TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

January 4, 1984

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	)	50-391

Please refer to my letters to you dated September 14 and October 29, 1981 and March 11 and August 12, 1982 and July 26, 1983 which provided our initial and revised responses to NUREG-0737, Item II.F.2 for Watts Bar Nuclear Plant.

In accordance with the October 28, 1983 telephone conference call between NRC/TVA representatives, held to discuss TVA's July 26, 1983 submittal on NUREG-0737 item II.F.2, TVA was requested to supplement its previous submittal by providing additional information addressing the following items:

(1) Provide the schedule for the installation and preoperational testing of the Reactor Vessel Level Instrumentation System (RVLIS); also provide the current status of the system's installation.

(2) Certain modifications associated with the upgrading of the Incore Thermocouple System are scheduled to be completed by startup following the first refueling outage; therefore, provide justifications to support the operation of the Incore Thermocouple System during the initial fuel cycle.

(3) TVA's July 26, 1983 submittal discussed the availability of the Watts Bar and Sequoyah Nuclear Plant computers. Describe the methods used for determining the 99.95-percent availability of the Sequoyah computer.

(4) TVA's July 26, 1983 submittal stated that the Reactor Coolant System T-hot RTDs are "pegged high" with the computer unavailable; define "pegged high."

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Director of Nuclear Reactor Regulation January 4, 1984

Enclosed is TVA's latest submittal on NUREG-0737 item II.F.2 which addresses those items. Appendix A of our August 12, 1982 submittal remains unchanged and is therefore not included in the enclosure.

Please note that items 1c-1.3 and 1c-1.4 of our previous submittal have been revised to reflect the current schedules for completion of those tasks.

If you have any questions concerning this matter, please get in touch with D. B. Ellis at FTS 858-2681.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 4th day of January 1984

Paulette H. White

Notary Public
My Commission Expires 9-5-84

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Mr. James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

ENCLOSURE

INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING

TVA Response

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 by letter from L. M. Mills to A. Schwencer dated January 2, 1982. The attached RVLIS report reflects the actual system design for Watts Bar. 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 will be installed and preoperational tested before fuel load of the respective unit. 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 will be installed by fuel loading and the system will be scaled, calibrated, and tested by initial criticality.

      1a-2. Saturation Temperature Meter (STM)

      TVA will provide a backup means of obtaining reactor coolant subcooling margin by providing a STM (see section 1b-2 for primary system). The STM is simply a dual scale reactor coolant system (RCS) pressure indicator. The STM will be implemented by adding a saturation temperature vertical scale to the existing qualified main control room RCS pressure indicator. RCS pressure (0-3000 lb/in^2 g) will be indicated on one scale and saturation temperature will be indicated on the other scale (212° F-695.5° F nonlinear) so that the operator can easily correlate RCS pressure to its corresponding saturation temperature. The operator can then use the saturation temperature in conjunction with the actual RCS hot leg temperature to calculate (simple subtraction) 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. The STM will be the backup indication to be used in conjunction with the process computer calculated display (see Section 1b-2.). Redundant STMs will be provided before fuel load.

b. Existing Instrumentation

1b-1. Core Exit Thermocouples

The Watts Bar Nuclear Plant core exit thermocouples (T/C) 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 thermocouples will be designated as Post Accident Monitoring sensors.

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 thermocouple location.

2. An example of the Watts Bar selection readings is an on-demand tabular listing of all instantaneous core exit thermocouple values.

3. A printout of average, instantaneous, and maximum values is provided for all thermocouple temperatures. The range will meet the suggested range of 200^{o} F-2300^{o} 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 thermocouple 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 which uses the average of all the thermocouple readings in the calculations (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.

A backup analog readout is provided with the capability of selective reading of any thermocouple in the system. The present range of this system is 0-700^{o} F.

Since this existing main control backup display requires a heated reference junction box, the installation of the new qualified cold reference 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 1c-1, item 5), it will be tagged to alert the main control operator that its reading is not temperature compensated and instructions will be available for the operator to obtain compensated data.

Another means of obtaining this data can be achieved by reading the raw signals (T/C and reference junction temperature output) with portable test equipment. This data is available in the control building and would be accessible under all conditions should the primary and backup display devices fail.

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 pressurizer or 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 four narrow-range pressurizer pressures when system pressure is above 1700 lb/in^2 g. The lowest of the two wide-range pressure is used below 1700 lb/in^2 g and when there are no reliable narrow-range inputs available. The hottest wide-range loop temperature is selected from the four hot leg inputs on the basis of availability and reliability also. The lowest RCS pressure and the hottest hot leg temperature are removed from scan automatically if not reliable.

Average core exit temperature and hottest core exit temperature are calculated by a standard Westinghouse program. This program uses temperature values for any thermocouple that is reliable. If a T/C is giving an unreliable signal, the operator will manually remove it from computer scan and insert a value of zero. This will cause the computer to reject that reading.

A control board annunciator is actuated by the computer when any of the three temperature inputs being correlated with the lowest RCS pressurizer pressure input is found to be below the setpoints 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 pressurizer or wide range system pressure
T^{SAT} = Saturation temperature for existing P^{SYS}

$P^{SAT\ 1,\ 2,\ 3}$ = 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 setpoint, the control board annunciator will not clear until all margins have returned to values above the setpoints. The operator can periodically test the annunciator by simply changing either of the setpoints to a value greater than a current margin value.

c. Modifications to Existing Instrumentation

1c-1. <u>Core Exit Thermocouples</u>

TVA is proceeding with an upgrade for the Incore Thermocouple (T/C) System. This upgrade will consist of the following:

1. Replacement of the existing inside containment connectors with qualified connectors for all 65 T/C cables before fuel load.

2. All existing T/C cable will be replaced with qualified T/C cable before fuel load.

3. Reroute 32 of the 65 T/C cables to provide adequate separation between PAM I and PAM II T/C cable before fuel load. Reroute the associated RTD cable before startup following the first refueling outage.

4. Replacement of the existing reference junction boxes with qualified junction boxes prior to fuel loading.

5. A qualified display device to provide PAM I and PAM II indication will be installed in the main control room prior to startup following the first refueling outage. Each display device will have the capability for selectively reading a minimum of 8 operable thermocouples, 2 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.

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

7. The primary and backup displays will be separated to meet the intent of Regulatory Guide 1.75 by startup following the first refueling outage.

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

2. Appendix 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 prior to 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 thermocouple 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 drive 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 inputs conform to the Category 1 requirements of Regulatory Guide 1.97 up to the first isolation device.

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

5. The plant computer at Watts Bar 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 thermocouple system, calculate a margin to saturation as described in section 1b-2, and display the margin to saturation calculations. No availability data on the Watts Bar computer has been submitted to TVA by Westinghouse (W) at this time, but a 2,900 hour test was performed during the fall of 1979 in cooperation with Westinghouse on the Sequoyah plant computer (P-250) which is very similar to the Watts Bar plant computer. This test was performed to determine the reliability of W P-250 computer over a 120-day period. The test began on October 22, 1979 and was completed on February 19, 1980. Completion of the test period was contingent on a minimum required operability of the P-250 computer of 2900 hours which was considered equivalent to 120 days. Before performing the test, TVA purchased all spare parts recommended by W and acquired the necessary equipment for repairing the P-250 computer. In addition, a detailed computer checkout procedure was performed to ensure that all computer functions were operating properly before test initiation. During the 2900 hours of required computer availability, the total downtime recorded was 2.83 hours. This produced a system availability of 2900 hours divided by 2900 hours plus 2.83 hours which equals an availability of 99.9 percent.

6. It is presently anticipated that all ICC monitors (except as noted for incore T/C upgrade, item 1c-1) for Watts Bar 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 from which plant specific emergency operation procedures

(EOPs) can be written will not be available before September 1983 and possibly may be delayed until 1984. The upgraded EOPs will be implemented, including completion of validation and training, prior to startup following the first refueling outage on Watts Bar Unit 1 assuming any required UHI/ice condenser reanalysis is completed and the NRC's SER for WOG generic ERGs (revision 1) is issued at least 12 months before this date. (Ref: L. M. Mills letter to E. Adensam of NRC dated April 15, 1983.)

8. The present Emergency Operating Instructions (EOIs) tell the operator that inadequate core cooling (ICC) exists if any one of three conditions exist:

   A. Five of more Incore T/Cs exhibit readings equal to or greater than 1200°F with computer available.

   B. The reactor coolant system (RCS) T-hot RTDs are pegged high (i.e., offscale high) with computer unavailable.

   C. Five or more Incore T/Cs are off-scale above 700°F with computer unavailable.

   These EOIs will be modified following the same procedure with the WOG as in 7 above prior to startup following the first refueling outage on Watts Bar Unit 1.

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

TABLE 1c-1

	Item	STM	RVLIS	CORE EXIT T/C
1.	Environmental Qualification	YES(note 1)	YES(note 2)	YES(note 3)
2.	Single Failure Analysis	YES	YES	YES(note 4)
3.	Class 1E Power Source	YES	YES	YES(note 5)
4.	Availability Prior to an Accident	YES	YES	YES
5.	Quality Assurance	YES(note 6)	YES(note 6)	YES(note 6)
6.	Continuous Indications	YES	YES	YES
7.	Recording of Instrument Outputs	YES	YES	YES
8.	Identification of Instruments	YES	YES	YES
9.	Isolation	YES	YES	YES(note 7)
10.	Checking for Operational Availability	YES	YES	YES
11.	Servicing, Testing, and Calibrating	YES	YES	YES
12.	Adminstrative Control for Removing Channels	YES	YES(note 8)	YES
13.	Adminstrative Control of Access	YES	YES	YES
14.	Anomalous Indication Minimization	YES	YES	YES
15.	Malfunctioning Components Recognition	YES	YES	YES
16.	Monitoring Instrumentation Inputs	YES	YES	YES
17.	Normal and Accident Instrument Usage	YES	YES	YES
18.	Periodic Testing Requirements	YES	YES	YES

Notes:

1. During TVA's NUREG-0588 review, it was found that the existing pressure transmitters for the STM may not perform within specified accuracy requirements when subjected to the post-LOCA environment. This will be resolved in accordance with 10CFR50.49.

2. During TVA's NUREG-0588 review, it was found that the pressure transmitters for the RVLIS may not be environmentally qualified when subjected to accident environments. This will be resolved in accordance with 10CFR50.49.

3. The existing backup indicator (not qualified) will be replaced with a qualified indicator prior to startup following the first refueling outage. The existing reference junction boxes (not qualified) will be replaced by startup following the first refueling outage.

4. 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 5), isolation improvements (note 7), environmental qualification (note 3), and physical separation (response item 1.c-1) will have been implemented.

5. 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 3) will be upgraded to class 1E by startup following the first refueling outage.

6. TVA's QA program is described in the topical report TVA-TR75-1, revision 5. This program was approved in a letter from Walter P. Haass to L. M. Mills dated July 6, 1982.

7. 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.

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

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. 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 where the equipment will be protected from high-energy pipe breaks. 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 exist temperature. A similar computer system at SQN has exhibited a 99.9 percent availability during a 2900 hour test. If, for some reason, the computer display is not available, plant personnel can easily access the RTD and T/C signals by disconnecting the T/C cables at the terminal board and the RTD cables at the computer and measure the millivolt output of the T/Cs with a volt meter and the RTD resistance with an ohmmeter. With this information and a calibration curve the correct core exit temperature can be obtained.

Therefore, based on the 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 Watts Bar unit 1.