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November 14, 1979

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. R. L. Baer, Chief
Light Water Reactor Project Branch No. 2

Re: McGuire Nuclear Station
Units 1 and 2
Docket Nos. 50-369, 50-370

Dear Mr. Denton:

Attached is Duke Power Company's evaluation of the conformance of the McGuire design to Reactor Systems Branch Technical Position 5-1. This is identified as item number 7 on the NRC staff's milestone chart. Please advise if you have further questions or desire additional discussion on this matter.

With regard to milestone chart item number 11, Guide Tube Wear, a meeting was held on October 12, 1979, with Duke, NRC and Westinghouse representatives to discuss the staff concerns. This item was essentially resolved in the meeting. Final documentation, consisting of responses to requests for information contained in Mr. Robert L. Baer's letter of September 11, 1979, will be submitted by December 14, 1979.

Very truly yours,

William O. Parker, Jr.

William O. Parker, Jr. By [signature]

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Attachment

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McGuire Nuclear Station

Evaluation of Compliance With NRC Branch Technical Position RSB 5-1 On Design Requirements of the Residual Heat Removal System

The following is a discussion of the means by which McGuire Nuclear Station complies with the technical requirements of BTP RSB 5-1.

1. Provide safety-grade steam generator dump valves, operators, air and power supplies which meet the single failure criterion.

   One safety-grade steam generator power operated relief valve is provided for each of the four steam generators. An air supply to the operators is available during loss of offsite power. The steam generator power operated relief valves can be operated locally to permit plant cooldown. Safety-grade remote operators and power supplies are not provided since hot standby can be achieved and maintained using the safety-grade steam generator safety valves. See the cold shutdown scenario and single failure evaluation provided below (Part II - Removal of Residual Heat).

2. Provide the capability to cooldown to cold shutdown in a reasonable amount of time assuming the most limiting single failure and loss of off-site power or show that manual actions inside or outside containment or return to hot standby until the manual actions or maintenance can be performed to correct the failure provides an acceptable alternative.

   The plant can be maintained in a safe hot standby condition while any necessary manual actions are taken. The plant is capable of being cooled via natural convection and reaching Residual Heat Removal System (RHRS) initiation conditions in a reasonable amount of time including the time required to perform any manual actions. See the cold shutdown scenario and single failure evaluation provided below (Part II - Removal of Residual Heat).

3. Provide the capability to depressurize the Reactor Coolant System with only safety-grade systems assuming a single failure and loss of off-site power or show that manual actions inside or outside containment or remaining at hot standby until manual actions or repairs are complete provides an acceptable alternative.

   The plant can be maintained in a safe hot standby condition while any required manual actions are taken. See the cold shutdown scenario and single failure evaluation provided below (Part IV - Depressurization).

4. Provide the capability for borating with only safety-grade systems assuming a single failure and loss of offsite power or show that manual actions inside or outside containment or remaining at hot standby until manual actions or repairs are completed provides an acceptable alternative.

   The plant can be maintained in a safe hot standby condition while any required manual actions are taken. See the cold shutdown scenario and single failure evaluation provided below (Part III-Boration and Makeup).

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5. Provide the system and component design features necessary for the prototype testing of both the mixing of the added borated water and the cooldown under natural circulation conditions with and without a single failure of a steam generator atmospheric dump valve. These tests and analyses will be used to obtain information on cooldown times and the corresponding AFW requirements.

   The plant design provides the capability for conducting natural circulation cooldown tests, if required. However, other Westinghouse pressurized water reactors will have conducted such tests prior to the startup of the McGuire Nuclear Station, and because of the great similarity in design between all Westinghouse pressurized water reactors, it is believed that these tests will be representative of McGuire. Duke Power Company intends to review these tests for applicability and reference them rather than conducting such tests on the McGuire Plant.

6. Commit to providing specific procedures for cooling down using natural circulation and submit a summary of these procedures.

   Specific procedures for cooling down using natural circulation will be prepared prior to the startup of the McGuire Plant. A summary of the procedures is provided in the cold shutdown scenario and single failure evaluation provided below.

7. Provide a seismic Category I AFW supply for at least 4 hours at Hot Shutdown plus cooldown to the RHR system cut-in based on the longest time (for only onsite or offsite power and assuming the worst single failure), or show that an adequate alternate seismic Category I source will be available.

   Sufficient emergency feedwater is available from the Seismic Category I Standby Nuclear Service Water Pond to permit four hours operation at hot standby plus cooldown to RHRS initiation conditions. See the cold shutdown scenario and single failure evaluation provided below (Part II-Removal of Residual Heat).

8. Provide for collection and containment of RHR pressure relief or show that adequate alternative methods of disposing of discharge are available.

   The RHR relief valves discharge to the pressurizer relief tank, located inside Containment.

COLD SHUTDOWN SCENARIO

The safe shutdown design basis for McGuire is hot standby. The plant can be maintained in a safe hot standby condition while manual actions are taken to permit achievement of cold shutdown conditions following a safe shutdown earthquake with loss of offsite power. Under such conditions the plant is capable of achieving RHRS initiation conditions (approximately 350^{o}F, 425 psia) in a reasonable amount of time, including the time required for any manual actions. To achieve and maintain cold shutdown, four key functions must be performed. These are (1) circulation of the reactor coolant, (2) removal of residual heat, (3) boration and makeup, and (4) depressurization of RCS.

I. Circulation of Reactor Coolant

Circulation of the reactor coolant has two stages in a cooldown from hot standby to cold shutdown. The first stage is from not standby to 350°F. During this stage, circulation of the reactor coolant is provided by natural circulation with the reactor core as the heat source and steam generators as the heat sink. Steam release from the steam generators is initially via the steam generator safety valves and occurs automatically as a result of turbine and reactor trip. Steam release for cooldown is via the steam generator power operated relief valves which may be operated manually. The steam generator power operated relief valves are accessible for local operation. Redundant level and pressure indication is provided in the control room for each steam generator. Power for this instrumentation is derived from the 120 VAC vital instrumentation and control power systems.

Feedwater to the steam generators is provided by the Auxiliary Feedwater System. The AFS is provided with two 100 percent capacity motor driven pumps and one 200 percent capacity turbine driven pump. Each of the motor driven pumps supplies two steam generators and the turbine driven pump supplies water to all four steam generators. A seismic Category I source of water for the AFS is available from the Standby Nuclear Service Water Pond which has more than sufficient inventory for the longest cooldown time needed with either only onsite or only offsite power available with an assumed single failure. AFS pump suction switchover to this assured source occurs automatically upon detection of low pump suction pressure. Sufficient safety-grade instrumentation will be provided in the control room to monitor AFS operation.

The second stage of reactor coolant circulation is from 350°F to cold shutdown. During this stage, circulation of the reactor coolant is provided by the RHR pumps.

II. Removal of Residual Heat

Removal of residual heat also has two stages in a cooldown from hot standby to cold shutdown. The first stage is from hot standby to 350°F.

During this stage, the steam generators act as the means of heat removal from the Reactor Coolant System (RCS). Initially, steam is released from the steam generators via the steam generator safety valves to maintain hot standby conditions. When the plant operators are ready to begin the cooldown, the steam generator power operated relief valves are opened slightly. As the cooldown proceeds, the operators will occasionally adjust these valves as required to maintain a reasonable cooldown rate. Feedwater makeup to the steam generators is provided from the Auxiliary Feedwater System. The Auxiliary Feedwater System has the ability to remove decay heat by providing feedwater to all four steam generators for extended periods of operation.

The second stage is from 350°F to cold shutdown. During this stage, the RHRS is brought into operation. The heat exchangers in the RHRS act as the means of heat removal from the RCS. In the RHR heat exchangers, the residual heat is transferred to the Component Cooling System which ultimately transfers the heat to the Nuclear Service Water Systems. The Component Cooling and the Nuclear Service Water Systems are both designed to Seismic Category I. The RHRS includes two RHR pumps and two RHR heat exchangers.

Each RHR pump is powered from a different emergency power train and each RHR heat exchanger is cooled by a different Component Cooling System loop. If any component in one RHR subsystem becomes inoperable, cooldown of the plant is not compromised; however, the time for cooldown would be extended. The status of the RHRS can be monitored using Class 1E instrumentation in the Control Room.

III. Boration and Makeup

Boration is accomplished using portions of the Chemical and Volume Control System (CVCS). Four wt % boric acid from the boric acid tanks is supplied to the suction of the centrifugal charging pumps by the boric acid transfer pumps. The centrifugal charging pumps inject the borated water into the RCS via the normal charging and/or reactor coolant pump seal injection flow paths. Two boric acid tanks are provided for the plant. They are interconnected so that either tank may be aligned to either unit. Two boric acid transfer pumps are provided for each tank. The boric acid tanks, boric acid transfer pumps, centrifugal charging pumps, and associated piping are of seismic Category I design. The boric acid transfer pumps and centrifugal charging pumps are powered from emergency power trains.

There is sufficient boric acid volume stored in each tank to provide for a cold shutdown with the most reactive rod withdrawn. Redundant boric acid tank level indication is provided in the control room.

An alternative boration source is the 12 wt % boric acid contained in the boron injection tank located in the Safety Injection System. This source can be used to supplement the boric acid tank to accomplish boration, depending on initial plant conditions. The contents of the boron injection tank can be delivered to the RCS by aligning the discharge of the centrifugal charging pumps to this tank while the suction is aligned to the boric acid tanks.

Makeup, in excess of that required for boration can be provided from the Refueling Water Storage Tank (RWST) using centrifugal charging pumps and the same injection flow paths as described for boration. Two motor operated valves, each powered from different emergency power trains and connected in parallel, would transfer the suction of the charging pumps to the RWST. RWST level can be monitored using redundant control room instrumentation which has its power derived from the 120 VAC vital instrumentation and control power system.

IV. Depressurization

Depressurization of RCS is accomplished using portions of the Chemical and Volume Control System (CVCS). Either four wt. % boric acid or refueling water may be used for depressurization with the flow path being from the centrifugal charging pumps via the auxiliary spray valve to the pressurizer. The centrifugal charging pumps of the CVCS are of Seismic Category I design and are powered from separate emergency power trains. The pumps can be operated and monitored from the control room. Redundant pressurizer level and RCS pressure indication is provided in the control room for monitoring depressurization. Power for this instrumentation is derived from the 120 VAC vital instrumentation and control power systems.

An alternative method of depressurization consists of discharging reactor coolant from the pressurizer to the pressurizer relief tank via the pressurizer power operated relief valves.

V. INSTRUMENTATION

Redundant instrumentation which has its power derived from the 120 VAC vital instrumentation and control power system is available in the Control Room to monitor key functions associated with achieving cold shutdown. This instrumentation is discussed in FSAR Section 7.5 and includes the following:

a. RCS wide range temperature

b. RCS wide range pressure

c. Pressurizer water level

d. Steam generator narrow range water level

e. Steam line pressure

f. RWST level

g. Containment pressure

This instrumentation is sufficient to monitor the key functions associated with cold shutdown and to maintain the RCS within the desired pressure, temperature and inventory relationships. Alternatively, operation of the auxiliary systems that service the RCS can be monitored by the control room operator via remote communication with an operator in the plant.

MAINTAINING RCS TEMPERATURE AND PRESSURE DURING COOLDOWN

The plant will be maintained in a hot standby condition while the operator evaluates the initial plant conditions and the availability of equipment and systems (including non-safety grade equipment) that can be used in shutdown. Prior to initiating cooldown, the operator will determine the boration requirements and the method by which the plant will be taken to cold shutdown. In performing the cooldown, the operator will integrate the functions of heat removal, boration and makeup, and depressurization in order to accomplish these functions without letdown from the RCS. Once the plant is cooled to 350°F and depressurized to 425 psia, RHRS operation will be initiated and the RCS will be taken to cold shutdown conditions.

Boration, cooldown, and depressurization will be accomplished in a series of short steps arranged to keep RCS temperature and pressure and pressurizer level in the desired relationships. However, to demonstrate that boration and depressurization can be done without letdown, a simpler scenario can be used. First the operators integrate the cooldown and boration functions taking advantage of the steam space available in the pressurizer and the RCS inventory contraction resulting from the cooldown. Then, the operators use auxiliary spray from the CVCS to depressurize the plant to RHRS initiating conditions. Finally, the RCS is cooled to cold shutdown conditions using the RHRS while makeup with borated water continues as necessary.

The calculation to demonstrate this capability assumes worst case boration requirements based on core end of life/peak xenon conditions and the following RCS initial conditions following plant trip:

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RCS Temperature	557°F
RCS Pressure	2250 psia
Pressurizer Water Volume	450 ft^3
Pressurizer Steam Volume	1350 ft^3

The cooldown from 557°F decreases the volume of water in the RCS by approximately 1610 cubic feet assuming that the pressurizer is not cooled. Makeup for contraction is supplied by 4 wt % boric acid stored in the boric acid tanks at 70°F. A boric acid tank volume of approximately 1450 cubic feet will expand to approximately 1610 cubic feet as it is heated to the RCS temperature at 350°F, thus bringing pressurizer level back to the initial condition. The volume of four wt % boric acid at 70°F required for boration to technical specification requirements at 350°F is approximately 1350 cubic feet. Thus the volume required for boration is significantly less than the volume available due to contraction.

To calculate if depressurization can be accomplished without letdown and without taking the plant water solid, it was assumed that the pressurizer was at saturated conditions with 450 cubic feet of water, 1350 cubic feet of steam, and the pressurizer metal, all at 653°F (2250 psia). It was further assumed that no additional water would be removed from the pressurizer by the cooldown contraction. With these assumptions, and including the effect of heat input from the pressurizer metal, it was determined that spraying in approximately 630 cubic feet of 70°F water would produce saturated conditions at 425 psia (450°F) with a water volume of 1250 cubic feet and steam volume of 550 cubic feet.

Once depressurized to 425 psia, RHRS operation is initiated and cooldown is continued to cold shutdown conditions. The cooldown from 350°F to 200°F further decreases the volume of water in the RCS by approximately 550 cubic feet assuming that the pressurizer is not cooled. Makeup for contraction is again supplied by 4 wt % boric acid. A boric acid tank volume of approximately 530 cubic feet will expand to approximately 550 cubic feet as it is heated to the RCS temperature of 200°F, thus bringing pressurizer level back to the initial condition. The additional volume required for boration at 200°F, to maintain the reactor within the technical specification shutdown requirements, is no more than 260 cubic feet, the operator having taken full advantage of the previous contraction. Thus, the technical specification requirements for cold shutdown conditions are satisfied.

The results of the calculations described above demonstrate that, based on the assumed initial conditions, boration and depressurization with 4 wt % boric acid can be accomplished without letdown and without taking full credit for the available volume created by the cooldown contraction. However, the operator may elect to borate using the 12 wt % boric acid contents of the boron injection tank as well as 4 wt % boric acid from the boric acid tanks. Should boration without letdown prove impractical due to any combination of plant conditions or equipment failures, letdown can be achieved by discharging RCS inventory via the pressurizer.

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SINGLE FAILURE EVALUATION

I. Circulation of the Reactor Coolant

A. From Hot Standby to 350°F (refer to FSAR Figures 5.1-1, 10.3.2-1, and 10.4.7-4) - four reactor coolant loops and four steam generators are provided, any two of which can provide sufficient natural circulation flow to provide adequate core cooling. Even with the most limiting single failure (a steam generator power operated relief valve), three of the reactor coolant loops and steam generators remain available.

B. From 350°F to cold shutdown (refer to FSAR Figure 5.5.7-1) - two RHR pumps are provided, either one of which can provide adequate circulation of the reactor coolant.

II. Removal of Residual Heat

A. From Hot Standby to 350°F (refer to FSAR Figures 10.3.2-1, 10.4.7-4, and 9 2.2-1) -

1. Steam Generator Power Operated Relief Valves - Four are provided (one per steam generator), any two of which are sufficient for residual heat removal. In the event of a single failure, three power operated relief valves remain available.

2. Auxiliary Feedwater Pumps - Two motor driven pumps and one steam driven pump are provided. In the event of a single failure, two pumps remain available to provide sufficient feedwater flow.

3. Flow Control Valves - Air operated, fail open valves are provided. In the event of a single failure of one flow control valve (which affects flow to one steam generator from either a motor driven pump or the steam driven pump) emergency feed flow can still be provided to all four steam generators from the other pumps.

4. If the normal non-seismic sources of auxiliary feedwater are not available, automatic re-alignment to the Seismic Category I Standby Nuclear Service Water Pond is provided. Separate and redundant lines provide water to the suction of the AFS pumps.

B. From 350°F to 200°F (refer to FSAR Figures 5.5.7-1, 9.2.4-1, and 9.2.2-1 through 3) -

1. RHR Suction Isolation Valves ND1A and ND2B - these valves are powered from different emergency power trains. Failure of either power train or of either valve operator could prevent initiation of RHR cooling in the normal manner from the control room. In the event of such a failure, operator action could be taken to open the affected valve manually. The mechanical failure of the disc separating from the stem has been investigated (WCAP-9207) and its probability has been found to be in the range of 10^{-4} and to 10^{-3} per year. The probability of an earthquake larger than the OBE is 10^{-3} to $5X10^{-3}$ per year. The combined probability of valve stem failure coincident with the earthquake is so low that it need not be considered in the

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single failure analysis. In the event of such a failure, the plant would remain in a safe hot standby condition with heat removal via the steam generators.

2. RHR Pumps A and B - Each pump is powered from a different emergency power train. In the event of a single failure, either pump can provide sufficient RHR flow.

3. RHR Heat Exchangers A and B - If either heat exchanger is unavailable for any reason, the remaining heat exchanger can provide sufficient heat removal capability.

4. RHR Flow Control Valves ND14 and ND29 - If either of these normally open fail open valves malfunctions, sufficient RHR cooling can be provided by the unaffected RHR subsystem. These valves may also be manually positioned by an operator.

5. RHR/SIS Cold Leg Isolation Valves NI173A and NI178B - These are parallel, normally open, motor operated valves which are powered from separate emergency power trains. Sufficient RHR cooling flow can be provided through either valve. These valves are also equipped with hand wheels for manual operation.

6. Component Cooling System - Two redundant trains are provided, either of which can provide sufficient heat removal capacity via one of the RHR heat exchangers.

7. Nuclear Service Water System - Two redundant trains are provided, either of which can provide sufficient heat removal via one of the Component Cooling System heat exchangers.

III. <u>Boration and Makeup</u> (refer to FSAR Rigures 9.3.4-1, 2, 3, and 5, and 6.3.2-1)

A. Boric Acid Tanks 1 and 2 - Two boric acid tanks are provided with one aligned to each unit. Each tank contains sufficient four wt % boric acid to borate the RCS to cold shutdown with the most reactive rod withdrawn.

B. Boric acid Transfer Pumps A and B - Two pumps are aligned to each tank. Each pump is powered from a different emergency power train. In the event of a single failure, either pump can provide sufficient boric acid flow.

C. Isolation Valve NV267A - This valve fails open on loss of air or power to allow boric acid flow to the blender. MOV NV265B, which is supplied from a separate power train, may be opened to supply boric acid flow directly to the suction header of the centrifugal charging pumps if required.

D. Isolation Valves NV171A and NV175A - If either of these valves fails closed, the alternate valve may be opened. If both valves fail closed due to loss of air or power, MOV NV265B may be opened to supply boric acid flow directly to the suction heater of the centrifugal charging pumps.

E. Charging Pump Suction Isolation Valves NV141A and NV142B - These normally open, motor operated valves are piped in series. If one of these valves closes spuriously, an operator can de-energize the valve operator and reopen the valve with its handwheel.

F. Centrifugal Charging Pumps A and B - Pumps A and B are powered from redundant emergency power trains. In the event of a single failure, either pump can provide sufficient boration or makeup flow.

G. Normal Charging Flow Control Valve NV238 - This normally open valve fails to open on loss of air or power to assure a charging flow path. A flow path may also be established through the Boron Injection Tank by opening valves NI4A or NI5B and NI3A or NI10B.

H. Reactor Coolant Pump Seal Injection Flow Control Valve NV241 - This normally open valve fails open upon loss of air or power to assure a charging flow path. It is fitted with a handwheel for manual control. A flow path may also be established through the Boron Injection Tank as explained in G above.

I. Charging Line Isolation Valves NV244A and NV245B - If either or these normally open, motor operated valves closes spuriously, an operator may de-energize the valve operator and reopen the valve with its handwheel. If this is not possible, a flow path can be established through the Boron Injection Tank as in G above.

J. Reactor Coolant Loop I Charging Isolation Valve NV13B - This normally open valve fails open upon loss of air or power. It is supplied with Train B emergency power. Loop 4 isolation valve NV16A, which also fails open upon loss of air or power, may also be opened to provide a charging flow path. NV16A is supplied with Train A emergency power.

K. Boron Injection Tank Isolation Valves NI4A and NI5B - Each valve is powered from a different emergency power train; only one of these normally closed, motor operated valves needs to be opened to provide an alternate path and source for boration.

L. Boron Injection Tank Isolation Valves NI3A and NI10B - Each valve is powered from a different emergency power train; only one of these normally closed, motor operated valves needs to be opened to provide an alternate path and source for boration.

M. Refueling Water Storage Tank IsolationValves NV221A and NV222B - Each valve is powered from a different emergency power train. Only one of these normally closed motor operated valves needs to be opened to provide an alternate makeup flow path from the RWST to the centrifugal charging pumps.

IV. <u>Depressurizati</u> efer to FSAR Figure 9.3.4-1)

A. Auxiliary Spray Valve NV21A - This normally closed valve fails closed on loss of air or power. In this case, NV21A may be opened by using a portable nitrogen bottle. If NV21A is stuck closed as a result of a single failure, the redundant Seismic Category I pressurizer power operated relief valves may be used to depressurize the RCS by discharging to the pressurizer relief tank.

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B. Charging Valves NV16A and NV13B - These valves fail open on loss of air or power. In this case, NV16A and NV13B may be closed by using portable nitrogen bottles. If either is stuck open, the redundant Seismic Category I pressurizer power operated relief valves can be used to depressurize the RCS by discharging to the pressurizer relief tank.

C. RHR Suction Isolation Valve NC1B and ND2A - The RHR suction isolation valves are qualified for the steam line break environment. Therefore, they are qualified for the less severe environment that would result if, as described in the above A and B, the RCS is depressurized by discharging the pressurizer to the pressurizer relief tank.

V. Instrumentation

Sufficient instrumentation is provided in the control room to monitor key functions in the event of a single failure, the operator can make comparisons between duplicate information channels or between functionally related channels in order to identify the particular malfunction. Refer to FSAR Section 7.5 for applicable details.