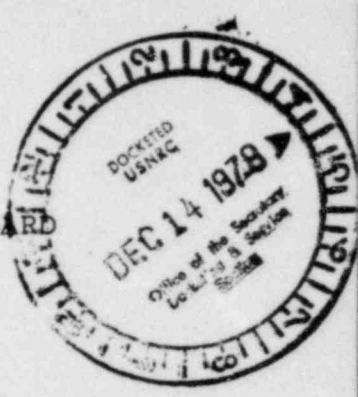


UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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| In the Matter of | ) | |
| | ) | |
| VIRGINIA ELECTRIC AND POWER COMPANY | ) | Docket Nos. 50-338 OL<br>50-339 OL |
| | ) | |
| (North Anna Nuclear Power Station, Units 1 and 2) | ) | |

12/13/78
12/14/78

UNION OF CONCERNED SCIENTISTS
REPLY BRIEF, AMICUS CURIAE

## Introduction and Summary

In ALAB-491, the Appeal Board directed the Staff to provide "a full and detailed explanation of why it is acceptable to permit the North Anna Units to operate in the face of the safety issues under study," including specification of the present status of the generic study and "all the measures employed at North Anna to compensate for the current absence of the answers sought by those studies," (Sl.Op., p.8).

The standard by which the Staff's response is to be judged is "whether . . . [the issue has] been taken into account in a manner that is at least plausible and that, if proven to be of substance, would be adequate to justify operation," (Id., p. 6 n. F).

There is one technical document that has been filed by the Staff in support of its position before the Appeal Board that North Anna can legally begin operation prior to resolution of the turbine missile issue; the filing entitled



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"Response to Atomic Safety and Licensing Appeal Board's Request for Information on the North Anna Units 1 and 2 Regarding Missiles," dated September 15, 1978 and attaching the Task Action Plans covering turbine missiles.

UCS has argued in its brief amicus curiae that the Staff's position is legally indefensible, represents an attempt to circumvent the Commission's regulations and is factually insupportable because of unjustified reliance on probabilitie's derived from WASH-1400. The Staff (and VEPCO) respond by arguing that UCS has misconstrued the Staff's position, that North Anna has been completely reviewed on a plant-specific basis and that resolution of the outstanding generic issues concerning turbine missiles are simply irrelevant. We will attempt to demonstrate here that that assertion is untrue. In fact, what the Staff has done in this latest argument contained in its response to UCS' amicus brief, is to assume, without technical support, the outcome of the generic task action plan.

Essentially, the existence of turbine missiles as a Category A[1/] unresolved safety issue represents the Staff's

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1/ "Category A" is defined as follows: "Those generic technical activities judged by the Staff to warrant priority attention in terms of manpower and/or funds to attain early resolution. These matters include those the resolution of which could (1) provide a significant increase in assurance of the health and safety of the public or (2) have a significant impact upon the reactor licensing process." "NRC Program for the Resolution of Generic Issues Related to Nuclear Power Plants," NUREG-0410, Jan., 1978.

acknowledgement that the probability of a turbine missile causing substantial damage to safety-related structures, systems or components is unacceptably high, based on the best present understanding of the behavior of turbine missiles or, as the Staff might prefer to state the issue, it cannot be proven based on present knowledge, that the risks are acceptably low. The overall probability of a missile causing unacceptable damage is the product of the probabilities of (1) a missile being generated (2) the missile striking safety-related equipment, and (3) the missile seriously damaging the equipment it strikes.

There are two ways to resolve this problem in the context of the unresolved generic issue. First, the task action plan, when completed, might support a conclusion that there never was a real safety problem in the first place but simply a failure to understand the probable behavior of turbine missiles in relation to nuclear plants. That is, it might conclude that new information and analysis prove that the probability is acceptably low that a turbine missile could seriously damage safety-related equipment, given present licensing requirements. Second, it could confirm that the problem is a real one of more serious dimension than previously supposed, and identify an acceptable way or ways of dealing with it, such as shielding of the turbine.

What the Staff has done now is essentially to argue that the first possibility outlined above will be the

ultimate outcome of the Task Action Plan. However, it has done so in advance of the completion of the generic task and without the answers to the fundamental technical questions which the generic study was designed to provide.

It is clear that no real plant-specific measures have been proposed for North Anna which would justify operation pending resolution of this unresolved safety problem. The issue may be placed in focus by considering the following proposition: If the turbine missile problem could be solved by the measures wich have been proposed at North Anna (with its "unfavorably-oriented turbines")there would clearly be no reason for turbine missiles to be listed as a "Category A" unresolved issue. The Staff could announce that its previous calculations of the overall probability of a missile causing unacceptable damage were based on overly conservative calculations of the underlying probabilities of turbine failure, strike and damage. And, it could order all plants to adopt an inservice inspection, testing and maintenance program. This could all be done tomorrow; there is nothing unique about North Anna. The fact that it has not been done provides powerful support for UCS' argument that the Staff's North Anna position amounts to an attempt to "resolve" on an ad hoc basis, the core of the unresolved safety question.

## Technical Argument

The risk to public health and safety from turbine missiles is composed of three principal elements:

1. The probability of turbine failure;
2. The probability of the turbine missile striking a safety-related structure, system, or component; and
3. The probability of unacceptable damage to the safety-related structure, system, or component.

As VEPCO correctly observed,[2/] "Regulatory Guide 1.115 says that the probability of damage [i.e., the mathematical product of the three probabilities listed above] to essential systems [components or structures] should be less than $10^{-7}$ per year." It can also be noted from Regulatory Guide 1.115, Revision 1, July 1977, the Staff has identified two distinct types of turbine missiles: low-trajectory missiles and high-trajectory missiles. Note also that Regulatory Guide 1.115 "outlines acceptable methods of protection against low-trajectory turbine missiles." The earlier version of Regulatory Guide 1.115 published for comment in March 1976, likewise outlined acceptable methods of protection against low-trajectory turbine missiles and stated: "Another [regulatory] guide is under preparation with regard to protection against high trajectory (lob shot) missiles resulting from turbine failures."

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2/ VEPCO's Response to Pollard's Limited Appearance, July 5, 1977, page 55. This comment was attached to the Union of Concerned Scientists Request for Leave to File Reply Brief.

This sentence does not appear in Revision 1 of Regulatory Guide 1.115, but UCS is aware of no Regulatory Guide addressing the subject of acceptable protection against high-trajectory turbine missiles.

It is also important to note that Regulatory Guide 1.115 discusses two distinct types of turbine failure: failures at or below design overspeed (120% to 130% of turbine operating speed) and destructive overspeed turbine failures (180% to 190% of turbine operating speed). Turbine failures at or below design overspeed and turbine failures caused by destructive overspeed can cause both high-trajectory and low-trajectory missiles.

The turbine missiles are fragments of the turbine disks. These steel pieces can have a large mass (approximately 2-3 tons), will be traveling at high velocity (on the order of a few hundred miles per hour), and are capable of penetrating several feet of reinforced concrete (approximately six feet or more).

We will now explain why UCS "believes that the turbine missile question cannot be resolved for the North Anna facility independently of the outcome of the generic inquiry,"[3/] which is the single point the Board has permitted UCS to address.

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3/ Order of December 7, 1978.

This sentence does not appear in Revision 1 of Regulatory Guide 1.115, but UCS is aware of no Regulatory Guide addressing the subject of acceptable protection against high-trajectory turbine missiles.

It is also important to note that Regulatory Guide 1.115 discusses two distinct types of turbine failure: failures at or below design overspeed (120% to 130% of turbine operating speed) and destructive overspeed turbine failures (180% to 190% of turbine operating speed). Turbine failures at or below design overspeed and turbine failures caused by destructive overspeed can cause both high-trajectory and low-trajectory missiles.

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3/ Order of December 7, 1978.

The Staff does not distinguish between high-trajectory and low-trajectory missiles in its testimony. However, since they point to the existence of structural barriers which could (potentially) be effective in stopping missiles, we assume their arguments are directed principally to low-trajectory missiles and we discuss these first.

The Staff's principal argument before the Appeal Board (as opposed to its argument to the Licensing Board in response to R. Pollard's limited appearance statement),[4/] is that alleged conservatisms were used in the plant-specific analysis for the North Anna plant and, therefore, long-term operation of North Anna is not dependent on the successful outcome of Task A-37, and, does not rely on WASH-1400. The Staff advances the argument that these alleged conservatisms "compensate for the uncertainties in the available data and state-of-the-art analytical methods which Task Action Plan A-37 was initiated to quantify." (NRC Staff's Response to UCS Brief Amicus Curiae, November 16, 1978, page 3.)

The Staff states that "the use of historically observed probabilities for estimating turbine failure, in lieu of more realistic probabilities associated with modern turbines which have substantial improvements in materials and overspeed protection, is itself a conservation [sic]." (Id., page 2) UCS does not agree that this is a conservatism. First, improvement

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4/ "Staff's Response to Board's Request for Additional Information Letter, Dated October 21, 1977," page 1. This document is attached to UCS' Request For Leave to File Reply Brief.

in materials was a necessary development in order to construct the turbines now used in nuclear power plants. That is, but for the improvement in materials, today's turbines could not be built and safely operated. Thus, although the improvement in material technology may reduce failure rates below those historically observed, this may well be offset by factors such as the larger size of modern turbines and the increased number of turbine blade wheels used in modern turbines. There is simply not sufficient operating history with current turbines to say whether their failure rates will be higher or lower than the historical rates. This is acknowledged in Regulatory Guide 1.115.

Second, with respect to improvements in overspeed protection, there are several factors the Staff neglects to mention:

1. Improvements in overspeed protection have no effect on the probability of design overspeed failures. At best, they could only act to reduce the probability of destructive overspeed failures.

2. Historically-observed destructive overspeed failures were caused by failure of the steam supply valves to close--not because of failure of the devices used to sense overspeed and initiate closure of the steam supply valves. Therefore, improvements in overspeed protection (i.e., sensing overspeed and signalling the steam supply valves to close) may not reduce the historically-observed rate of destructive overspeed failures. The Staff has not required the installation of redundant steam supply valves which could ameliorate the cause of the historically-observed rate of destructive overspeed failures.

3. The Staff has not determined what, if any, credit can be taken for the "improved" materials and overspeed protection system. Indeed, this is one of the problems set out to be resolved by the generic task: "Presently, there is no formal NRC guidance on how to evaluate the effect of toughness of turbine disk materials, or testing and inspection of disks, overspeed control systems, and steam valves on the missile generation probability ($P_1$)." (Task Action Plan A-37, page A-37/1)

Therefore, based on the above, UCS believes that the Staff's assertion that reliance on historically-observed turbine failure rates is a conservatism is not even plausible. In fact, the assertion relies on information yet to be obtained in the generic task action plan and thus completion of the generic investigation is essential to establishing whether operation of North Anna Units 1 and 2 would pose undue risk to the public.

Next the Staff argues that "a second conservatism...involved the estimation of turbine missile strike probabilities with respect to safety related structures. In arriving at this estimate, the Staff assumed the creation of more missiles than would necessarily result based on observed failures." (NRC Staff's Response to UCS Brief Amicus Curiae, page 2) UCS believes that this, also, is not a conservatism. The Staff inserts the word "necessarily" necessarily. While it is correct that some observed failures have involved fewer than four wheel fragments, the number assumed, it is also true that some failures have involved more than four fragments. Furthermore, while the number of fragments does affect the probability of striking safety-related structures, systems and components, it also affects the energy of each fragment, which in turn affects the amount of damage each fragment will cause. The rotating wheel has a fixed amount of rotational kinetic energy. Therefore, the more fragments that are generated, the less kinetic energy each one will have. Moreover, the original rotational kinetic energy of the wheel will be divided between the translational and rotational kinetic energy of each fragment.

To establish the conservatism the Staff alleges to exist, there must be a demonstration that the missiles assumed in the plant-specific analysis represent the worst combination of probability of striking a safety-related structure, system, or component and the probability of unacceptable damage to that safety-related structure, system, or component (i.e., the worst combination of the number of missiles and the kinetic energy of each missile).

Once again, the task action plan includes among the generic questions to be resolved the very issue of whether or not this is a conservatism:

> Also, the acceptable methods for estimating missile strike probability ($P_2$) for both low and high trajectory missiles should be identified and documented. 5/

The above involves determining how many fragments result from wheel failures. In addition, "[e]valuation of the effect of turbine missile impact,"6/ involves determining the kinetic energy of the turbine.

Finally, the assumption of four wheel fragments is identical to that used in developing the information which forms the basis for Regulatory Guide 1.115. Therefore, based on the above, UCS concludes that the Staff's assertion that the use of four wheel fragments is a conservatism is not even plausible in the absence of the information sought by the generic tasks.

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5/ Task Action Plan A-37, page A-37/1.

6/ Task Action Plan A-32, page A-32/1.

The Staff proceeds to argue that "[a] third conservatism resulted from the assumption that given a missile strike on a structure, the probability for penetration and damage to the safety-related equipment was unity." (Staff's Response to UCS Brief Amicus Curiae, p. 2-3) The conservatism is said to result from ignoring "the existence of structural barriers and the possibility that a missile might not strike or, if it did strike, that it might not damage the safety-related equipment inside of the structure." (Id., page 3)

UCS agrees that there is some conservatism in this assumption, however, UCS disagrees that the current state of knowledge permits a determination of the degree of conservatism. The principal reason the Staff used this assumption in North Anna as well as in developing Reg. Guide 1.115, is the complexity involved in analyzing the behavior of the missile once it penetrates the structural barrier (or in analyzing the behavior of a secondary missile while results from concrete fragments being expelled from the inside surface of the structural barrier.) In other words it is a conservative assumption that must be made because it is not known, in a quantitative sense, how much protection is afforded the safety equipment if penetration does occur. Nor is it in any sense a plant-specific conservatism. Once again this is the point of the ongoing generic task A-32: "[Q]uantitative acceptance criteria for judging the

acceptability of barrier failure probability, given the occurrence of a missile impact, need to be developed." (Task Action Plan A-32, p. A-32/2) It is an open question, until the generic task is completed, whether the existence of structural barriers reduces the probability of damage to the safety-related equipment to a value significantly less than unity. Thus the current assumption may turn out to be in fact the only reasonable assumption.

This discussion had demonstrated that, far from being "plant-specific," the extent to which all of the alleged conservatisms identified by the Staff are in fact conservatisms are open questions which the ongoing generic study on turbine missiles is designed to answer. The same is true of the inservice inspection, maintenance and testing program, as the Staff has acknowledged in the description of the Task Action Plan:

> Presently, there is no formal NRC guidance on how to evaluate the effect of toughness of turbine disk materials or testing and inspection of disks, overspeed control systems, and steam valves on the missile generation probability (P1).7/

As we noted at the outset, there is a distinction between high- and low-trajectory missiles. All of the arguments above apply to both, but the following additional points go to high-trajectory missiles only. The Staff has provided no guidance on acceptable protection against

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7/ Task Action Plan A-37, p. A-37/1.

high-trajectory missiles.[8]

The probability of a high-trajectory missile strike on a safety-related structure, system or component is not significantly affected by the turbine orientation. However, the structural barriers available to prevent damage to safety-related equipment are significantly less effective against high-trajectory missiles because the postulated point of strike - the roofs of such buildings as the containment and control room - are substantially thinner than the walls, wich are the target of low-trajectory missiles. Thus, although the probability of a high-trajectory missile striking a safety-related structure, system or component is less than the corresponding probability for a low-trajectory missile, this does not compensate for the reduced protection afforded by the thinner roof. It is precisely this problem which has prevented the Staff from issuing guidance on high-trajectory missiles and which is one of the principle tasks of the ongoing generic study.

The Staff states in its description of the turbine missile task action plan that:

> This task will re-examine the methods of analysis used by applicants for estimating strike probability for low- and high-trajectory missiles and will include review of Appendix A of section 3.5.1.3 of the SRP. "Turbine Missiles," with respect to high-trajectory missiles.[9]

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[8] See the discussion, supra p. 5-6 .

[9] Task Action Plan A-37, p. A-37/5.

Therefore, the Staff's argument that safe operation of North Anna in no way depends on satisfactory completion of the generic task is not plausible.

Conclusion

Insofar as can be discerned from the course of this case, the Staff's position on the relationship between the unresolved generic issue of turbine missiles and the North Anna licensing proceedings has undergone rather a dramatic metamorphosis. When it was before the Licensing Board, the Staff adopted the circumspect and limited position that the risks were only justified for the interim period pending completion of the generic study. It stated:

> In reference to the applicant's statement on page 55 that "the [turbine missile] risk . . . has been found to be acceptably low," the Staff believes that some qualification is necessary. It should be noted that the Staff's conclusions in Section 10.2 of Supplement No. 2 to the North Anna Power Station, Units 1 and 2 Safety Evaluatin Power limit the acceptability of the risk to being sufficiently low for permitting the plant to operate until a generic study on the subject of turbine missiles is completed.10/

Even this limited conclusion was further qualifed as being dependent on the implementation of the inservice-inspection, maintenance and testing program and on the applicant's promise to provide any additional protection

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10/ NRC "Staff Responses to Board's Request for Additional Information Letter Dated Oct. 21, 1977," p. 1 (Emphasis added) This document was attached to UCS' Request for Leave to File Reply Brief.

which the results of the generic study might warrant.[11]

In its response to this Appeal Board of September 15, 1978, the Staff's position had lost a good bit of its tentativeness and qualification. This time it appeared to say that the so-called "conservatisms" in its probability analysis, plus the inservice inspection, maintenance and testing,provided sufficient protection so that the Staff believed that the outcome of the generic task would not require more:

> These measures, in the Staff's view constitute an acceptable level of protection for North Anna, it is the Staff's view that completion of Task A-37 will not result in additional requirements for that facility and we consider the matter resolved.
>
> As noted in Section 3 of the Task Action Plan A-37, the current licensing requirements, coupled with the low probability of unacceptable damage to essential systems by turbine missiles, provide the basis for allowing continued operation of the existing LWR's.[12]

Now the Staff states that that it is in no way relying on the expected results of the generic study.[13] However, we have shown that, to the contrary, the purported "plant-specific" analysis for North Anna is fundamentally based on assumptions

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11/ Id., p. 2

12/ "Response to Atomic Safety and Licensing Appeal Board's Request for Information on the North Anna Units 1 and 2 Regarding Missiles," Sept. 15, 1978, p. 6.

13/ "NRC Staff's Response to UCS Brief Amicus Curiae", p. 4

whose truth are the subject of the generic study.

It must be noted that no additional substantive review is claimed by the Staff to have been performed since the SER or since its very qualified answer to the Licensing Board, quoted above. It is, rather, the characterization of its results in relation to the generic study which has changed so markedly. UCS believes that the earlier version was a more accurate reflection of the state of the knowledge of this subject. It can then be seen why it was necessary for the Staff to rely on WASH-1400's probabilities to justify operation pending completion of the generic task: WASH-1400 was the only source of new information and analysis (now substantially discredited) which could be used to argue that the risk of unacceptable damage was sufficiently low. The claim now that North Anna can be justified solely on a plant-specific basis comes late in the process and does not comport with the facts as we have presented them here. Rather, the metamorphosis in the characterization of the results of the North Anna review would appear to coincide with the changing exigencies of the licensing process, as represented first by the River Bend decision and then by the Lewis Report.

No plausible or credible plant-specific reason has been given why North Anna should be permitted to operate pending either resolution of the generic study or implementation of a solution to the turbine missile problem such as shielding.

Respectfully submitted,

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DATED: December 14, 1978

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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| | ) | |
| (North Anna Nuclear Power Station, Units 1 and 2) | ) | |
| | ) | |

AFFIDAVIT OF ROBERT D. POLLARD

I, ROBERT D. POLLARD, hereby make my affidavit as follows:

I am the staff nuclear safety engineer in the Washington, D.C., office of the Union of Concerned Scientists.

My formal education in nuclear technology began in May, 1959, when I was selected to serve as an electronics technician in the nuclear power program of the United States Navy. After completing the required training, I became an instructor responsible for teaching naval personnel both the theoretical and practical aspects of operation, maintenance and repair of naval nuclear power plants.

From February, 1964, to April, 1965, I served as the senior reactor operator and supervised the reactor control division aboard the U.S.S. Sargo, a nuclear-powered submarine. In 1965, I was honorably discharged from the U.S. Navy and attended Syracuse University, where I received the degree of Bachelor of Science magna cum laude in Electrical Engineering in June, 1969.

In July, 1969, I was hired by the U.S. Atomic Energy Commission (AEC) and continued as a technical expert with the AEC and its successor, the NRC, until February, 1976. After joining the AEC, I studied advanced electrical and nuclear engineering at the Graduate School of the University of New Mexico in Albuquerque. I subsequently advanced to the positions of Reactor Engineer (Instrumentation) and Project Manager.

As a Reactor Engineer assigned to the Electrical, Instrumentation and Control Systems Branch, I was primarily responsible for analyzing and evaluating the adequacy of the design of reactor protection systems, control systems and emergency electrical power systems in proposed nuclear facilities. In September, 1974, I was promoted to the position of Project Manager and became responsible for planning and coordinating all aspects of the design and safety reviews of applications for licenses to construct and operate several commercial nuclear power plants.

I am a member of the Institute of Electrical and Electronics Engineers (IEEE). I have served as the NRC representative on various IEEE committees that developed some of the IEEE standards used by the NRC to evaluate the safety of nuclear power plants.

One of the duties to which I was assigned while at the AEC was to act as the principal staff reviewer for the turbine missile generic issue. My duties in that area during the

period of 1972 - 1973 were approximately equivalent to those now assigned to the Task Action Manager for this subject. Among other tasks, I performed the calculations for probability of strike for high and low trajectory missiles, analyzed the possible mitigating effect of reinforcing steel and steel liners for reinforced concrete structures, and performed calculations attempting to analyze the damage caused by missile impact as a function of the angle of incidence.

Portions of this work were used to support the conclusions reached by S. H. Bush in "Probability of Damage to Nuclear Components," Nuclear Safety, Vol. 14, No. 3, May-June, 1973, which is a major document referenced in Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles." So far as I am aware, the staff has developed no new information or analysis inconsistent with my work.

I have reviewed the staff submissions on this issue in the North Anna proceedings and provided the technical analysis contained in the UCS reply brief which accompanies this affidavit. The technical statements are accurate to the best of my knowledge.

By: Robert D. Pollard
Robert D. Pollard
Union of Concerned Scientists

December 13, 1978

I hereby affirm that the foregoing is true and correct to the best of my knowledge and belief.

Robert D. Pollard
Robert D. Pollard

Subscribed and sworn to on
December 13, 1978, at
Washington, D.C.

Notary Public

My commission expires January 31, 1983

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CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing, UCS Reply Brief, Amicus Curiae, and Affidavit of Robert D. Pollard were mailed postage pre-paid this 14th day of December 1978, to the following parties:

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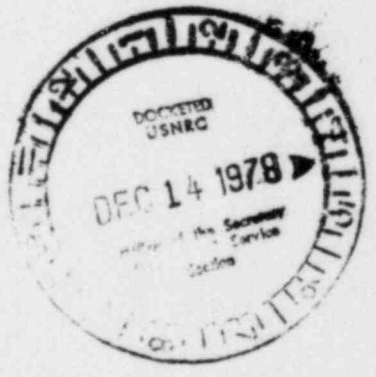


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