TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

September 19, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority)

Please refer to J. W. Hufham's letter to you dated February 25, 1985 and the supplemental information provided in my letter to you dated March 21, 1985 concerning our response to NUREG-0737, Item II.F.2. The enclosed response supersedes these previous responses and was required because of problems encountered in qualification testing of the incore thermocouples.

Appendix A referenced in the enclosure is not included with this response but was previously provided with the NUREG-0737 Item II.F.2 response from L. M. Mills to you dated August 12, 1982.

To expedite review, revisions to our currently docketed position are denoted with revision bars.

If there are any questions, please get in touch with K. P. Parr at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

J. A. Domer

J. A. Domer, Chief
Nuclear Licensing Branch

Sworn to and subscribed before me
this 19th day of Sept. 1985

Bryant M. Lowery
Notary Public

My Commission Expires 4/8/86

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attention: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

A002
1/1

ENCLOSURE
WATTS BAR NUCLEAR PLANT UNIT 1
NUREG-0737, ITEM II.F.2
INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE-COOLING

TVA Response (Revised August 30, 1985)

1. Description of Proposed Final System Design

a. Additional Instrumentation

1a-1. Reactor Vessel Level Instrumentation System (RVLIS)

The RVLIS is described in Appendix A of this response. This information was previously submitted to the NRC on the Sequoyah Nuclear Plant (SQN) docket by L.!M.!Mills' letter to A.!Schwencer dated January 2, 1981 (A27 810102 017). The attached RVLIS report reflects the initial system design for Watts Bar Nuclear Plant (WBN). It should be noted that this information is proprietary to Westinghouse Electric Corporation, and the application for withholding this information from public disclosure (CAW-80-77) is also included in Appendix A.

The RVLIS has been installed and will be preoperationally tested during initial criticality. The instrument racks have been installed in the auxiliary instrument room and the displays are in place in the main control room. The sensors and sense lines have been installed and the system will be scaled, calibrated, and tested during initial criticality.

1a-2. PAM I and II Display for Core Exit Thermocouple (CET) Temperature Readout Including Subcooling Margin

A qualified display device to provide postaccident monitoring (PAM) I and PAM II indication CET temperature readout will be installed in the main control room before startup following the first refueling outage. Each display device will have the capability for selectively reading a minimum of eight operable thermocouples, two from each quadrant. The range will extend from 200°F to 2300°F.

The types and locations of displays and alarms will be determined by performing a human-factors analysis taking into consideration:

A. The use of this information by an operator during both normal and abnormal plant conditions.

B. Integration into emergency procedures.

C. Integration into operator training.

D. Other alarms during emergency and need for prioritization of alarms.

In addition, this display will provide a backup means of obtaining reactor coolant subcooling margin. The display will provide direct and continuous recording of CET temperature and, on demand, subcooling margin information consistent with the reading provided by the primary system (see Section 1.b-2 for primary system). The primary and backup displays will be separated to meet the intent of Regulatory Guide 1.75 by startup following the first refueling outage.

b. Existing Instrumentation

1b-1. Core Exit Thermocouples

The WBN core exit thermocouples (T/Cs) are located at the core exit for each quadrant and, in conjunction with core inlet RTD data, are sufficient to provide indication of radial distribution of the coolant enthalpy rise across representative sections of the core. Sixteen (four per quadrant) of the core exit T/Cs will be designated as PAM sensors. Eight (two per quadrant) will be designated as PAM II by start up following the first refueling outage.

The primary operator display for the core exit T/Cs is a computer-driven printer. This system has the following capabilities:

1. A spatially oriented core map is available on demand which indicates the temperature at each core exit T/C location.

2. An example of the WBN selection readings is an on-demand tabular listing of all instantaneous core exit T/C values.

3. A printout of average, instantaneous, and maximum values is provided for all T/C temperatures. The range will meet the required range of 200°F to 2300°F.

4. Trend capability showing temperature time histories is designed into the system. Strip chart recorder points are available to assign to any core exit T/C on demand. In addition, a point value trend printout is available on the control room printer.

5. Alarm capability is provided in conjunction with the subcooling monitor function (see Section 1b-2).

6. The control room displays are designed for rapid operator access and ease of viewing data. Also, the core exit program has a validity-check comparison which reduces the probability of accessing false readings.

Until installation and implementation of the qualified PAM I and II CET temperature display device (see section 1a-2) the existing backup analog readout is available as a backup means of obtaining CET temperature. The backup analog readout is provided with the capability of selective reading of any T/C in the system. The present range (0 to 700°F) of this system will be extended to 0 to 2000°F. This modification will be made before exceeding 5-percent power operation.

Since the existing display requires a heated reference junction box, the installation of the new qualified junction boxes (see Section 1c-1 item 4) will not provide this display with an input that is temperature compensated. Therefore, until this display is replaced (see Section 1a-2) it will be tagged to alert the main control operators that its reading is not temperature compensated. Instructions are available for the operator to obtain compensated data. The process consists of reading the reference junction temperature from junction box RTDs with a voltmeter and correcting the incore T/C reading. Technicians have been trained on the use of this procedure.

1b-2. Primary Coolant Saturation Monitoring

The plant process computer is utilized to continuously monitor pressure and temperature margins-to-saturation of the primary coolant system, and to give early warning when any of these margins reaches preset limits.

Saturation pressures, saturation temperatures, and their associated margins-to-saturation are calculated based on the following primary system inputs:

1. System pressure (lowest wide-range).
2. Hot-leg temperature (hottest).
3. Average incore T/C temperature.
4. Hottest incore T/C temperature.

A single pressure input is used in the calculations. It is selected from the lowest of the two wide-range pressures. The hottest wide-range loop temperature is selected from the four hot-leg inputs on the basis of availability and reliability.

Average core exit temperature and hottest core exit temperature are calculated by a standard Westinghouse program. This program uses temperature values for any T/C that is reliable, in scan, in limit check, and not in alarm (low limit alarm based on average cold leg temperature). If a T/C is giving an erratic signal, the operator can remove it from scan. This will cause the computer to reject that reading.

A single control board annunciator is actuated by the computer when any of the three temperature inputs being correlated with the lowest reactor coolant system (RCS) pressurizer pressure input is found to be below the set points for either temperature or pressure margin-to-saturation. The relationship for the calculated saturation margin is shown below:

T^1 = Hottest hot leg temperature
T^2 = Average core exit T/C temperature
T^3 = Hottest core exit T/C temperature
P^{SYS} = Lowest wide-range system pressure
T^{SAT} = Saturation temperature for existing P^{SYS}

T^{SAT} = Saturation pressure for any existing T^1 T^2, or T^3
T^{MAR} = Temperature margin to saturation
P^{MAR} = Pressure margin to saturation

$T^{SAT} - T^1 = T^{MAR\ 1}$ Annunciate if $T^{MAR\ 1}$ is less than 15,F

$T^{SAT} - T^2 = T^{MAR\ 2}$ Annunciate if $T^{MAR\ 2}$ is less than 15,F

$T^{SAT} - T^3 = T^{MAR\ 3}$ Annunciate if $T^{MAR\ 3}$ is less than 15,F

$P^{SAT\ 1} - P^{SYS} = P^{MAR\ 1}$ Annunciate if $P^{MAR\ 1}$ is less than 200 lb/in^2

$P^{SAT\ 2} - P^{SYS} = P^{MAR\ 2}$ Annunciate if $P^{MAR\ 2}$ is less than 200 lb/in^2

$P^{SAT\ 3} - P^{SYS} = P^{MAR\ 3}$ Annunciate if $P^{MAR\ 3}$ is less than 200 lb/in^2

When any temperature or pressure margin-to-saturation is found to be below its associated set point, the control board annunciator is actuated and will not clear until all margins have returned to values above the set points. TVA has surveillance instructions in place to periodically verify that annunciator actuation is operating properly.

In addition, a single saturation temperature meter (STM) has been installed which will provide an additional backup means of obtaining reactor coolant subcooling margin (see Section 1c-10 for upgrade of the STM). The STM is simply a dual-scale RCS pressure indicator with a saturation temperature vertical scale added to show the corresponding saturation temperature. RCS pressure (0-3000 lb/in^2 g) will be indicated on one scale and corresponding saturation temperature (212°F to 695°F nonlinear) will be indicated on the other scale so that the operator can easily correlate RCS pressure to its corresponding saturation temperature. The operator can then read the actual RCS hot-leg temperature and by simple subtraction determine the subcooling margin. The RCS hot-leg temperature indicators and the STM will be sufficiently human engineered to preclude confusion of the saturation temperature indication with the actual RCS hot-leg temperature. Individual RCS pressure and

hot-leg temperature measurements are recorded on strip chart recorders; therefore, a continuous trend of subcooling margin to saturation could be manually calculated if required.

c. Modifications to Existing Instrumentation

1c-1. Core Exit Thermocouples

TVA is proceeding with an upgrade for the incore T/C system. This upgrade consists of the following:

1. Interim Modifications

Westinghouse has been performing environmental qualification tests on the various components of the safety grade core exit T/C system as part of their IEEE 323-1974 qualification program described in WCAP 8587. These components include the T/Cs, connectors, potting adaptors, splices and the reference junction box. Evaluation of test results obtained through early May of 1985 indicate that the T/C signal will be maintained although some errors could be experienced in the system during and following a postulated high-energy line break (HELB). The T/Cs have satisfactorily completed the qualification program. The recent testing on connectors,

splices, etc., have led to a potential total system error that exceeds the allowance for certain functions in the Emergency Response Guidelines that are the basis for the plant specific emergency procedures implementation.

As an interim measure, TVA is following the recommendations proposed by Westinghouse. These recommendations are as follows:

a. Core Exit T/Cs - For inadequate core cooling situations, the operator's two primary decision points are currently at core exit temperature greater than 1200°F and core exit temperature greater than 700°F. An inaccuracy of up to 200°F is acceptable for the 1200°F decision point. However, the 700°F point is allocated a temperature uncertainty of only 30°F. To ensure that the core exit temperature is indeed in the superheat region prior to entering any inadequate core cooling (ICC) mitigation guidelines, the operators will be instructed to take action at 900°F rather than 700°F.

b. Saturation Margin Calculation - As described in section 1b-2, saturation margin is calculated with hottest hot-leg temperature, average incore T/C temperature, and hottest incore T/C temperature. During adverse containment conditions (HELB) the operators will be instructed to rely on the margin calculated by hottest hot-leg temperature.

Westinghouse is currently involved in defining component accuracies through additional tests and analysis. Until Westinghouse completes this effort, the backup core exit temperature meter and the MCR recorder associated with saturation margin will be tagged with a statement to the effect that unacceptable accuracies may be present under adverse containment conditions.

2. All T/C cable and connectors have been replaced with T/C cable and connectors which are qualified as described in equipment qualification sheet (EQS) No. WBN-NEB-94-48, revision 4.

3. Thirty-two of the 65 T/C cables and the associated RTD cables will be rerouted to provide adequate separation between PAM I and PAM II T/C cable before startup following the first refueling outage.

4. The reference junction boxes have been replaced and the boxes installed are qualified as described in EQS No. WBN-NEB-94-48, revision 4.

5. Cable splices necessitated by the replacement of the reference junction boxes are being qualified. Refer to EQS No. WBN-NEB-94-48, revision 4, for the justification for interim operation (JIO) for these splices.

6. The original T/Cs were replaced with new T/Cs in order to eliminate the old T/C connector which could not be qualified. The new T/Cs are qualified as described in EQS No. WBN-NEB-94-48, revision 4.

7. Conformance to NUREG-0737, Appendix B is shown in Table 1c-1.

8. An evaluation of the partial core exit T/C upgrade which will be implemented before fuel loading is included as Appendix B. We conclude that it is safe to operate WBN with the core exit T/C upgrade in the interim stage of completion until final modifications can be implemented.

2. Apppendix A and its references contain the necessary design analysis to support the RVLIS design described in section 1a-1 above.

3. The RVLIS will be preoperationally tested to verify proper installation, calibration, and scaling. Data will be collected before criticality for verification of the functions provided in the compensation electronics. The wide-range indicators will also be marked at their appropriate percentages according to the number of reactor coolant pumps in service. Also, this test will familiarize the Operations staff with the functions provided in the RVLIS.

   The incore T/C system will be preoperationally retested to verify proper installation and calibration before initial criticality.

Due to the simplicity of the STM, we feel no additional testing of this plant feature will be required.

4. Conformance of RVLIS to Regulatory Guide 1.97, Revision 2, Category 1, requirements is shown in Appendix A Table 4.1.

   Conformance of the STM to Regulatory Guide 1.97, Revision 2, Category 1 requirements can be shown by noting that the analog signal used to derive the STM is the RCS wide-range pressure signal. We consider the RCS wide-range pressure a Category 1 variable as defined by Regulatory Guide 1.97, Revision 2, and the design of its display will meet the Category 1 requirements of Regulatory Guide 1.97, Revision 2.

   The Primary Coolant Saturation Monitoring Computer Program's input will conform to the Category 1 requirement of Regulatory Guide 1.97, Revision 2 up to the first isolation device by first refueling outage.

   The upgraded core exit T/C system (see Section 1b-1 and 1c-1) will conform to the requirements of attachment 1 of NUREG-0737 item II.F.2 before startup following the first refueling outage.

   It should be noted that the status of the first item of table 4.1, seismic qualification, has recently changed. Westinghouse has notified TVA that printed circuit cards in the RVLIS cabinets experience an unacceptably large calibration shift under postulated safe shutdown earthquake conditions. As such, the RVLIS system is not presently considered to be seismically qualified. The evaluation related to this and determination of necessary corrective actions are being handled under Significant Condition Report WBNNEB8508 revision 1. TVA will implement corrective actions prior to initial criticality.

5. The plant computer at WBN is a P-2500 system supplied by Westinghouse. The computer's function in ICC monitoring is to provide a primary display for the core exit T/C system, calculate a margin-to-saturation as described in section 1b-2, and display the margin-to-saturation calculations. The most recent informal availability numbers gathered by WBN site maintenance personnel for the P-2500 computer imply an availability of 99.84 percent for unit 1 and 99.77 percent for unit 2. This is for a period extending from May 1984 to April 1985.

6. All ICC monitors (except as noted for incore T/C upgrade, item 1c-1) for WBN will be operational before initial criticality of each unit.

7. TVA is an active member of the Westinghouse Owners Group (WOG) Procedures Subcommittee. The Emergency Response Guideline (ERG) Program has been under development since early 1981. The upper head injection (UHI)/ice condenser ERGs based on revision 1 of the WOG ERG's, from which plant specific emergency operation procedures (EOP) can be implemented, were received by TVA in July 1984. The upgraded EOP's will be implemented, including completion of validation and training, before startup following the first refueling outage on WBN unit 1.

The operators have been trained on the design of the RVLIS. First cycle operation will be used for familiarizing the operations staff with the response of RVLIS. RVLIS will be used with prudence, in accordance with NRC Generic Letter 82-28, during this period of time. RVLIS will be operational and capable of providing information for use, with prudence, by the operators.

8. The present emergency procedures tell the operator that ICC exists if:

   Incore T/Cs exhibit readings equal to or greater than 900°F.

   These procedures will be modified following the same procedure with the WOG as in 7 above before startup following the first refueling outage on WBN unit 1.

9. The documentation discussed in item 7 above will be provided to the NRC by the WOG.

10. TVA has recently decided to change out the RCS wide-range pressure transmitter for more accurate instrumentation. The transmitters will also be relocated to a milder environment. This upgrade will be completed by initial criticality.

Table 1c-1

Item	STM	RVLIS	CORE EXIT T/C
1. Environment Qualification	YES	YES	YES (note 1,8)
2. Single Failure Analysis	NO (note 7)	YES	YES (note 2)
3. Class 1E Power Source	YES	YES	YES (note 3)
4. Availability Prior to an Accident	YES	YES	YES
5. Quality Assurance	YES (note 4)	YES (note 4)	YES (note 4)
6. Continuous Indications	YES	YES	YES
7. Recording of Instrument Outputs	YES (note 9)	YES	YES
8. Identification of Instruments	YES	YES	YES
9. Isolation	YES	YES	YES (note 5)
10. Checking for Operational Availability	YES	YES	YES
11. Servicing, Testing, and Calibrating	YES	YES	YES
12. Administrative Control for Removing Channels	YES	YES (note 6)	YES
13. Administrative Control of Access	YES	YES	YES
14. Anomalous Indication Minimization	YES	YES	YES
15. Malfunctioning Components Recognition	YES	YES	YES
16. Monitoring Instrumentation Usage	YES	YES	YES
17. Normal and Accident Instrument Usage	YES	YES	YES
18. Periodic Testing Requirements	YES	YES	YES

Notes:

1. The existing backup indicator (not qualified) will be replaced with a qualified indicator before startup following the first refueling outage. The inside-containment portion of the CET system is qualified for interim operation as described in EQS WBN-NEB-94-48, revision 4.

2. The single failure criterion will be met for the core exit T/Cs by startup following first refueling outage at which time the power source upgrade (note 3), isolation improvements (note 5), environmental qualification (note 1), and physical separation (response item 1.c-1) will have been implemented.

3. The power supply for the existing backup indicator and the plant computer is not class 1E. The power supply for the new backup indicator (see note 1) will be class 1E.

4. TVA's quality assurance program is described in the topical report TVA-TR75-1, revision 5. This program was approved in Walter P. Haas' letter to L. M. Mills dated July 6, 1982 (A27 840708 012).

5. The existing backup indicator does not meet the isolation requirements of this item. This indicator will be replaced with a qualified indicator that does meet this requirement by startup following the first refueling outage.

6. The design facilitates administrative control of the access to ICC instrumentation with one exception. The RVLIS hydraulic isolators are not located within an administratively controlled area.

7. Only one channel available.

8. Core exit T/C components have completed qualification testing and have exhibited inaccuracies beyond certain allowable limits. See section 1C-1 and EQS WBN-NEB-94-48 Rev. 4.

9. Recording of saturation margin is available through assignable pen recorders driven by the plant computer.

APPENDIX B
JUSTIFICATION FOR OPERATION OF THE INCORE THERMOCOUPLE SYSTEM
DURING THE INITIAL FUEL CYCLE

All components inside containment (T/C connectors, T/C cables, reference junction boxes) will be environmentally and seismically qualified as noted in Table 1c-1. Separation requirements will be met up to and including the reference junction boxes. The reference junction boxes, the copper cables and the RTD cables will be located in the incore instrument room. All cables from the reference junction boxes will be routed from the incore instrument room to a nearby containment penetration. From the containment penetration, the T/C cables are routed to the incore instrumentation racks in the main control room and then to the computer. The RTD cables are routed directly to the computer. All cables will be routed in low-level voltage cable trays to minimize electromagnetic interference and to prevent possible damage from high-voltage shorts. There is no credible Auxiliary Building event, for which the core exit temperature indication is needed, that will also cause the loss of temperature indication.

The primary indication is supplied by a Westinghouse P-2500 computer system which uses the T/C and RTD inputs to calculate the correct core exit temperature. If, for some reason, the computer display is not available, plant personnel can read the backup T/C display directly and provide compensation through established procedures.

Therefore, based on the described qualification of equipment inside containment, the reliability of the computer and the accessibility for direct measurements outside the containment in the control room, TVA believes this interim modification represents an acceptable level of compliance with the requirements of NUREG-0737, Item II.F.2, for the initial fuel cycle of WBN unit 1.