

# The Light company

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April 3, 1985  
ST-HL-AE-1220  
File No.: G9.15

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South Texas Project  
Units 1 & 2  
Docket Nos. STN 50-498, STN 50-499  
FSAR Questions 032.42, 032.44 and 032.45

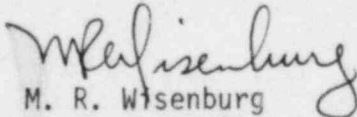
Dear Mr. Knighton:

In order to support resolution of questions from the NRC Instrumentation & Controls Systems Branch (ICSB) Review Meeting during the week of March 26, 1985 we are submitting the attached FSAR Question Responses for your use.

Each of these responses will be included in our FSAR Amendment 46. The intent of this additional letter submittal is to assist in ICSB's Draft SER review efforts.

If there are any questions please contact Mr. Michael E. Powell at (713) 993-1328.

Very truly yours,

  
M. R. Wisenburg  
Manager, Nuclear Licensing

CAA:y d

Attachments: 1) Response to Question 032.42  
2) Response to Question 032.44  
3) Response to Question 032.45

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Question 032.42

If reactor control and vital instruments derive power from common electrical distribution systems, the failure of such electrical distribution systems may result in an event requiring operator action concurrent with failure of important instrumentation upon which these operator actions should be based. This concern was addressed in IE Bulletin 79-27 (enclosed). On November 30, 1979, IE Bulletin 79-27 was sent to operating license (OL) holders, the near term OL applicants (North Anna 2, Diablo Canyon, McGuire, Salem 2, Sequoyah, and Zimmer), and other holders of construction permits (CP), including South Texas Project. Of these recipients, the CP holders were not given explicit direction for making a submittal as part of the licensing review. However, they were informed that the issue would be addressed later.

You are requested to address these issues by taking IE Bulletin 79-27 Actions 1 thru 3 under "Actions to be Taken by Licensees". Within the response time called for in the attached transmittal letter, complete the review and evaluation required by Actions 1 thru 3 and provide a written response describing your reviews and actions.

## RESPONSE

The responses to each action item of IE Bulletin 79-27 are given below by action item number.

1. A review of the instrumentation and control systems which could affect the ability to achieve a hot standby condition (see Section 7.4) and a cold shutdown condition (see Appendix 5.4A) has been performed. Each of these systems is supplied power from one of the redundant Class 1E 120 vac or 125 vdc buses. Refer to Figure 8.3-3.

The Class 1E 120 vac power is provided from one of the six 120 volt vital ac channel distribution panels. Each panel is supplied power through manual transfer circuit breakers from an individual inverter. There are two panels each for Channels I and IV and one panel each for Channels II and III. See also Section 8.3.1.1.4.5.

The Class 1E 125 vdc power is provided from one of the four 125 vdc distribution switchboards. Each switchboard is connected to a separate battery and two battery chargers. See also Section 8.3.2.1.1.

Turbine, non-safety-related reactor and other non-safety-related instrumentation and control systems are provided power from non-Class 1E panels and switchboards. Refer to Figure 8.3-3. The non-Class 1E 120 vac power for the EAB is provided from one of two 120 volt vital ac distribution panels, each connected to an automatic transfer switch and an individual inverter. Another 120 volt vital ac distribution panel is provided in the TGB; this panel is connected to an inverter package with an internal static transfer switch. Two 120 vac regulated power distribution panels are also provided for non-Class 1E instrumentation and control systems.

The non-Class 1E 125 vdc power is provided from two 125 vdc distribution switchboards, each connected to one battery and two battery chargers. A 48 vdc distribution switchboard supplying power only to the plant annunciator system is connected to one battery and two battery chargers. A non-Class 1E 250 vdc distribution switchboard is provided in the TGB, serving motors and the main generator breaker control panels; it is connected to one battery and two battery chargers.

A separate non-Class 1E uninterruptible power supply system (120 vac) is provided for the plant computer. The ERF computer is powered from non-Class 1E 480 vac and has an uninterruptible power supply system to support its functions during a loss of power.

The Radiation Monitoring System (RMS) computer is powered from non-Class 1E 480 vac and has an uninterruptible power supply system to support its functions during a loss of power.

Non-Class 1E power is not required to support the ability to achieve hot standby or cold shutdown conditions. However, the non-Class 1E power supports indications to the operator (such as computer alarms and annunciation) of abnormal conditions and control systems normally used during plant operating modes.

1a. Loss of power to each of the six Class 1E 120 volt vital ac distribution panel buses is alarmed individually in the control room on a window of the ESF status monitoring system. A ground fault on any of these panel buses is alarmed individually on a window of the plant annunciator as Panel Trouble. The ERF computer also indicates that a loss of power or a ground fault has occurred. Alarms are provided for each inverter through the ERF computer and either the annunciator or the ESF status monitoring system.

Loss of power to each of the four Class 1E 125 vdc distribution switchboard buses is alarmed individually in the control room on a reflash window of the plant annunciator, along with other bus and battery charger alarms, as System Trouble. The ERF computer indicates whether bus or charger trouble has occurred.

Loss of power or a ground fault to the two EAB non-Class 1E 120 volt vital ac distribution panel buses is alarmed individually in the control room through the plant computer. Alarms are provided for each inverter through the annunciator and the plant computer.

Loss of power or a ground fault to the TGB non-Class 1E 120 volt vital ac distribution panel bus is alarmed in the control room through the plant computer. Inverter/rectifier alarms are provided through the plant computer and the annunciator.

Loss of power to either of the two non-Class 1E 120 vac regulated power distribution panel buses is alarmed in the control room through the plant computer.

Loss of power to either of the two non-Class 1E 125 vdc switchboard buses is alarmed individually in the control room on a reflash window of the plant annunciator, along with other bus and battery charger alarms, as System Trouble. The plant computer indicates whether bus or charger trouble has occurred.

Loss of power to the non-Class 1E 48 vdc switchboard bus is alarmed in the control room via the plant computer. Other bus and battery charger alarms are provided on a reflash window of the plant annunciator as System Trouble. The plant computer indicates whether bus or charger trouble has occurred.

Loss of power to the non-Class 1E 250 vdc switchboard bus is alarmed in the control room on a reflash window of the plant annunciator, along with other bus and battery charger alarms, as System Trouble. The plant computer indicates whether bus or charger trouble has occurred.

Loss of power or a ground fault to the non-Class 1E 120 vac distribution panel bus for the plant computer is alarmed in the control room. Various battery, charger and inverter alarms for the computer UPS are given in the control room on two reflash windows of the plant annunciator, one for Battery/Charger Trouble and one for Inverter Failure. The ERF computer indicates which signal caused the annunciator alarm.

A description of the alarms for loss of power to the ERF computer and to the RMS computer will be provided later.

1b. The review and evaluation of the Class 1E and non-Class 1E buses described above indicate that loss of power to any one instrumentation and control bus will not inhibit the ability to achieve a cold shutdown condition.

1c. The review and evaluation indicate that design modifications are not required.

2. The operating procedures used by control room operators will be reviewed with respect to loss of power to each Class 1E and non-Class 1E bus supplying power to instrumentation and control systems.

2a. The procedures will define symptoms and specify actions to be taken by the operators upon loss of power to Class 1E or non-Class 1E instrumentation and control systems.

2b. Where necessary, the procedures will specify alternate instrumentation and control circuits for use by operators.

2c. The procedures will include methods and precautions for restoring power to each Class 1E and non-Class 1E bus supplying power to instrumentation and control systems.

Should any design modifications or administrative controls be required as a result of the development of these procedures, descriptions of these will be provided.

3. IE Circular No. 79-02 has been reviewed in relation to the safety-related power supply inverters. All safety-related power supply inverters are Class 1E. For these inverters, relative to the Circular requirements:

- a. Class 1E inverters do not use time delay circuitry.
- b. The ac input to each Class 1E inverter is to a transformer/rectifier section. The transformer has taps that will be set according to the recommendations of the manufacturer. A relay trips the transformer/rectifier supply circuit breaker if overvoltage occurs.
- c. The alternate 120 volt source is supplied by manual operation of interlocked circuit breakers. This manual bypass of the Class 1E inverters allows maintenance to be performed.
- d. Administrative controls will confirm the position of transformer taps and manual bypass circuit breakers when maintenance or testing have been completed.

No design modifications or additional administrative controls are required.

Question 032.44

Operating reactor licensees were informed by IE Information Notice 79-22, issued September 19, 1979, that certain non-safety grade or control equipment, if subjected to the adverse environment of a high energy line break, could impact the safety analyses and the adequacy of the protection functions performed by the safety grade equipment. Enclosed is a copy of IE Information Notice 79-22, and reprinted copies of an August 20, 1979 Westinghouse letter and a September 10, 1979 Public Service Electric and Gas Company letter which address this matter. Operating Reactor licensees conducted reviews to determine whether such problems could exist at operating facilities.

We are concerned that a similar potential may exist at light water facilities now under construction. You are, therefore, requested to perform a review to determine what, if any, design changes or operator actions would be necessary to assure that high energy line breaks will not cause control system failures to complicate the event beyond your FSAR analysis. Provide the results of your reviews including all identified problems and the manner in which you have resolved them to NRR.

The specific "scenarios" discussed in the above referenced Westinghouse letter are to be considered as examples of the kinds of interactions which might occur. Your review should include those scenarios, where applicable, but should not necessarily be limited to them. Applicants with other LWR designs should consider analogous interactions as relevant to their designs.

Response

IE Information Notice 79-22 specifically identified four (4) potential interaction scenarios between non-safety grade and safety grade equipment which could occur because of the effect of an adverse environment following a high energy line break. The four systems identified are:

- Steam Generator PORV Control System
- Pressurizer PORV Control System
- Main Feedwater Control System
- Automatic Rod Control System

A discussion of each scenario and affected system and its applicability to STP follows.

It has been postulated that a failure of the steam generator PORV control system, due to adverse environment following a feedline rupture, could cause a depressurization of the unaffected steam generators. The STP steam generator PORV system is a Class 1E system. In addition, all portions of the steam generator PORV system that could be exposed to an

adverse environment are isolated in the IVC structure on a loop-by-loop basis. Only one PORV could be affected by adverse conditions and that PORV would be in the affected steam generator loop. For these reasons, the scenario concerning the steam generator PORV control system is not applicable to STP.

The second scenario assumes that the pressurizer PORV's fail in the open position, due to an adverse environment following a feedline rupture. This would cause a depressurization of the Reactor Coolant System, which may result in a voiding of the RCS and potentially uncovering the core. However, all portions of the pressurizer PORV control system located inside Containment have been environmentally qualified for the adverse environment. For this reason, the scenario involving the pressurizer PORV control system is not applicable to STP.

The third scenario assumes a failure of the main feedwater control system, due to adverse environment following a small feedline rupture which occurs between the main feedline check valve and the Containment penetration. Such a failure could cause the liquid mass in the intact steam generators at the time of reactor trip to be less than was assumed in the FSAR analysis. The STP steam flow and steam generator water level transmitters are located within the Containment and are environmentally qualified for the adverse environment. The feedwater flow transmitters are located inside the Turbine Generator Building and the feedwater process controls are located in the Mechanical and Electrical Auxiliary Building. Because of their respective locations, the transmitters and the feedwater controls would not be exposed to an adverse environment following a feedline rupture between the main feedline check valve and the Containment penetration. In addition, the feedwater isolation valves and associated instrumentation are compartmentalized by loop within the isolation valve cubicle, thus restricting exposure to the harsh environment to the loop with the break. For these reasons, the scenario involving a failure of the main feedwater control system is not applicable to STP.

The fourth scenario assumes that the automatic rod control system fails, due to adverse environment following a small steamline rupture, in such a way that the control rods begin stepping out prior to receipt of a reactor trip signal on overpower delta-T. This could result in a DNB ratio less than the limiting value. For a steamline rupture, the excore detectors which supply input to the rod control system could be exposed to the adverse environment and initiate rod withdrawal. In STP, these excore detectors (and associated safety-related equipment) are part of the reactor trip system and have been environmentally qualified for a limited period of time (5 minutes) after a MSLB. For this reason, the scenario involving the automatic rod control system for a steamline rupture is not applicable to STP.



Question 032.45

The analyses reported in Chapter 15 of the FSAR are intended to demonstrate the adequacy of safety systems in mitigating anticipated operational occurrences 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:

- (1) Identify those control systems whose failure or malfunction could seriously impact plant safety.
- (2) Indicate which, if any, of the control systems identified in (1) 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.
- (3) Indicate which, if any, of the control systems identified in (1) 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.
- (4) Provide justification that any simultaneous malfunctions of the control systems unidentified in (2) and (3) 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

The evaluation required to answer this 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 common instrument line
- c) Loss of power to all systems powered by a single power supply system (f.e. single inverter)
- d) Loss of power to individual protection, control, or auxiliary process cabinets

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

- 1) Reactor control system
- 2) Steam dump system
- 3) Pressurizer pressure control system
- 4) Pressurizer level control system
- 5) Feedwater control system

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

The results of the analysis indicate that, for any of the postulated events considered in a) through d) above, the ANS Condition II accident analyses given in Chapter 15 of the South Texas FSAR are bounding.

LOSS OF ANY SINGLE INSTRUMENT (Item a)

Table Q032.45-1, 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 failures 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 (Items c and d)

The South Texas NSSS instrument power supply consists of eight instrument distribution panels receiving power through eight inverters hereafter labelled I through VIII for convenience. Figure Q032.45-1 provides a schematic of the power distribution arrangement. As shown, the instrumentation which comprises Protection Set I is housed in Protection Cabinets 1 and 1A. Similarly, the instrumentation for Protection Sets II and III is assigned to Protection Cabinets 2/2A and 3/3A respectively. Protection Set IV instrumentation resides in a single cabinet. The Control Groups are assigned to four separate cabinets powered from two non Class 1E inverters. Finally, four additional Auxiliary Process Cabinets are shown. These cabinets are part of the Qualified Display Processing System (QDPS). They are considered in this analysis because a few of the signals of interest (specifically, charging flow, pressurizer water level, and narrow range steam generator water level) are routed from the field to these cabinets first and are then passed on to the NSSS 7300 process cabinets. As indicated in the schematic, the Auxiliary Process Cabinets are aligned in a channel oriented manner corresponding to the associated protection channels so as to maintain separation; the signal channels are assigned and routed accordingly.

Tables Q032.45-13 through Q032.45-20, Loss of Power to Inverters I through VIII respectively, analyze the effects on the control systems caused by the most limiting failure, loss of power to an entire instrument distribution panel. The control systems affected, the sensors affected, the failure direction, the control system responses, and the bounding FSAR accident are given in the tables. Where no control action occurs or where control action is in a safe direction, no bounding accident is given.

Besides the loss of an inverter, there is also a chance of losing power to a single control cabinet, protection cabinet, or auxiliary process cabinet (for example, through the failure of a fuse or circuit breaker). The consequences of a loss of power to a protection cabinet are tabulated in Tables Q032.45-2 through Q032.45-8. Loss of power to a control cabinet (group) is addressed in Tables Q032.45-9 through Q032.45-12. Finally, Tables Q032.45-21 and Q032.45-22 consider loss of power to the individual auxiliary process cabinets not covered by the loss of an inverter analyses. In each case, the data is presented in a similar manner to that for the loss of an inverter described in the previous paragraph. Loss of power to individual NIS channels is not explicitly considered since the responses are identical to the low failure of an individual NIS instrument in Table Q032.45-1.

Besides the loss of power to an entire cabinet, 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 is used 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 Q032.45-1.

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

BREAK OF COMMON INSTRUMENT LINES (Item b)

Table Q032.45-23, 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 as indicated below:

- 1) Loop steam flow (control groups 1 and 2 for each steam generator) and narrow range steam generator water level (Protection Sets I and II for each steam generator). Each control group 1 flow sensor considered shares a tap with a Protection Set I level sensor; each control group 2 flow sensor shares a tap with a Protection Set II level sensor.
- 2) Pressurizer water level and pressurizer pressure (Protection Sets I, II, III, or IV). The level and pressure sensors on common taps are in the same protection set.

Table Q032.45-23 shows that in the event of a common instrument line break, the Condition II events itemized in FSAR Chapter 15 are bounding.

Not shown on the table since they are not part of the plant control system but are used just for protection are the RCS 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

really not 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 building of sludge is a slow process, any buildup would be detected during response time testing done during shutdown. Therefore, the hypothesis of 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 (e.g. flow induced noise in flow channels) or slight controller action (e.g. cycling operation of spray and heaters in the pressurizer). By a comparison of the static channel to the redundant unblocked channels, the operator would be informed that a blockage in one channel has occurred.

#### CONCLUSIONS

The accompanying tables have illustrated that failures of individual sensors, losses of power to inverters, losses of power to individual protection, control, and auxiliary process cabinets, 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.

LIST OF TABLES

Table No.

- Q032.45-1 - Loss of Any Single Instrument
- Q032.45-2 - Loss of Power to Protection Cabinet 1
- Q032.45-3 - Loss of Power to Protection Cabinet 1A
- Q032.45-4 - Loss of Power to Protection Cabinet 2
- Q032.45-5 - Loss of Power to Protection Cabinet 2A
- Q032.45-6 - Loss of Power to Protection Cabinet 3
- Q032.45-7 - Loss of Power to Protection Cabinet 3A
- Q032.45-8 - Loss of Power to Protection Cabinet 4
- Q032.45-9 - Loss of Power to Control Group 1
- Q032.45-10 - Loss of Power to Control Group 2
- Q032.45-11 - Loss of Power to Control Group 3
- Q032.45-12 - Loss of Power to Control Group 4
- Q032.45-13 - Loss of Power to Inverter I (Protection Cabinets 1 and 1A, NIS Channel I)
- Q032.45-14 - Loss of Power to Inverter II (Protection Cabinets 2 and 2A, NIS Channel II, Aux. Process Cabinet II)
- Q032.45-15 - Loss of Power to Inverter III (Protection Cabinets 3 and 3A, NIS Channel III, Aux. Process Cabinet III)
- Q032.45-16 - Loss of Power to Inverter IV (Protection Cabinet 4, NIS Channel IV)
- Q032.45-17 - Loss of Power to Inverter V (Control Groups 1 and 3)
- Q032.45-18 - Loss of Power to Inverter VI (Aux. Process Cabinet I)
- Q032.45-19 - Loss of Power to Inverter VII (Aux. Process Cabinet IV)
- Q032.45-20 - Loss of Power to Inverter VIII (Control Groups 2 and 4)
- Q032.45-21 - Loss of Power to Aux. Process Cabinet II
- Q032.45-22 - Loss of Power to Aux. Process Cabinet III
- Q032.45-23 - Loss of Common Instrument Lines

FIGURE Q032.45-1  
SIMPLIFIED SCHEMATIC OF SOUTH TEXAS NSSS POWER DISTRIBUTION ARRANGEMENT  
(note 3)

INVERTER I  
Class 1E  
7.5 KVA  
(3E241EIV1201)

--Protection Cabinet 1 (note 1)  
--Protection Cabinet 1A  
--NIS Channel I

INVERTER II  
Class 1E  
7.5 KVA  
(3E241EIV1202)

--Protection Cabinet 2  
--Protection Cabinet 2A  
--NIS Channel II  
--Aux. Process Cabinet II

INVERTER III  
Class 1E  
7.5 KVA  
(3E241EIV1203)

--Protection Cabinet 3  
--Protection Cabinet 3A  
--NIS Channel III  
--Aux. Process Cabinet III

INVERTER IV  
Class 1E  
7.5 KVA  
(3E241EIV1204)

--Protection Cabinet 4  
--NIS Channel IV

INVERTER V  
Non 1E  
25 KVA  
(8E241EIV002)

--Control Cabinet 1 (note 2)  
--Control Cabinet 3

INVERTER VI  
Class 1E  
25 KVA  
(3E241EIV001)

--Aux. Process Cabinet I

INVERTER VII  
Class 1E  
25 KVA  
(3E241EIV002)

--Aux. Process Cabinet IV

INVERTER VIII  
Non 1E  
25 KVA  
(8E241EIV001)

--Control Cabinet 2  
--Control Cabinet 4

NOTES:

- 1) Protection cabinets 1/1A,2/2A,3/3A comprise Protection Sets I/II/III respectively.
- 2) Control cabinets also referred to as 'Control Groups'.
- 3) Only cabinets of interest are shown.



TABLE Q032.45-1

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 1 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRTY I</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
Feedpump Discharge Pressure	1 per plant	_____	o Feedwater Control	Lo	FW pump speed increases if in auto mode. (FW control valves close due to increased flow if in auto mode.)	If FW pump in manual - no event. If FW pump and FCVs in auto - new steady state w/higher pump speed and decreasing FCV lift. If FW pump in auto and FCVs in manual - bounding event is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
				Hi	FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode).	If FW pump in manual - no event. Other modes result in a decreased FW flow over time, hence bounding event is Loss of Normal FW Flow (Section 15.2.7)
Steam Header Pressure	1 per plant	_____	o Feedwater Control o Steam Dump (T <sub>avg</sub> Mode)	Lo	FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode).	If FW pump in manual - no event. Other modes result in a decreased FW flow over time, hence bounding event is Loss of Normal FW Flow (Section 15.2.7)

TABLE Q032.45-1 (Continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 2 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				Hi	FW pump speed increases if in auto mode. (FW control valves close due to increased flow if in auto mode).	If FW pump in manual - no event. If FW pump and FCVs in auto - new steady state w/higher pump speed and decreasing FCV lift. If FW pump in auto and FCVs in manual - bounding event is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
Steam Header Pressure	1 per plant	_____	<ul style="list-style-type: none"> <li>o Feedwater Control</li> <li>o Steam Dump (Pressure Mode)</li> </ul>	Lo	FW pump speed decreases if in auto mode. (FW control valves open due to decreased flow if in auto mode).	If FW pump in manual - no event. Other modes result in a decreased FW flow over time, hence bounding event is Loss of Normal FW Flow (Section 15.2.7)

TABLE Q032.45-1 (Continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 3 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				H1	FW pump speed increases if in auto mode. (FW control valves close due to increased flow if in auto mode). Dump valves open unless steam dump blocked on 1o-1o T <sub>avg</sub> (P-12).	Steam dump in pressure mode at hot standby or very low power only. Hence, dump valves will open for only a very short time, until 1o-1o T <sub>avg</sub> (P-12) is reached. If FW pump is in manual or FW pump and FCVs in auto, then this event is bounded by Excessive Increase in Secondary Steam Flow (Section 15.1.3). If FW pump in auto and FCV in manual, result is increase in FW flow causing excessive cooling. Bounding event is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)

TABLE Q032.45-1 (Continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 4 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
Loop Steam Flow	2 per loop	1 selected for control	o Feedwater Control	Lo	FW pump speed decreases if in auto mode. FW control valves close if in auto mode.	If FW pump and FCV in manual - no event. Other modes result in decreased FW flow; bounding event is Loss of Normal FW Flow (Section 15.2.7)
				H1	FW pump speed increases if in auto mode. FW control valves open if in auto mode.	If FW pump and FCV in manual - no event. Other modes result in increased FW flow; bounding event is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
Loop FW Flow	2 per loop	1 selected for control	o Feedwater Control	Lo	FW control valve opens if in auto mode	If FCV in manual - no event. If FCV in auto, result is bounded by FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 5 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				Hi	FW control valve closes if in auto mode	If FCV in manual - no event. If FCV in auto, result is decreased FW flow. Bounding event is Loss of Normal FW Flow (Section 15.2.7)
Steam Generator Narrow Range Water Level	4 per Steam Generator (two available for control)	1 selected for control (I or II)	o Feedwater Control	Lo	FW control valve opens if in auto mode	If FCV in manual - no event. If FCV in auto, bounding event is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
				Hi	FW control valve closes if in auto mode.	If FCV in manual - no event. If FCV in auto, result is decreased FW flow. Bounding event is Loss of Normal FW Flow (Section 15.2.7)
Pressurizer Water Level (Control)	4 per plant	1 selected for control (I or III)	o Pressurizer Level Control	Lo	Charging flow increases. Heaters turn off (except for local control). If Channel I is failed, letdown isolated by Channel I protection signal (VCT empties, charging pumps take suction from RWST.)	Bounding event is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2)

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 6 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				HI	Charging flow decreases. Backup heaters on (Later, let-down isolation from Channel IV protection signal, heaters blocked from interlock channel.)	While heaters are on, no net depressurization of RCS. After heaters are blocked, decreased charging flow acts to depressurize RCS. Depressurization event is therefore bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1)
Pressurizer Water Level (Interlock)	3 per plant	1 selected for control (II or III)	o Pressurizer Level Control	Lo	Pressurizer heaters blocked (except for local control).	No event.
				HI	No control action, get high level annunciation.	Not applicable
Pressurizer Water Level (Protection Grade Action Only)	4 per plant	IV	o Pressurizer Level Control (Letdown Isolation)	Lo	Letdown isolated.	Bounding event is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2)
				HI	No control action.	Not applicable.

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 7 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>ASSUMED FAILURE SYSTEM</u>	<u>DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
Charging Flow	1 per plant	I	o Pressurizer Level Control	Lo	Charging flow increases until integral controller on level error generates zero flow demand.	New steady state reached at high level. Depending on magnitude of level increase, bounding event is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2).
				Hi	Charging flow decreases until integral controller on level error generates maximum flow demand; possibly letdown isolation on low level.	New steady state reached at low level; transient mitigated on letdown isolation. No event.
Pressurizer Pressure	4 per plant	I	o Pressurizer Pressure Control (Pos. 1 or 2)*	Lo	PORV PCV-655A blocked. Spray remains off. All back-up heaters on.	Heaters being on causes increase in pressurizer pressure to PORV PCV-656A actuation. No event.
				Hi	Variable heaters turned off. PORV PCV-655A opens, blocked on low pressure due to interlock. Spray turned on.	Result is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1)

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 8 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>ASSUMED FAILURE SYSTEM</u>	<u>DIRECTION</u>	<u>BOUNDING EFFECT</u>	<u>EVENT</u>
Pressurizer Pressure	4 per plant	II	o Pressurizer Pressure Control (Pos. 2 or 3)*	Lo	No control action. PORV PCV-656A blocked from opening. PORV PCV-655A still available for normal control.	Not applicable
				Hi	PORV PCV-656A opens, closes when pressure falls below interlock setpoint.	Result is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1)
Pressurizer Pressure	4 per plant	III	o Pressurizer Pressure Control	Lo	PORV PCV-656A blocked. If channel III selected for control, PORV PCV-655A also blocked, spray remains off, and all back-up heaters turn on.	Heaters being on causes increase in pressurizer pressure possibly to safety valve actuation. Result is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1).
				Hi	PORV PCV-656A unblocked. If channel III selected for control, PORV PCV-655A opens, blocked on low pressure due to interlock, spray turned on and variable heaters turned off.	Result is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1)



TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 9 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>	
Pressurizer Pressure	4 per plant	IV	o Pressurizer Pressure Control	Lo	No control action. PORV PCV-655A blocked from opening. If channel IV selected for control, PORV PCV-656A also blocked.	Not applicable	
				Hi	PORV PCV-655A unblocked. If channel IV selected for control, PORV PCV-656A opens, closes when pressure falls below interlock set-point.	Result is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1)	
T <sub>avg</sub>	one per loop	Any	Auct. ____	o Turbine Loading	Lo	Stop turbine loading (C-17); annunciation occurs.	Not applicable
			Lo				
			Auct. ____	o Steam Dump (T <sub>avg</sub> Mode)	Hi	Rods in (safe direction). Charging flow increases until full power pressurizer water level is reached (if at reduced power). If reactor trips, steam dump enabled and dump valves open. Steam dump stops when low-low T <sub>avg</sub> is reached.	No event unless reactor trips, then dump valves open and bounding event is Excessive Increase in Secondary Steam Flow (Section 15.1.3)
			Hi	o Reactor Control			
				o Pressurizer Level Control			

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 10 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
T <sub>avg</sub>	one per loop	Any	o Turbine Loading	Lo	Stop turbine loading (C-17); annunciation occurs	Not applicable
		Auct. _____ Lo				
		Auct. _____ Hi	o Steam Dump	Hi	Rods in (safe direction). Charging flow increases until full power pressurizer water level is reached (if at reduced power).	Steady state reached at full power pressurizer water level.
			o Reactor Control	Hi		No event.
		o Pressurizer Level Control				
Turbine Impulse Chamber Pressure	2 per plant	I (Control)	o Steam Dump (T <sub>avg</sub> Mode) o Reactor Control o FW Control	Lo	Rods in (safe direction). Steam dump signaled to open but is blocked by interlock. (If reactor trip occurs, steam dump unblocked and dump valves modulate until no load T <sub>avg</sub> is reached). No effect on FW Control since SG level program is constant. If selector switch in normal position, auto rod withdrawal blocked (C-5). If switch in	Not applicable

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 11 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
					alternate position, no effect on rod block.	
				HI	Stop turbine loading (C-17). Rods out until blocked by high flux, overpower or over-temperature rod stop, or until programmed $T_{ref}$ limit is reached. If reactor trip occurs, steam dump unblocked and dump valves open until no load $T_{avg}$ is reached. No effect on FW Control since SG level program is constant.	Result is bounded by Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (Section 15.4.2)
Turbine Impulse Chamber Pressure	2 per plant	I (Control)	o Steam Dump (Pressure Mode) o Reactor Control o FW Control	Lo	Rods in, (safe direction). No effect on FW control since SG level program is constant. If selector switch in normal position, auto rod withdrawal blocked (C-5). If switch in alternate position, no effect on rod block.	Not applicable

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 12 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				Hi	Stop turbine loading (C-17). Rods out until blocked by high flux, overpower or over-temperature rod stop. (Steam dump valves open if required to keep steam header pressure at or below setpoint.) No effect on FW control since SG level program is constant.	Result is bounded by Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (Section 15.4.2).
Turbine Impulse Chamber Pressure	2 per plant	II (Interlock)	o Steam Dump (T <sub>avg</sub> Mode)	Lo	Unblock steam dump. If selector switch in alternate position, auto rod withdrawal blocked (C-5). If switch in normal position, no effect on rod block.	Not applicable
				Hi	Steam dump on turbine trip only; steam dump blocked on load rejection.	Not applicable
Turbine Impulse Chamber Pressure	2 per plant	II (Interlock)	o Steam Dump (Pressure Mode)	Lo or Hi	Steam dump functions normally. If selector switch in alternate position, auto rod withdrawal blocked (C-5). If switch in normal position, no effect on rod block.	Not applicable

TABLE Q032 45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 13 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
Power Range Flux	4 per plant	Any	<ul style="list-style-type: none"> <li>o Reactor Control</li> <li>o FW Control</li> </ul>	Lo	No control action.	Not applicable
				Hi	Auto and manual rod withdrawal blocked (C-2), rods in (safe direction). FW bypass control valves open if in auto. (If reactor trip occurs, dump valves open until no-load $T_{avg}$ is reached.) Rising SG water level causes main FW valves to close until steam and feed flows match.	Steady-state reached with higher SG water level. No event.
$T_{avg}$ High Auctioneer	1 per plant	—	<ul style="list-style-type: none"> <li>o Steam Dump</li> <li>o Reactor Control</li> <li>o Pressurizer Level Control</li> </ul>	Lo	Steam dump blocked ( $T_{avg}$ mode). Backup hrs. on, charging flow decreases till no-load pressurizer water level reached. Rods out, $T_{avg}$ and core power increase until blocked by high flux, overpower or overtemperature rod stop.	Result is bounded by Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (Section 15.2.2)
				Hi	Identical to $T_{avg}$ channel failing high, see analysis above (sheet 9).	See above

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 14 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
Power Range Flux High Auctioneer	1 per plant	_____	o Reactor Control o Feedwater Control (bypass valves)	Lo	Rods out, $T_{avg}$ and core power increase until blocked by high flux, overpower or overtemperature rod stop. If FW bypass control valve in auto (typically low power levels, 0-25%), valve closes initially; SG water level restored by automatic re-opening of bypass control valve on level error.	Result is bounded by Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (Section 15.2.2); FW flow transient is small in comparison.
				Hi	Identical to Power Range Flux channel failing high; see analysis above (sheet 13).	
Condenser Available	1 per plant	_____	o Steam Dump	Lo	No control action-steam dump blocked, condenser unavailable.	Not applicable
				Hi	No control action-steam dump unblocked, condenser available.	
Steam Flow Pressure Compensator	2 per loop	Control Channel	o Steam Flow	Lo	Identical to Loop Steam Flow channel failing low. See analysis above (sheet 4).	See above

TABLE Q032.45-1 (continued)

LOSS OF ANY SINGLE INSTRUMENT  
 (Sheet 15 of 15)

<u>SENSOR</u>	<u>NUMBER OF CHANNELS</u>	<u>FAILED CHANNEL</u>	<u>SYSTEM</u>	<u>ASSUMED FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING EVENT</u>
				HI	Identical to Loop Steam Flow channel failing high. See analysis above (sheet 4).	See above

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\* Signals for pressurizer water level, pressurizer pressure, and turbine impulse chamber pressure can be obtained from different channels. Channel selection is achieved by manual switches in the control room. Resulting effect due to failed instrument is dependent on switch positions.

TABLE Q032.45-2

LOSS OF POWER TO PROTECTION CABINET 1

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o Turbine Impulse Chamber Pressure (Control)	Low	Steam dump demanded but blocked from interlock. (If reactor trips, steam dump performs as designed).	Bounding event for loss of cabinet power is either FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2), or Loss of Normal Feedwater Flow (Section 15.2.7), depending on channels used. Increased charging flow and pressurizer transients have little effect in comparison.
	o T <sub>avg</sub> (Loop 1)	Low	No control action from T <sub>avg</sub> due to auctioneer.	
Reactor Control	o Turbine Impulse Chamber Pressure (Control)	Low	Rods in (safe direction), power decreases. Stop turbine loading (C-17).	
	o TAVG (Loop 1)	Low	If turbine impulse chamber pressure switch in normal position, auto rod withdrawal blocked (C-5).	
FW Control	o Narrow Range SG Water Level (Any Loop)	Low	Depending on the relative switch positions in each loop for steam flow and narrow-range SG water level, FW valves could open, close, or remain fixed; thus, a FW transient may occur in these loops.	
	o Steam Flow Pressure Compensation (Any Loop)	Low		



TABLE Q032.45-2 (Continued)

LOSS OF POWER TO PROTECTION CABINET 1

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Pressurizer Level	o Pressurizer Water Level (Control)	Low	No control action on $T_{avg}$ due to auctioneer. If affected level signal used for control, charging flow increases and heaters blocked.	
	o $T_{avg}$ (Loop 1)	Low	Otherwise, level channel not connected. Due to low flow signal, charging flow increases until integral controller on level error generates zero flow demand and a new steady state is reached.	
	o Charging Flow	Low		
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-655A)	Low	If affected pressure signal used for control, PORV PCV-655A stays closed, back-up heaters on (but could be blocked on level signal, see above). Spray off. (PORV PCV-656A available if required.) Otherwise, channel not connected, no control action.	

TABLE Q032.45-3

LOSS OF POWER TO PROTECTION CABINET 1A

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	---	No signals affected, no control action.	
Reactor Control	o None	---	No signals affected, no control action.	Bounding event for loss of cabinet power is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
FW Control	o Feedwater Flow (any loop)	Low	If failed FW channel selected for control, FCV opens. Otherwise, no control action.	
Pressurizer Level	o None	---	No signals affected, no control action.	
Pressurizer Pressure	o None	---	No signals affected, no control action.	

TABLE Q032.45-4

LOSS OF POWER TO PROTECTION CABINET 2

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o Turbine Impulse Chamber Pressure (Interlock) o T <sub>avg</sub> (Loop 2)	Low	Steam dump unblocked. (If reactor trips, steam dump performs as designed.) No control action from T <sub>avg</sub> due to auctioneer.	Bounding event for loss of cabinet power is either FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2), or Loss of Normal FW Flow (Section 15.2.7), depending on channels used.
Reactor Control	o T <sub>avg</sub> (Loop 2)	Low	No control action due to auctioneering of T <sub>avg</sub> . Stop turbine loading (C-17).	
FW Control	o Narrow Range SG Water Level (Any Loop) o Steam Flow Pressure Compensation (Any Loop)	Low	Depending on the relative switch positions in each loop for steam flow and narrow-range SG water level, FW valves could open, close, or remain fixed; thus, a FW transient may occur in these loops.	
Pressurizer Level	o Pressurizer Water Level (Interlock) o T <sub>avg</sub> (Loop 2)	Low	If affected level signal used for interlock, block heaters; otherwise, channel not connected, no control action. No control action on T <sub>avg</sub> due to auctioneer.	
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-656A)	Low	If affected pressure signal used for control, PORV PCV-656A stays closed. (PORV PCV-655A available if required.) Otherwise, channel not connected, no control action.	

TABLE Q032.45-5

LOSS OF POWER TO PROTECTION CABINET 2A

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o None	--	No signals affected, no control action.	Bounding event for loss of cabinet power is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2)
Reactor Control	o None	--	No signals affected, no control action.	
FW Control	o Feedwater Flow (any loop)	Low	If failed FW channel selected for control, FCV opens. Otherwise, no control action.	
Pressurizer Level	o None	--	No signals affected, no control action.	
Pressurizer Pressure	o None	--	No signals affected, no control action.	

TABLE Q032.45-6

LOSS OF POWER TO PROTECTION CABINET 3

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o $T_{avg}$ (Loop 3)	Low	No control action due to auctioneer.	
Reactor Control	o $T_{avg}$ (Loop 3)	Low	No control action due to auctioneer. Stop turbine loading (C-17).	Combining effects of pressurizer level and pressure control systems, could have either increasing charging flow with heater off causing a depressurization, or else heaters cause pressure to increase until safety valve opens.
FW Control	o None	--	No signals affected, no control action.	In one case, event is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1). For the other case, bounding event for loss of cabinet power is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2).
Pressurizer Level	o Pressurizer Water Level (Control or Interlock) o $T_{avg}$ (Loop 3)	Low	If affected level signal used for control, charging flow increases and heaters blocked. If used for interlock, heaters blocked. Otherwise, channel not connected, no control action. No control action on $T_{avg}$ due to auctioneer.	
Pressurizer Pressure	o Pzr. Pressure (PORV PCV-655A Control, PORV PCV-656A Interlock)	Low	PORV PCV-656A stays closed. If signal selected for control, pressurizer heaters on (if allowed by level signal, see above), spray off, and PORV PCV-655A stays closed.	

TABLE Q032.45-7

LOSS OF POWER TO PROTECTION CABINET 3A

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	--	No signals affected, no control action.	
Reactor Control	o None	--	No signals affected, no control action.	
FW Control	o None	--	No signals affected, no control action.	Not applicable
Pressurizer Level	o None	--	No signals affected, no control action.	
Pressurizer Pressure	o None	--	No signals affected, No control action.	

TABLE Q032.45-8

LOSS OF POWER TO PROTECTION CABINET 4

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o T <sub>avg</sub> (Loop 4)	Low	No control action due to auctioneer.	
Reactor Control	o T <sub>avg</sub> (Loop 4)	Low	No control action due to auctioneer. Stop turbine loading (C-17).	
FW Control	o None	--	No signals affected, no control action.	No event is initiated due to loss of power to this cabinet, therefore bounding event is not applicable.
Pressurizer Level	o T <sub>avg</sub> (Loop 4) o Pressurizer Level	Low	No control action due to auctioneer. No letdown isolation since bistables are energize to actuate.	
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-656A Control or PORV PCV-655A Interlock)	Low	PORV PCV-655A stays closed. If signal selected for control, PORV PCV-656A also stays closed.	

TABLE Q032.45-9

LOSS OF POWER TO CONTROL GROUP 1

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o All (System Deenergized) except Condenser Available	Off/Closed	No initiating event, steam dump system unavailable. (If reactor trip occurs, SG power-operated relief valves available.)	
Reactor Control	o None	--	No signals affected, no control action	Bounding event for loss of cabinet power is Loss of Normal FW Flow (Section 15.2.7). (Plant trips on low-low water level in SG 1.)
FW Control and FW Pump Speed Control	o All (System Deenergized, SG 1)  o Steam flow (any loop)	FW Control Valve closes, pumps' speed decreases (all pumps, Auto mode only)  Low	Loss of main FW in SG 1. If FW pumps in auto mode, pumps' speed decreases causing FCV's to open in SG 2, 3 and 4 unless failed steam flow selected for control, in which case FCV's may close on steam flow/feedwater flow mismatch. (Plant trips on low-low water level in SG 1)	
Pressurizer Level	o Pressurizer Water Level (LB 666A)	Off	No control action (bistable is energize to actuate).	
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-655A Control)  o Spray and Heater Actuation	Closed  Off	No initiating event, PORV PCV-655A remains closed, heaters and spray remain off. (PORV PCV-656A available if needed.)	



TABLE Q032.45-10

LOSS OF POWER TO CONTROL GROUP 2

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	--	No signals affected, no control action.	
Reactor Control	o None	--	No signals affected, no control action.	
FW Control	o All (System Deenergized, SG 2) o Steam flow (any loop)	FW Control Valve Closes Low	Loss of main FW in SG 2. (Plant trips on low-low water level in SG 2.) If failed steam flow channel selected for control, FCV's close in remaining loops and FW pump speed decreases.	Bounding event for loss of cabinet power is Loss of Normal FW Flow (Section 15.2.7) (Plant trips on low-low water level in SG 2.)
Pressurizer Level	o All (System Deenergized) (Except LB 666A)	Off	Charging flow increases, backup heaters off.	
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-656A Control)	Closed	PORV PCV-656A blocked closed. (PORV PCV-655A available if needed.)	

TABLE Q032.45-11

LOSS OF POWER TO CONTROL GROUP 3

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	--	No signals affected, no control action.	
Reactor Control	o None	--	No signals affected, no control action.	
FW Control (SG 3)	o All (System Deenergized)	FW Control Valve Closes	Loss of main FW in SG 3. (Plant trips on low-low water level in SG 3.)	Bounding event for loss of cabinet power is Loss of Normal FW Flow (Section 15.2.7) (Plant trips on low-low water level in SG 3.)
Pressurizer Level	o None	--	No signals affected, no control action.	
Pressurizer Pressure	o Pressurizer Pressure Interlock (PORV PCV-656A, bistable PB 657)	Deactuated	No control action. PORV PCV-656A blocked, PORV PCV-655A still available.	

TABLE Q032.45-12

LOSS OF POWER TO CONTROL GROUP 4

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Pump	o Auctioneered	Low	No initiating event, steam dump system unavailable. (If reactor trip occurs, SG power-operated relief valves available.)	Bounding event for loss of cabinet power is Loss of Normal FW Flow (Section 15.2.7) since increased charging flow has little effect in comparison. (Plant trips on low-low SG 4 water level.)
	o $T_{avg}$			
	o $T_{ref}$ (from Rod Control)	Low		
Reactor Control	o All (System Deenergized)	Off	Rods stay stationary. Stop turbine loading (C-17).	
FW Control (SG 4)	o All (System Deenergized)	FW Control Valve Closes	Loss of main FW in SG 4. (Plant trips on low-low water level in SG 4.)	
Pressurizer Level	o Auctioneered	Low	Charging flow increases.	
	o $T_{avg}$			
	o Charging Flow Controller	Low		
Pressurizer Pressure	o Pressurizer Pressure Interlock (PORV PCV-655A, bistable PB 658)	Deactuated	PORV PCV-655A blocked from automatic opening. PORV PCV-656A still available. No control action.	

TABLE Q032.45-13

LOSS OF POWER TO INVERTER I  
 (PROTECTION CABINETS 1 AND 1A, NIS CHANNEL 1)

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o Turbine Impulse Chamber Pressure (Control)	Low	Steam dump demanded but blocked from interlock. (If reactor trips, steam dump performs as designed).	Bounding event for loss of inverter power is either FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2), or Loss of Normal Feedwater Flow (Section 15.2.7), depending on channels used. Increased charging flow and pressurizer transients have little effect in comparison.
	o T <sub>avg</sub> (Loop 1)	Low		
Reactor Control	o Power Range Flux (Ch. 1)	Low	Rods in (safe direction), power decreases. Stop turbine loading (C-17). If turbine impulse chamber pressure selector switch in normal position, auto rod withdrawal blocked (C-5).	
	o Turbine Impulse Chamber Pressure (Control)	Low		
	o T <sub>avg</sub> (Loop 1)	Low		
FW Control	o Narrow Range SG Water Level (Any Loop)	Low	Depending on the relative switch positions in each loop for steam flow, feedwater flow, and narrow-range SG water level, FW valves could open, close, or remain fixed; thus, a FW transient may occur in these loops.	
	o Steam Flow Pressure Compensation (Any Loop)	Low		
	o Feedwater Flow (Any Loop)	Low		
	o Power Range Flux (Ch. 1)	Low		

TABLE Q032.45-13 (Continued)

LOSS OF POWER TO INVERTER I  
 (PROTECTION CABINETS 1 AND 1A, NIS CHANNEL I)

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Pressurizer Level	o Pressurizer Water Level (Control)	Low	If affected level signal used for control, charging flow increases and heaters blocked. No control action on T <sub>avg</sub> due to auctioneer. On low flow signal, charging flow increases until integral controller on level error generates zero flow demand. New steady state reached at higher level.	
	o T <sub>avg</sub> (Loop 1)	Low		
	o Charging Flow	Low		
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-655A)	Low	If affected pressure signal used for control, PORV PCV-655A stays closed, back-up heaters on (but could be blocked on level signal, see above). Spray off. (PORV PCV-656A available if required.) Otherwise, channel not connected, no control action.	

TABLE Q032.45-14

LOSS OF POWER TO INVERTER II  
 (PROTECTION CABINETS 2 AND 2A, NIS CHANNEL II, AUX. PROCESS CABINET II)

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o Turbine Impulse Chamber Pressure (Interlock)	Low	Steam dump unblocked. (If reactor trips, steam dump performs as designed.)	Bounding event for loss of inverter power is either FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2), or Loss of Normal FW Flow (Section 15.2.7), depending on channels used.
	o $T_{avg}$ (Loop 2)	Low		
Reactor Control	o Power Range Flux (Channel II)	Low	No control action due to auctioneering of flux and $T_{avg}$ . Stop turbine loading (C-17).	
	o $T_{avg}$ (Loop 2)	Low		
FW Control	o Narrow Range SG Water Level (Any Loop)	Low	Depending on the relative switch positions in each loop for steam flow and narrow-range SG water level, FW control valves could open, close, or remain fixed; thus, a FW transient may occur in these loops.	
	o Steam Flow Pressure Compensation (Any Loop)	Low		
	o Feedwater Flow (Any Loop)	Low		
	o Power Range Flux (Channel II)	Low		
Pressurizer Level	o Pressurizer Water Level (Interlock)	Low	If affected level signal used for interlock, block heaters; otherwise, channel not connected, no control action. No control action on $T_{avg}$ due to auctioneer.	
	o $T_{avg}$ (Loop 2)	Low		

TABLE Q032.45-14 (Continued)

LOSS OF POWER TO INVERTER II  
 (PROTECTION CABINETS 2 AND 2A, NIS CHANNEL II, AUX. PROCESS CHANNEL II)

CONTROL SYSTEMS <u>AFFECTED</u>	SIGNALS <u>AFFECTED</u>	FAILURE <u>DIRECTION</u>	ITEMIZED <u>EFFECTS</u>	BOUNDING <u>EVENT</u>
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-656A)	Low	If affected pressure signal used for control, PORV PCV-656A stays closed. (PORV PCV-655A available if required.) Otherwise, channel not connected, no control action.	

TABLE Q032.45-15

LOSS OF POWER TO INVERTER III  
 (PROTECTION CABINETS 3 AND 3A, NIS CHANNEL III, AUX. PROCESS CABINET III)

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o T <sub>avg</sub> (Loop 3)	Low	No control action due to auctioneer.	
Reactor Control	o Power Range Flux (Channel III)	Low	No control action due to auctioneers. Stop turbine loading (C-17).	Combining effects of pressurizer level and pressure control systems, could have either increasing charging flow with heater off causing a depressurization, or else heaters cause pressure to increase until safety valve opens.
	o T <sub>avg</sub> (Loop 3)	Low		
FW Control	o Power Range Flux (Channel III)	--	No control action due to auctioneer.	
Pressurizer Level	o Pressurizer Water Level (Control or Interlock)	Low	If affected level signal used for control, charging flow increases and heaters blocked. If used for interlock, heaters blocked.	In one case, event is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1). For the other case, bounding event for loss of inverter power is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2).
	o T <sub>avg</sub> (Loop 3)		Otherwise, channel not connected, no control action. No control action on T <sub>avg</sub> due to auctioneer.	
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-655A Control, PORV PCV-656A Interlock)	Low	PORV PCV-656A stays closed. If signal selected for control, pressurizer heaters on (if allowed by level signal, see above), spray off, and PORV PCV-655A stays closed.	



TABLE Q032.45-16

LOSS OF POWER TO INVERTER IV  
 (PROTECTION CABINET 4, NIS CHANNEL IV)

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o T <sub>avg</sub> (Loop 4)	Low	No control action due to auctioneer.	
Reactor Control	o Power Range Flux (Channel IV)	Low	No control action due to auctioneers. Stop turbine loading (C-17).	
	o T <sub>avg</sub> (Loop 4)	Low		
FW Control	o Power Range Flux (Channel IV)	--	No control action due to auctioneer.	No event is initiated due to loss of power to this inverter; therefore bounding event is not applicable.
Pressurizer Level	o T <sub>avg</sub> (Loop 4)	Low	No control action due to auctioneer.	
	o Pressurizer Level		No letdown isolation since bistables are energize to actuate.	
Pressurizer Pressure	o Pzr. Pressure (PORV PCV-656A Control or PORV PCV-655A Interlock)	Low	PORV PCV-655A stays closed. If signal selected for control, PORV PCV-656A also stays closed.	

TABLE Q032.45-17

LOSS OF POWER TO INVERTER V  
 (CONTROL GROUPS 1 AND 3)

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Steam Dump	o All (System deenergized) except Condenser Available	Off/Closed	No initiating event, steam dump system unavailable. (If reactor trip occurs, SG power-operated relief valves available.)	
Reactor Control	o None	_____	No signals affected; no control action.	
FW Control (SG 1 and 3) and FW pump speed control	o All (System deenergized, SG 1 and 3)  o Steam flow (any loop)	FW Control Valves close, pumps' speed decreases (all pumps, AUTO mode only)  Low	Loss of main FW in SG 1 and 3. If FW pumps in auto mode, pumps' speed decreases causing FCV's to open in SG 2 and 4 unless failed steam flow selected for control, in which case FCV's may close on steam flow/feedwater flow mismatch. (Plant trips on low-low water level in SG 1 and 3).	Bounding event for loss of inverter power is Loss of Normal FW Flow (Section 15.2.7). (Plant trips on low-low water level in SG 1 and 3)
Pressurizer Level	o Pressurizer Water Level (LB666A)	Off	No control action (bistable is energize to actuate).	

TABLE Q032.45-17 (Continued)

LOSS OF POWER TO INVERTER V  
 (CONTROL GROUPS 1 AND 3)

CONTROL SYSTEMS AFFECTED	SIGNALS AFFECTED	FAILURE DIRECTION	ITEMIZED EFFECTS	BOUNDING EVENT
Pressurizer Pressure	<ul style="list-style-type: none"> <li>o Pressurizer Pressure (PORV PCV-655A Control; Interlock on PORV PCV-656A, bistable PB 657)</li> </ul>	Off/closed	PORVs PCV-655A and PCV-656A remain closed, heaters and spray remain off. (Manual PORV and heater actuation available if needed.)	
	<ul style="list-style-type: none"> <li>o Spray and Heater Actuation Off</li> </ul>			

TABLE Q032.45-18

LOSS OF POWER TO INVERTER VI  
 (AUX. PROCESS CABINET I)

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	---	No signals affected, no control action.	
Reactor Control	o None	---	No signals affected, no control action.	
FW Control	o Narrow Range SG Water Level (Any loop)	Low	If failed level channel selected for control, FCV opens and SG water level increases. Otherwise, no control action.	
Pressurizer Level	o Pressurizer Level (Control)	Low	Letdown isolated (protection grade). If affected level signal used for control, charging flow increases and heaters blocked. Otherwise, level channel not connected; due to low flow signal, charging flow increases until integral controller on level error generates zero flow demand; new steady state reached.	Bounding event for loss of inverter power is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2) since increased charging flow has little effect in comparison.
	o Charging Flow	Low		
Pressurizer Pressure	o None	---	No signals affected, no control action.	

TABLE Q032.45-19

LOSS OF POWER TO INVERTER VII  
 (AUX. PROCESS CABINET IV)

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	---	No signals affected, no control action.	
Reactor Control	o None	---	No signals affected, no control action.	
FW control	o None	---	No signals affected, no control action.	Bounding event for loss of inverter power is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2).
Pressurizer Level	o Pressurizer Level (Control)	Low	Letdown isolation. (protection grade).	
Pressurizer Pressure	o None	---	No signals affected, no control action.	

TABLE Q032.45-20

LOSS OF POWER TO INVERTER VIII  
 (CONTROL GROUPS 2 AND 4)

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o Auctioneered	Low	No initiating event, steam dump system unavailable. (If reactor trip occurs, SG power-operated relief valves available.)	Bounding event for loss of inverter power is Loss of Normal FW Flow (Section 15.2.7) since increased charging flow has little effect in comparison. (Plant trips on low-low water level in SG 2 and 4.)
	o $T_{avg}$ $T_{ref}$ (from Rod Control)	Low		
Reactor Control	o All (System Deenergized)	Off	Rods stay stationary. Stop turbine loading (C-17).	
FW Control	o All (System Deenergized, SG 2 and 4)	FW Control Valve closes	Loss of main FW in SG 2 and 4. (Plant trips on low-low water level in these loops.) If failed steam flow channel selected for control, FCV's close in remaining loops and FW pump speeds decrease.	
	o Steam flow (any loop)	Low		
Pressurizer Level	o All (System Deenergized, except Lo 000A)	Off	Charging flow increases, backup heaters off.	
	o Auctioneered $T_{avg}$	Low		
	o Charging FCV Control	Low		
Pressurizer Pressure	o Pressurizer Pressure (PORV PCV-656A control; Interlock on PORV PCV-655A, bistable PB 658)	Closed	PORVs PCV-655A and PCV-656A remain closed. Manual actuation available if needed.	

TABLE Q032.45-21

LOSS OF POWER TO AUX. PROCESS CABINET II

<u>CONTROL SYSTEMS AFFECTED</u>	<u>SIGNALS AFFECTED</u>	<u>FAILURE DIRECTION</u>	<u>ITEMIZED EFFECTS</u>	<u>BOUNDING EVENT</u>
Steam Dump	o None	---	No signals affected, no control action.	
Reactor Control	o None	---	No signals affected, no control action.	Bounding event for loss of cabinet power is FW System Malfunction Resulting in an Increase in FW Flow (Section 15.1.2).
FW Control	o Narrow Range SG Water Level (any loop)	Low	If failed level channel selected for control, FCV opens and SG water level increases. Otherwise, no control action.	
Pressurizer Level	o Pressurizer Level (Interlock)	Low	If failed level channel selected, heaters blocked. Otherwise, no control action.	
Pressurizer Pressure	o None	---	No signals affected, no control action.	

TABLE Q032.45-22

LOSS OF POWER TO AUX. PROCESS CABINET III

CONTROL SYSTEMS <u>AFFECTED</u>	SIGNALS <u>AFFECTED</u>	FAILURE <u>DIRECTION</u>	ITEMIZED <u>EFFECTS</u>	BOUNDING <u>EVENT</u>
Steam Dump	o None	---	No signals affected, no control action.	
Reactor Control	o None	---	No signals affected, no control action.	
FW Control	o None	---	No signals affected, no control action.	
Pressurizer Level	o Pressurizer Level (Control or Interlock)	Low	If failed level channel selected for control, charging flow increases, heaters blocked; if selected for interlock, heaters blocked. Otherwise, no control action.	Bounding event for loss of cabinet power is CVCS Malfunction That Increases Reactor Coolant Inventory (Section 15.5.2).
Pressurizer Pressure	o None	---	No signals affected, no control action.	



TABLE Q032.45-23

LOSS OF COMMON INSTRUMENT LINES

(ASSUMED BREAK IN LINE)

<u>SENSORS</u>	<u>FAILED CHANNELS</u>	<u>SYSTEM</u>	<u>FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING ACCIDENT</u>
Loop Steam Flow and Narrow Range SG Water Level	I or II	Feedwater Control	Lo Hi	If steam flow and/or narrow-range SG water level selectors switched to failed channel, FW control valve closes in affected SG(s). All FW pump speeds decrease if in auto mode.	Bounding event is Loss of Normal FW Flow (Section 15.2.7)
Pressurizer Level (Control) and Pressurizer Pressure (PORV PCV-655A, Control)	I	Pressurizer Level Control (Sw. Pos. 2 or 3) Pressurizer Pressure Control (Sw. Pos. 1 or 2)	Hi Lo	If switch positions not as shown, no control actions. If level selector switch in position shown: charging flow decreases, backup heaters on. (Later, on low level, heaters blocked and letdown isolated from interlock channel.) If pressure selector switch in position shown: PORV PCV-655A stays closed, spray unavailable, backup heaters on.	These effects at worst result in a depressurization which is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1).

TABLE Q032.45-23 (Continued)

LOSS OF COMMON INSTRUMENT LINES

(ASSUMED BREAK IN LINE)

<u>SENSORS</u>	<u>FAILED CHANNELS</u>	<u>SYSTEM</u>	<u>FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING ACCIDENT</u>
Pressurizer Level (Interlock) and Pressurizer Pressure (PORV PCV-656A, Control)	II	Pressurizer Level Control (Sw. Pos. 1 or 2)  Pressurizer Pressure Control (Sw. Pos. 2 or 3)	Hi  Lo	If switch positions not as shown, no control actions. If level selector switch in position shown: no control action, get high level annunciation. If pressure selector switch in position shown: PORV PCV-656A stays closed.	Not applicable.
Pressurizer Level (Control or Interlock) and Pressurizer Pressure (PORV PCV-655A, Control; PORV PCV-656A, Interlock)	III	Pressurizer Level (Control or Interlock, switch positions 1 or 3 respectively) Pressurizer Pressure Interlock, also Control (Sw. Pos. 3)	Hi  Lo	Regardless of switch positions, PORV PCV-656A blocked closed (by PB 657).  If level selector switch in position 1 (control), charging flow decreases, backup heaters on. (Later, on low level, let-down isolated and heaters blocked from interlock channel.) If level selector switch in position 3 (interlock): no control action, get high level annunciation. If pressure selector switch in position 3, PORV PCV-655A also stays closed, spray unavailable, backup heaters on.	These effects at worst result in a depressurization which is bounded by Inadvertent Opening of a Pressurizer Safety or Relief Valve (Section 15.6.1).

TABLE Q032.45-23 (Continued)

LOSS OF COMMON INSTRUMENT LINES

(ASSUMED BREAK IN LINE)

<u>SENSORS</u>	<u>FAILED CHANNELS</u>	<u>SYSTEM</u>	<u>FAILURE DIRECTION</u>	<u>EFFECT</u>	<u>BOUNDING ACCIDENT</u>
Pressurizer Level (Protection Grade Action Only) and Pressurizer Pressure (PORV PCV-655A, Interlock PORV PCV-656A, Control)	IV	Pressurizer Level Control (Letdown Isolation)	Hi  Lo	No action (protection or control) resulting from level sensor failing high. PORV PCV-655A blocked closed. If pressure selector switch in position 1, PORV PCV-656A also blocked.	Not applicable.