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FINAL REPLY:

Bob Christie
Performance Technology

TO:

Chairman & Comm.

FOR SIGNATURE OF : ** GRN ** CRC NO: 00-0460

DESC:

Comments on Option 3 of Risk Informed Regulation

ROUTING:

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DATE: 07/14/00

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SPECIAL INSTRUCTIONS OR REMARKS:

For appropriate action.

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July 10, 2000

Chairman Richard A. Meserve
Commissioner Greta J. Dicus
Commissioner Nils J. Diaz
Commissioner Edward McGaffigan, Jr.
Commissioner Jeffrey S. Merrifield
U. S. Nuclear Regulatory Commission

Dear Commissioners:

On June 20, 2000, I attended your meeting on Option 3 of Risk Informed Regulation at which James P. Riccio was a participant. Mr. Riccio made certain statements during the meeting that I believe need some rebuttal.

a. Mr. Riccio indicated that his goal is to keep the regulatory fence as high as possible so that we might prevent another meltdown in the United States. He indicated the best way to avoid another reactor core meltdown is to not wipe out the existing regulatory structure that helped achieve that performance. Mr. Riccio believes that the existing regulations have some commensurate safety benefit and prevent core damage because the existing regulations were premised on "conservative" analyses.

b. Mr. Riccio believes that "risk-informed" regulation means that the public will be exposed to greater risk while the industry is exposed to less regulation.

I have enclosed some information on these two items (Attachment 1 and 2) for your review. The following is a summary of my thoughts on these two items.

1. Mr. Riccio's belief that the way to prevent another reactor core meltdown is to enforce rigid compliance with the existing regulations which are largely based on design basis accidents is invalid and has been known to be invalid for over 20 years.

2. Mr. Riccio's belief that recent efforts to "risk-inform" the regulations will result in the public being exposed to greater risk is incorrect.

As summarized above and detailed in the attachments, Mr. Riccio and I have different views about the basic goals for the "safety" of commercial nuclear electric power units and the means to achieve adequate protection of public health and safety.

It has been a long time since the 1979 accident at Three Mile Island Unit 2. Some of us who were working in the industry at that time have vivid memories of the accident and the reports issued after the accident. A large number of people (I include myself among them) presently working at the nuclear units have devoted their lives to assuring that

another accident such as Three Mile Island Unit 2 does not happen again. We recognize that public health risk comes from severe accidents (reactor core damage) in which the containment is bypassed or breached. We recognize that the probability of such an accident is not zero and can never be zero. I would be glad to explain to you why I believe that the risk of such an accident is acceptable for today's nuclear units.

Since 1979, personnel at the nuclear units have made many changes to the unit's equipment and procedures using Probabilistic Risk Assessments. I acknowledge that most of these changes were dedicated to preventing core damage and were done because the economic survival of the nuclear units depended on preventing reactor damage. Clearly economic survival was and will remain a major motivator for the operators of nuclear electric power units. Preventing core damage also contributes to adequate protection of public health and safety. The workers at the nuclear units take seriously their responsibility to provide adequate protection of public health and safety. Besides being dedicated and professional workers, it is their families and neighbors who will be impacted by a severe accident in which containment is bypassed or breached.

Today, we must do more to implement the recommendations found in the Kemeny Commission Report and the Rogovin Report and address the root causes of problems in the regulations. Most of the improvements made at the nuclear units in previous years using Probabilistic Risk Assessment were implemented without changing the NRC regulations. Today, we must change the regulations to focus on severe accidents with containment bypassed or breached. NRC regulations should address public health risk directly and the regulations should be both effective and efficient. There are better ways to achieve adequate protection of public health and safety than the existing regulations.

The beauty of the commercial nuclear electric power units is that the achievement of all the goals of safe and economic generation can be met at the same time. In my opinion, it is impossible for a commercial nuclear electric power unit to meet its economic goals without meeting the goal of adequate protection of the public. A well-run nuclear electric power unit, complying with effective and efficient regulations, has minimal impact on health (worker and surrounding population) and the environment. It also has the potential to be the cheapest electric power source except for the hydro electric power units.

I believe it would be advantageous for us to meet to discuss these matters and I will contact your staff to arrange a time.

Sincerely,

Bob Christie

Bob Christie

Cc: James P. Riccio

Attachment 1 – Regulations
(Letter from Bob Christie to NRC commissioners, dated 7/10/00)

Preventing Reactor Core Damage

1. Adequate Protection

The Nuclear Regulatory Commission has been empowered by Congress, the President, and the Courts to "provide reasonable assurance of adequate protection of public health and safety" from the operation of nuclear electric power units. In some of the wording of the regulations, this is sometimes referred to as "no undue risk." Adequate protection does not mean zero risk. The laws governing the generation of electricity by nuclear power plants accept the fact that the technology is not risk free.

In the past, it has been generally presumed that if a nuclear unit is in compliance with all the relevant regulations, adequate protection was assured. In general, the existing regulations are based on "design basis" accidents. It is an assumption of design basis accidents that if you can meet the criteria for the design basis accidents, you will envelope all accidents and reactor core damage will be prevented.

The present definition of adequate protection is ambiguous at best and perhaps misleading given the negative impact of some existing regulations on public health and safety. See Attachment 2 for examples of negative impact.

2. What Is Wrong with the Existing USA Regulatory System?

In my opinion, the existing USA regulatory system for providing adequate protection of public health and safety is neither effective (the existing system does not address the issues that are significant to risk to the public) nor efficient (the existing system adds unnecessary burden to the operation of nuclear electric power plants).

The problems with the existing regulatory system for nuclear electric power plants were defined in the reports issued after the accident at the Three Mile Island Unit 2 in 1979. The reports issued by the Commission appointed by President Carter (Kemeny Commission) and the Special Inquiry Group appointed by the NRC Commissioners (Rogovin Committee) were fairly clear and specific with respect to the problems of the regulatory system adopted by the Nuclear Regulatory Commission and accurately depicted the problems. For example: from the Overview section of the President's Commission (Kemeny Commission).

> "We note a preoccupation with regulations. It is, of course, the responsibility of the Nuclear Regulatory Commission to issue regulations to assure the safety of nuclear power plants. However, we are convinced that regulations alone cannot assure safety. Indeed, once regulations become as voluminous and complex as those regulations now in place,

they can serve as a negative factor in nuclear safety. The regulations are so complex that immense efforts are required by the utility, by its suppliers, and by the NRC to assure that regulations are complied with. This Commission (Kemeny) believes that it is an absorbing concern with safety that will bring about safety – not just the meeting of narrowly prescribed and complex regulations.

We find a fundamental fault even with the existing body of regulations. While scientists and engineers have worried for decades about the safety of nuclear equipment, we find that the approach to nuclear safety had a major flaw. It was natural for the regulators and the industry to ask: 'What is the worst kind of equipment failure that can occur?' Some potentially serious scenarios, such as the break of a huge pipe that carries the water cooling the nuclear reactor, were studied extensively and diligently, and were used as a basis for the design of plants. A preoccupation developed with such large-break accidents as did the attitude that if they could be controlled, we need not worry about the analysis of 'less important' accidents.

Large-break accidents require extremely fast reaction, which therefore must be automatically performed by the equipment. Lesser accidents may develop much more slowly and their control may be dependent on the appropriate actions of human beings. This was the tragedy of Three Mile Island, where the equipment failures in the accident were significantly less dramatic than those that had been thoroughly analyzed, but where the results confused those who managed the accident. A potentially insignificant incident grew into the TMI accident, with severe damage to the reactor. Since such combinations of minor equipment failures are likely to occur much more often than the huge accidents, they deserve extensive and thorough study. In addition, they require operators and supervisors who have a thorough understanding of the functioning of the plant and who can respond to combinations of small equipment failures."

Following the accident at Three Mile Island Unit 2 in 1979, the staff of the Nuclear Regulatory Commission took certain actions. However, the actions taken did not make substantial changes to the regulatory system that existed before the accident. Most NRC regulations are still based on design basis accidents. The actions taken by the staff of the NRC following the accident at Three Mile Island were not effective in eliminating the root causes of the problems with regulations as identified by the people investigating the Three Mile Island accident. The actions taken by the NRC tended to add additional complexity to the regulations. The root causes of the problems with the NRC regulations still exist today.

The best identification of the root causes of problems with the regulations was contained in a supplemental view by Dr. Thomas Pigford in the Report of the President's Commission on the Accident at Three Mile Island (Kemeny Commission).

"The Major Problems with NRC's Approach to Reactor Safety

1. Lack of quantified safety goals and objectives. When a safety concern is postulated, there is no yardstick to judge the adequacy of mitigating measures.

2. Inability to set priorities and to allocate resources in proportion to the estimated risk to the public. In my view, a disproportionate effort is being required for some issues, which have only a marginal impact upon risk to the public.

3. Lack of experienced staff. An undesirably large proportion of NRC staff and management have little or no practical experience in designing or operating the equipment which they regulate.

4. Arbitrary requirements. Too many of the NRC requirements are mandated without valid technical back-up and value-impact analysis.

5. A stifling adversary approach. The existing process inhibits the interchange of technical information between the NRC and industry. It discourages innovative engineering solutions.

6. Ineffective evaluation of operations. NRC has no effective system for evaluating data from operating plants. Data should be analyzed systematically to identify trends and patterns.

7. Lack of a comprehensive system approach to the whole plant. A large percentage of the NRC staff are specialists focusing upon narrow topics. There are relatively few systems engineers within NRC who can integrate individual safety features into an overall concept and who can place issues into perspective.

8. An overwhelming emphasis on conservative models and assumptions. Realistic analyses are needed to identify the margins of safety and to aid competent decisions."

In my opinion, Dr. Pigford accurately and concisely described all of the major problems with the NRC regulations. Some attempts were made to solve the root cause problems after 1979 but they were generally ineffective. For example: the NRC put a lot of effort into the 1986 Policy Statement on Safety Goals for the Operation of Nuclear Power Plants but no effective use was made of the Quantitative Health Effects Objectives after they were published.

Another place where the NRC put a lot of attention and effort was operating data evaluation but here the historical record is spotty. Some good actions were taken. For

example: the Office of Analysis and Evaluation of Operating Data (AEOD) was formed and the Accident Precursor Program was initiated in AEOD. The NRC created AEOD after the accident at Three Mile Island Unit 2 to specifically address the assembly and evaluation of operating data. AEOD was the organization in the NRC that made the most use of Probabilistic Risk Assessment and tried to spread its use to other NRC organizations. However, AEOD was just recently downgraded and moved to NRC Office of Research. AEOD is now just a part of an organization (NRC Research) that is fighting for its life with respect to budget and mission instead of being a separate organization with an importance (at least on paper) similar to NRR and RES.

Also in the area of operating data: the Revised Reactor Oversight Program has recently been implemented at the nuclear electric power units and this is a positive step for the evaluation of operating data. However, the performance indicators are not risk-informed to the individual nuclear unit if they are risk-informed at all. In my opinion, the Significance Determination Process, which addresses NRC inspection findings, is the only significant part of the Revised Reactor Oversight Program that is risk-informed. In the future, other parts of the Revised Oversight Program may or may not be risk-informed but this just brings up the question, why wasn't this done in the first place?

The organizations that investigate the NRC today still find that the NRC staff does not use any objective, quantifiable, systematic standard for their decisions. Today, I believe that all the major problems identified by Dr. Pigford still exist to some degree in the regulatory system used by the staff of the NRC.

3. Recommendations for Change

The committees investigating the accident at Three Mile Island made many recommendations about changes to the regulatory system. Chapter 8, "Improvement in the Basis for Safety Review of Reactor Design and Increased Use of Quantitative Risk Assessment Techniques," of the NRC Special Inquiry Group headed by Mitchell Rogovin was devoted to improving the regulatory system and contained the following remarks.

> "The NRC inherited and has continued to apply this system (so-called design basis accidents concept) of determining whether designs are acceptable for licensing, despite the fact that we have now accumulated concrete experience with these designs and a far better basis for estimating failure rates and pinpointing weaknesses, and despite the fact that our techniques of risk assessment with this technology have improved substantially in the past decade. The licensing approach incorporating these concepts has produced reactor designs that have compiled an excellent safety record. But the Three Mile Island accident suggests that this stylized process should now be amalgamated with, and ultimately supplanted by, a more sophisticated and comprehensive approach to "hazard control' that takes advantage of human factors techniques as well as the significant advances in quantitative risk analyses.

and also:

> "The best way to improve the existing design review process is by relying in a major way upon quantitative risk analyses, and by emphasizing those accident sequences that contribute significantly to risk. The design review can then focus on those plant systems that contribute to risk, identify weak points, and upgrade various requirements (maintenance, for example) to eliminate them.
>
> The present system has been criticized for relying too heavily on 'engineering judgment,' which is the term often used to hide an inadequate analytical capability. In our view, there is no way to eliminate such judgments, in part because risk assessment techniques are not now well enough developed, and also because there will always be judgments that go beyond whatever results are produced by these techniques. What the use of these methods will do is to put the judgments into the safety review process at a better point, judging which accident sequences are important, and why.
>
> We do not suggest here that the existing safety review process be immediately supplanted by a more probabilistic review. What we are suggesting is that it be augmented, and that quantitative methods be used as the best available guide to which accidents are the important ones, and which approaches are best for reducing their probability or their consequences.
>
> We believe that the advantages of such an approach far outweigh the difficulties. We strongly urge that NRC begin the long and perhaps painful process of converting as much as is feasible of the present review process to a more accident-sequence-oriented approach. This conversion process may be difficult. It could easily take as much as a decade to accomplish. The time to begin is now."

NRC managers, staff, and consultants wrote these statements over two decades ago. Further advances in technology in the last 20 years by the Probabilistic Risk Assessment analysts in the nuclear industry and in the NRC have added reinforcement to these words. The nuclear industry and some efforts of the NRC followed the recommendations of these committees. The nuclear electric power industry has gone from one reactor core damage event in about the first 400 reactor years to zero reactor core damage events in about the last 1600 reactor years. Personnel at the nuclear electric power units made changes and followed the recommendations in these reports because the survival of the nuclear electric power unit was at stake and self-interest is a powerful motivator. But at the same time, personnel at the nuclear electric power units were well aware of their responsibility for the health and safety of the public surrounding the nuclear electric power unit. These changes were made without changing the design basis regulations.

It is now time to change the regulatory system to conform to the recommendations by the Committees evaluating the accident at Three Mile Island and solve the root causes of the problems with the existing regulatory process. The regulations must directly address severe accidents with containment bypassed or breached. The regulations must be made simpler. The detailed, prescriptive, process-oriented regulations must be replaced by regulations based on performance and risk insights. The new regulations must define the performance to be achieved and leave the "how" the performance is achieved to the licensee.

The movement toward the economic deregulation of the electric power industry dictates that we move as rapidly as possible to make the NRC regulations effective and efficient. Further delay can only be detrimental to public health and safety.

Attachment 2 – Positive Risk Achievement
(Letter from Bob Christie to NRC Commissioners, dated 7/10/00)

Safer Nuclear Units

For almost four years, I have been personally working on fostering changes to the regulations that will make the regulations more effective and efficient. This effort is known to the NRC staff as the "Whole Plant Study." The NRC Commissioners approved the staff of the NRC working on this study in 1997. In the meeting on June 20, 2000, Mr. Riccio made statements to the effect that the public would be exposed to greater risk while the industry is exposed to less regulation through "risk-informed" regulation. The issue of compliance to design basis accidents was dealt with in Attachment 1. I now wish to point out three concrete examples where industry initiatives, based on the results from Probabilistic Risk Assessment in the "Whole Plant Study" led to or will lead to safer nuclear units. Public health risk was or will be decreased in these efforts because we followed the recommendations in the reports evaluating the accident at Three Mile Island Unit 2 and "risk-informed" the regulations.

1. Task Zero - Arkansas Nuclear One

March 2, 1998
Letter from ANO to U. S. NRC
Change time for monitoring hydrogen following accidents from 30 minutes to 90 minutes.

> "This one hour delay will have a positive impact on the ability of the operators to concentrate on their more immediate actions while having no negative impact on the much longer term actions that will not be needed for greater than 24 hours. Therefore, as stated above, this change would actually result in an improvement in public health and safety."

September 28, 1998
Letter from NRC to ANO
Approved ANO request of March 2, 1998 for changing the time of hydrogen monitoring.

> "On the basis of the NRC's staff's review of information provided by the Licensee, consideration of the lessons learned since the TMI-2 accident pertaining to severe accident management and emergency planning, and in order to make NRC licensing and regulatory oversight more efficient, the staff concludes that the Licensee should have the flexibility and assume the responsibility for determining the appropriate time limit for indication of hydrogen concentration in containment, such that control room personnel are not distracted from more important tasks in the early phases of accident mitigation, and decisionmakers, mostly outside the control room, are able to benefit from having useful information on hydrogen

concentration. Because the appropriate balance between control room activities and longer term management of the response to severe accidents can best be determined by the Licensee, the NRC staff has determined that the Licensee may elect to adopt a risk-informed functional requirement in lieu of the current 30 minute time limit for indication of hydrogen concentration as imposed by the Orders dated March 14, 1983, and as described by TMI Action Item II.F.1, Attachment 8 in NUREG-0737."

The Utility has stated and the NRC agreed that the change resulted in an improvement in public health and safety.

2. Task Zero – San Onofre

September 10, 1998
Letter from San Onofre to U. S. NRC
Request for exemption from hydrogen control requirements as defined by 10CFR50.44; 10CFR50, Appendix A, General Design Criterion 41; and 10CFR50, Appendix E, Section VI.

> "An exemption from the requirements for a hydrogen control system will eliminate the need for Emergency Operating Instruction steps for hydrogen control and hence simplify the Emergency Operating Instructions. This will have a positive impact on public health risk by reducing the probability of operator error during potential accidents and hence reduce the core damage frequency. An exemption will allow the operators to address hydrogen control issues as part of the proposed Accident Management Guidelines, which cover operator actions at long time frames following accidents.
>
> An exemption from the requirements for a hydrogen control system will also eliminate the need for Emergency Operating Instruction steps to initiate a hydrogen purge of the containment. This would result in a lower probability of a failed-open containment purge valve. Consequently, the offsite doses would be reduced due to the reduction of the probability of a failed-open containment purge valve."

September 3, 1999
Letter from NRC to San Onofre
Issuance of exemption from certain requirements of 10CFR50.44.

> "...The overall public health risk and radiological consequences from reactor accidents is dominated by the more severe core damage accidents that involved containment failure or bypass.
>
> ...Subsequent risk studies have shown that the majority of risk to the public is from accident sequences that lead to containment failure or

bypass, and that the contribution to risk from accident sequences involving hydrogen combustion is quite small...

...As mentioned in the previous section, the risk associated with hydrogen combustion is not from design-basis accidents but from severe accidents...

...In a postulated Loss of Coolant Accident, the San Onofre Nuclear Generating Station Units 2 and 3 Emergency Operating Instructions direct the control room operators to monitor and control the hydrogen concentration inside the containment after they have carried out the steps to maintain and control the higher priority critical safety functions. The key operator actions in controlling the hydrogen concentration are to place the hydrogen recombiners or hydrogen purge system in operation which involves many procedural steps. These hydrogen control activities could distract operators from more important tasks in the early phases of accident mitigation and could have a negative impact on the higher priority critical operator actions. An exemption from hydrogen recombiner and purge-repressurization system requirements will eliminate the need for these systems in the Emergency Operating Instructions and hence simplify the Emergency Operating Instructions. As mentioned previously, the NRC staff still expects the licensee's severe accident management guidelines to address the removal of hydrogen due to radiolysis in the long term. The NRC staff concludes that this simplification would be a safety benefit and, therefore, is acceptable."

The Utility has stated and the NRC agreed that the changes have a positive impact on public health risk.

3. Petition for Rulemaking

Following the approval of the San Onofre exemption request, I sent a letter to the NRC Commissioners, dated October 7, 1999, that indicated that I believed the approval of the San Onofre exemption request by the NRC illustrated a situation where strict implementation of the existing regulations concerning hydrogen control could be detrimental to public health and safety at the other nuclear units in the United States. My letter to the Commissioners was converted to a petition for rulemaking that was noticed in the Federal Register on January 12, 2000, by my agreement.

The approval of my petition for rulemaking would result in "safer" nuclear electric power units for the same reasons that the ANO Task Zero and San Onofre Task Zero were approved. Approval of the petition for rulemaking would simplify the Emergency Operating Instructions for all nuclear electric power units and result in a smaller probability of reactor core damage. Approval of my petition for rulemaking would reduce the likelihood of actuation of the hydrogen purge equipment during severe accidents and thus reduce the probability of radiation from severe accidents impacting the surrounding population. To the best of my knowledge, the staff of the NRC agrees that

we should remove the existing post-LOCA hydrogen control measures and that these changes would have a positive impact on public health risk. However, the NRC has yet to approve the petition.