Duquesne Light Company Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077-0004
(412) 393-5206
(412) 643-8069 FAX

GEORGE S. THOMAS
Division Vice President
Nuclear Services
Nuclear Power Division

March 1, 1995

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Beaver Valley Power Station, Unit No. 1
Docket No. 50-334, License No. DPR-66
Response to Request for Additional Information
Related to Neutron Flux Instrumentation (TAC No. M81201)

Reference: Duquesne Light Company letter to the NRC submitting the report "Evaluation of the Adequacy of Existing Neutron Flux Instrumentation for NUREG-0737, Supplement 1," dated May 31, 1991

This letter responds to the NRC's Request for Additional Information (RAI), dated November 29, 1994. Duquesne Light Company (DLC) has provided several submittals to the NRC on this issue since the issuance of NUREG-0737, Supplement 1, in December 1982. Agreement has been reached on each of the technical issues of NUREG-0737, with one exception; i.e., environmental qualification of neutron flux instrumentation for beyond design basis accidents that produce a harsh containment environment. In the referenced report submitted on May 31, 1991, DLC provided technical justification for not upgrading the neutron flux instrumentation according to the guidance of Regulatory Guide 1.97 (Revision 2).

The existing Unit No. 1 neutron flux monitors are appropriately qualified for the majority of postulated accidents. In the unlikely event of a beyond design basis accident causing harsh containment conditions, the consequences of neutron flux monitoring unavailability will not prevent the operator from determining and taking appropriate corrective action. Use of the temperature monitoring instrumentation system, in the manner described in the Emergency Operations Procedures (EOPs), allows the operator to predict the appropriate event paths and to take corrective action to mitigate the resulting conditions.

It was estimated in the referenced report that an upgrade of the existing neutron flux instrumentation will cost in excess of $3 million. As described in the attached response to the subject RAI, this expense provides little or no safety benefit nor derives increased protection, and an upgrade will not result in any changes to the mitigative actions prescribed by existing EOPs. Therefore, we believe the additional cost is unnecessary because the existing neutron flux instrumentation is properly qualified for all its design

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basis accidents including the beyond design basis ATWS event. In lieu of upgrading neutron flux instrumentation, the use of the existing qualified Reactor Coolant System temperature measurement instrumentation during events which could generate an adverse containment environment will allow the operator to confirm return to core power conditions.

We believe our position to not upgrade the neutron flux instrumentation is consistent with our licensing basis and pertinent regulatory requirements.

This submittal is the result of a cooperative effort with Consolidated Edison and Rochester Gas and Electric. Once the NRC has reviewed our attached response, as well as those from the other two utilities, we would be pleased to meet with you in a technical forum to discuss any additional concerns and to finalize the resolution of this issue.

Sincerely,

George S. Thomas

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cc: Mr. L. W. Rossbach, Sr. Resident Inspector
Mr. T. T. Martin, NRC Region I Administrator
Mr. G. E. Edison, Sr. Project Manager

Response to NRC Request for Additional Information
Related to Neutron Flux Instrumentation, Dated November 29, 1994

QUESTION 1

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 consequences and required operator action, relative to the case where the increasing neutron flux is detected by the flux instrumentation at approximately 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 TO QUESTION 1

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

1. The temperature instrumentation only replaces neutron flux instrumentation under harsh containment conditions. These conditions exist for the design basis accidents described in our May 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. These are usually local, non-homogeneous conditions which may not be detected by the neutron flux instruments. 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 funded experiments at the Pennsylvania State University Breazeale nuclear reactor and LOFT facility (Nuclear Technology, Vol. 96, December 1991).

RESPONSE TO QUESTION 1 (Continued)

3. Post-accident criticality is only monitored as part of the Emergency Operating Procedures (EOP) Critical Safety Function Status Trees (CSFST). The CSFSTs are only intended to determine if an imminent threat to a critical safety function exists. The CSFSTs 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 previously submitted 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 the NRC question.

Based on these three points, time response of the temperature measurements 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.

QUESTION 2

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 TO QUESTION 2

The proposal is to use temperature measurements for gross indication of core power production, rather than the existing neutron flux instrumentation, and then only under conditions where the existing instrumentation is not qualified. There are no features unique to the Beaver Valley plant that support this position. The studies referenced in Item 2 of the response to Question No. 1 support the use of RCS temperature indication in lieu of neutron flux instrumentation under harsh environmental conditions at any PWR.

QUESTION 3

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-I.

RESPONSE TO QUESTION 3

As described in the response to the first question, the WOG emergency response guidelines for use of CSFSTs, and consequently the Beaver Valley EOPs, only implement safety function restoration procedures if a continuous challenge to that function exists. This implies the need to monitor 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. Only a gross indication of core power is required which would be evidenced by an RCS temperature increase. Additionally, the shutdown margin is verified by the operators monitoring the boron concentration in the containment sump or, as applicable, the RCS and confirming it to be above the minimum shutdown value.

QUESTION 4

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. In view of these recommendations, 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 TO QUESTION 4

As indicated in the response to Question No. 2, the existing neutron flux instrumentation will be used for all events which do not generate an adverse containment environment.

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 EOPs 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 such that a release of radioactive materials to the environment could occur. This only requires a gross indication of core power. The proposed temperature indication is more than adequate for this purpose, and is less likely than excore neutron flux instrumentation to provide ambiguous and misleading information to the operator under the conditions described in this question.

QUESTION 5

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. How does this curve account for the range of beyond Design Basis Accident (DBA) core conditions.

RESPONSE TO QUESTION 5

Environmental qualification of equipment for beyond design basis accidents is beyond the scope of NUREG-0737 requirements. For events beyond design basis but addressed by the EOPs, the EOPs are designed to prevent core damage and/or melting. The EOPs currently use boron values corresponding to minimum shutdown margin for time in core life. These boron concentration curves are utilized throughout the EOPs, including functional restoration procedures (FRPs). It is expected that the required subcritical boron concentrations are adequate for any conceivable post accident core configuration.

QUESTION 6

What are the qualified temperature limits of the plant core exit thermocouples and hot and cold leg temperature measurements? How will criticality be determined when the plant is outside these limits?

RESPONSE TO QUESTION 6

The qualified limits for the core exit thermocouples are 32 to 2300°F; the hot and cold leg temperature measurements indicate a range of 0 to 700°F. These limits are consistent with the NRC approved Environmental Qualification Program. These ranges: a) are sufficient to determine core criticality for all conditions where core criticality is a concern, b) are consistent with EOP utilization of these instruments, and c) are consistent with Regulatory Guide 1.97 (Revision 2) guidance for these instruments. A temperature in excess of the 700°F value indicates that either decay heat removal has been lost, or that the reactor is not subcritical. (Refer to Question 11, and to Section 4 of our submittal report.) With the exit thermocouples indicating a temperature in excess of 2300°F, the core void fraction would be such that core criticality most likely could not be achieved even with the control rods completely withdrawn.

QUESTION 7

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 TO QUESTION 7

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 EOPs and are periodically monitored by operators, as well as reported on the Safety Panel Display System (SPDS). EOP instructions will direct the operator to the correct CSFST based on the environmental conditions in containment. This is consistent with other EOPs where direction is given on the use of post-accident instrumentation based on whether normal or harsh conditions exist in containment. Instruments used to complete the EOPs are qualified to the necessary criteria.

QUESTION 8

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 TO QUESTION 8

No special interpretations of the WOG ERGs have been made. The EOPs instruct the operator to use RCS temperature indication in lieu of excore neutron flux indication under harsh environmental conditions. As detailed in Section 4.2 of our submittal report, the plant remains within the technical basis of the ERG guidelines, and differences are fully consistent with the EOP diagnosis and mitigative strategies.

QUESTION 9

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 TO QUESTION 9

The design basis events evaluated in Section 3.1 of our submittal report and the beyond design basis, but within EOPs, events evaluated in Section 3.2 are the events which result in harsh containment environmental conditions, i.e., the events in which RCS temperature indications would be used in lieu of excore neutron flux instrumentation. The intent of Section 3.2 of the submittal report is to demonstrate that should certain design basis events degrade due to multiple equipment failures (i.e., beyond the design basis of the plant) and produce harsh containment conditions, proper EOP guidance would be provided by use of the temperature monitoring instrumentation. For those other design basis events which degrade but do not produce harsh conditions, the existing neutron flux instrumentation would be used. Other beyond design basis events that fall below the probability threshold of the ERGs are outside the guidance of Regulatory Guide 1.97, the requirements of Supplement 1 to NUREG-0737, and the scope of these submittals.

QUESTION 10

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 measurement should be made with a flux detector which spans the range from $1x10^{-8}$ to $1x10^{-3}$ 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 water level is measured to be above the hot leg, and the neutron flux provides a proportional indication of the core neutron flux.

RESPONSE TO QUESTION 10

Our plant is not designed nor committed to ANSI/ANS-4.5 (or Regulatory Guide 1.97 Revision 3); however, ANSI/ANS-4.5 "...specifically does not preclude use of other variables or combinations of variables." Qualification criteria for instrumentation is established based on the safety function of the system whose variable qualification category is based upon whether monitoring of system parameters is needed during and following an accident and whether subsequent operator actions are dependent on the information provided by this instrumentation. The DLC report, dated May 1991, analyzes event scenarios to determine the consequences of neutron flux monitoring unavailability and concludes that the failure of this instrumentation will not prevent the operator from determining whether mitigative action is required. As described in

RESPONSE TO QUESTION 10 (Continued)

the responses to Questions No. 1 and No. 4, we believe that the alternate parameter indications (RCS temperature) provide a better alternative than excore neutron flux instrumentation for monitoring the EOP CSFSTs for criticality during accidents which produce harsh containment conditions. This is consistent with the stated qualification criteria as subsequent operator action is dependent on RCS temperatures or boron concentration. This is discussed in our submittal report in Section 4.

QUESTION 11

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 TO QUESTION 11

The temperature value (700°F) 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 functional restoration procedures (FRPs) when responding to a challenge to core subcriticality.