Department of Energy
Washington, D.C. 20545

Docket No. 50-537
HQ:S:82:043

JUN 08 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Check:

RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION

Reference: Letters, P. S. Check to J. R. Longenecker, "CRBRP Request for Additional Information," dated March 23 and April 9, 1982

This letter formally responds to your request for additional information contained in the referenced letter.

Enclosed are responses to Questions CS 421.7 and CS 491.7. These responses will also be incorporated into the PSAR Amendment 69, scheduled for submittal in June.

Sincerely,

John R. Longenecker

John R. Longenecker
Acting Director, Office of the
Clinch River Breeder Reactor
Plant Project
Office of Nuclear Energy

Enclosures

cc: Service List
Standard Distribution
Licensing Distribution

D001

Question CS421.7

Various instrumentation and control system circuits in the plant (including the reactor protection system, engineered safety features actuation system, instrument power supply distribution system) rely on certain devices to provide electrical isolation (PSAR 7.2.2) capability in order to maintain the independence between redundant safety circuits and between safety circuits and non-safety circuits. Therefore, provide the following information:

a) Identify the types of isolation devices which define the Class 1E boundary for interfaces between the safety circuits and non-safety circuits.

b) Provide the acceptance criteria for each isolation device identified in response to part a above.

c) Describe the type of testing that will be conducted on the isolation devices to ensure adequate protection against EMI (i.e., noise), short-circuit failures, voltage faults, and/or surges.

Response

I. NSSS

Within the NSSS, Class 1E isolation devices are applied to the interconnections of Class 1E and non-Class 1E circuits, and to Class 1E logic circuits of redundant divisions. For devices isolating instrument signals, the normal operating level on the isolated output side is < 50 volts (AC or DC) with signal levels in the milliampere range. For control signals, the normal operating level on the isolated output side is 120 VAC/125 VDC. Isolation devices are applied as follows:

A. LED - Phototransistor Pairs

(a) These devices are used to isolate Class 1E low energy instrument level signals.

(b) The acceptance criteria is for the isolation device to withstand 1250 VAC (RMS) for 1 minute without damage and to provide $10^{10}$ ohms isolation resistance.

(c) Type testing is conducted in an as-installed configuration by applying 1250 VAC (RMS) for 1 minute across the isolation barrier with the unit at maximum temperature and humidity. This is followed by a megger check for isolation resistance.

B. Transformer/LED - Phototransistor Pairs

(a) These devices are used to isolate the Class 1E instrument level analog input signals from the analog output signals used in non-1E systems (control, indication).

(b) The buffers meet the isolation acceptance criteria of Part E of this response.

(c) Type testing is performed with 250 VAC (RMS) and ± 170 VDC accident potentials.

(d) In addition, the isolation barrier is tested to 1250 VAC for one minute with acceptance based upon no arcing or damage.

C. Relays

(a) Relays are used to provide isolation between redundant channel outputs from the Reactor Shutdown System for channel inputs to the heat transport system pump trip logic and for Class 1E/non-1E isolation of channel trip indications to the annunciator and computer. Inputs may be control level or instrument level signals.

(b) For relays operating at control signal levels, the relay must withstand 1250 VAC coil to contact for one minute without arcing/damage. For instrument signal levels, relays must withstand 500 VAC coil to contact, and contact to contact, for one minute without arcing or damage.

(c) Type testing is performed by applying the appropriate voltage from (b) across the isolation barrier with no arcing or damage. This is followed be a megger check for isolation resistance.

D. Isolation Transformers on AC Power Inputs

(a) Isolation transformers with Faraday shields are required.

(b) Power supplies must be capable of withstanding a ± 20% voltage transient (surge) and a ± 10% frequency transient with respect to design center values without damaging the loads connected to it. Loads must be capable of normal on-off cycling of the power supply without damage.

(c) Equipment is checked for proper operation with a ± 10% voltage and ± 5% frequency variation of the power supply input.

E. Acceptance Criteria for Buffers

Electronic buffers are functionally specified which will not require recalibration or adjustments of any nature after being subjected to the following:

1. Short circuit of the buffer output and short to ground of the buffer output.

2. Open circuit of the buffer output.

3. Application of 250 VAC 60 Hz from either output connection or power supply connection to chassis ground.

4. Application of 170 VDC of either polarity from either input connection or output connection or power supply connection to chassis ground.

5. Application of 250 VAC 60 Hz from either output connection to either input connection.

6. Application of 170 VDC of either polarity from either output connection to either input connection.

7. Application of 250 VAC 60 Hz directly across the output connections.

8. Application of 170 VDC of either polarity directly across the output connections.

9. AC common mode interference shall not exceed ± 0.02% of span per volt when supplied from a 60 Hz source. DC common mode interference shall not change calibration by more than ± 0.01% of span per volt.

10. Calibration change due to normal mode interference from a 60 Hz source equal to ten times input span of no more than ± 0.1% of output span.

11. The peak to peak noise and ripple together shall not exceed 0.1% of output span when measured at the output of the buffer. Input noise feedback from the buffer into the PPS input signal shall be less than 0.01% of input span.

12. Insulation resistance shall not be less than 20 megohms at 24°C (75°F) and 500 volts, when measured on the completed assembly. In addition the reliability, maintainability, design life, and fail safe features shall be analyzed by the Supplier and included in the supplied documentation.

II. BOP

For BOP systems either opto. isolators or relays are used for isolation. The acceptance criteria and type of testing used for BOP Class 1E isolators are:

a) The acceptance criteria is to withstand 1250VAC (RMS) and 1250VDC for one minute without damage and to provide a minimum of $10^9$ ohms isolation resistance.

b) Type testing is conducted in an as-installed configuration by applying the voltages specified in 3(b) above, for one minute across the isolation barrier with the unit at maximum temperature and humidity. This is followed by a megger check across the barrier for isolation resistance. All systems inputs and outputs are tested for Surge Withstand Capability per IEEE 472.

Question CS491.7 (4.3.2.1)

The Source Range Flux Monitoring (SRFM) System is described in Section 4.3.2.1.5. The applicant is requested to provide the minimum acceptable neutron flux at the detector, the maximum acceptable gamma-ray dose at the detector, and the calculated neutron flux and gamma-ray dose rate at the detector. Also, provide a description (method, models, etc.) of how these calculations were made.

In this same section it is indicated that SRFM detector operating character will be experimentally verified in ZPPR critical experiments which will mockup the actual CRBR installation as close as practical. In addition, transport calculations will be employed to account for neutron scattering effects in the cavity which cannot be mocked up in the ZPPR. Please respond to the following:

(1) Describe the transport calculations (method, models, etc.) to be performed.

(2) What plans are being made to verify that the planned ZPPR experiment is an accurate test of the SRFM detectors for the actual CRBR?

(3) Are transport calculations being planned to determine the radiation environment at the SRFM detectors for the actual CRBR configuration as well as the ZPPR configuration. If no, describe these planned calculations; e.g., method, models, etc.

Response

The minimum acceptable neutron flux at the SRFM detectors can be established in terms of the electronic noise and gamma background in the detector and its associated signal processing equipment. This noise level is expected to correspond to only about 1 count per second. Thus, neutron signals from fuel in the reactor core at the same level, i.e., approximately 1 cps, should be distinguishable from this background noise. At the SRFM detector, 1 cps corresponds to 0.025 nv based on a minimum detector sensitivity of 40 cps/nv. The minimum acceptable gamma-ray dose at the detector is 100 R/hr to assure that the sensitivity of the $BF_2$ counters is not adversely affected.

The neutron flux at the SRFM location (beginning-of-life conditions with a fully loaded core of fresh [low inherent source] fuel and blanket assemblies and all control rods fully inserted) has been calculated to be 0.6 nv, which corresponds to 24 cps at each of the three SRFM detectors. Calculations have also shown that the local gamma-ray dose rate never exceeds 84 R/hr at the detectors within the SRFM block. This calculation was performed for the reactor conditions existing immediately following shutdown of CRBRP including the affect of maximum burnup on all the fuel and blanket assemblies and a 30 year life of the plant.

The prediction of the minimum neutron flux at the SRFM detectors is calculated using multigroup two-dimensional discrete ordinates transport methods (DOTIIIW) for the fully shutdown beginning-of-cycle reactor core. The analysis model used includes the reactor core configuration (fuel, inner blanket, radial blanket, and radial shielding assemblies), fixed radial

shield, core support structure, upper internals/sodium pool, reactor vessel, guard vessel, an annular SRFM moderator/shielding assembly, and reactor cavity wall. The R-Z model of the reactor system in the reactor cavity models the geometrical configuration of the CRBR design including the radial position of the SRFM detector relative to the reactor core centerline. Multigroup angular dependent neutron fluxes at the outer surface of the guard vessel at the reactor core/SRFM detector midplane are used in discrete ordinates transport calculations (annular or R-O) to correct the predicted value in the R-Z model to the actual CRBR configuration. All design calculations are performed in forty-two (42) energy groups using a Po (transport corrected) cross-section library derived from ENDF/B-IV.

Calculation of the gamma-ray dose rate at the SRFM detector well is performed using two-dimensional (R-Z and R-O) models of the reactor system and SRFM configuration. Thirteen energy group discrete ordinates transport analysis of the gamma-ray dose rate following reactor shutdown have been performed using the gamma-ray sources due to neutron activation of 1) the sodium primary coolant within the reactor vessel and in the primary piping in the reactor cavity, 2) the reactor vessel and guard vessel materials, 3) the SRFM moderator/shielding assembly, and 4) the detector thimble and detector assembly. The neutron activation source calculations include the trace impurity levels of elements in materials which contribute to the SRFM gamma environment following shutdown after 30 years of operation.

Transport calculations to account for neutron scattering effects in the cavity have been completed. The DOTIV discrete ordinates transport computer code was used with an R-O geometry model. An $S_6$ angular quadrature was used with a 51 energy group neutron cross-section library and a $P_3$ scattering approximation. The primary result of this analysis was that less than 20% of the SRFM count rate is due to neutron back scatter from the cavity wall and neutron streaming into the SRFM assembly.

The experimental verification of the SRFM detector operating characteristics has been completed in the ZPPR critical experimental program. That program had the following objectives: (1) to demonstrate the validity (similitude) of the ZPPR mockup to CRBRP and (2) the interpretability of the SRFM signal in both the initial load-to-critical phase and in the fully loaded phase. The ZPPR Engineering Mockup Critical experiment mocked up the entire CRBRP core out through the second row of removable radial shield assemblies and a 90 degree sector mockup out through one SRFM graphite moderator block. These experiments have been analyzed by ORNL and the results compared with CRBRP. The same nuclear cross-section data set was employed and the analytical methods were as similar as practical (2-D discrete ordinates transport methods in XY geometry for ZPPR and R-O geometry for CRBRP). The required similitude and interpretability of the ZPPR mockup has been demonstrated. These analyses are currently documented by ORNL and will be subsequently issued.

Calculations of the radiation environment in the ZPPR critical experiment mockup have been performed. The calculation-to-experiment comparison for the radial flux distribution was very good. The C/E factors varied from approximately 1.06 at the inner edge of the removable radial shield assemblies to approximately 0.80 at the SRFM detector location in the mockup of the graphite moderator block.

Transport calculations of the radiation environment at the SRFM detectors for the actual CRBR configuration have been completed. The actual design analysis is described in the response to the first part of this question.