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February 8, 1985

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

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: McGuire Nuclear Station
Docket Nos. 50-369 and 50-370

Dear Mr. Denton:

Ms. E. G. Adensam's letter of December 19, 1984 transmitted a request for additional information regarding the McGuire Nuclear Station's Safety Parameter Display System.

The attached response addresses the specific concerns of the staff regarding the SPDS.

Very truly yours,

H.B. Tucker / [signature]

Hal B. Tucker

RLG/mjf

Attachment

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

Mr. Darl Hood, Project Manager
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NRC Resident Inspector
McGuire Nuclear Station

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DUKE POWER COMPANY
MCGUIRE NUCLEAR STATION

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION -

MCGUIRE SAFETY PARAMETER DISPLAY SYSTEM (SPDS)
January 31, 1985

REQUEST:

The licensee's submittal, H. B. Tucker (Duke) To H. R. Denton (NRC), March 9, 1984, Attachment Section 4, does not provide evidence that Critical Safety Functions for SPDS, Section 4.1(f) of NUREG-0737, Supplement 1, were considered in the selection of McGuire SPDS variables.

1. Provide a listing of the variables proposed for the display on the McGuire SPDS that constitute sufficient information to allow control room operators to assess the status of:

   a. reactivity control

   b. reactor core cooling and heat removal from the primary system

   c. reactor coolant system integrity

   d. radioactivity control

   e. containment conditions

RESPONSE:

Section 4.1.4 of H. B. Tucker's (Duke) To H. R. Denton (NRC), March 9, 1984 submittal contains six (6) Critical Safety Functions (CSF) which, for Westinghouse plants, address the same functions referenced in section 4.1(f) of NUREG-0737, Supplement 1. The basis for the selection of these six CSF's is contained in the document "Background Information for Westinghouse Owners Group Emergency Response Guidelines", HP/LP-Rev. 1, dated September 1, 1983, under the tab named "Status Trees".

The results of the NRC's review of Rev. 1 of these guidelines is contained in D. G. Eisenhut (NRC) letter dated December 27, 1985 addressed to J. J. Sheppard, Chairman of the Westinghouse Owners Group.

Described below are the six Critical Safety Functions as defined for the McGuire units. These six CSF's correspond to the five proposed in NUREG 0737, Supplement 1 as follows:

a. "REACTIVITY CONTROL" is addressed by the Critical Safety Function, Subcriticality. The variables monitored by the McGuire SPDS and the basis for their selection are described in section 3.23.1, pages 3-94 and 3-95 of the attachment "A", excerpted from Duke Power Company, McGuire Nuclear Station, Emergency Procedure Guidelines Reference, Volume I, dated June 1984.

b. "REACTOR CORE COOLING AND HEAT REMOVAL FROM THE PRIMARY SYSTEM" is addressed by two CSF's: Core Cooling described in section 3.23.2; and Heat Sink described in section 3.23.3. See pages 3-95, 3-96, and 3-97 of Attachment "A".

c. "REACTOR COOLANT SYSTEM INTEGRITY" is addressed by two CSF's: Integrity described in section 3.23.4 beginning on page 3-97; and Inventory described in section 3.23.6 on pages 3-100 and 3-101.

d. "RADIOACTIVITY CONTROL" is addressed by the Containment CSF described in section 3.23.5 on pages 3-99 and 3-100.

e. "CONTAINMENT CONDITIONS" is addressed by the Containment CSF described in section 3.23.5 on pages 3-99 and 3-100.

REQUEST:

2. Describe the basis on which the selected parameters are sufficient to assess the safety status of each of the five functions listed above.

RESPONSE:

The McGuire SPDS is based upon the six (6) Status Trees, one for each CSF, as defined in the Westinghouse Owner's Group Emergency Response Guidelines and specifically developed for and applied to the McGuire Units in Duke Power's "Emergency Procedure Guidelines for McGuire."

These plant specific guidelines are essentially the same as those developed for Catawba Nuclear Station. The acceptability of Duke's implementation of the Westinghouse Owners Group Emergency Response Guidelines for Catawba is documented in Section 13.5.2 of "Safety Evaluation Report related to the operation of Catawba Nuclear Station, Units 1 and 2" dated December 1984.

McGuire's Status Tree based SPDS takes credit for the validation programs which were performed on the above documents, and specifically, those associated with the definition and selection of the six CSF's and associated variables which are required to determine the safety status of the plant.

3.23 F-0 Critical Safety Function Status Trees

3.23.1 F-0.1 Subcriticality

Reactor Trip Required

The Subcriticality CSF is designed to monitor the post-trip reactor status. This branch point results in a GREEN status during normal power operation.

Power Range <5%

Following a reactor trip, nuclear power promptly drops to only a few percent of nominal, and then decays away to a level some 8 decades less. Decay heat levels resulting from radioactive fission product decay are never more than a few percent of nominal power and also decrease in time. Safeguards heat removal systems are sized to remove only decay heat and not significant core power. The 5% level was chosen because it is clearly readable on the power range meters. Nuclear power above 5%, in a core that is supposed to be shutdown, is considered an extreme challenge to the fuel clad/matrix barrier and a RED priority is warranted. The appropriate guideline for function restoration is FR-S.1, RESPONSE TO NUCLEAR POWER GENERATION/ATWS.

Intermediate Range SUR Zero or Negative

At this point, power range flux has been determined to be not significant, so no extreme challenge exists. However, a positive startup rate (SUR) in the intermediate range will shortly lead to power production if operator action is not taken, since no inherent feedback mechanisms exist below the point of adding heat. A positive SUR is considered a severe challenge to the CSF and an ORANGE priority is warranted. The appropriate guideline for function response is FR-S.1, RESPONSE TO NUCLEAR POWER GENERATION/ATWS.

Source Range Energized

This decision point is used to determine if further evaluation should be directed at the source range flux behavior, or back at the intermediate range channel indications.

Intermediate Range SUR More Negative Than -0.2 DPM

Normally, following reactor trip, intermediate range flux decays at a constant -0.3 DPM. A rate of decrease less negative than -0.2 DPM (e.g., -0.1 DPM) is considered to represent an unsatisfactory condition and a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-S.2, RESPONSE TO LOSS OF CORE SHUTDOWN. If the rate of decrease is less negative than -0.2 DPM, then the CSF is satisfied.

Source Range SUR Zero or Negative

Normally, following reactor trip, neutron flux decreases into the source range and stays there. Typically source range count rate fluctuates, and does not exhibit any sustained increasing trend. Such a trend, as indicated by a positive SUR, is considered an unsatisfactory condition and a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-S.2, RESPONSE TO LOSS OF CORE SHUTDOWN. If source range SUR is zero or negative the CSF is satisfied.

3.23.2 F-0.2 Core Cooling

Core Exit TCs <1200°F

Analyses of inadequate core cooling scenarios show that core exit temperature greater than 1200°F is a satisfactory criterion for basing extreme operator action. The average of the 5 highest core exit 5 thermocouples should be reading greater than 1200° F. Five has been chosen to allow margin for individual thermocouples failing high. This temperature indicates that most liquid inventory has already been removed from the NC system and that core decay heat is superheating steam in the core. An extreme challenge to the fuel matrix/clad barrier is imminent and a RED priority is warranted. The appropriate guideline for functional response is FR-C.1, RESPONSE TO INADEQUATE CORE COOLING.

NC System Subcooling >0°F

If NC system subcooling is less than 0° F, then SI flow should be maintained to the NC system to provide inventory makeup and the Core Cooling CSF is not satisfied. Subsequent blocks check for inadequate or degraded core cooling conditions. If greater than 0° F NC system subcooling is indicated, then the CSF is satisfied.

At Least One NC Pump Running

The RVLIS design has two ranges relevant for core cooling, lower range and dynamic head range, for use without NC pumps running and with NC pumps running, respectively. This block determines which range should be used to assess the Core Cooling CSF status in subsequent blocks. If any NC pump is running, then the RVLIS dynamic head range should be used in assessing core cooling conditions. If no NC pump is running, then the lower range should be used.

Core Exit TCs <700°F

If the average of the 5 highest core exit thermocouples indicates greater than 700°F, superheat at the core exit is indicated. An inadequate core cooling condition will exist if, in the next block, RVLIS indicates less than <45% (6 feet) collapsed liquid level in the core. If core exit thermocouples indicate less that 700°F, then an inadequate core cooling condition does not exist and the subsequent RVLIS check will assess whether a degraded core cooling condition has been reached.

RVLIS Lower Range >43% (Core Exit Temperatures Greater than 700°F)

If RVLIS lower range is less than 43%, then the core is uncovered and an inadequate core cooling condition has been reached. A RED priority is warranted and FR-C.1, RESPONSE TO INADEQUATE CORE COOLING, is the appropriate guideline for functional response. If RVLIS lower range is greater than 43%, then a degraded core cooling condition exists since the core exit temperatures are greater than 700° F from the previous block. An ORANGE priority is warranted and FR-C.2, RESPONSE TO DEGRADED CORE COOLING, is the appropriate guideline for functional response.

RVLIS Lower Range >43% (Core Exit Temperatures Less than 700° F)

If RVLIS lower range is less than 43%, then the core is uncovered, but since core exit temperature has not reached 700° F, an inadequate core cooling condition has not been reached. A degraded core cooling condition exists. An ORANGE priority is warranted and FR-C.2, RESPONSE TO DEGRADED CORE COOLING, is the appropriate guideline for functional response. If RVLIS lower range is greater than 43%, then only a saturated core cooling condition exists. A YELLOW priority is warranted and FR-C.3, RESPONSE TO SATURATED CORE COOLING, is the appropriate guideline for functional response.

RVLIS Dynamic Head Range > Setpoint

If an NC pump is operating, then even under a highly voided NC system condition the core exit thermocouples can be expected to indicate saturated temperatures. This block checks for NC system voiding less than approximately 25 percent which, if NC pumps are subsequently stopped, would ensure the core would initially be kept covered and adequately cooled. If RVLIS dynamic head range is less than the indicated setpoint a degraded core cooling condition exists. An ORANGE priority is warranted and FR-C.2, RESPONSE TO DEGRADED CORE COOLING, is the appropriate guideline for functional response. If RVLIS dynamic head range is greater than the indicated setpoint only a saturated core cooling condition exists. A YELLOW priority is warranted and FR-C.3, RESPONSE TO SATURATED CORE COOLING, is the appropriate guideline for functional response.

3.23.3 F-0.3 Heat Sink

Narrow Range Level in at Least One SG >5% (>18% ACC)

A level in the narrow range in any steam generator, including a ruptured one is sufficient to ensure an adequate secondary inventory for a secondary heat sink. If level is not in the narrow range, the operation of the feedwater systems will determine whether a loss of secondary heat sink is imminent.

Total Auxiliary Feedwater Flow to SGs >450 gpm

Total auxiliary feedwater flow of greater than 450 gpm ensures that, in the absence of narrow range level in any steam generator, the capability of auxiliary feedwater to restore level and maintain a secondary heat sink is available. If not, then an extreme challenge the heat sink CSF is imminent and a RED priority is warranted. The appropriate guideline for functional response is FR-H.1, RESPONSE TO LOSS OF SECONDARY HEAT SINK.

Pressure in All SGs <1225 psig

In the event that pressure in any steam generator is greater than the highest steam line safety valve setpoint, then the steam generator design limit may be exceeded and integrity may be challenged. Also, there is no flow path in use removing energy from that steam generator. The Heat Sink CSF is not satisfied and a YELLOW priority is warranted. The appropriate guideline for functional response is FR-H.2, RESPONSE TO STEAM GENERATOR OVERPRESSURE.

Narrow Range Level in All SGs <82% (<67% ACC)

An overfeed due to excess feed flow or a steam generator tube rupture may lead to a high level in a steam generator. This block checks all steam generators to ensure identification since this condition may cause unwanted atmospheric releases or challenge steam generator integrity. Note that although the level in the affected steam generator may reach the top of the narrow range span, significant volume still exists before the steam generator fills with water. The Heat Sink CSF is not satisfied and a YELLOW priority is warranted. The appropriate guideline for functional response is FR-H.3, RESPONSE TO STEAM GENERATOR HIGH LEVEL.

Pressure in All SGs <1170 psig

If any steam generator safety valve is open, then an unisolable heat removal path is being used. A better path is to use steam dump to condenser or SM PORVs which are controllable and isolable. Also, condenser steam dump will not release steam to the atmosphere. The Heat Sink CSF is not satisfied and a YELLOW priority is warranted. The appropriate guideline for functional response is FR-H.4, RESPONSE TO LOSS OF NORMAL STEAM RELEASE CAPABILITIES.

Narrow Range Level in All SGs >5% (>18% ACC)

Feedwater should be maintained until all steam generators are in the narrow range unless a faulted steam generator is identified. Narrow range level is reestablished in all steam generators to maintain symmetric cooling of the NC system. If any level is low, the Heat Sink CSF is not satisfied and a YELLOW priority is warranted. The appropriate guideline for functional response is FR-H.5, RESPONSE TO STEAM GENERATOR LOW LEVEL.

3.23.4 F-0.4 Integrity

Temperature Decrease in All Cold Legs <100°F in Last 60 Minutes

If the temperature decrease in any cold leg has exceeded 100°F in the previous 60 minutes, then there is a potential concern for thermal shock. If not, then no other checks on rate-dependent limits are necessary. The remaining concerns are NC system overpressure and cold overpressure which will be checked in subsequent blocks. If the temperature decrease has exceeded 100°F in the previous 60 minutes, the degree of cooldown must be assessed before a thermal shock concern can be identified. This is checked in subsequent blocks.

All NC System Pressure-Cold Leg Temperature Points to Right of Limit A

The objective of Limit A is to provide a limit that indicates an extreme thermal shock condition. The basis of this limit is to prevent growth of a flaw in the vessel. If Limit A has been exceeded, then operator action is necessary to limit further NC system temperature decreases or NC system pressure increases. A RED priority is warranted since an extreme challenge to the CSF is occurring and FR-P.1, RESPONSE TO IMMINENT PRESSURIZED THERMAL SHOCK CONDITION, is the appropriate guideline for functional response.

All NC System Cold Leg Temperatures >350°F

If any cold leg temperature is less than 350°F, then operator action is necessary to minimize further NC system temperature decreases and NC system pressure increases. An ORANGE priority is warranted since a severe challenge to the function exists and FR-P.1, RESPONSE TO IMMINENT PRESSURIZED THERMAL SHOCK CONDITION, is the appropriate guideline for functional response.

Pressurizer Pressure <2400 psig (2250 psig ACC)

Since pressurizer pressure should normally decrease following an accident, this setpoint is not expected to be exceeded except for pressurization transients such as spurious safety injection or a power generation heat removal mismatch. The pressurizer PORV lift setpoint is 2335 psig, so a pressure of 2400 indicates PORV malfunction, or other inability to handle the transient, and therefore a possible challenge to the pressurizer code safety valves.

All NC System Cold Leg Temperature >457°F

The temperature region between 457°F and 350°F is intended to allow time for operator action to try to prevent entering a region of potential thermal shock. In this region the CSF is not completely satisfied and a YELLOW priority is warranted. The appropriate guideline for functional response is FR-P.2, RESPONSE TO ANTICIPATED PRESSURIZED THERMAL SHOCK CONDITION. If all NC system cold leg temperatures are greater than 457°F, then the Integrity CSF is satisfied.

Pressurizer Pressure <2400 psig (2250 psig ACC)

Since pressurizer pressure should normally decrease following an accident, this setpoint is not expected to be exceeded except for pressurization transients such as spurious safety injection or a power generation heat removal mismatch. The pressurizer PORV lift setpoint is 2335 psig, so a pressure of 2400 indicates PORV malfunction, or other inability to handle the transient, and therefore a possible challenge to the pressurizer code safety valves.

All NC System Cold Leg Temperature >300°F

In order to determine if cold overpressure is a concern, a check is made on whether NC system temperature has decreased to below the temperature at which the pressurizer PORV low setpoint should be enabled. Subsequent blocks check if a cold overpressure condition exists.

NC System Pressure <400 psig

If the pressurizer PORV low setpoint should be enabled and NC system pressure exceeds 400 psig, then action may be necessary to minimize or decrease NC system pressure. The priority of action will be determined in subsequent blocks. If NC system pressure has not exceeded the cold overpressure limit, then the Integrity CSF is satisfied.

All NC System Cold Leg Temperatures >250°F

If cold leg temperature in any NC system cold leg is less than 250°F and NC system pressure is greater than 400 psig, then a severe challenge to the function exists and operator action is necessary to limit NC system pressure. An ORANGE priority is warranted and FR-P.1, RESPONSE TO IMMINENT PRESSURIZED THERMAL SHOCK CONDITION, is the appropriate guideline for functional response.

If all NC system cold leg temperatures are greater than 250°F, then even though the cold overpressure limit has been exceeded (previous block), there is no extreme or severe challenge to vessel integrity, even at very high pressure. A YELLOW priority is warranted, however, since the CSF is not satisfied and FR-P.2, RESPONSE TO ANTICIPATED PRESSURIZED THERMAL SHOCK CONDITION, is the appropriate guideline for functional response.

3.23.5 F-0.5 Containment

Containment Pressure <15 psig

If containment pressure is greater than design pressure, an extreme challenge to the containment barrier exists. The challenge does not necessarily come from the pressure alone, but rather from the potential pressure spike which could result from a hydrogen ignition. Also, above containment design pressure, leakage may exceed design basis limits. It is expected that containment pressure suppression equipment should be able to maintain pressure below design pressure. If not, then operator action is necessary to check containment functions and a RED priority is warranted. The appropriate guideline for function restoration is FR-Z.1, RESPONSE TO HIGH CONTAINMENT PRESSURE.

Containment Pressure <3 psig

Pressure above 3 psig indicates a significant energy release to containment and merits prompt operator action to ensure operation of containment pressure suppression equipment and performance of Phase B isolation. Such a pressure also requires Steam Line Isolation and is considered a severe challenge to the containment barrier and an ORANGE priority is warranted. The appropriate guideline for function restoration is FR-Z.1, RESPONSE TO HIGH CONTAINMENT PRESSURE.

Containment Hydrogen Concentration <0.5%

Appreciable accumulation of hydrogen gas inside containment is not expected except for inadequate core cooling scenarios. When significant amounts of hydrogen are generated by the metal-water reaction in the core, the gas may be released into the containment atmosphere more quickly than the electric hydrogen recombners can remove it. In this case it is important to have an anticipatory hydrogen concentration setpoint to provide maximum opportunity for the various mitigation systems to reduce the concentration before it reaches flammability limits which would cause a containment pressure integrity concern due to a hydrogen burn.

Containment Sump Level <13 ft.

High energy line breaks could result in a large volume of water being pumped into containment. As the water level rises, it might threaten the availability of equipment required for long term cooling of the core and/or containment. Such a high water level is considered a severe challenge to the containment barrier and an ORANGE priority is warranted. The appropriate guideline for function restoration is FR-Z.2, RESPONSE TO CONTAINMENT FLOODING.

Containment Radiation Monitors <3R/hr

Normally, containment building radiation levels are fairly low and constant. However, during an accident, significant radioactivity may be released into the containment atmosphere. In-containment systems are available to filter and scrub the contaminants from the atmosphere, and radiation alone does not represent a threat to containment integrity. This is considered an unsatisfied condition and a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-Z.3, RESPONSE TO HIGH CONTAINMENT RADIATION. If containment radiation monitors are <3R/hr, then the CSF is satisfied.

3.23.6 F-0.6 Inventory

Pressurizer Level <92% (<80% ACC)

This decision point allows proper resolution of the actual inventory condition in subsequent decision blocks. If pressurizer level is above the normal operating range, the next decision block determines if it is due to excess inventory or voids in the vessel. If level is not high, then further questions check for low level and voids in the vessel.

RVLIS UR Indicates >97% and Stable (Pressurizer Level >92% (>80% ACC)

Having already determined that pressurizer level is high, this question tries to define the cause. If the upper head region is full, then the problem is simply one of excess inventory; the Inventory CSF is considered not satisfied and a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-I.1, RESPONSE TO HIGH PRESSURIZER LEVEL. If the RVLIS does indicate voids in the upper head region, then the problem is likely due to some type of bubble in that region. Since the presence of a bubble is considered an unsatisfied condition, a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-I.3, RESPONSE TO VOIDS IN REACTOR VESSEL.

Pressurizer Level >17% (>45% ACC)

This block is entered after having determined that pressurizer level is not high. If level is also not low, then the pressurizer inventory is considered satisfactory and a further question is asked about reactor vessel level. If pressurizer level is not greater than the indicated setpoint, then the problem is one of low inventory, with or without voids in the vessel. The condition is considered an unsatisfied condition and a

YELLOW priority is warranted. The Core Cooling Status Tree checks for more severe or extreme challenges to Inventory that also challenge the Core Cooling CSF. The appropriate guideline for function restoration is FR-I.2, RESPONSE TO LOW PRESSURIZER LEVEL.

RVLIS UR Indicates >97% and Stable (Pressurizer Level Determined to be Normal)

Having determined that pressurizer level is normal, the remaining inventory question relates to water level in the reactor vessel. If level does not indicate that the vessel is full, then some type of voids are present in the vessel upper head. The presence of a bubble is considered an unsatisfied condition and a YELLOW priority is warranted. The appropriate guideline for function restoration is FR-I.3, RESPONSE TO VOIDS IN THE REACTOR VESSEL.