reactor would be to construct a brand new reactor at the same site to use the same transmission lines and infrastructure. There is no question that a new reactor would have to meet today's regulations and the safety margins they require. Prudent protection of public health dictates there should be no unanswered questions about whether ancient reactors have comparable safety margins.

Statement of Marilyn Kray, Vice President for Project Development, Exelon Generation, on Behalf of NuStart Energy Development LLC

Chairman Voinovich, Senator Carper, and Members of the Subcommittee:

I am Marilyn Kray, Vice President of Project Development for Exelon Nuclear, a subsidiary of Exelon Corporation. I am appearing today in my capacity as the lead representative of NuStart Energy Development, a recently formed consortium of power companies and reactor vendors. Thank you for the opportunity to appear before you today.

Congress has an important role in providing oversight of the Nuclear Regulatory Commission, and this oversight will be particularly important as the Commission proceeds with a new process for licensing nuclear power plants. My testimony today will focus on the benefits of nuclear power, the Department of Energy's Nuclear Power 2010 Initiative, the formation of NuStart Energy Development, and the prerequisites for the construction of new nuclear power plants.

BENEFITS OF NUCLEAR POWER

Nuclear power is a safe, clean, reliable and economic method of generating electricity. Indeed, the nation's 103 operating reactors provided over 20 percent of the electricity generated in the United States last year.

Nuclear plants are safe, both from an operational and a homeland security perspective. Despite concerns expressed by some that nuclear plants would become less safe as plant operators focused improving operational efficiency, data has shown that plant performance and safety go hand-in-hand. The best performing plants in terms of capacity factor also have the fewest safety-related incidents. Operational excellence not only increases plant output, it also enhances safety. In fact, commercial nuclear plants have an exceptional record of worker safety.

From a security perspective, independent reviews of commercial nuclear power plants have shown these plants to be perhaps the most secure industrial facilities in the United States. The same plant features that are used to isolate the public from radiation also serve to fortify the plants against outside intruders. Nuclear security, already robust prior to September 11, 2001, has been significantly enhanced since that time. Plants have made significant capital investments to upgrade security and have roughly doubled the size of their security forces.

Nuclear power is also one of the cleanest sources of electric generation. Since nuclear power is not based on combustion, nuclear plants emit none of the air pollutants associated with climate change, acid rain, or smog. Since the electricity produced by nuclear plants displaces electricity that would otherwise be supplied by fossil-fired power plants, it is estimated that U.S. nuclear plants avoided 3.38 million short tons of sulfur dioxide, 1.39 million short tons of nitrogen oxides, and 189.5 million metric tons of carbon dioxide during 2002.[1]

Nuclear plants do not discharge pollutants into the water, though they do discharge warm water into the environment. These discharges are carefully regulated and monitored to protect aquatic life. And while nuclear plants do generate radioactive waste materials, these wastes are carefully managed and are isolated from the environment.

From a reliability perspective, nuclear plants are an ideal source of baseload generation. Demand for electricity is expected to grow by 50 percent by 2025, according to the Department of Energy. Nuclear power will be necessary to ensure that the U.S. maintains a balanced, diverse and reliable electricity supply while protecting the environment.

In 2003, the U.S. reactor fleet produced 766.5 billion kWh of electricity at an average capacity factor of nearly 90 percent. In part, this is due to the inherent design philosophy to run for extended periods of time between scheduled refueling outages. Most nuclear plants now run on a 2-year cycle between refueling outages. Because of these long run cycles, nuclear plants are not subject to fuel delivery issues that can affect some generation sources. In addition, unlike other generation sources, nuclear plants are generally not affected by weather conditions.

Finally, nuclear generation has proven to be an extremely cost competitive form of electricity generation. For 2002, nuclear plant production costs, which encompass fuel and operation and maintenance costs, were 1.71 cents/kWh. These productions costs were lower than comparable costs for coal, which were 1.85 cents/kWh, and significantly lower than natural gas and oil, whose production costs were 4.06 cents/kWh and 4.41 cents/kWh, respectively.[2]

DOE'S NUCLEAR POWER 2010 INITIATIVE

Despite the nuclear industry's impressive performance in recent years, companies have been reluctant to consider investing in new nuclear plants. Uncertainty regarding the NRC's new licensing process, new advanced reactor designs, the future regulatory environment, the existence of a repository for used nuclear fuel, and the fu-

[1] Calculated by the Nuclear Energy Institute using regional fuel emission rates from EPA CEMS data and individual plant generation data from the Energy Information Administration. Last updated September 2003.

[2] U.S. DOE/Nuclear Power Industry, Strategic Plan for Light Water Reactors Research and Development, First Edition, February 2004.

ture of electricity markets in the U.S. all represent risks that give investors pause when it comes to nuclear power.

Recognizing the valuable role of nuclear energy in meeting the nation's current and future energy needs, Energy Secretary Spencer Abraham unveiled the Department of Energy's Nuclear Power 2010 initiative in February of 2002. The program seeks to partner with the private sector to achieve three goals: (1) to evaluate potential sites to host new reactors; (2) to demonstrate the Nuclear Regulatory Commission's licensing process for new plants; and (3) to conduct research to promote safer and more efficient nuclear plant technologies in the United States.

In June 2002, the Department awarded grants to Dominion, Entergy, and Exelon in support of their proposals to develop and submit Early Site Permit applications to the Nuclear Regulatory Commission. Each company submitted their application to the NRC for review in the Fall of 2003. Final NRC action on the applications is expected in 2006.

In November 2003, the Department issued a formal solicitation inviting cooperative agreement applications to demonstrate the NRC's combined operating license (COL) process. The solicitation encouraged a consortium approach among power generation companies, plant owners and operators, reactor vendors, architect engineers and construction companies and proposed a 50 percent minimum industry cost share over the life of the project.

In 1989, the NRC introduced 10 CFR Part 52, an improved and more efficient licensing process for new nuclear plants. However, this process has not been demonstrated, and the prolonged regulatory interactions on previously licensed plants only serves to increase the financial community's uneasiness over the NRC's licensing process. This is why DOE's Nuclear Power 2010 Initiative is essential.

The Part 52 process has three subparts: Early Site Permits, Design Certification, and Combined Construction Permits and Operating Licenses. These subparts have common concepts and common principles. It is important for these common concepts and principles to be maintained during the reviews, issuance and implementation of the Part 52 subparts. For example, one of these common concepts, the Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC), is applicable in design certification and in the combined license element. The principles for the design certification ITAAC are the same as for the combined license ITAAC, though the regulatory reviews may be years apart. If these concepts and principles—which include implementation—are not maintained, the reviews will become prolonged. Every effort should be made to maintain personnel stability within a project for the duration of the combined license review and plant construction.

The majority of the existing 103 reactors in the U.S. are unique design. Standardization was not a consideration in the early plants, where incorporating lessons learned as previous plants were built took priority. In the 1990's, the industry made a commitment to standardize new plants to the fullest extent possible. As a result, once the first plant receives its license, subsequent licensing activities for future plants of the same design should be easier and take less time. The only issues to review would be associated with site-specific differences and design compatibility with the site.

The industry commends the NRC for moving forward with improvements to 10 CFR Part 2, Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders. These improvements will make the licensing process more objective and efficient, while maintaining full public involvement on issues that are relevant and germane to the proceedings. When coupled with the new Part 52 process, these regulatory and process improvements should assure that a combined construction and operating license for a completely new design can be issued in 24 months of the application being filed. For subsequent application of the same design, the licensing review and process should take no more than 18 months. This timeframe assumes that that all the elements of the Part 52 process are being used (an approved early site permit, and a certified design) and that there is no need for a formal adjudicatory hearing.

In response to the COL solicitation, three consortia applied for assistance from DOE. The three consortia include a team composed of Dominion, AECL of Canada, Bechtel and Hitachi; a team composed of the Tennessee Valley Authority, General Electric, Bechtel and USEC; and NuStart Energy Development, which includes Constellation Energy, Duke Energy, EDF International North America, Entergy Corporation, Exelon Corporation, Southern Company and the Tennessee Valley Authority, as well as General Electric and Westinghouse.

NUSTART ENERGY DEVELOPMENT

As noted above, NuStart includes nine participating companies. Of these companies, TVA is a limited participant, providing in-kind services only, while GE and Westinghouse serve as subcontractors to the formal LLC.

The total cost of the project is just over $800 million over a 7-year period. We are requesting that DOE provide one-half the cost. Each of the six power companies will provide $1 million cash annually for 5 years from 2004 through 2008, and reduced amounts in 2009 and 2010. In addition, each of the six power companies will provide inkind services throughout the 7-year duration of the project, for a total project share of $6.2 million of cash and in-kind services from each of the six power companies. The reactor vendors will provide significantly greater funding—Westinghouse approximately $208.3 million and GE approximately $157.2 million—over the course of the project.

The NuStart Energy Development proposal is divided into three overlapping phases: Planning, Evaluation and Licensing. The significant activities of each phase are outlined below:

Planning Phase (2004–2005)

- Finalize consortium organization
- Finalize contractual relationships
- Prepare for design selection
- Identify candidate sites
- Develop general licensing strategy

Evaluation Phase (2004–2005)

- Develop design selection criteria
- Select site
- Finalize licensing strategy
- Reevaluate economic evaluation for nuclear investments

Licensing Phase (2004–2010)

- Receive from NRC Design Certification for selected designs
  - Westinghouse AP1000
  - General Electric ESBWR
- Issue Request for Proposal to reactor vendors
- Select reactor design for submittal
- Submit COL application to NRC
- COL granted by NRC

PREREQUISITES TO NEW PLANT CONSTRUCTION

As defined by DOE, the scope of the NuStart Energy Development proposal is limited to the pursuit of a combined operating license. The consortium has made no commitment beyond obtaining the operating license. While the consortium, or members of the consortium, would be able to use the COL to pursue construction of a new plant, there is no commitment to build a plant once the COL is obtained.

Successful completion of the proposed COL project will address two of the main areas of risk associated with new nuclear investments—lack of regulatory predictability and lack of completed designs to allow for accurate estimates of construction and operation cost. The industry expects to develop significant information regarding cost estimates of new plant construction and operation through the COL process. However, the issue of regulatory uncertainty remains a concern for those companies interested in pursuing new plant opportunities. The financial community has stated that it considers regulatory predictability and stability to be prerequisites to obtaining funding for a new nuclear power plant, and continued Congressional attention toward future regulatory stability and the licensing of new plants will help build confidence among investors and within the industry.

In addition to mitigating the risks of regulatory predictability and design completion, other pre-conditions are necessary before new nuclear investments can be made:

(1) Congress and the Administration must fully fund the Nuclear Power 2010 program at $80 million for fiscal year 2005, and DOE must commit to fund the program at levels that will sustain it to meet the above mentioned targets by 2010.

(2) The industry must continue to ensure outstanding performance of the current fleet of operating reactors. Recent trends indicate that the industry is succeeding: performance and safety indicators are at record levels. For instance, nuclear plant capacity factors averaged 90 percent, the highest of any source

of electricity generation. Public perception of new nuclear power is based, in part, on the performance of the current fleet of operating plants. Thus, continued solid industry performance is essential to maintain the confidence of the regulators, the financial community and the general public.

(3) Congress and the Administration must continue to support a clear path forward to resolve the issue of spent fuel disposal. Particular milestones that will signal progress include adequate funding levels for the Yucca Mountain program, the submittal of the Yucca Mountain license application by DOE to the NRC—which is scheduled to occur in December 2004, and the NRC's timely review of the application.

(4) Power companies must have confidence that open and competitive wholesale markets for electricity exist. Many power companies are operating in a deregulated environment. Although they no longer need to demonstrate that their investment in new generation is "used and useful," these companies must have confidence that there will be a consistent market for the power. The ideal solution to this issue is to have a power purchase agreement in place for the sale of the proposed project's output, at least for the early years of production. In addition to alleviating the uncertainty regarding the need for the additional power, the power purchase agreement would remove the risk associated with price fluctuations by establishing a price schedule for the output. The power purchase model is used extensively in the wind generation business. In the absence of a power purchase agreement, very high confidence in the projections for demand growth and market prices will be needed for companies to consider investing in new nuclear plants.

(5) Congress and the Administration must support incentives to alleviate concerns by the financial community concerning the risks associated with being a "first mover" in the construction of new plants. These incentives are particularly important given the significant capital investment required for nuclear construction. A number of financial incentives have been identified by the industry New Plant Task Force in conjunction with the Department of Energy. Some of the incentives being considered include:

- Insurance against substantial cost increases or cancellation resulting from the regulatory process
- Low interest government loans or loan guarantees
- Seven year depreciation schedule
- Investment tax credits
- Production tax credits
- Protection against electricity price fluctuations, especially for the early years of plant operation

A successful and sustainable program to build new nuclear plants in the United States does not require all of the above incentives. Various combinations or even a portfolio approach which caps the value of the incentive could be used.

It is important to emphasize that the industry is not seeking a totally risk-free business environment. Rather, it is seeking government assistance to contain those risks that are beyond the private sector's control. The goal is to ensure that the level of risk associated with the next nuclear plants built in the United States generally approaches what the electricity industry would consider normal for a commercial project.

There is ample precedent in other areas for this type of government support for critical infrastructure. The Transportation Department's Transportation Infrastructure Finance and Innovation Act (TIFIA) is just one example. The TIFIA was developed to address a similar scenario where major investments in bridges and tunnels were needed for the common public benefit, but the construction projects were not attractive enough for individual entities to pursue. The incentives within the TIFIA framework were developed to stimulate private capital investments using limited government funds.

SUMMARY

Nuclear power will play a critical role in allowing the Nation to meet its future energy needs while preserving a sound environment. Not only is nuclear power a safe, reliable and economic source of electricity—allowing it to meet the nation's future need for baseload power generation, it is also the only major emissions-free source of generation currently in operation. While aggressive efforts must be made to explore and expand other forms of environmentally responsible generation, including wind, solar, biomass, natural gas and clean coal, the U.S. must also take steps today to ensure that the Nation will enjoy the benefits of a new generation of nuclear plants in the future.

Congress and the Administration should fully fund the Department of Energy's Nuclear Power 2010 Initiative, take steps to assure a stable regulatory environment, continue to support work on the Yucca Mountain project, and provide financial incentives for the construction of the first series of new nuclear plants that are built.

RESPONSE BY MARILYN C. KRAY TO AN ADDITIONAL QUESTION FROM SENATOR JEFFORDS

Question. Nuclear plants that are seeking license renewal may not always conform to current safety standards, but to a number of regulations dating back nearly 40 years with exemptions, deviations, and waivers granted along the way. While each individual exemption or waiver may be justified and not reducing safety margins, the cumulative effect of so many exceptions can adversely affect safety. Is your consortium concerned that the new reactor you are proposing will have to meet standards that older plants do not, and does that present a competitive disadvantage?

Response. The most important aspect of this response is to clarify the misperception that the existing nuclear plants have defaulted to a relaxed set of safety standards. The suggestion is that this relaxed safety environment is the result of the vintage of the plants and the cumulative effect of the various exemptions or waivers granted over the life of a plant.

The activities or tools in place to prevent this relaxed safety environment from occurring can be categorized into three areas: continuous plant upgrades, reassessment against new regulations and maintenance of a "living" Probabilistic Risk Assessment (PRA).

With respect to the first area, the components and systems of the existing fleet of plants are continuously tested and monitored to ensure that they are capable of performing their required safety functions. Based on results of this continuous monitoring as well as pre-emptive actions by the plant owners, equipment and components are periodically upgraded or replaced. Examples of this range from the replacement of small devices such as piping, fittings and valve packings to the replacement of large components such as reactor vessel heads, steam generators and turbine rotors. Current plant licensees have also installed new, more modern systems to replace or supplement original systems that may become obsolete or no longer considered adequate. Examples of this include replacement of various analog control systems with digital control systems. In addition to the owner-initiated upgrades, the Nuclear Regulatory Commission (NRC) also has required licensees to correct design deficiencies that could impact plant safety.

Regarding the second category of new regulations, the NRC frequently updates its regulations as a result of improvements to technology and operating experience. When NRC requirements are changed, the NRC applies a rigorous evaluation standard to determine if the safety benefit of the new requirement justifies imposing the changes on existing licensees. Examples where licensees have been required to "backfit" new requirements include the many hardware and program changes that resulted from the accident at Three Mile Island as well as the security enhancement changes resulting from the September 11 attacks. While later plants may need to demonstrate compliance with certain requirements beyond those of the existing plants, cost effective solutions have generally been established which are not onerous when incorporated into the initial plant design engineering prior to construction.

The last area that upholds the safety standards of existing plants is the maintenance of a PRA individualized for each plant. The PRA is a sophisticated computer model of the entire plant that accounts for each of the risks and mitigators that contribute to potential core damage. The PRA calculates the probability of core damage based on inputs from all of the modeled systems and components along with their status. It is this important tool that allows the cumulative effects to be evaluated including any plant equipment that might be degraded or out of service as a result of a waiver, exemption or routine maintenance. This allows an ongoing and comprehensive assessment of plant risk to be made as opposed to a "compartmentalized" approach where each condition was evaluated exclusively.

Aside from attempting to characterize the vigilance associated with upholding the safety standards of existing plants, it is necessary to discuss briefly the design philosophy of the next generation of Advanced Light Water Reactors. The nine power companies comprising the NuStart consortium deliberately selected two reactor designs based on their optimization of passive safety systems. The two designs selected are the Westinghouse AP1000 and the General Electric ESBWR. The incorporation of "passive safety systems" refers to the design principle wherein laws of nature such as gravity feed, convective heat transfer and natural circulation are used in place of complex systems comprised of numerous pumps, valves and actuation devices. This passive safety system approach translates into very tangible results. For example, when comparing the AP1000 against current light water reactors, the Westinghouse AP1000 requires:

- 50 percent fewer safety-related valves
- 80 percent less safety-related piping
- 35 percent fewer pumps
- 85 percent less cable
- 45 percent less seismic building volume

For the General Electric ESBWR, similar improvements are realized. Most notably, the ESBWR does not require any safety related diesel generators or safety system pumps, including reactor recirculation pumps. For both of the selected reactor technologies, this passive safety system approach makes the operation of the plant safer in that it is less prone to equipment malfunction or human error, and more economical since there are fewer components to design, construct and maintain.

In summary, the NuStart consortium is not concerned that the new reactors will be competitively disadvantaged as compared to the existing plants as a result from any differences in safety standards. The existing plants are continuously upgraded and re-evaluated. NuStart Energy Development sees that one of the critical elements to the success of a future generation of nuclear plants is the continued strong performance of the current fleet. Excellent safety performance is needed to establish and sustain the confidence of the public, regulators, financial community as well as any future power company investors.

STATEMENT OF BARCLAY G. JONES, PH.D., PROFESSOR, DEPARTMENT OF NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Chairman Voinovich, Mr. Carper and members of the Committee, thank you for the opportunity to provide your committee with some information and perspectives about the roll that nuclear engineering programs have in providing a supply of educated professionals to the required work force in the nuclear field. This topic is a central concern of the Nuclear Engineering Department Heads Organization (NEDHO), which I chaired several years ago. This organization includes the Heads and Chairs of all nuclear engineering departments/programs in the US and is broadly representative of our common interests. I am speaking this morning from my personal interests as a long time faculty member and former Head of the Department of Nuclear, Plasma and Radiological Engineering at the University of Illinois at Urbana-Champaign. It is the sole department of nuclear engineering in Illinois, the birthplace of the first man-made nuclear reactor and currently the state with the most operating nuclear power plants, eleven at six sites.

Last year testimony was presented before the Energy Subcommittee of the House Committee on Science by my colleague Professor James Stubbins at the Hearing on University Resources for the "Future of Nuclear Science and Engineering Programs." That presentation delineated the interacting forces that were bringing attention to the need for support and growth of university programs in nuclear science and engineering to address the manpower needs facing the field. These forces are equally active today and point to the continued need to nurture and support these educational programs. In particular, several activities impact directly on the workload of the Nuclear Regulatory Commission and its need for human resources to address them in a timely manner. I will list only four:

- licensing of the Yucca Mountain high level waste repository;
- evaluation of early site permits and combined construction license applications for new nuclear power plant construction;
- continued evaluation of existing nuclear plant life extension requests: and
- evaluation for licensing of Generation IV reactor designs;

To meet the demands of this increased workload, the Commission will be faced with strong competition for educated and experienced professionals in the field. The emerging graduates from nuclear engineering programs generally are not highly experienced, but they are well educated. The experienced workers in the field will continue to be in high demand, but are shrinking in numbers due to the disproportionate distribution of mature persons in the demographic making up the work force. This will be a continuing and increasing challenge, at least over the next decade.

The work force demographic, thus, becomes a significant issue. It cannot be transformed to meet demand in a short timeframe because of the inherent 4-year BS educational timeframe, and even longer if MS and PhD degrees are involved. In addition, there is a period immediately following graduation in which experience is an important aspect to fully integrate the graduates into being productive employees. But all is not bad news.

Over the past 2 or 3 years there have been increases in undergraduate enrollments in nuclear science and engineering programs. This increase will also work its way into graduate degree programs. However, graduate programs are driven, not so much by the workplace demand conditions, but by limitations imposed by the availability of funded research contracts to support graduate study. It is important to note that much of the fundamental research funding is from government sources. Thus, it is no surprising to observe that there is a strong correlation between such funding and enrollments. Funding remains a vitally important necessity to retain viable nuclear science and engineering programs within leading universities.

Focusing more directly on the manpower needs side in the nuclear engineering field, a common issue emerges, the aging of the experienced work force. In the nuclear power sector, many of the experienced employees will reach normal retirement age within the present decade. Although there has been downsizing of operating and support staff at power stations since deregulation of the electric utility industry, there is projected to remain a shortfall in vital experienced and certified staff. Similar conditions exist in the Nuclear Regulatory Commission technical staff, in government nuclear laboratories and in university nuclear engineering faculties.

These shortages cut across BS, MS and PhD degree levels. The supply of a decade ago of operational and support staff from US Navy personnel entering the civilian work force has also diminished. Estimates of the shortfall between BS and MS Annual Employment Needs and students graduated range from 350 in 1999 to more than 450 in 2003. This has been exacerbated by the rapid and precipitous decline of enrollments in BS nuclear engineering programs from 1500 in 1992 to less than 500 in 2000. A steady growth has occurred to where there are about 1000 currently enrolled. Continued growth is projected as next year's applications and admissions are remaining steady and strong. Thus, the supply side is currently strong, but well below the earlier mentioned short fall in graduating numbers of nuclear engineers.

Can the remaining nuclear engineering programs handle the increased enrollments? The answer is generally yes, presently. But the teaching staff are also aging and replacements need to be immediately acquired to make the transition smooth and effective. A study in which the distributed age of nuclear engineering faculty by the Nuclear Energy Institute is incorporated in the bar graph included here. This clearly shows a skewed distribution with the expected significant retirements in the next 5 to 10 years. Working against the earlier replacement is the relatively small size of nuclear engineering departments and enrollments, compared to electrical, mechanical and computer science units. It requires enlightened administrations to respond favorably to the nuclear engineering national needs.

In conclusion the educational programs in US universities have much of the necessary infrastructure but will need to replace and add faculty in a timely manner in order to continue the increased enrollments to meet the discussed personnel demands. Clearly continued and expanded government is essential to retain present trends and meet projected nuclear engineering staffing needs in the nuclear field.

I would be pleased to respond to your questions.

Report of The Nuclear Energy Research Advisory Committee

Nuclear Power Engineering Curriculum Task Force

ANDREW C. KLEIN, CHAIR, OREGON STATE UNIVERSITY; JAMES F. STUBBINS, UNIVERSITY OF ILLINOIS, CHAMPAIGN-URBANA; GILBERT BROWN, UNIVERSITY OF MASSACHUSETTS, LOWELL; HAROLD RAY, SOUTHERN CALIFORNIA EDISON; EUGENE S. GRECHECK, DOMINION ENERGY

APRIL 7, 2004

I. Introduction and Charge to the Task Force

In October 2002 the U.S. Department of Energy's (DOE) Office of Nuclear Energy Science and Technology asked the Nuclear Energy Research Advisory Committee (NERAC) to form a Nuclear Power Engineering Curriculum Task Force to investigate the assertion that university nuclear engineering departments and educational programs are not currently producing engineers with education optimal to the needs of industry.

The specific DOE charge to the Task Force was:

• In the course of our efforts to support nuclear energy educational infrastructure in the United States, we have heard from various industry sources that university nuclear engineering departments are not producing engineers with training optimal to the needs of industry.

• We request that NERAC form a task force composed of current and former nuclear utility executives and university nuclear engineering professors to discuss and assess this concern.

• If the concern is found to have merit, we request that this task force evaluate the need for a new curriculum optimized to the needs of industry. If such a need is identified, we request that this task force work with expert consultants to outline an optimal curriculum as a model for the use of university nuclear engineering departments.

• Before any products are finalized, we request that NERAC review its draft conclusions with the broader nuclear industry and university community.

• We defer to the judgment of the task force regarding the time required for this effort.

During the 2002–03 academic year the Task Force asked all of the universities that offer undergraduate degree programs in nuclear engineering to voluntarily provide a copy of their current curriculum and their curriculum from sometime in the second half of the 1980's. This request was made through an email solicitation to the Nuclear Engineering Department Heads Organization (NEDHO). In all, 14 schools provided curricula to the Task Force for evaluation. Responses were received from an excellent distribution of schools both geographically and by size of program. Information was received from small and large programs and from all corners of the U.S. It is important to note that all of the programs that responded have maintained accreditation of their undergraduate nuclear engineering programs through the ABET, Inc., the cognizant organization for engineering accreditation in the United States.

The list of schools contributing curricula for evaluation includes:

Massachusetts Institute of Technology
North Carolina State University
Oregon State University
Rensselear Polytechnic Institute
Texas A&M University
University of California, Berkeley
University of Florida
University of Illinois at Urbana-Champaign
University of Massachusetts, Lowell
University of Michigan
University of Missouri, Rolla
University of New Mexico
University of Tennessee
University of Wisconsin

The Task Force members conducted the initial analysis of the curricula independently and then the Task Force met on November 4, 2003 to discuss their individual findings and directions for further analysis.

The curricula from the 14 universities reviewed by the Task Force included courses and content beginning at general and basic fundamentals that continued through general engineering science and finished up with specific nuclear engineering discipline subjects. All curricula reviewed include general and basic fundamental content in advanced mathematics through differential equations, physical sciences in chemistry and physics and some include additional content in areas such as computer programming, numerical methods and analysis. All curricula also included education in the fundamental engineering science areas of statics, dynamics, mechanics, materials, economics, thermodynamics, fluid mechanics, and heat transfer and many curricula include additional content in areas such as electrical fundamentals, control systems and engineering graphics.

Finally, all curricula included content with specialization in the nuclear engineering discipline. The topics covered by all of the curricula include—atomic and nuclear physics, laboratory classes to measure radiation and radioactivity, the interactions of radiation with matter, radiation protection, reactor physics and theory, reactor thermal hydraulics, and nuclear engineering design. Most of the curricula also include material related to nuclear reactor laboratories. Because of the variety of faculty interests from university to university some of the curricula also include more depth of coverage in topics such as reactor engineering, systems engineering, fuel management, reactor safety, fuel cycles, nuclear materials, nuclear waste management, risk assessment, applied radiation protection, radiation transport, fusion and other diverse topics.

II. Overview of the Evolution in Nuclear Engineering at Universities

The curricula in all engineering and science majors can be expected to evolve over time as areas of focus become increasingly and decreasingly important to the industries and enterprises that utilize the graduates from the country's higher education system. The educational programs in nuclear engineering have also seen these evolutionary developments. When one examines the history of nuclear engineering education during the past half-century in this country, they recognize a variety of changes from the early days to present. In the 1950's as the country emerged from World War II with the realization that there would be a need for nuclear trained and educated engineers, there were numerous efforts to increase the number of nuclear-trained and—educated engineers and scientists, most notably through the USAEC fellowship programs and the Reactor School at ORNL. These programs gave high visibility to the nuclear engineering profession, attracted many outstanding students, and developed a large cadre of highly educated people. University programs in nuclear engineering also started developing in the late 1950's, predominantly growing out of departments of physics, mechanical and chemical engineering. In the 1960's and 1970's as commercial nuclear power began to develop, many universities started nuclear engineering programs and extended the educational enterprise in this area from the B.S. to the Ph.D. degree. Many of these same schools also added research reactors to give their graduates significant hands-on experiences as part of their education. There were also many research opportunities for students and faculty in the broad nuclear engineering discipline around this time, some of which directly or indirectly utilized the on-campus nuclear research reactors. In 1973 there were 48 schools that offered undergraduate and graduate education in nuclear engineering and more than 60 research reactors on campuses around the country. The changes in the power industry (no new plant orders, deregulation, and consolidation of the industry) from the mid-1970's through the end of the 1990's were reflected on the nation's campuses through declining university enrollments in nuclear engineering, the closing of university nuclear engineering degree programs and the closing of university research reactors. In response to these declines, the remaining nuclear engineering programs were forced to restructure with results that ranged from mergers with other, larger departments to broadening of their education and research foci. Currently 26 schools that offer one kind of nuclear engineering degree or another remain. There are also 26 on-campus university research reactors remaining, but not all on campuses with nuclear engineering degree programs.

In 1998 the Nuclear Engineering Department Heads Organization (NEDHO) conducted a study and developed a report that discussed "the current status and future directions of the nuclear engineering profession in the United States as viewed by the nuclear academic community". This report also surveyed "the contributions of nuclear engineering to enhancing the well being of society, now and in the future" and laid out the "steps that the university community and the U.S. Government can take to ensure that our national needs are met". The report goes on to state that:

> "The main conclusion of this report is that the nuclear engineering profession is essential to the well being of the country since it brings great benefits to society in terms of energy security, national defense, medical health, and industrial competitiveness. We further recognize that the nuclear engineering profession is in a period of transition to one encompassing a much broader range of applications of nuclear science and radiation technologies. The country has a persistent demand for nuclear engineers that will almost certainly increase in the future, notably in nontraditional areas of nuclear engineering.

The report concludes by making the following recommendations:

- The university community needs to make a major cultural shift in its thinking about nuclear engineering education. In essence it has to make a transition from a curriculum dominated by a single technology, nuclear power, to a unified curriculum characterized by a common educational core from which flows a multitude of diverse applications. This core is to be centered on applied nuclear sciences and encompasses low energy nuclear physics, the interaction of ionizing radiation with matter, and plasma science and technology.
- In order to satisfy increasing societal demands for nuclear engineers with training in radiation science and technology it is recommended that the DOE establish a separately designated, clearly distinguished, program for bionuclear and radiological research similar to basic energy sciences or high energy physics. Bionuclear technology and radiological engineering are applications of nu-

clear engineering of particular importance to the medical health of the country. Currently, governmental funding of such research is dispersed in many small segments over many different programs.

Changes in direction for nuclear engineering departments were reflected in this NEDHO report which was written during a time when industry was consolidating and it appeared to many observers that most of the existing plants might not pursue re-licensing and would terminate operation at the end of their design life. This meant that most of the existing power reactor fleet in the U.S. would be retired in the first quarter of the 21st century. It was also perceived by many that no new reactors were likely to be in the planning process for more than a decade or beyond. This perception signaled further declines in university enrollments in nuclear related disciplines with no hope of recovery in the fission power area.

During this time, schools were seen to be moving their research programs away from power engineering into other varying research directions. This was to be expected since the power industry was not directly supporting the research programs at the universities. Also during this time nuclear engineering faculty, in order to meet the demands of their universities for greater research support, began looking for other applications of their capabilities, some completely outside the nuclear field. Additionally, when universities were able to replace faculty who left or retired, schools often replaced them with someone with a research focus away from the power industry.

Since 1998 much has changed in the nuclear power industry. Most of the currently operating power plants appear to be headed toward re-licensing and upgrade, new plants are under consideration for construction and operation as early as this decade, Generation IV reactor concepts are being seriously considered for development and appear to be very competitive with other means of energy generation, USDOE is developing new research programs on advanced fuel cycles and the direct production of hydrogen using high temperature heat from a reactor as a new energy carrier to replace petroleum based transportation fuels. All of these developments have also spurred significant increases in nuclear-related university enrollments across the country principally in the nuclear power area.

With current and future changes to the nuclear power industry, perhaps the charge to the Task Force was too narrowly defined to just including nuclear utilities. There is a spectrum of needs within the industry, ranging from technician level individuals who can succeed with a high school or community college education and specialized training through the B.S. or M.S. educated engineers and scientists covering a wide set of disciplines, including what has traditionally been called nuclear engineering, to PhD educated scientists and engineers needed for the development of the next generation of nuclear reactors, systems and fuel cycles. The solutions and types of personnel to provide the solutions that are chosen by each of the entities within the industry will no doubt be different. This indicates that educational opportunities in the nuclear discipline should be available at all levels.

III. Analysis of NE Curricula and Nuclear Power Industry Needs

The first step in the Task Force's process was a review of the curricula submitted by the universities with an eye toward determining whether the curricula of university nuclear engineering departments had changed to such a degree over the past 15 years that they are not producing engineers with "education optimal to the needs of industry".

It appears from the Task Force's review that for the most part, the curricula at the 14 universities who submitted information have not changed considerably over the past 15 years and are adequate and appropriate to support the needs of the broad nuclear industry and the power industry in particular. In fact, several programs have strengthened their nuclear engineering course offerings by adding courses at the Junior and Senior level. This is possible due to the improved math background of incoming students, which also allows some introductory courses to be moved into the Freshman and Sophomore years.

There is one area that could be improved in the education of nuclear engineers, however. That is the development of a practical understanding of the workplace and the individual practical skills that are needed to be successful. This can be best accomplished by providing a practical work experience for all students interested in nuclear power engineering. These experiences can be best provided either through co-op programs throughout the academic year or through summer internships. The Task Force encourages the university nuclear engineering programs to include at least one practical work experience opportunity in all of their undergraduate programs. It also encourages the nuclear industry to make numerous opportunities available for undergraduates studying nuclear engineering in the country. To work, this approach must be supported by both the universities and industry. This could be a required part of each university's curriculum, and industry would need to make these opportunities available for all students. To help make internships possible for students, the Nuclear Energy Institute has recently established an internship clearinghouse on their web site.

The Task Force was also asked to evaluate the need for a new curriculum optimized to the needs of industry. The Task Force's analysis and discussion led to the conclusion that a new curriculum was not needed and that the development of a common, or model, curriculum for use by all academic departments offering the nuclear engineering discipline was not in the best interests of either the schools or the broad nuclear industry. In general the current nuclear engineering curricula currently are already similar in nature with minor differences between curricula determined by faculty expertise and research interests. The Task Force also believes it is better to have a mix of curricula with different focus areas in order to stimulate high quality education and research across the country.

The Task Force also feels that there really is no need for a direct role for the U.S. Department of Energy in formulating undergraduate nuclear engineering curricula.

Adapting the universities nuclear engineering curricula to meet the needs of the broad nuclear industry can best be accomplished through following established ABET accreditation procedures since all schools now are working in a "continuous improvement process" regime which relies on stakeholders to help them tailor their curricula to the needs of their constituents. Thus, all ABET accredited programs have self-correcting, self-regulating processes in place which help them develop curricula suitable to those aspects of the nuclear industry that they are aiming to serve and that are consistent with the input that they receive from the constituents they serve.

As a part of the current ABET accreditation process each program must consider who their clients and constituents are and this is to be used to guide each institution in the design of their curricula. For example, most programs consider their constituents to be the companies in the nuclear power industry (including the operating companies and utilities, reactor manufacturers, and fuel vendors), the national laboratories, government and regulatory agencies (including DOE), and graduate schools. A typical university departmental advisory committee is made up of a diverse membership including members from power producers, vendors, utilities, national laboratories and others. The Task Force feels that over the long run, this process will support the evolution of the best curricula to meet the needs of the broad nuclear industry. Thus, the Task Force recommends that all sectors of the broadly based nuclear industry become active with the university nuclear engineering programs across the country to ensure a strong educational environment that produces graduates who will meet their future staffing needs.

The Task Force's recommendation for industry involvement in development and support undergraduate curricula extends to support faculty. The development of professors in the universities is driven by the need for faculty to build and maintain strong research programs. This has led many young faculty members to develop research programs in areas that are not of direct interest or applicability to the nuclear power industry. To change this, industry must work more directly with university faculty to develop appropriate research programs. This will enable these faculty members to bring currency to their classes and work on research issues that will move the industry forward.

Finally, prior to completion of this report a draft was made available for review and comment to the nuclear energy community through the Nuclear Engineering Department Heads Organization, the American Nuclear Society's Education and Training Division and Special Task Force on Work Force Issues, the Institute for Nuclear Power Operations, the Nuclear Energy Institute, and the Electric Power Research Institute. This final report contains certain additions and changes to reflect the comments that were received as a part of this review.

IV. Conclusions and Recommendations

Conclusion #1: The nuclear engineering curricula at the U.S. universities have not changed considerably over the past 15 years and are adequate and appropriate to support the needs of the broad nuclear industry. It is the observation of the Task Force that the curricula are now stronger, even in the power area, since students are doing more in their first 2 years of study based on their better math skills, and because faculty are connecting with students early in their programs in order to keep them involved in the nuclear engineering degree programs. Furthermore, the ABET accreditation process supports continuous improvement with input from various constituencies, including the nuclear power sector, and has had a positive effect on strengthening these programs.

Conclusion #2: It is impractical to attempt to establish an "optimal" educational curriculum for all "nuclear engineers" since there is a wide range of needs within the nuclear industry.

Conclusion #3: There is no need for a direct role for the U.S. Department of Energy in formulating undergraduate nuclear engineering curricula.

Conclusion #4: The one area that could be improved in the education of nuclear engineers is the development of practical engineering work experience and the individual practical skills appropriate nuclear power venues.

Recommendation #1: The Task Force recommends that the university nuclear engineering programs consider including at least one practical work experience opportunity in all of their undergraduate programs. It also encourages the nuclear industry to make numerous opportunities available for all undergraduates studying nuclear engineering in the country.

Recommendation #2: All components of the nuclear industry should become closely involved in the undergraduate curricula development at universities through their active participation on departmental advisory committees and boards. This also supports the ABET "continuous improvement" requirements.

Recommendation #3: All components of the nuclear industry are encouraged to directly support the research programs at universities to develop faculty who will work on industry specific research problems and involve students with industrial interests.

Recommendation #4: All components of the nuclear industry are encouraged to support faculty members with research projects, including summer and internship work experiences and sabbatical opportunities for faculty.

National Academy for Nuclear Training

Educational Assistance Program

Report of Progress

April 2003

EXECUTIVE SUMMARY

This report provides results of the National Academy for Nuclear Training Educational Assistance Program through April 2003. Results are described for the following program elements:

- Percentage of supported students accepting employment in the nuclear industry after completion of their education

- Level of support provided to students and universities

Hiring results for graduated students from 1993 through 2002 are 39 percent for undergraduate students accepting jobs in the nuclear power industry and 67 percent for graduate students (16 percent and 23 percent, respectively, at nuclear utilities). Table 1 (pages 7-8) provides detailed information on utility hiring of students.

During the 2002-2003 academic year, 152 undergraduate and 53 graduate students are receiving financial support. Tables 2 (page 9) and 3 (page 10) provide detailed information on undergraduate and graduate support, including a list of schools attended by students.

Although the overall number of applications decreased approximately 19 percent over 2002 applications, 2003 applications were about 30 percent higher than applications received the five years prior to 2002. Current applicants also indicated greater interest in industry careers. In 2003, nearly two-thirds of applicants had completed or were seeking cooperative education or intern work assignments in the nuclear industry compared to 45 percent in 2002.

To date, the program has provided more than $20 million to 3,600 students. Program funding from 1993 through 2003 is shown in Figure 3.

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BACKGROUND

The Institute of Nuclear Power Operations (INPO) was established in 1979 by the nuclear electric utility industry as a nonprofit organization dedicated to ensuring the high quality of operations in nuclear power plants. The National Academy for Nuclear Training was formed as a focal point for efforts to improve training and education.

In 1980, the INPO Board of Directors recognized the need to plan for the future and help provide an ongoing supply of entry-level engineers to fill the continuing employment needs of nuclear utilities. With funding provided by INPO member utilities and supplier participants, the National Academy's Educational Assistance Program was established to support U.S. nuclear engineering education and to encourage students to consider careers in the nuclear power industry. Since 1980, the industry has provided more than $20 million to support approximately 3,600 students.

The National Academy awards scholarships and fellowships to students demonstrating outstanding academic achievement and interest in careers in the nuclear power industry. The scholarship program provides financial support to eligible undergraduate students majoring in nuclear, mechanical, and electrical engineering; power generation health physics; and chemical engineering with a nuclear or power option. Similarly, a fellowship program provides support to graduate students majoring in nuclear engineering and power generation health physics.

Experience indicates that Academy-supported students are eager to work in the nuclear industry and make highly skilled, motivated employees.

Ann Winters, Educational Assistance Program, and Scott Jolley, Duke Energy, met with faculty and students at the University of Tennessee.

STUDENT EMPLOYMENT

Contact is maintained with Educational Assistance Program students throughout their support periods and thereafter until they accept their first full-time employment. To promote industry hiring of students, the Academy routinely communicates with utilities, students, and universities. For example, lists of students are provided to utility executive and human resource contacts, and lists of those utility contacts are provided to students—each group is encouraged to communicate directly with the other. Utilities are requested to appropriately consider Academy scholars and fellows for summer, cooperative, internship, or permanent employment. To assist utilities in their recruiting efforts, current student lists are maintained on the INPO member Web site for easy access.

Student and institution surveys are conducted periodically to determine career paths of students who received financial support. Employment information is provided for the most recent 10 years and is reported by graduation year.

Nuclear Engineering faculty and students at Pennsylvania State University with Dianne Coffin, PPL Susquehanna, and Ann Winters, Educational Assistance Program.

The statistics in Figure 1 (page 3) and Figure 2 (page 4) represent information on students who have graduated as Academy-supported students during the past 10 years and who have reported employment and are seeking employment, as well as those for whom post-graduation employment is unknown. The statistics do *not* include students who are currently being supported, withdrew, were dropped, or for some other reason did not graduate as Academy-supported students.

Table 1 (pages 7-8) is a listing of the number of scholarship and fellowship students hired to date by INPO member utilities.

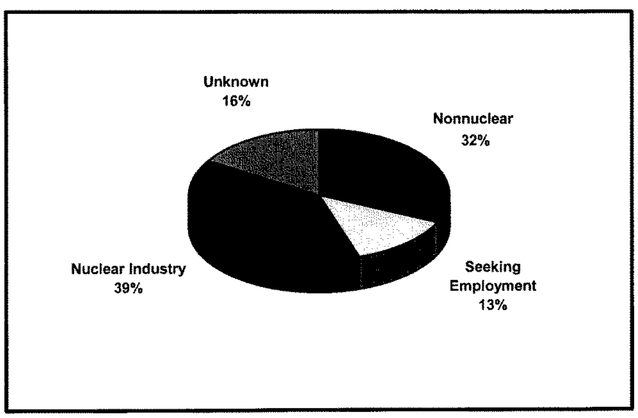
Scholarship Students

From 1993 through 2002, 868 scholarship students completed undergraduate studies while supported by the program. Employment information is known for 555 students. Additionally, there are 128 students for whom post-graduation information is unknown, 113 students who are seeking employment, and 72 students who are continuing education. Availability for employment may occur after graduation with a bachelor's degree or after completion of additional education. Follow-up contacts are conducted periodically to obtain employment information.

Figure 1 is a breakdown of 10-year information for 796 students through academic year 2001-02:

Nuclear Utilities	**16%**
Other Nuclear	**10%**
Nuclear-Related Government	**6%**
Suppliers	**7%**
Nuclear Industry	**39%**
Nonnuclear	**32%**
Seeking Employment	**13%**
Unknown	**16%**
	100%

Figure 1. Scholarship Student Employment: 1993-2002
By Graduation Year



Utilities: utility members of INPO
Other Nuclear: contractors, consultants, educators, and others who support the nuclear industry
Nuclear-Related Government: the NRC and nuclear-related positions at DOE and national laboratories
Suppliers: major vendors and architect-engineering members of INPO
Seeking Employment: graduated students who are not yet employed or whose employment status will be determined through later follow-up
Unknown: students who graduated and for whom follow-on contact has not been successful

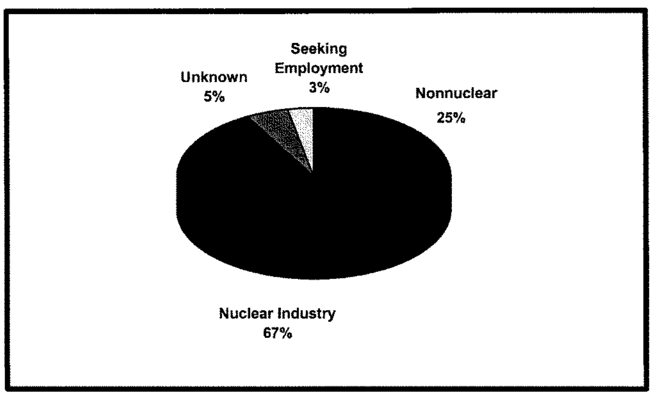
Fellowship Students

From 1993 through 2002, 331 fellowship students completed their Academy support periods. Employment information is known for 282 students. Additionally, there are 16 students for whom post-graduation information is unknown, 8 students who are seeking employment, and 25 students who are continuing education. Since the Academy fellowship is for one year, students may be supported during either year of a typical two-year master's program. Availability for employment generally occurs after graduation with a master's degree or after completion of additional education. Follow-up contacts are conducted periodically to obtain employment information.

Figure 2 is a breakdown of 10-year information for 306 fellowship students through academic year 2001-02:

Nuclear Utilities	**23%**
Other Nuclear	**19%**
Nuclear-Related Government	**14%**
Suppliers	**11%**
Nuclear Industry	**67%**
Nonnuclear	**25%**
Total Students Employed	**92%**
Seeking Employment	**3%**
Unknown	**5%**
	100%

Figure 2. Fellowship Student Employment: 1993-2002
By Graduation Year

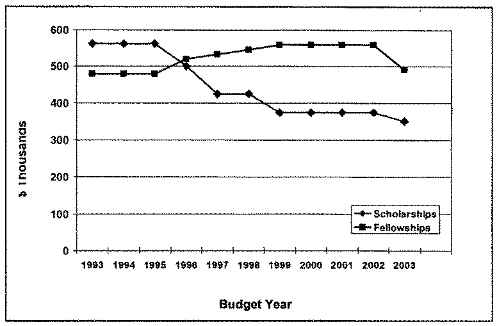


Utilities: utility members of INPO
Other Nuclear: contractors, consultants, educators, and others who support the nuclear industry
Nuclear-Related Government: the NRC and nuclear-related positions at DOE and national laboratories
Suppliers: major vendors and architect-engineering members of INPO
Seeking Employment: graduated students who are not yet employed or whose employment status will be determined through later follow-up
Unknown: students who graduated and for whom follow-on contact has not been successful

STUDENT AND UNIVERSITY SUPPORT

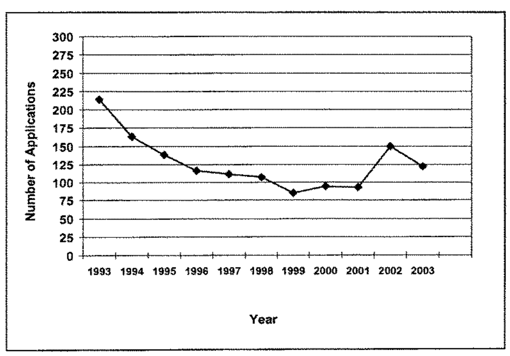
When the Educational Assistance Program was established in 1980, only graduate fellowships were funded. In 1981, undergraduate scholarships were added to the program. The budget for scholarships and fellowships for budget year 2003 is $840,000. Annual budgets 1993-2003 are shown in Figure 3.

Figure 3. Annual Budget: 1993-2003



Although the overall number of applications decreased approximately 19 percent over 2002 applications, 2003 applications were about 30 percent higher than applications received the five years prior to 2002. Current applicants also indicated greater interest in industry careers. In 2003, nearly two-thirds of applicants had completed or were seeking cooperative education or intern work assignments in the nuclear industry compared to 45 percent in 2002. Figure 4 shows the number of scholarship applications from 1993-2003.

Figure 4. Scholarship Applications: 1993-2003



Over the years, the total number of annual scholarships has been adjusted to more closely match the number of qualified applicants. As nuclear-related applicants began declining in the early 1990s, the number of scholarships was adjusted downward (Figure 5), from 275 in 1990-91 to 150 in 1999-2000. Beginning in 2003-04, 140 scholarships, at $2,500 each, are budgeted. Scholarships are renewable for up to three years. Table 2 (page 9) lists the number of scholarship students attending individual colleges and universities.

The number of fellowship students remained constant at about 40 per year (Figure 5) through 2002-03. Beginning in 2003-04, 35 fellowships are budgeted. Fellowships increased from $11,000 in 1992-93 to $14,000 in 1999-2000, the current level. Each fellowship is for one year and is comprised of a $10,500 stipend to the student and an additional $3,500 allowance to the institution to support other expenses related to the student's course of study and to help maintain the university's infrastructure. Table 3 (page 10) lists fellowships awarded to individual colleges and universities for academic year 2003-04.

Figure 5. Scholarship and Fellowship Students 1993-2002

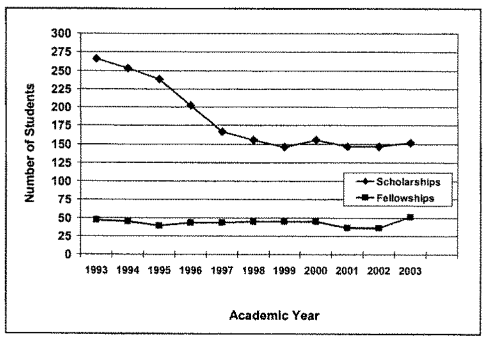


Table 1: Utility Hiring of Scholarship and Fellowship Recipients 1982-2002

The following table lists the number of scholarship and fellowship students hired to date by INPO member utilities. Employment data is provided by students and universities, and at times by utilities. This data typically consists only of company name, with occasional breakdown by plant site. Because of mergers, acquisitions, and plant purchases, historical data for affected former members in many cases has been incorporated into data for the respective current member utilities, with no attempt to selectively transfer numbers by plant or station site unless that information is specified at time of receipt.

	SCHOLARSHIP	FELLOWSHIP	TOTAL
AmerGen Energy Company, LLC	4	5	9
American Electric Power	16	11	27
Arizona Public Service Company	7	3	10
Constellation Energy Group	13	7	20
Dominion Energy	17	15	32
Duke Energy Corporation	29	16	45
Energy Northwest	3	4	7
Entergy Nuclear	27	25	52
Exelon Corporation	42	41	83
First Energy Nuclear Operating Co.	9	4	13
Florida Power & Light Co.	3	4	7
Nebraska Public Power District	4	3	7
Nuclear Management Company, LLC	25	20	45
Omaha Public Power District	3	1	4
Pacific Gas and Electric Company	3	3	6
PPL Susquehanna, LLC	2	2	4
Progress Energy, Inc.	12	11	23
PSEG Nuclear, LLC	12	6	18
Rochester Gas and Electric Corporation	--	1	1
South Carolina Electric & Gas Co.	4	--	4
Southern California Edison Co.	7	3	10
Southern Nuclear Operating Co.	29	4	33
STP Nuclear Operating Company	10	4	14
Tennessee Valley Authority	8	10	18
The Detroit Edison Company	8	2	10
TXU Electric Company	10	1	11

	SCHOLARSHIP	FELLOWSHIP	TOTAL
Union Electric Company	6	4	10
Wolf Creek Nuclear Operating Corp.	3	2	5
Former INPO Members (SMUD, P. S. Colorado, Maine Yankee, Portland General Elec., P. S. Indiana, UNC, Long Island Lighting, Yankee Atomic, P. S. New Hampshire, NU-Connecticut Yankee)	18	16	34
TOTAL	**334**	**228**	**562**

UNDERGRADUATE SCHOLARSHIPS

The number of scholarship students is based on considerations such as hiring needs of the industry, student enrollment trends and potential eligible applicants, viability of eligible university programs, and number of graduates potentially available for entry-level industry jobs. The number of scholarships awarded in a particular year can be greater or fewer than the number budgeted based on the number of applications and eligible students, and students who receive partial scholarships for cooperative education participation, mid-year awards, early graduation, and withdrawals.

Students must be U.S. citizens with a minimum 3.0 grade point average (B) and have demonstrated interest in careers in the nuclear power industry. Eligible majors are nuclear, mechanical, and electrical engineering; power generation health physics; and chemical engineering with a nuclear or power option. For the 2002-03 academic year, scholarship recipients majored in the following disciplines:

Discipline	
Nuclear Engineering	58%
Mechanical Engineering	21%
Chemical Engineering	15%
Health Physics	5%
Electrical Engineering	4%

Table 2: Institutions Attended by 2002-03 Scholarship Students
(Although not shown, historical data is maintained for all other institutions.)

INSTITUTION	STUDENTS		INSTITUTION	STUDENTS
Texas A&M University	17		University of Florida	2
University of Missouri-Rolla	14		University of New Mexico	2
Pennsylvania State University	13		Arizona State University	1
Georgia Institute of Technology	10		Brigham Young University	1
University of Alabama	10		Idaho State University	1
University of Michigan-Ann Arbor	10		Michigan Technological University	1
University of Maryland	7		New Mexico State University	1
Purdue University	6		Rochester Institute of Technology	1
Washington State University	6		Tuskegee University	1
Auburn University	5		University of Central Florida	1
North Carolina State University	5		University of Missouri-Columbia	1
University of Tennessee at Knoxville	5		University of Nevada-Las Vegas	1
Kansas State University	4		University of North Carolina	1
Mississippi State University	4		University of South Alabama	1
Oregon State University	4		University of South Carolina	1
University of Illinois	4		University of Texas-Austin	1
University of Notre Dame	4		University of Utah	1
Louisiana Tech University	2		University of Wisconsin	1
University of Connecticut	2		Total Scholarship Students	152

GRADUATE FELLOWSHIPS

In academic year 2003-04, 35 fellowships are awarded annually, approximately 26 in nuclear engineering and 9 in power generation health physics.

Beginning in academic year 2002-03, the fellowship award process was changed so that universities provided earlier student identification for all awards. Any unused fellowships could then be reassigned from one school to another. All universities cooperated fully with the new process. Four fellowships were relinquished by schools unable to fill them and were subsequently reassigned to other schools with viable student candidates. As a result, all 2002-03 fellowships were awarded to eligible students, with timely payment of funds to the schools. This accomplished the National Academy's goal to fully fund all awards and support as many students as possible in the year for which the fellowships are budgeted.

Students must be U.S. citizens, enrolled full-time in on-campus masters degree programs, in good academic standing, majoring in nuclear engineering or power generation health physics, and have demonstrated interest in careers in the nuclear power industry. The number of students in a particular year may be greater than the number budgeted due to students sharing awards. Each fellowship is for up to one year.

Table 3: Fellowships Awarded to Institutions 2003-04
(Although not shown, historical data is maintained for all other institutions.)

INSTITUTION	AWARDS
Oregon State University	3
University of Florida	3
University of Tennessee	3
Georgia Institute of Technology	2
North Carolina State University	2
Ohio State University	2
Pennsylvania State University	2
Purdue University	2
Texas A&M University	2
University of Cincinnati	2
University of Illinois	2
University of Michigan	2
University of Missouri-Columbia	2
University of Wisconsin	2
Massachusetts Institute of Technology	1
University of California-Berkeley	1
University of Massachusetts-Lowell	1
University of Missouri-Rolla	1
Total Fellowships	35

RECENT FEEDBACK FROM NATIONAL ACADEMY-SUPPORTED SCHOLARSHIP AND FELLOWSHIP STUDENTS

Students receiving scholarship and/or fellowship support from the National Academy frequently provide feedback about the Academy program. The following selected comments are representative of student feedback over the past couple of years. An asterisk (*) denotes university attended during the support period and graduation year.

The NANT fellowship helped me through college and made it possible for me to find employment with Energy Northwest. Having been a NANT fellowship recipient played a part in my attaining employment with Energy Northwest. I am currently working on becoming a Station Nuclear Engineer.	Scott O'Connor MS/NE 2002* Idaho State University* Energy Northwest
Thank you for the financial assistance my senior year and for the employment contacts at member plants. I'm certain that it aided me in obtaining employment.	Glenn Erskine BS/EE 2001* Arkansas Technological University* TXU Electric – Comanche Peak Steam Electric Station
I am currently employed as a Safety Analysis Engineer at a nuclear plant. I sent my resume to the chief nuclear officer from one of your lists and everything went smoothly. Thanks.	Crystal Diane Buchanan BS/NE 1993*; ME/PhD 2000 North Carolina State University* AmerGen—UE/Callaway Plant
Thank you all so much for your help with my education and for your efforts at helping me secure employment. While I am currently working for DOE, I have not ruled out the possibility of working for a power utility later on. The direction of nuclear power as a future energy option in this country will likely influence that decision.	Greg Gibbons BS/HP 1998*; MS/HP 2000 Idaho State University* Westinghouse Savannah River Company
Without financial assistance from the National Academy for Nuclear Training, my education would have suffered. This assistance allowed me to decrease the number of hours that I worked at my job. This extra time was useful during times of intense study periods. The contacts in the nuclear industry that were provided was a nice feature as well. Thank you.	Robert Clint Chedester BX/NE 2000*; MS/NE 2002 University of Tennessee*
I appreciate your support during my undergraduate years. The newsletter and publications I received from you along with the professional contacts aided my professional growth nearly as much as my years of co-op work experience.	Christopher N. Culbertson BS/NE 1999*; MS/NE 2001*; PhD/NE 2002 Purdue University*
This scholarship program is great; the money really helped me through school. The program is very well administered and run. I really appreciated the mailings listing industry HR contacts. Thanks again for your help!	David Griesheimer BS/NE 2000*; PhD/NE 2005 University of Cincinnati*
I appreciated your listing of nuclear power contact information. Using it, I obtained a summer internship last year at Point Beach Nuclear Plant in Wisconsin. The internship was a valuable experience that definitely increased my interest in the nuclear power industry.	Karin Marcinicowski BS/NE 1999*; MS/NE 2000 University of Michigan*
Thank you for the executive contact information and keeping tabs. I would like to again thank INPO and NANT for their support during my time in college. I am working at Point Beach Nuclear Power Plant as the fuel handling system engineer. Thank you for helping me to have the chance to work at a nuclear utility.	Michael D. Bartel BS/NE 1998*; MS/NE 1999* Purdue University* Nuclear Management Company
Thank you for allowing me to be an Academy scholar for the National Academy for Nuclear Training.	David Scott Exum BS/EE 2000* Auburn University* Southern Nuclear Operating Company

RECENT FEEDBACK FROM NATIONAL ACADEMY-SUPPORTED SCHOLARSHIP AND FELLOWSHIP STUDENTS, (Continued)

I would like to thank all INPO member utilities for helping me advance my education in nuclear engineering. INPO is one of the many factors that has assisted me in becoming a success in this field. Once again, thank you very much.	Shann DeCarlo Coleman MS/HP 1999* Ohio State University* Knolls Atomic Power Lab
Thank you for your contribution and support of my education and future.	Amy Diane Presson BS/NE 2000* North Carolina State University* Duke Energy – Catawba Nuclear Power Plant
Thanks for the support throughout my undergraduate career! Communication through newsletters and annual correspondence made the program run smoothly from student and program side of things. It was always easy to get in contact with someone from the program with any questions or concerns. I am happy to have been granted the opportunity to participate in the NANT program.	Keisha C. Williamson BS/EE 2000* North Carolina State University* General Electric – Power Systems
After four years' service in the Navy, I have accepted a job full time with Comanche Peak in the joint engineering team. Thank you for your help with my education.	Betinna Gaitros Withers BS/NE 1995* Kansas State University* South Texas Project – Comanche Peak
The INPO fellowship was a great help for me in affording the time to stay at A&M and receive my master's degree. But the most benefit was the executive contact information I received from your office. I sent a resume to each listing. I was overwhelmed with interviews and was able to make the best choice for my goals and interest. Southern Nuclear has truly been a great experience so far!	Christopher M. Comfort MS/NE 1998* Texas A&M University* Southern Nuclear Operating Company

VISITS TO UNIVERSITIES

From May 2002 through April 2003, nine visits to universities were conducted by the manager of the Educational Assistance Program and utility representatives. The purpose of the visits was to meet current and potential Academy scholars and fellows, to promote closer interactions between universities and utilities, and to inform interested college students and faculty of career opportunities available in the nuclear power industry.

The following utility representatives participated in seven of the nine university visits:

Utility Representative	Title	Company	University Visits
Stephen A. Byrne	**Senior Vice President, Nuclear Operations**	**South Carolina Electric & Gas Company**	**South Carolina State University**
Preston Swafford	**Vice President**	**Exelon Power**	**University of Missouri-Columbia** **University of Missouri-Rolla**
Ron Clary	**Manager, Design Engineering**	**South Carolina Electric & Gas Company**	**University of South Carolina**
D. Scott Jolley	**Manager Technical/Craft Recruiting**	**Duke Energy Corporation**	**Clemson University** **Francis Marion University**
Dianne B. Coffin	**Senior Engineer**	**PPL Susquehanna LLC**	**Pennsylvania State University**
Jay McGraw	**Technical Recruiting**	**Duke Energy Corporation**	**Clemson University** **Francis Marion University**

Students were receptive, enthusiastic, and eager to learn more about the industry. A number of recent applicants for National Academy scholarships noted their interest in the awards was generated during these visits. Also, the visits contributed to utility involvement in several university advisory groups.

Utility representatives interested in participating in future university visits should contact Ann D. Winters, manager, Educational Assistance Program, at (770) 644-8595 or e-mail: wintersad@inpo.org.

National Academy fellowship recipients at the University of Missouri-Columbia with Ann Winters, Educational Assistance Program.

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