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Performance Technology

PO Box 51663 Knoxville, Tennessee 37950-1663 Phone (423) 588-1444 Fax (423) 584-3043

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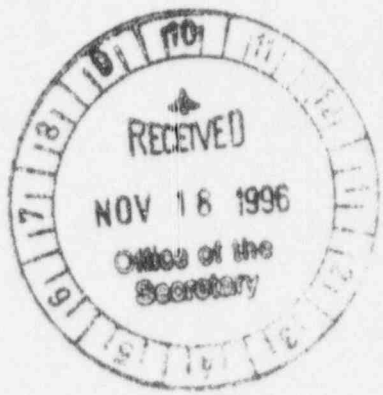

Commissioners
Comments on "Strategic Assessment"
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Dear Commissioners,

With regard to the request for comments on "Strategic Assessment" for the future of the U. S. Nuclear Regulatory Commission, I have enclosed a copy of a paper I presented at the American Nuclear Society Conference PSA 96 in Park City, Utah, on September 30, 1996, "Call to Action; Pilot Programs for Performance-Based Regulation.". This paper is directly applicable to the strategic assessment subject "Risk Informed Regulation."

As indicated in my paper, I believe that it is time for the nuclear industry to start to base "safety" decisions on the Probabilistic Risk Assessments that are available for each unit in the United States. In the paper, I suggest that the NRC immediately start at least two pilot programs to demonstrate the efficiency of such a decision process. Nuclear electric generating units can maintain adequate protection of the public health and safety in a more cost effective fashion. If the nuclear units are not allowed to operate in a more cost effective fashion, then, as indicated in the paper, the nuclear option for electric generation will no longer exist in the United States.

I will be making a presentation to the NRC Advisory Committee on Reactor Safeguards on this subject on November 21, 1996.

Sincerely,

Bob Christie

cc: Dr. George Apostalakis, ACRS

CALL TO ACTION; PILOT PROGRAMS FOR PERFORMANCE-BASED REGULATION

Bob Christie

Performance Technology

September 30, 1996

at

PSA 96

Park City, Utah

" CALL TO ACTION: PILOT PROGRAMS FOR PERFORMANCE-BASED REGULATION "

Bob Christie
Performance Technology
P. O. Box 51663
Knoxville, TN 37950-1663
(423) 588-1444
(423) 584-3043 FAX

ABSTRACT

This paper recommends the trial use of performance-based regulation at a minimum of two existing nuclear electric generating units in the United States on an accelerated basis as pilot programs for the eventual use of performance-based regulations in all the nuclear electric generating industry. Such a step would represent a significant cultural change in the regulatory process.

The objective of performance-based regulation should be to make better decisions primarily by using the mean values for public health risk and factoring in the uncertainty when necessary. If we accurately define and measure performance and feedback operating experience into the quantitative models, performance will improve and nuclear electric power generation will be more cost effective. The ultimate test of success will be if new nuclear units are ordered in the United States and the United States nuclear industry continues to exist and increases its share of the electric power generation.

I. BACKGROUND

The present challenge for the United States nuclear electric power industry is for U. S. nuclear electric generating units to achieve "adequate protection of public health and safety" in a more cost effective manner. In the United States over the last 15 years, nuclear electric generating units have lost their once clear economic advantage over the majority of other means of electric generation. Since 1989, six operating nuclear units have bee i shutdown before their license expired (Table 1), mos ly for economic reasons, and no new nuclear units ha ve been ordered. This trend will continue and the United S ates nuclear electric power industry will disappear unless significant changes are made in the way the nuclear utilities can allocate their resources.

Much has been done during the last few years in the areas for which the nuclear utilities have control of their resources with the result that the efficiency of most of the existing nuclear units has increased significantly. It appears that the upward climb in Operations and Maintenance expense per Megawatt-Hour generated has been halted, at least for the time being, by increasing the production from each nuclear unit while holding the O & M costs fairly constant. However, it is getting increasingly difficult to achieve substantial increases in generation. Now the approach to cut costs is to maintain high levels of generation while "downsizing" the number of people.

The key area remaining for cost effective change is the regulatory process. The traditional regulatory framework, based on deterministic criteria to identify what is important to "safety" and detailed prescriptive regulations for "safety related equipment," resulted in adequate protection of public health and safety at the expense of the economic advantage of the nuclear units. These prescriptive regulations did not stop the loss of the reactor core at Three Mile Island 2 in March 1979. In fact, these prescriptive regulations actually contributed to the event occurring according to the committees that investigated the accident at TMI 2. The accident at TMI 2 in March 1979 did not impact public health and safety but the accident had a clear negative impact on the economics of the entire United States nuclear electric generating industry.

The insights and recommendations of the Rogovin Report, the Kemeny Commission, and other independent organizations that reviewed the regulatory process after the loss of the reactor core at Three Mile Island 2 did not slow the issuance of new rules, regulatory guides, bulletins and generic letters in the 1980's. At best, the insights and recommendations of these committees have been implemented in a piece meal fashion on a delayed time scale. The 1980's saw the cancellation of approximately 50 proposed nuclear units

(Table 2) and an expanded construction time for the ones that were finally completed.

Most of the new technological advances in the nuclear field are being made by foreign utilities and foreign companies because they are the ones building new nuclear plants. Foreign utilities achieve economic advantage with their nuclear units. Foreign nuclear plants are built in a far shorter time than United States nuclear plants and there is minimal fear that the plants will be prevented from operating because of litigation and regulatory action. Foreign regulatory agencies and utilities cooperate with each other to assure that the best plant is constructed and operated. Some of the more economically viable United States nuclear utilities are expanding into the operation of foreign plants because they believe by running foreign plants (both nuclear and fossil), they can be assured of a better rate of return on investment than they can get building new nuclear plants in the United States. People in the United States nuclear industry, which started the entire world nuclear industry, are now in the position of having to expand their craft primarily in foreign lands.

The United States nuclear electric power industry is now a mature industry. With the current rate of nuclear plant permanent shutdowns and with no new nuclear units, the United States has over 1/3 of all the commercial nuclear plant operating experience it will ever get. The nuclear industry has the operating experience and the trained people necessary to make cost effective changes in the way money is spent if allowed to do so. However, timing is now critical. A significant portion of the trained people are being "downsized" and others are leaving because there is limited future advancement. Few new people are entering the industry.

Without substantial change now, these adverse trends concerning trained nuclear personnel and investment capital will get worse in the United States. There is no economic incentive in the United States for people to either start to work in the nuclear industry or to invest capital in the nuclear industry. The existing nuclear units will survive on the cash flow the existing nuclear unit can generate and by reducing costs by reducing people where possible. When the cash flow becomes negative or a large amount of new capital is needed, the nuclear unit will be permanently shut down and replaced with cheaper power from other generating sources.

Several nuclear industry and NRC efforts over the last few years have sought to improve the current regulatory process by trying to jointly work together refining the prescriptive regulations to make them a little less onerous. However, the adversarial relationship between personnel from the Nuclear Regulatory Commission and personnel from the nuclear electric generating industry persists and the prescriptive regulations change incrementally if at all. Current efforts to blend prescriptive regulations and performance-based regulations are not going to help the nuclear industry. The nuclear industry can not afford another layer of regulation on top of the existing regulations.

II. OVERALL NUCLEAR PLANT PERFORMANCE

Performance at a commercial nuclear electric generating plant is generally defined as generating the maximum amount of electricity with the lowest feasible cost and acceptable health risk. As such, performance at a nuclear electric generating unit is measured by three major parameters:

1. Amount of power generation.

2. Worker/public health risk.

3. Cost.

III. PERFORMANCE-BASED REGULATION

This paper proposes to begin using performance-based regulations at a minimum of two nuclear units as pilot programs to address public health risk. Performance-based regulation is defined and characterized as a regulatory approach that focuses on **results** as the primary means of regulatory oversight, and that has the following attributes:

1. Measurable parameters which identify performance.

2. Objective criteria to define acceptable performance which are agreed to by all parties.

3. Flexibility to determine how to meet the objective criteria.

4. An objective, quantitative monitoring process to determine acceptability of actual performance.

5. A cost effective corrective action process if the actual results are not acceptable.

It is believed that the performance-based approach offers a more objective regulatory process and affords the licensee more flexibility in developing cost-effective measures to insure adequate protection of public health and safety.

The current regulatory activities are centered around all aspects of a licensee's work practices and operations. In this culture, the regulations specify both what the licensee must do: i.e., the requirements (10CFR), and how the licensee must do it: i.e., the Standard Review Plan, the Regulatory Guides, the Branch Technical Positions, etc.

Performance-based regulation specifies what the licensee must accomplish but performance-based regulation leaves the how up to the licensee. In performance-based regulation, the NRC would define the measurable parameters that identify the relevant performance and the objective criteria that would define adequate protection of public health and safety for commercial nuclear electric generating units. The Nuclear Regulatory Commission has already done the majority of this work in the setting of the Safety Goals for the Operations of Nuclear Power Plants back in August 1986. These Safety Goals will form the backbone of any nuclear electric generating industry performance-based regulatory process.

The Licensees in the pilot programs will implement an objective, quantitative monitoring process to determine what levels of performance actually exist at the nuclear unit and compare the actual performance to the objective criteria. If a nuclear unit's public health and safety performance is acceptable when compared to the objective criteria, the NRC will observe and audit the monitoring process to make sure that the nuclear unit remains in the acceptable area. If a nuclear unit's performance is unacceptable when compared to the public health and safety criteria, personnel at the nuclear unit would define cost effective corrective action and make the changes necessary to bring the nuclear unit into the acceptable range. Personnel from the NRC could assist in this process to define cost effective corrective action. Personnel from the NRC would be carefully monitoring progress in any case. The effort should be cooperative rather than adversarial because as stated at the beginning, "As a nation, our economic viability in a world economy demands that the government become a participant in the quest to remain competitive in all areas."

The monitoring process would confirm that the changes result in acceptable performance after the changes are implemented. If the nuclear unit's performance remains unacceptable when compared to the public health and safety criteria and no cost effective options to change the situation are available, the nuclear unit would be shutdown. Fines would be imposed on the utility only if the utility falsified information or deliberately tried to mislead the NRC as to the actual performance of the nuclear unit.

Performance-based regulation for United States nuclear units will be very plant specific. The public health risk from radiation from each nuclear unit appears to be unique. Only accidents that damage the reactor core and allow fission products from the core to be transported to the public have any measurable impact on public health risk and these accidents are unique to each nuclear unit. There will be no standard review plan for performance-based regulation. There will be a decision process that will be based on the specific public health risk profile of each unit. Commonality will exist only in that each nuclear unit will have the same objective criteria, the NRC Safety Goals. How the Safety Goals are met is left to each nuclear unit and each unit will have its own cost effective program to meet the Safety Goals.

IV. NRC SAFETY GOALS

The parameter that has caused the nuclear plants the most trouble is Public Health Risk. The inability to monitor this parameter in a cost effective fashion has led to the decline and possible extinction of the nuclear option for electric power generation in the United States. This is in spite of the fact that there has been no injury from radiation effects to any member of the public in over 1500 reactor years of commercial nuclear electric generation in the United States and in spite of the fact that the Nuclear Regulatory Commission adopted its own Safety Goals for the Operations of Nuclear Power Plants in 1986.

In August 1986, the Nuclear Regulatory Commission published a policy statement pertaining to 10 CFR Part 50 that established goals that broadly define an acceptable level of radiological risk with regard to the operation of nuclear power plant. The Commission established two qualitative safety goals which are supported by two quantitative objectives. The two supporting objectives are based on the principle that nuclear risks should not be a significant addition to other societal risks.

The qualitative safety goals are as follows:

– Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and death.

– Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The following quantitative objectives are to be used in determining achievement of the above safety goals:

– The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the United States population are generally exposed.

– The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks resulting from all other causes.

The Safety Goals for the Operations of Nuclear Power Plants are rarely used by the staff in the Nuclear Regulatory Commission because of the distrust of Probabilistic Risk Assessment by most of the NRC staff. It is stated in the General Considerations for the NRC Safety Goals, "In particular, because of the present limitations in the state of the art of quantitatively estimating risks, the quantitative health effects objectives are not a substitute for existing regulations." Today, 10 years later, the same rationale is cited by staff of the NRC when people suggest the use of the Safety Goals. However, this position may be changing.

V. PROBABILISTIC RISK ASSESSMENT

In order to apply the Safety Goals, one must be able to measure the public health risk (what can happen to impact the health of the public, how often does it happen, what are the consequences if it happens) to the individual and to society. The nuclear industry does this through the use of Probabilistic Risk Assessment (PRA). These Probabilistic Risk Assessments address accidents at the nuclear units that can damage the reactor core. Only accidents that damage the reactor core and allow fission products from the core to be transported to the public have any measurable impact on public health risk.

The first major Probabilistic Risk Assessment of nuclear units was completed in 1975 and was called the Reactor Safety Study (WASH 1400). Since that time, there have been many PRA's completed and today all nuclear units have at least an Individual Plant Examination (IPE) which satisfies the requirements of NRC Generic Letter 88-20. The conclusions of all these studies has been that the nuclear units represent a very small incremental risk to the public health. All nuclear units are believed to meet the quantitative objectives defined in the NRC Safety Goals.

Even though the Probabilistic Risk Assessments of nuclear units show that the nuclear units represent a very small incremental risk to the public, some of the staff of the Nuclear Regulatory Commission have been very reluctant to use these PRA's in the regulatory process.

VI. WILL PRA'S EVER BE GOOD ENOUGH TO USE?

Probabilistic Risk Assessments have a huge advantage over the existing prescriptive, "conservative" calculations. This advantage is that the Probabilistic Risk Assessments quantify the state of knowledge about public health risk from radiation at the nuclear units and quantify the uncertainty in the PRA calculations and display the uncertainties for all to see. The prescriptive, "conservative" calculations do not do this.

The PRA's can allow operating experience to feedback into the data and methods used in the PRA's and requantify the absolute values and the uncertainties about these absolute values on a continuing basis. A living Probabilistic Risk Assessment can tell you whether you are getting better or worse with respect to public health risk and quantify the amount you are better or worse. This cannot be done in the prescriptive, "conservative" calculations. By using prescriptive, "conservative" calculations, one never knows where the mean values lie with respect to public health risk or what the distribution about the means looks like.

The advantage of quantification and uncertainty analysis is treated as a disadvantage by those who advocate continued use of prescriptive, "conservative"

calculations. These people point to the PRA uncertainties, which for a rare event such as a core damage event can range from a factor of 5 to 20, and say that we can't make decisions using these tools because they have too much uncertainty. These people prefer not to be presented with the uncertainties. They might acknowledge that some uncertainty exists in the "conservative" calculations but it has to be much less than the PRA's because it is "conservative." In fact, prescriptive, "conservative" calculations have an uncertainty of infinity. For instance, core damage events are not explicitly considered in the current regulatory process. A core damage event is theoretically precluded by the prescriptive, "conservative" regulations. Thus we have the dilemma that the only significant portion of public health risk, that which comes from core damage events, is not even acknowledged as possible in the current regulatory prescriptive rules. When an event such as the March 1979 core damage event at Three Mile Island 2 occurs, it just means that you need more prescriptive regulations which will preclude such events from happening.

There is no such thing as a risk free electric generating industry. Probabilistic Risk Assessments are always good enough to use. The very act of quantifying risk increases the understanding of the risk. To imply that you have eliminated risk by prescriptive, "conservative" calculations is to ignore the real risk. Successful technologies all use Probabilistic Risk Assessments and operating experience to refine the technology to make it successful even if the technology does not document the risk assessment. In most cases this is called cost/benefit analysis. The nuclear industry has long passed the point where Probabilistic Risk Assessments are "good enough to use." We should have paid more attention to the Reactor Safety Study in 1975.

VII. EXISTING BUILDING BLOCKS FOR SUCCESS

The nuclear industry and the NRC already have most of the tools necessary to implement a performance based regulatory process. These tools are:

1. Nuclear Regulatory Commission Safety Goals for the Operations of Nuclear Power Plants.

2. Trained people. Most nuclear units have people with 10-20 years of "hands on" experience in the units. The success the nuclear units have had in the past is due to the efforts of these people. Future success will continue to depend on their efforts. These people can make performance-based regulation work if given the chance. The people in the nuclear units are some of the most highly trained and motivated people in the entire electric generating industry. A lot of them have worked in the fossil units and can truly appreciate the benefits of nuclear electric power. Most of them have not yet given up trying to help the nuclear industry survive and even prosper.

3. Over 1500 reactor years of commercial operating experience including the event at Three Mile Island 2. As stated earlier, over 1/3 of the operating information that will come from United States nuclear units now exists if no new units are built and the present rate of existing nuclear plant shutdowns occur. This operating experience identifies what is important and what has been successful. There is a wealth of valid data in the nuclear plant records which is fairly easily retrieved for use in Probabilistic Risk Assessments. The nuclear industry also has recently developed an extensive research data base on severe accident phenomena based on the Three Mile Island 2 accident.

4. Methodologies exist to evaluate the impact of rare events on large, complex technical facilities and quite a bit of experience has been built up in the last 20 years with the applications of these methodologies. Every nuclear unit has completed a Probabilistic Risk Assessment/Individual Plant Examination. The nuclear industry has people trained in the use of Probabilistic Risk Assessment.

VIII. IMPEDIMENTS TO SUCCESS

The road to achieving cost effective change to the regulatory process by means of performance-based regulation involves significant cultural changes in both the nuclear industry and the NRC. Personnel in the nuclear industry and the NRC will have to accept new technologies and approaches. The principal obstacle to improvement will be to overcome the culture that has grown around the traditional regulatory framework in both the industry and the NRC.

Some people at the nuclear units and at the NRC believe that the only thing wrong with the regulatory process is that there are not enough regulations. They do not believe that the traditional prescriptive regulatory process leads to increased cost, accidents similar to TMI 2, existing nuclear plants shutdown for economic reasons before their license expires, no orders for new nuclear

units in the United States, and "downsizing" for existing personnel in the nuclear industry. These people want even more prescriptive requirements added to those that already exist to cover every concern that they believe exists. An example is the effort for more prescriptive regulations for shutdown and low power operation. These people fear "relaxing" the existing regulatory process especially in the areas for which they are responsible. They worry that they will no longer control the actions of others who need to do what "experts" tell them to do.

Some people also believe that there must be an adversarial relationship between the industry and the NRC. These people have the attitude that the people at the nuclear units who operate and maintain the units cannot be trusted and that the people at the nuclear units are concerned only with electric power production and not with "safety." This is in spite of the fact that Chernobyl dramatically taught us that it is the plant workers who will be the first to die if the reactor core is damaged long before any member of the public is harmed.

It also appears that morale may be falling at the existing commercial nuclear units. "Downsizing" while capital and people flow overseas is one of the reasons for deteriorating morale at the United States nuclear units. Very few nuclear workers see much future for the United States nuclear industry. The fact that the nuclear industry is thriving in some foreign countries exacerbates the situation.

Finally, there is the recognition by the thousands of people who are involved in the current regulatory process that if it is true that a performance-based regulatory process will be more efficient than the existing regulatory process, there will not be the need for as many people to regulate the nuclear units. The result will be more "downsizing." This is a very real concern for the individuals involved in the regulatory process. What these people need to recognize is that if the nuclear units could recover their cost advantage over the majority of other forms of electric generation in the United States **and** the regulatory process were more efficient, utilities would be more likely to order more nuclear units. Then the nuclear industry would need more workers and nuclear utilities would be hiring, not "downsizing."

IX. SUMMARY

The nuclear industry needs to immediately start pilot programs to implement a performance-based regulatory process at a minimum of two nuclear units in the United States. The pilot programs must be a total change in the regulatory process by people who are committed to making the change work. We cannot "nickel and dime" the changes. We have been doing this for 17 years and the incremental changes have not had any significant impact on the regulatory decision process for the reasons stated above in Section D. - Impediments To Success.

Performance-based regulation will be simple. The implementation will be very plant specific. Documentation will consist of a Probabilistic Risk Assessment and monitoring programs. There will be detailed probabilistic calculations and uncertainty calculations for each unit.

Performance-based regulation is not perfect but the method tries to avoid the situations where decisions are made on the basis of "My judgment is better than your judgment." Performance-based regulation will have the advantage of quantifying the uncertainties involved in the process. The method also allows the use of operating experience to feedback directly into the decision making process. This feedback is especially critical because the most important element of any program to improve performance is the ability to monitor performance and feedback operating experience into the decision process. This element is lacking in the present regulatory process.

The intent of the pilot programs is to demonstrate that performance-based regulation can lead to more cost effective operation of the nuclear units. The pilot programs will require a significant effort because no one can presently say exactly what structure the new regulatory process will take. The pilot programs will succeed if they have trained people who have the proper tools and the people are motivated to make the new regulatory process work. This motivation will have to be present in all personnel involved in the pilot programs including personnel from the Nuclear Regulatory Commission.

No one can assert with any degree of certainty that performance-based regulation will alleviate the economic pressures on the nuclear units. Even if performance-based regulation is successful in making the nuclear units more economically competitive, there is no guarantee that the nuclear utilities will order more nuclear

units for the United States. However, one can be pretty well assured that without a more cost effective regulatory process, there will be no new nuclear units in the United States and the United States nuclear electric generating industry will eventually disappear. To prevent this disappearance, we need a regulatory process that is more objective, efficient, and cooperative. We need it now.

This trial use of performance-based regulation should be a major step in fulfilling the words of Donald W. Edwards, who stated in June 1992, while working for the Yankee Atomic Electric Company, in his paper *Regulatory Improvement: Which Way?*: "As a nation, our economic viability in a world economy demands that the Government become a participant in the quest to remain competitive in all areas. This includes regulation of nuclear generated electricity. Performance-based regulation offers a viable mechanism to achieve effective risk reductions within limited NRC budgets as well as permit cost-effective responses by licensees."

TABLE 1

Operating Nuclear Units Shutdown Since 1989

Year Shutdown	Unit	Utility	Years between low power operating license and shutdown
1989	Fort St. Vrain	Colorado Public Service	16
1989	Rancho Seco	Sacramento Municipal Utility District	15
1991	Shoreham	Long Island Lighting	6
1992	Yankee Rowe	Yankee Atomic Electric	32
1992	San Onofre 1	Southern California Edison	25
1993	Trojan	Portland General Electric	18

TABLE 2

Planned Nuclear Units Canceled Since 1979

Year Announced	Units	Utility
1967	Midland 1, 2	Consumers Power
1969	Hope Creek 2	Public Service Electric & Gas
1969	Zimmer	Cincinnati Gas & Electric
1970	Bellefonte 1, 2	Tennessee Valley Authority
1970	Watts Bar 2	Tennessee Valley Authority
1971	Harris 2, 3, 4	Carolina Power & Light
1971	North Anna 3	Virginia Electric & Power
1971	River Bend 2	Gulf States Utilities
1972	Allens Creek	Houston Lighting & Power
1972	Blue Hills 1, 2	Gulf States Utilities
1972	Clinton 2	Illinois Power
1972	Hartsville 1, 2, 3, 4	Tennessee Valley Authority
1972	Seabrook 2	Public Service of New Hampshire
1972,73,74	WNP 1, 3, 4, 5	Washington Public Power Supply System
1973	Black Fox 1, 2	Public Service of Oklahoma
1973	Grand Gulf 2	Mississippi Power & Light
1973	Marble Hill 1, 2	Public Service of Indiana
1973	Skagit 1, 2	Puget Sound
1974	Carroll County 1, 2	Commonwealth Edison
1974	Cherokee 1, 2, 3	Duke Power
1974	Perkins 1, 2, 3	Duke Power
1974	Pebble Springs 1, 2	Portland Gas/Pacific Power
1974	Phipps Bend 1, 2	Tennessee Valley Authority
1974	Yellow Creek 1, 2	Tennessee Valley Authority
1976	Vandalia	Iowa Power & Light