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SUBJECT: Responds to NRC 941130 RAI re use of neutron flux instrumentation for monitoring post-accident severe accident conditions,w/respect to Reg Guide 1.97.

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Vice President
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February 3, 1995

U.S. Nuclear Regulatory Commission
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Attn: Allen R. Johnson
Project Directorate I-3
Washington, D.C. 20555

Subject: Request for Additional Information
Use of Neutron Flux Instrumentation During
Post-Accident Severe Accident Conditions (TAC No. M90036)
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Ref. (a): Letter from Allen R. Johnson, NRC, to Robert C. Mecredy, RG&E, "Request for Additional Information Dealing with Regulatory Guide 1.97 Provisions for Nuclear Instrumentation," November 30, 1994.

Dear Mr. Johnson:

This letter is in response to your Request for Additional Information (Reference a), regarding the use of neutron flux instrumentation for monitoring post-accident severe accident conditions. It supplements our previous detailed technical submittal on this subject, dated May 6, 1991, which was the result of a cooperative effort with Duquesne Light and Consolidated Edison.

As noted in Reference (a), we have been corresponding with the NRC on this subject for many years, ever since the issuance of NUREG-0737, Supp. 1 in December 1982. We have been able to reach agreement on every one of these complex technical issues, with one narrow (but expensive) exception: environmental qualification of neutron flux instrumentation to follow the course of an accident which results in harsh containment conditions. As clarified in the attached responses, we do not propose the wholesale substitution of alternative instrumentation for neutron flux monitors, but only in those situations where it has been shown that the alternative instrumentation provides a more accurate indication of core behavior situations.

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Once the NRC has reviewed our responses, as well as those from Duquesne Light and Consolidated Edison, we would be pleased to meet with you in a technical forum to finalize the resolution of this issue.

Very truly yours,

Robert C. Mecredy

GJW\361

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1. Question:

A major difference between the existing neutron flux measurement and the proposed temperature measurements is the additional delay introduced, during a reactivity insertion accident, by the time required for the temperature measurement to detect sensible heat. For slow reactivity insertion rates this delay can become substantial.

In order to evaluate this effect, provide a quantitative estimate of the time delay in identifying a situation in which the reactivity is increasing (assuming, e.g., a constant reactivity insertion rate) for a complete range of reactivity insertions. Provide a detailed evaluation of the effect of this delay on plant safety analyses, accident consequence and required operator action, relative to the case where the increasing neutron flux is detected by the flux instrumentation at $\sim 10^{-5}\%$ power. Any comparison to the excore neutron flux instrumentation should only be made for the condition where the water level is measured to be above the hot leg, and the neutron flux provides a proportional indication of the core neutron flux.

Response:

It is important to understand three fundamental points with respect to the proposed use of Reactor Coolant System temperature measurements (core exit, hot leg, cold leg) in lieu of environmentally qualified neutron flux instrumentation:

1. The temperature instrumentation only replaces neutron flux instrumentation under harsh containment environmental conditions. These conditions exist for the design basis accidents described in our May 6, 1991 submittal (section 3.1), and a number of beyond design basis accidents which were considered during Emergency Response Guideline (ERG) development (section 3.2).

2. As is implied in the NRC question, neutron flux instrumentation is not always proportional to reactor power, and therefore may provide anomalous indications which can potentially mislead the operator. Excore neutron flux instrumentation response is dependent on the location of voiding in the core and/or downcomer, the degree of core uncovery, and detector location. This is particularly likely for accidents which produce harsh containment environments, since reactor vessel voiding may be occurring. Anomalous neutron flux indication (i.e. indication not proportional to reactor power) was observed at the Three Mile Island accident (as shown in Appendix Recrit of NSAC-1), and has been demonstrated in NRC financed experiments at the Pennsylvania State University Breazeale nuclear reactor and LOFT facility (Nuclear Technology, Vol. 96, December 1991)

3. Post-accident criticality is only monitored as part of the Emergency Operations Procedures (EOP) Critical Safety Function Status Trees (CSFST). The CSFST's are only intended to determine if an imminent

threat to a critical safety function exists. The CSFST's act as a decision point in order to determine if the operator should immediately suspend the performance of optimum recovery procedures, in order to address this challenge. Westinghouse Owners Group (WOG) guidance suggests that this decision should be made only if there is a continuous challenge to the safety function. As described in our submittal report, a continuous challenge does not exist unless the core is producing enough power that a temperature rise is indicated on the RCS temperature instrumentation. This rise results when core power exceeds decay heat removal capability, well above the power levels suggested for analysis by this question.

Based on these three points, time response of the temperature indication is not a concern for the intended function, nor is it necessary, under post accident conditions, to be able to detect core criticality at the power level suggested in the question.

2. Question:
Describe any unique plant-specific design features or operating conditions that support the use of temperature measurements for criticality, rather than the existing neutron flux instrumentation.

Response:
The proposal is to use temperature measurements for gross indication of core power, rather than the existing neutron flux instrumentation, only under conditions where the existing instrumentation is not qualified. The studies referenced in point 2 of the response to question 1 support the use of RCS temperature indication in lieu of neutron flux instrumentation under harsh environmental conditions at any PWR - there are no additional unique features at Ginna relative to this position.

3. Question:
Since the temperature measurements only determine that a critical state exists and sufficient power is being generated to be measured on the temperature instrumentation, describe how the proposed temperature measurements will determine the subcritical states of the core as suggested in Section 3.

Response:
As described in the response to the first question, the WOG emergency response guidelines for use of CSFST's, and consequently, the Ginna EOP's, only implement safety function restoration procedures if a continuous challenge to that function exists. This implies the need to determine gross changes in core power, not the subcritical state of the core. A precise measurement of neutron flux, even if it is a valid measurement, is not necessary to determine if a challenge to a safety function exists. Post-accident boron sampling assures the long term subcritical state of the core.

4. Question:
Regulatory Guide 1.97, Rev. 3 recommends measurements that: a) provide a direct measurement of the desired variable (flux in the case of criticality) and b) minimize the development of conditions which could cause the measurements to give anomalous readings that would be potentially confusing to the operator. NRC staff recognizes your discussion, in previous RG&E submittals, of Emergency Operating Procedure (EOP) instructions involving use of core exit thermocouples; however, additional information is required. Please discuss in detail the ability of the core exit thermocouples and the hot and cold leg temperature measurements to provide an accurate indication of criticality in the presence of large uncontrolled and potentially unknown variations in the core flow and heat removal rate during accident conditions.

Response:
Potential variations in core flow and heat removal rate during accident conditions affect the accuracy of neutron flux instrumentation as well as RCS temperature indication. The important point is that the EOP's do not require a highly accurate indication of criticality. The indication is only required to determine if there is an imminent threat by the critical state of the core to one of the barriers to release of radioactive materials to the environment. This only requires a gross indication of core power. As noted in point 3 of the response to question 1, the proposed temperature indication is more than adequate for this purpose, and is less likely to provide ambiguous and misleading information to the operator under the conditions described in this question than excore neutron flux instrumentation.

5. Question:
In certain situations, the critical boron versus fuel burnup curve is used to determine if the coolant boron concentration is adequate to insure subcriticality during accident conditions. The NRC staff is aware of the information RG&E submitted previously concerning design basis accident (DBA) range requirements. In addition to this information, how does the critical boron versus fuel burnup curve account for the range of beyond DBA core conditions?

Response:
Environmental qualification of equipment for beyond design basis events is beyond the scope of NUREG-0737 requirements . However, due to the attempted optimization of operating core loading pattern, it is expected that the required subcritical boron concentrations are adequate for any conceivable post accident core configuration. These boron concentration curves are utilized throughout the EOP's, including function restoration procedures (FR's).

6. Question:
In previous correspondence with the NRC, RG&E indicated the qualified temperature limits of the plant core exit thermocouples to range from 0 to 2300°F, the hot leg temperature measurements to range from 0 to 700°F. Please confirm these temperature measurement ranges and explain how criticality will be determined when the plant is outside these limits?

Response:
The ranges reported in the question have been confirmed. These ranges are consistent with EOP utilization of these instruments, and are consistent with NUREG 0737/Regulatory Guide 1.97 guidance and 10CFR50.49 Environmental Qualification requirements for these instruments.

7. Question:
NRC staff acknowledges RG&E submittal with information concerning EOP instructions involving use of core exit thermocouples. Additionally, under what specific conditions will the neutron flux instrumentation and the (core exit thermocouple and hot and cold leg) temperature measurements be used to determine criticality? If the neutron flux instrumentation will not be used during conditions of a hostile environment, how will these conditions be identified? How will it be assured that the Category 3 neutron flux instrumentation is not used under conditions for which the instrumentation system is not qualified?

Response:
RCS Temperature indication is only used in lieu of excore neutron flux instrumentation for determination of the critical status of the core when harsh containment conditions exist. These conditions are called out in the EOP's and are periodically monitored by operators, as well as reported on the Safety Assessment System (SAS). The proposed EOP instructions will direct the operator to the correct CSFST based on the environmental conditions in containment (e.g., containment pressure greater than 4 psig). This is consistent with current EOP's where direction is given on the use of post-accident instrumentation based on whether normal or harsh conditions exist in containment.

8. Question:
Have any special interpretations been made in the application of the Westinghouse Owners Group Emergency Response Guidelines to accommodate the use of the temperature measurements for the subcriticality function?

Response:
No special interpretations of the WOG ERG's have been made. Proposed changes to the EOP's to instruct the operator to use RCS temperature indication in lieu of excore neutron flux indication under harsh environmental conditions is not currently included in the WOG ERGs. As detailed in section 5.2 of our May 1991 submittal report, this difference from the Rev 1A ERGs was evaluated. It concludes that the plant remains within the technical basis of the guidelines, and that the proposed changes are fully consistent with the EOP diagnosis and mitigative strategies.

9. Question:
The Chapter 3 evaluation of the beyond DBAs considered the loss of reactor coolant, loss of secondary coolant and steam generator tube rupture events. How are the other beyond DBAs included in the safety evaluation?

Response:
The events described in the question are the design basis events (section 3.1), and the "beyond design basis"events considered when the ERGs were established (section 3.2), which result in harsh containment environmental conditions, i.e. the events under which RCS temperature indications would be used in lieu of excore neutron flux instrumentation. The intent of Section 3.2 of the submittal is to demonstrate that should the design basis events degrade due to multiple equipment failures (i.e. beyond the design basis of the plant), proper guidance would be provided by use of the proposed instrumentation. For those other design basis events which degrade but do not produce harsh containment conditions, the proposed instrumentation would not be used. Other beyond design basis events that fall below the probability threshold of the ERGs are outside the scope of these submittals, the guidance of Regulatory Guide 1.97, and the requirements of NUREG-0737, Supplement 1.

10. Question:
Discuss how the proposed core exit thermocouple and the hot and cold leg temperature measurements satisfy the very strong recommendation of ANSI/ANS-4.5 that: a) the criticality measurements should be made with a flux detector which spans the range from 1×10^{-8} to 1×10^{-3} of full power or an equivalent or better alternative and b) to the extent possible, the selected measured variables shall be those that most directly monitor subcriticality.

Any comparison to the excore neutron flux instrumentation should only be made for the condition when the water level is measured to be above the hot leg, and the neutron flux provides a proportional indication of the core neutron flux.

Response:
Ginna Station is not designed to, nor committed to ANSI/ANS-4.5 (or Regulatory Guide 1.97, revision 3). As described in the responses to questions 1 and 4, we believe that the RCS temperature indications provide a better alternative than excore neutron flux instrumentation for monitoring the EOP CSFSTs for accidents which produce harsh containment condition.

11. Question:
Describe the method used to determine the specific threshold values for the (core exit thermocouple and hot and cold leg) temperature measurements and the boron concentration that are used to protect from the effects of reactivity insertion events.

Response:
The temperature value (700 degF) is chosen to be consistent with the value used for the Core Cooling CSFST, and is based on WOG ERG Background Document recommendations. It is intended to indicate the presence of superheated conditions in the reactor vessel, an indication that either decay heat removal has been lost or that the reactor is not subcritical. The conservative action is to address the critical status of the core first, unless it is known to be subcritical (i.e. adequate boron concentration). The

subcritical boron concentration curves are established during each Reload Analysis, with margin added to compensate for uncertainties and stuck control rod(s). These curves are consistent with those currently used throughout the EOPs, including the Function Restoration procedures (FRs) responding to a challenge to core subcriticality.

12. Question:
In the analysis of beyond design basis events, how are events other than loss-of-coolant accident secondary break and steam generator tube rupture accounted for?

Response:
(see response to Question 9)