**NORTHEAST UTILITIES**

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
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April 11, 1984

Docket No. 50-423
B11120

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

References: (1) B. J. Youngblood letter to W. G. Counsil, request for additional information for Millstone Nuclear Power Station, Unit No. 3, dated May 31, 1983.

(2) B. J. Youngblood letter to W. G. Counsil, Draft SER for Millstone 3, dated December 20, 1983.

Dear Mr. Youngblood:

Mil[illegible]ear Power Station, Unit No. 3
Response to Qu[illegible].5 and Draft SER Open Item ICSB-20 (#166)

Enclosed is a revised response to the Question 420.5 contained in Reference (1). Please note that this information also responds to the Draft SER Open Item ICSB-20 (#166) listed in Reference (2). The response will be incorporated into the FSAR in a future amendment.

If you have any concerns related to information contained herein or any questions related to our responses, please contact our licensing representative directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY, ET AL.
By Northeast Nuclear Energy Company, Their Agent

W. G. Counsil
Senior Vice President



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STATE OF CONNECTICUT )
) ss. Berlin
COUNTY OF HARTFORD )

Then personally appeared before me W. G. Counsil, who being duly sworn, did state that he is Senior Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico
Notary Public

My Commission Expires March 31, 1988

NRC Letter: May 31, 1983

Question Q420.5 (Section 7.7)

Control System Failure concerns.

The analyses reported in Chapter 15 of the FSAR are intended to demonstrate the adequacy of safety systems in mitigating anticipated operational occurences and accidents.

Based on the conservative assumptions made in defining these design basis events and the detailed review of the analyses by the staff, it is likely that they adequately bound the consequences of single control system failures.

To provide assurance that the design basis event analyses adequately bound other more fundamental credible failures, you are requested to provide the following information:

(a) Identify those control systems whose failure or malfunction could seriously impact plant safety.

(b) Indicate which, if any, of the control systems identified in (a) receive power from common power sources. The power sources considered should include all power sources whose failure or malfunction could lead to failure or malfunction of more than one control system and should extend to the effects of cascading power losses due to the failure of higher level distribution panels and load centers.

(c) Indicate which, if any, of the control systems identified in (a) receive input signals from common sensors. The sensors considered should include, but should not necessarily be limited to, common hydraulic headers or impulse lines feeding pressure, temperature, level or other signals to two or more control systems.

(d) Provide justification that any simultaneous malfunctions of the control systems identified in (b) and (c) resulting from failures or malfunctions of the applicable common power source or sensor are bounded by the analyses in Chapter 15 and would not require action or response beyond the capability of operators or safety systems.

Response:

Introduction

The evaluation required to answer the above question consists of postulating failures which affect the major NSSS control systems and demonstrating that for each failure the resulting event is within the bounds of existing accident analyses. The events which are considered are:

A. Loss of any single instrument.

B. Break of any single instrument line.

C. Loss of power to all systems powered by a single power supply system (i.e., single inverter).

The analysis is conducted for all five major NSSS control systems:

- Reactor control system
- Steam dump system
- Pressurizer pressure control system
- Pressurizer level control system
- Feedwater control system

The initial conditions for the analysis are assumed to be anywhere within the full operating power range of the plant (i.e., 0 to 100 percent) where applicable.

The results of the analysis indicate that, for any of the postulated events considered in A through C above, the Condition II accident analyses given in Chapter 15 of the FSAR are bounding.

Loss of Any Single Instrument

Table Q420.5-1, Loss of Any Single Instrument, is a sensor-by-sensor evaluation of the effect on the control systems itemized above caused by a sensor failing either high or low. The particular sensor considered is given, along with the number of channels which exist, the failed channel, the control systems impacted by the sensor, the effects on the control systems for failure in both directions, and the bounding FSAR accident. Where no control action occurs or where control action is in a safe direction, no bounding accident is given.

The table clearly shows that for any single instrument failure, either high or low, the Condition II events itemized in FSAR Chapter 15 are bounding.

Loss of Power to an Inverter, Control Group, or Protection Set

Tables Q420.5-2 through Q420.5-5, Loss of Power to Inverters I through IV, respectively, analyze the effects on the control systems caused by the loss of power to an instrument distribution panel. The Millstone 3 NSSS instrument power supply consists of four instrument buses receiving power through four inverters (for convenience, called Inverters I through IV). Each instrument bus powers a single control group and single protection set (Inverter I distributes power to Control Group 1 and Protection Set I; Inverter II distributes power to Control Group 2 and Protection Set II; etc). Therefore, loss of power to one inverter causes a loss of power to both a protection set

and a control group. In the tables, the control systems affected, the sensors affected, the failure direction, the effect on the control systems, and the bounding FSAR accident are given. Where no control action occurs or where control action is in a safe direction, no bounding accident is given.

Besides the loss of the inverter feeding both a protection set and a control group, there is also a chance of losing power to just a control group or a protection set (for example, through the failure of a fuse or circuit breaker). The consequences of a loss of power to a control group or a protection set are tabulated in Tables Q420.5-6 through Q420.5-9 for losing Protection Set I, II, III, or IV, respectively, and on Tables Q420.5-10 through Q420.5-13 for losing Control Group 1, 2, 3, or 4, respectively. These data are presented in a similar manner to that for the loss of an inverter described in the previous paragraph. This analysis is conservative and assumes that the nonsafety-grade lighting and distribution panel which also powers the control groups is not available.

Besides the loss of power to a complete control group or protection set, there is the chance of having an electrical fault on one of the control system circuit cards. The control systems are designed so that each card consists of components in only one control system. A circuit card failure cannot directly impact more than one control system. A failure on a control card would cause the controller to generate either an "off" or a "full on" output, depending on the type of failure. This result would be similar to having a fault in a sensor feeding the control system. Therefore, the failure of or loss of power in any control system circuit card would be bounded by the loss of any single instrument analysis described in Table Q420.5-1.

The tables show that for a loss of power to any inverter, control group, or protection set, the Condition II events analyzed in FSAR Chapter 15 are bounding.

Loss of Common Instrument Lines

Table Q420.5-14, Loss of Common Instrument Lines, considers the scenario whereby an instrument line which supplies more than one signal ruptures, causing faulty sensor readings.

Two sets of sensors are located in common lines:

- Loop steam flow (Control Groups 1 through 4 for Steam Generators 1 through 4, respectively) and narrow range steam generator level (Protection Sets I or II, any steam generator).

- Pressurizer level (Protection Sets I, II, or III) and pressurzier pressure (Protection Sets I, II, III, or IV).

Not shown on the tables, since they are not part of the plant control system but are used just for protection, are the loop flow transmitters. There are three flow transmitters in each loop, with

each transmitter having a common high pressure tap but separate and unique low pressure taps. Therefore, a break at the high pressure flow transmitter tap would result in disabling all three flow transmitters in one loop, resulting in a low flow reading for all three transmitters. This would result in a reactor trip if the plant is above the P-8 setpoint, or an annunciation if it is below P-8.

The only malfunction mode explicitly analyzed was a break in the common instrument line at the tap. Another possibility is to have a complete blockage in the sensor tap, causing the sensor to read a constant (before blockage) value. However, this last failure mode is not analyzed since it is not really a credible event. There is no anticipated agent available that would cause a tap blockage. The reactor coolant system piping and fittings, and the instrument impulse line tubing are all stainless steel, so no products of corrosion are expected. Also, the water chemistry is of high quality, which along with high temperature operation, precludes the presence of solids in the water and assures the maintenance of the solubility of chemicals in the water. In addition, prior to startup, and during any shutdown as well, it is routine maintenance and servicing practice for instrument lines to be blown down to a canister. Since the buildup of sludge is a slow process, any buildup would be detected during response time testing done during shutdown. Therefore, the hypothesis of the presence of a complete blockage of the sensor tap is not sufficiently credible to warrant its consideration as a design basis.

In the extremely unlikely event that a complete instrument line blockage were to occur, the condition is detectable because the reading would become static (no variations over time). In an unblocked channel, a reading would always vary somewhat due to noise (i.e. flow induced noise in flow channels) or slight controller action (i.e., cycling operation of spray and heaters in pressurizer). By a comparisoin of the static channel to the redundant unlocked channels, the operator would be informed that a blockage in one channel has occurred.

Conclusions

The following tables illustrate that failures of individual sensors, losses of power to inverters feeding control groups and protection sets, or breaks in common instrument lines all result in events which are bounded by FSAR Chapter 15 analyses. Therefore, the FSAR adequately bounds the consequences of these fundamental failures.

TABLE Q420.5-1

LOSS OF ANY SINGLE INSTRUMENT

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| Feedpump Discharge Pressure | 1 per plant | | a Feedwater Control | Low | FW pump speed increases if in auto mode. (FW control valves close due to increased flow if in auto mode.) | No event if pump speed in manual. New steady-state reached if pump speed and FCV in auto; i.e., pump speed increases and FCV lift decreases. If pump speed in auto and FCV in manual, bounding event is excessive FW flow (FSAR 15.1.2). |
| | | | | High | FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode.) | No event if pump speed in manual. Other modes result in a decreased FW flow over time. Hence, bounding event is loss of normal FW flow (FSAR 15.2.7). |
| Steam Header Pressure | 1 per plant | | a Feedwater Control<br>a Steam Dump (Tavg Mode) | Low | FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode.) | No event if pump speed in manual. Other modes result in a decreased FW flow over time. Hence, bounding event is loss of normal FW flow (FSAR 15.2.7). |
| | | | | High | FW pump speed increases if in auto mode. (FW control valves close due to increased flow if in auto mode.) | No event if pump speed in manual. New steady-state reached if pump speed and FCV lift decreases. If pump speed in auto and FCV in manual, bounding event is excessive FW flow (FSAR 15.1.2). |
| Steam Header Pressure | 1 per plant | | a Feedwater Control<br>a Steam Dump (Pressure Mode) | Low | FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode.) | No event if pump speed in manual. Other modes result in a decreased FW flow over time. Hence, bounding event is loss of normal FW flow (FSAR 15.2.7). |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| Steam Header Pressure | 1 per plant | | | High | FW pump speed increases if in auto mode. (FW control valves open due to increased flow if in auto mode.) Dump valves open. (Steam dump blocked on low-low Tavg [P-12]. | Steam dump in pressure mode at hot standby conditions or at very low power. Hence, dump valves would open for only a very short time until low-low Tavg is reached.<br><br>If pump speed is in manual, or if both pump speeds and FCV are in auto, then this event is bounded by excessive increase in secondary steam flow (FSAR 15.1.3). If pump speed in auto and FCV in manual, bounding event is excessive FW flow (FSAR 15.1.2) because this results in excessive cooling. |
| Loop Steam Flow | 2 per loop | 1 selected for Control | a Feedwater Control | Low | FW pump speed decreases if in auto mode. FW valves close if in auto mode. | No event if pump speed and FCV in manual. Other modes result in decreased FW flow, and therefore bounding event is loss of normal FW flow (FSAR 15.2.7). |
| | | | | High | FW pump speed increases if in auto mode. FW valves open if in auto mode. | No event if pump speed and FCV in manual. Other modes result in an increased FW flow, and hence, bounding event is excessive FW flow (FSAR 15.1.2). |
| Loop FW Flow | 2 per loop | 1 selected for Control | a Feedwater Control | Low | FW valve opens if in auto mode. | No event if FW valve in manual. If in auto, bounding event is excessive FW flow (FSAR 15.1.2). |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| | | | | High | FW valve closes if in auto mode. | No event if FW valve in manual. If in auto, bounding event is loss of normal FW flow (FSAR 15.2.7). |
| Narrow Range Level | 4 per steam generator (two available for Control) | 1 selected for Control I or II | a Feedwater Control | Low | FW valve opens if in auto mode. | No event if FW valve in manual. If in auto, bounding event is excessive FW flow (FSAR 15.1.2). |
| | | | | High | FW valve closes if in auto mode. | No event if FW valve in manual. If in auto, bounding event is loss of normal FW flow (FSAR 15.2.7). |
| Pressurizer level (Control) | 3 per plant | I or III | a Pressurizer Level Control | Low | Charging flow increases. Heaters turn off (except for local control). letdown isolated. (VCT empties, charging pumps take suction from RWST.) | Bounding event is increased reactor coolant inventory (FSAR 15.5.2). |
| | | | | High | Charging flow decreases. Backup heaters on. (Later, letdown isolation from interlock channel and heaters blocked from interlock channel.) | While heaters are on, no net depressurization of RCS. After heaters blocked, the decreased charging flow acts to depressurize the RCS. Depressurization event is therefore bounding by inadvertent opening of a pressurizer safety or relief valve (FSAR 15.6.1). |
| Pressurizer level (Interlock) | 3 per plant | II or III | a Pressurizer Level Control | Low | letdown isolated. Pressurizer heaters blocked (except for local control). (Charging flow controller reduces flow to maintain level.) | Reach new steady-state with high pressurizer level. No event. |
| | | | | High | No control action, get High level annunciation. | Not applicable. |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| Pressurizer Pressure | 4 per plant | II or IV | a Pressurizer Pressure Control | Low | No control action. PORV 456 blocked from opening. PORV 455A opens if required, closes when pressure falls below deadband. | Not applicable. |
| | | | | High | PORV 456A opens. (PORV closes when pressure drops blow deadband.) | Bounding event is inadvertent opening of a pressurizer safety or relief valve (FSAR 15.6.1). |
| Pressurizer Pressure | 4 per plant | I or III | a Pressurizer Pressure Control | Low | Backup heaters on. Spray remains off. PORV 455A blocked from opening. (PORV 456 opens if required, closes when pressure falls below deadband.) | Heaters on cause increase in pressurizer pressure to PORV 456 actuation. No event. |
| | | | | High | PORV 455A opens. Spray on. (PORV 455A closes when pressure drops below deadband.) | Bounding event is inadvertent opening of a pressurizer safety or relief valve (FSAR 15.6.1). |
| Tavg | 1 per loop | Any Acut. | a Steam Dump (Tavg Mode) | Low | Stop turbine loading/ defeat remote dispatching (C-16). Annunciation occurs. | Not applicable. |
| | | High | a Reactor Control | | | |
| | | | a Pressurizer Level Control | | | |
| | | Auct. Low | a Turbine Loading/ Dispatching | | | |
| | | | | High | Rods in (safe direction). Charging flow increases until full power pressurizer level is reached (if at reduced power). (If reactor trips, steam dump enabled and dump valves open until steam dump stops when low-low Tavg (P-12) is reached.) | No event unless reactor trips, then steam dump valves open and this is bounded by excessive increase in secondary steam flow (FSAR 15.1.3). |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| Tavg | 1 per loop | Any Auct. | a Steam Dump (Pressure Mode) | Low | Stop turbine loading/defeat remove dispatching (C-16). Annunciation occurs. | Not applicable. |
| | | High | a Reactor Control<br>a Pressurizer Level Control | | | |
| | | Auct. Low | a Turbine Loading/ Dispatching | | | |
| | | | | High | Rods in (safe direction). Charging flow increases until full power pressurizer level is reached (if at reduced power). | Reach steady-state with pressurizer at full power level. No event. |
| Steamline Pressure | 3 per loop for protection, 1 per loop for control (different from those used for protection) | Control Channel | a Steam Generator PORV | Low | No control action. | Not applicable. |
| | | | | High | Steam generator relief valve opens. | Result is bounded by inadvertent opening of a steam generator relief or safety valve (FSAR 15.1.4). |
| Inter-mediate Range Flux | 2 per plant | I or II | a Reactor Control | Low | No control action. | Not applicable |
| | | | | High | Get reactor trip (during startup) due to C-1 actuation, otherwise no control action. | Not applicable. |
| Turbine Impulse Chamber Pressure | 2 per turbine | I (Control) | a Steam Dump (Tavg Mode)<br>a Reactor Control<br>a Feedwater Control | Low | Rods in (safe direction). Auto rod withdrawal blocked (C-5). (If reactor trip occurs, steam dump unblocked and dump valves open until no load Tavg is reached.) No effect on FW control since constant level program. | Not applicable. |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| | | | | High | Rods out until blocked by high flux, overpower, or overtemperature rod stop, or until programmed Tref limit is reached. (If reactor trip occurs, steam dump unblocked and dump valves open until no-load Tavg is reached.) No effect on FW control since have constant SG level program. | Result is bounded by uncontrolled rod cluster control assembly bank (withdrawal at power FSAR 15.4.2). |
| Turbine Impulse Chamber Pressure | 2 per turbine | II (Interlock) | a Steam Dump (Tavg Mode)<br>a Reactor Control<br>a Feedwater Control | Low | Steam dump unblocked. Rods in (safe direction). Auto rod withdrawal blocked (C-5). If reactor trip occurs, dump valves open until no-load Tavg is reached.) No effect on FW control, since have constant SG level program. | Not applicable. |
| | | | | High | Rods out until blocked by high flux, overpower, or overtemperature rod stop, or until programmed Tref limit is reached. (If reactor trip occurs, steam dump valves open until no-load Tavg is reached.) No effect on FW control, since have constant SG level program. | Result is bounded by uncontrolled rod cluster control assembly bank withdrawal at power (FSAR 15.4.2). |
| Turbine Impulse Chamber Pressure | 2 per turbine | I (Control) | a Steam Dump (Pressure Mode)<br>a Reactor Control<br>a Feedwater Control | Low | Auto rod withdrawal blocked (C-5). Rods in (safe direction). No effect on FW control, since have constant SG level program. (If reactor trip occurs, dump valves open to keep steam header pressure at or below setpoint.) | Not applicable. |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| | | | | High | Rods out until blocked by high flux, overpower, or overtemperature rod stop. (If reactor trip occurs, dump valves open to keep steam header pressure at or below setpoint). No effect on FW control since have constant SG level program. | Result is bounded by uncontrolled rod cluster control assembly bank withdrawal at power (FSAR 15.4.2). |
| Turbine Impulse Chamber Pressure | 2 per turbine | 11 (Interlock) | a Steam Dump (Pressure Mode)<br>a Reactor Control<br>a Feedwater Control | Low | Auto rod withdrawal blocked (C-5). Rods in (safe direction). No effect on FW control, since have constant SG level program. (If reactor trip occurs, dump valves open to keep steam header pressure at or below setpoint.) | Not applicable. |
| | | | | High | Rods out until blocked by high flux, overpower, or overtemperature rod stop or until programmed Tref is reached. (If reactor trip occurs, dump valves open to keep steam header pressure at or below setpoint.) No effect on FW control since have constant SG level program. | Result is bounded by uncontrolled rod cluster control assembly bank withdrawal at power (FSAR 15.4.2). |
| Power Range Flux | 4 per plant | Any | a Reactor Control<br>a Feedwater Control | Low | No control action (auctioneered high). | Not applicable. |
| | | | | High | Auto and manual rod withdrawal blocked (C-2). Rods in (safe direction). FW bypass valve opens if in auto. (If reactor trip occurs, dump valves open, until no-load Tavg is reached.) Rising SG level causes valve to close until steam and feed flows match. | Increased bypass valve opening would be bounded by excessive FW flow (FSAR 15.1.2). |
| Condenser Available | 3 per condenser | Any | a Steam Dump | Low | No control action. Steam dump unblocked; i.e., condenser available for steam dump. | Not applicable. |

TABLE Q420.5-1 (Cont)

| Sensor | Number of Channels | Failed Channel | System | Assumed Failure Direction | Effect | Bounding Event |
|---|---|---|---|---|---|---|
| | | | | High | No control action. Steam dump stays blocked; i.e., condenser unavailable for steam dump. | Not applicable. |
| Tavg (High Auctioneer) | 1 | | a Steam Dump<br>a Reactor<br>a Control<br>Pressurizer<br>a Level<br>Control | Low | Charging flow decreases until no-load level reached. Rods out until blocked by high flux, overpower, or over-temperature rod stop. Steam dump blocked (Tavg mode only). | Result is bounded by uncontrolled rod cluster control assembly bank withdrawal at power (FSAR 15.4.2). |
| | | | | High | Identical to Tavg channel failing high. See above analysis. | See above. |
| Steam Flow Pressure Compensator | 2 per loop | 1 selected for control | a Steam flow | Low | Identical to loop steam flow channel failing low. See above analysis. | See above. |
| | | | | High | Identical to loop steam flow channel failing high. See above analysis. | See above. |

TABLE Q420.5-2

LOSS OF POWER TO INVERTER 1
(loss of Power to Protection Set 1 and Control Group 1)

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | All (System Deenergized) | Off/Closed | No initiating event, steam dump system unavailable. | |
| Reactor Control | Power Range Flux (Control) | Low | If turbine pressure on control channel rods in, power decreases, and stop turbine loading/defeat remote dispatching. Otherwise, no effect. | Loss of FW flow (FSAR 15.2.7) event is bounding since increased charging flow/isolated letdown has little effect relative to the decreased feed flow. (Reactor trip would occur on SG low-low level.) |
| | Turbine Pressure (Control, Interlock, or both) | Low | | |
| | Tavg (loop 1) | Low | | |
| FW Control (SG 1) and Pump Speed Control | All (System Deenergized) | FW valve closes in SG 1. Pump speed decreases auto mode only) | loss of main FW in SG 1. (Plant trips on low SG 1 level). Other loops have decrease in FW flow due to decreased pump speed. | |
| Pressurizer Level | Pressurizer Level (Control) | Low | If affected level signal used for control, charging flow increases, heaters blocked, letdown isolated. Otherwise, channel not connected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 455A) | Low | If affected signal used for control, spray off; PORV 455A stays closed. PORV 456 available if needed. Heaters on unless blocked by level interlock. Otherwise, channel not connected, no control action. | |

TABLE Q420.5-3

LOSS OF POWER TO INVERTER II
(Loss of Power to Protection Set II and Control Group 2)

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | Turbine Pressure (Interlock) | Low | No control action, steam dump unblocked. | |
| Reactor Control | Power Range Flux | Low | If turbine pressure on interlock channel. Rods in, power decreases, stop turbine loading/defeat remote dispatching. | Loss of FW flow (FSAR 15.2.7) event is bounding for similar reasons as for loss of inverter 1. Reactor trip on either SG 2 low-low level or pressurizer high level |
| | Turbine Pressure (Control) | Low | | |
| | Tavg (Loop 2) | Low | | |
| FW Control | All in SG 2 (System Deenergized) | FW valve closes | Loss of main FW in SG 2. (Plant trips on low SG2 level) | Increased FW flow in other steam generators due to low level signal would be partially compensated by steam/FW mismatch signal, so total loss of FW would be more severe event. Also, increased charging flow would have little effect in comparsion with loss of FW. |
| | Steam flow Pressure Compensation | Low | If steam flow pressure compensation obtained from Protection Set II, get decrease in main FW in affected loop. | |
| FW Control (SG 1, 3 and/or 4) (if switch allows reading SG level from Protection Set II) | Narrow Range level | Low | FW valve opens, flow increases. | |
| Pressurizer level | All (System Deenergized) | Low | Charging flow valve fully opens, charging flow fully on, letdown isolated, heaters blocked. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 456) | Closed | PORV 456 stays closed, PORV 455A available if needed. | |

TABLE Q420.5-4

LOSS OF POWER TO INVERTER III
(Loss of Power to Protection Set III and Control Group 3)

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | None | --- | No signals affected, no control action. | |
| Rod Control | Power Range Flux<br>Tavg (Loop 3) | low<br>low | No control action due to auctioneers. | Loss of FW flow (FSAR 15.2.7) event is bounding for similar reasons as for loss of Inverter 1. Reactor trip will occur on SG 3 low-low water level. |
| FW Control (SG 3) | All (System De-energized) | FW valve closes | Loss of main FW in SG 3. (Plant trips on low SG 3 level). | |
| Pressurizer Level | Pressurizer level (Control or Interlock) | low | If affected level signal used for control charging flow increases, heaters blocked, letdown isolated. Otherwise, channel not connected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 456 Interlock PORV 455A Control) | low | | |

TABLE Q420.5-5

LOSS OF POWER TO INVERTER IV
(Loss of Power to Protection Set IV and Control Group 4)

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | Auctioneered Tavg | Low | No initiating accident, low Tavg prevents activation of steam dump. | |
| Rod Control | All (System Deenergized) | Low | No control action, no rod motion. | Loss of FW flow (FSAR 15.2.7) event is bounding since turning on of pressurizer heaters is temporary and transient effects are slow-reacting in comparsion with loss of FW. (SG 4 tripped on low-low water level). |
| FW Control (SG 4) | All (System Deenergized) | FW valve closes | Loss of main FW in SG 4. (Plant trips on low SG 4 level.) | |
| Pressurizer Level | Auctioneered Tavg | Low | Any switch position turn on all backup heaters. Charging flow reduced until no-load level reached. (Spray turned on when pressure rises to lower setpoint due to heaters). | |
| Pressurizer Pressure | Pressurizer Pressure (Interlock) | Low | Switch Position 1 - no control action; both PORVs stay closed. Switch Position 2 or 3 - no control action. PORV 455A stays closed. | |

TABLE Q420.5-6

LOSS OF POWER TO PROTECTION SET I

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | Turbine Pressure (Control) | Low | Steam dump demanded but blocked from interlock. | |
| Reactor Control | Power Range Flux (Control) | Low | If turbine pressure on control channel, rods in (safe direction), power decreases. If turbine pressure on interlock channel, stop turbine loading/defeat remote dispatching. | Bounding event is either excessive FW flow (FSAR 15.1.2), or loss of normal feedwater flow (FSAR 15.2.7), depending on channels used. Increased charging flow and pressurizer transients have little effect in comparison. |
| | Turbine Pressure (Control or Interlock) | Low | | |
| | Tavg (Loop 1) | Low | | |
| FW Control | Narrow Range Level (Any Loop) | Low | If affected level signal used for control, FCV opens in affected loop, FW flow increases (overrides steam flow signal). Otherwise, channel not connected, get decreased FW flow for loops with failed steam flow pressure compensation only. No effect on remaining loops. | |
| | Steam Flow Pressure Compensation (Any Loop) | Low | | |
| Pressurizer Level | Pressurizer Level (Control) | Low | If affected level signal used for control, charging flow increases, letdown isolated, heaters blocked. Otherwise, channel not connected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 455A) | Low | If affected pressure signal used for control, PORV 455A stays closed, back-up heaters on (but could be blocked on level signal, see above). Spray off. (PORV 456 available if required). Otherwise, channel not connected, no control action. | |

TABLE QA20.5-7

LOSS OF POWER TO PROTECTION SET II

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | Turbine Pressure (Interlock) | Low | No control action and steam dump unblocked. (If reactor trips, steam dump performs as designed.) | |
| Reactor Control | Power Range Flux (Control) | Low | If turbine pressure on control channel, rods in (safe direction), power decreases. If on interlock channel, stop turbine loading/defeat remote dispatching. Otherwise, no control action. | Bounding event is either excessive FW flow (FSAR 15.1.2), or loss of normal FW flow (FSAR 15.2.7), depending on channels used. |
| | Turbine Pressure (Control, Interlock, or both) | Low | | |
| | Tavg (Loop 2) | Low | | |
| FW Control | Narrow Range level (Any Loop) | Low | If affected level signal used for control, FCV opens in affected loop, FW flow increases (overrides steam flow signal). Otherwise, channel not connected, get decreased FW flow in loops with failed steam pressure compensation only. No effect on remaining loops. | |
| | Steam Flow Pressure Compensation (Any Loop) | Low | | |
| Pressurizer Level | Pressurizer Level (Interlock) | Low | If affected level signal used for interlock, block heaters and isolate letdown. Otherwise, channel not connected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 456) | Low | If affected pressure signal used for control, PORV 456 stays closed. (PORV 455A available if required). Otherwise, channel not connected, no control action. | |

TABLE Q420.5-8

LOSS OF POWER TO PROTECTION SET III

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | None | --- | No signals affected, no control action. | |
| Reactor Control | Power Range Flux (Control) | Low | No control action due to auctioneers. | Combining effects of pressurizer level and pressure control systems, could have either increasing charging flow with heaters off causing a depressurization, or else heaters cause pressure to increase until PORV 455A is actuated or until safety valve opens. Either way, event is bounded by inadvertent opening of a pressurizer safety or relief valve (FSAR 15.1.4) |
| | Tavg (Loop 3) | Low | | |
| FW Control | None | --- | No signals affected, no control action. | |
| Pressurizer Level | Pressurizer Level (Control or Interlock) | Low | If affected level signal used for control, charging flow increases, letdown isolated, heaters blocked. If used for interlock, heaters blocked and letdown isolated. Otherwise, channel not connected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (Control and Interlock) | Low | PORV 456 stays closed. If affected pressure signal used for control, PORV 455A stays closed, backup heaters on (if allowed by level signal, see above) and spray off. Otherwise, PORV 455A available if required. | |

TABLE Q420.5-9

LOSS OF POWER TO PROTECTION SET IV

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | None | --- | No signals affected, no control action. | |
| Reactor Control | Power Range Flux (Control) | Low | No control action due to auctioneers. | |
| | Tavg (Loop 4) | Low | | |
| FW Control | None | --- | No signals affected, no control action. | No event is initiated due to loss of power, therefore bounding event is not applicable. |
| Pressurizer Level | None | --- | No signals affected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (Control and Interlock) | Low | PORV 455A stays closed, PORV 456 available if needed. If affected pressure signal used for control, PORV 456 also stays closed. | |

TABLE Q420.5-10

LOSS OF POWER TO CONTROL GROUP 1

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | All (System Deenergized) | Off/ Closed | No initiating event, steam dump system unavailable. (If reactor trip occurs, SG atmosphere relief valves available.) | |
| Reactor Control | None | --- | No signals affected, no control action. | Bounding event is loss of normal FW flow (FSAR 15.2.7). (Plant trips on low level in SG 1.) |
| FW Control (SG 1) and FW Pump Speed Control | All (System Deenergized) | FW valve closes, pump speed decreases (auto mode only) | Loss of main FW in SG 1. If FW pump in auto mode, pump speed decreases causing FCV to open in SG 2, 3, and 4. (Plant trips on low level in SG 1.) | |
| Pressurizer level | None | --- | No signals affected, no control action | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 455A Control) | Closed | No initiating event, PORV 455A remains closed, heaters and spray remain off. (PORV 456 available if needed.) | |
| | Spray and Heater Actuation | Off | | |

TABLE Q420.5-11

LOSS OF POWER TO CONTROL GROUP 2

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | None | --- | No signals affected, no control action. | |
| Reactor Control | None | --- | No signals affected, no control action. | |
| FW Control (SG 2) | All (System Deenergized) | FW valve closes | Loss of main FW in SG 2. (Plant trips on low level in SG 2). | Bounding event is loss of normal FW flow (FSAR 15.2.7) (Plant trips on low level in SG 2). Increased charging flow would have little effect in comparison with loss of FW. |
| Pressurizer level | All (System Deenergized) | Off | Charging valve goes fully open, charging flow fully on, letdown isolated, heaters blocked. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 456 Control) | Closed | No initiating event, PORV 456 remains closed. (PORV 455A available if needed). | |

TABLE QA20.5-12

LOSS OF POWER TO CONTROL GROUP 3

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | None | --- | No signals affected, no control action. | |
| Reactor Control | None | --- | No signals affected, no control action. | |
| FW Control (SG 3) | All (System Deenergized) | FW valve closes | Loss of main FW in SG 3. (Plant trips on low level in SG 3). | Bounding event is loss of normal FW flow (FSAR 15.2.7) (Plant trips on low level in SG 3). |
| Pressurizer Level | None | --- | No signals affected, no control action. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 456 Interlock) | Closed | No initiating event, PORV 456 remains closed. (PORV 455A available if needed). | |

TABLE Q420.5-13

LOSS OF POWER TO CONTROL GROUP 4

| Control Systems Affected | Signals Affected | Failure Direction | Itemized Effects | Bounding Event |
|---|---|---|---|---|
| Steam Dump | Auctioneered Tavg | Low | No initiating event, steam dump system unavailable. (If reactor trip occurs, SG atmosphere relief valves available.) | |
| Reactor Control | All (System Deenergized) | Off | Rods stay stationary | |
| FW Control (SG 4) | All (System Deenergized) | FW valve closes | Loss of main FW in SG 4. (Plant trips on low level in SG 4). | Bounding event is loss of normal FW flow (FSAR 15.2.7) since decreased charging flow has little effect in comparison. (Plant trips on low SG 4 level). |
| Pressurizer Level | Auctioneered Tavg | Low | Charging flow decreases until no-load pressurizer level reached. | |
| Pressurizer Pressure | Pressurizer Pressure (PORV 455A Interlock) | Closed | No initiating event, PORV 455A remains closed. (PORV 456 available if needed.) | |

TABLE Q420.5-14

LOSS OF COMMON INSTRUMENT LINES
(Assumed Break in Line)

| Sensors | Failed Channels | Failure System | Direction | Bounding Effect | Accident |
|---|---|---|---|---|---|
| Loop Steam Flow and Narrow Range Level | I or II | Feedwater Control | Low<br>High | FW valve closes in affected SG; pump speed decreases | Bounding event is loss of normal FW (FSAR 15.1.2). |
| Pressurizer Level (Control) and Pressurizer Pressure (PORV 455A) | I (level and Pressure) | Pressurizer Level Control<br>Pressurizer Pressure Control | High<br>Low | PORV 455A stays closed. Spray unavailable. Charging flow decreases (Control). Backup heaters on (Control). (On low level, letdown isolated and heaters blocked from interlock channel). | This is depressurization event, which is bounded by inadvertent opening of a pressurizer safety or relief valve (FSAR 15.6.1). |
| Pressurizer Level (Interlock) and Pressurizer Pressure (PORV 456) | II (Level and Pressure) | Pressurizer Level Control<br>Pressurizer Pressure Control | High<br>Low | No level control action. PORV 456 stays closed. | Not applicable. |
| Pressurizer Level (Control or Interlock) and Pressurizer Pressure (either PORV) | III (Level)<br>III and IV (Pressure) | Pressurizer Level Control<br>Pressurizer Pressure Control | High<br>Low | PORV 455A and 456 stay closed. Spray unavailable if on Channel III. Charging flow decreases and backup heaters on if on control channel. No control action from interlock. (On low level, letdown isolated and heaters blocked from non-failed channel, either control or interlock). | Depending on switch positions, event is at most a depressurization event which is bounded by inadvertent opening of a pressurizer safety or relief valve (FSAR 15.6.1). |

Open Items

Instrumentation and Control Systems Branch

ICSB-20 Control System Failures Caused by Malfunctions of Common Power Source or Instrument Line (Draft SER Section 7.7.2.1)

To provide assurance that the FSAR Chapter 15 analyses adequately bounds events initiated by a single credible failure or malfunction, the staff asked the applicant to identify any power source or sensors that provide power or signals to two or more control functions, and demonstrate that failures or malfunctions of these power sources or sensors will not result in consequences more severe than those of Chapter 15 analyses or beyond the capability of operator or safety systems.

The applicant has not provided a response to this open item.

Response

Refer to the revised response to NRC Question 420.5.