Frederick W. Schneider
Vice President
Production

Public Service Electric and Gas Company 80 Park Place Newark, N.J. 07101 201/430-7373

June 27, 1980

Mr. Norman C. Moseley, Director
Division of Reactor Operations Inspection
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Moseley:

CONFIRMATORY ORDERS
LOSS OF NON-CLASS 1-E INSTRUMENTATION AND
CONTROL POWER BUS DURING OPERATION
SALEM GENERATING STATION
UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311

Pursuant to the Confirmatory Orders dated April 4, 1980 issued to Facility Operating License No. DPR-70 and Facility Construction Permit No. CPPR-53, we hereby submit our response to the information requested in Attachment A of the Confirmatory Orders. The information was written with regard to Unit No. 1, but the response is applicable to both Salem Units except as noted.

If you have any further questions, please do not hesitate to contact us.

Sincerely,

F W Schneider

Attachment A: Summary of Failure Analysis
Attachment B: Response to NRC IE Circular 79-02

CC Mr. Boyce H. Grier, Director
U. S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region 1
631 Park Avenue
King of Prussia, PA 19406

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STATE OF NEW JERSEY)
) SS:
COUNTY OF ESSEX)

FREDERICK W. SCHNEIDER, being duly sworn according to law deposes and says:

I am a Vice President of Public Service Electric and Gas Company, and as such, I signed the Response to the Confirmatory Order issued on April 4, 1980 to Facility Operating License No. DPR-70 and Facility Construction Permit No. CPPR-53.

The matters set forth in said change request are true to the best of my knowledge, information, and belief.

Frederick W. Schneider
FREDERICK W. SCHNEIDER

Subscribed and sworn to before me
this 30th day of June, 1980

Joanne E. Maccioccia
Notary Public of New Jersey

My commission expires on Oct. 1, 1983

RESPONSE TO

CONFIRMATORY ORDERS

ISSUED ON APRIL 4, 1980

SALEM GENERATING STATION

UNIT NOS. 1 AND 2

FACILITY OPERATING LICENSE NO. DPR-70

FACILITY CONSTRUCTION PERMIT NO. CPPR-53

NRC REQUEST

1. Review the Class 1E and Non-Class 1E buses supplying power to safety and non-safety related instrumentation and control systems which could affect the ability to achieve a cold shutdown condition using existing procedures or procedures developed under Item 2 below. For each bus:

   A. Identify and review the alarm and/or indication provided in the control room to alert the operator to the loss of power to the bus.

   B. Identify the instrument and control system loads connected to the bus and evaluate the effects of loss of power to these loads including the ability to achieve a cold shutdown condition.

   C. Describe any proposed design modifications resulting from these reviews and evaluations, and your proposed schedule for implementing those modifications.

RESPONSE

1.A. The loss of power to any 115v AC Vital Instrument Bus (VIB) or essential controls panel (11 MAC and 12 MAC) is alarmed on both the overhead and auxiliary annunciators. The overhead alarms for each bus/panel are grouped into a single annunciator window to provide a "systems level" alarm. The purpose of this alarm window is to alert the control room operator to an electrical system problem and to direct attention to the auxiliary annunciator for additional specific information. The auxiliary annunciator provides individual alarms for each bus/panel. The alarm message printouts are:

1A 115v AC Vital Instrument Bus Loss of Voltage
1B 115v AC Vital Instrument Bus Loss of Voltage
1C 115v AC Vital Instrument Bus Loss of Voltage
1D 115v AC Vital Instrument Bus Loss of Voltage

11MAC 115v AC Distr. Cabinet Loss of Voltage
12MAC 115v AC Distr. Cabinet Loss of Voltage

In addition to loss of voltage alarms, inverter failure alarms for each VIB are provided on individual overhead annunciator windows as follows:

1A VTL. BUS INVERT. FAILURE/FUSE BLOWN
1B VTL. BUS INVERT. FAILURE/FUSE BLOWN
1C VTL. BUS INVERT. FAILURE/FUSE BLOWN
1D VTL. BUS INVERT. FAILURE/FUSE BLOWN

The auxiliary annunciator also provides alarms for the failure of the power sources which supply the buses/panels. These alarms are:

1A Vital Instr. Bus Inv. Pwr. Supply Loss of AC Output

1B Vital Instr. Bus Inv. Pwr. Supply Loss of AC Output

1C Vital Instr. Bus Inv. Pwr. Supply Loss of AC Output

1D Vital Instr. Bus Inv. Pwr. Supply Loss of AC Output

11 and 12 Station Essential Controls Inverters Pwr. Supply Loss of AC Output

The above mentioned power sources which supply the inverters for the VIB's and essential MAC Panels are equipped with auctioneering devices which automatically shift the affected inverter input connection to a d.c. power source in the event the power supply output is lost.

The loss of power to a non-essential control panel (13 MAC and 14 MAC) is alarmed on the auxiliary annunciator. The alarm messages are:

13 MAC 115v AC Distr. Cabinet Loss of Voltage
14 MAC 115v AC Distr. Cabinet Loss of Voltage

The non-essential control panels are not supplied by inverters.

In addition to the alarms on the overhead annunciator related to bus/panel voltage problems, an alarm window is provided to notify the control room operator that the auxiliary annunciator is printing. Therefore, for those failures which are not alarmed on the overhead annunciator, the operator is referred to the auxiliary annunciator.

B. The VIB's and MAC panels can be supplied by a backup 115v AC source in the event of an inverter failure. Manual action is required to accomplish the transfer to the backup source. The transfer can be readily achieved before the plant approaches cold shutdown. Therefore, it is not anticipated that the plant will have to achieve the cold shutdown condition without the services provided by any one VIB or MAC Panel.

However, for the purpose of analysis it was assumed that the plant must possess the ability to safely achieve cold shutdown with one VIB or one MAC Panel unavailable. Consequently, the VIB's and MAC panels were analyzed on a circuit by circuit basis to determine the failure modes of bus loads and alarms/annunciations associated with a loss of power. The analysis included the following:

1. Circuit Loads

2. Failure modes of transmitters, indicators, recorders, signal comparators, and other equipment contained in instrumentation and control loops.

3. Failure modes of valves and valve control circuits.

4. The failure modes of status indicating circuits.

5. The effect of a loss of power on alarm circuitry (loss of alarm capability, erroneous alarms, valid alarms).

The results of the analysis were reviewed by engineering and Salem operations personnel, and expanded beyond the failure modes of individual circuit loads to include system interrelationships and the cumulative effects of various individual circuit failures. Particular attention was directed towards the ability of Salem Station personnel to safely bring the plant to cold shutdown.

The analysis review also included alternate indication available to the control room operators and alternate equipment which could be operated given the loss of a VIB or MAC Panel. It was determined that the failure of any one VIB or MAC panel would not prevent station operating personnel from taking the plant from power operation to cold shutdown in a safe manner.

Attachment A is a summary of the detailed analysis for those systems which may be or are required to be used in the process of taking the plant to cold shutdown. It describes only the most important effects of a postulated loss of power to a VIB or MAC Panel.

C. The tables of Attachment A include information pertaining to design modifications which are being evaluated. The design modifications being considered are not due to any inability to achieve cold shutdown, but rather to enhance the availability of information presented to the control room operator and to further aid the operator in bringing the plant to cold shutdown.

The desirability of modifications to existing procedures is dependent upon the degree of design modifications to be implemented for those items identified in Attachment A. It is expected that the evaluation of the potential design modifications being considered will be completed by August 1, 1980. The actual implementation of any design modifications considered can be expected to be completed during the first refueling outage for Salem 2 and the third refueling outage for Salem 1 (second refueling outage scheduled for July 1980).

NRC REQUEST

2. Prepare emergency procedures or review existing ones that will be used by control room operators, including procedures required to achieve a cold shutdown condition, upon loss of power to each class 1E and non-class 1E bus supplying power to safety and non-safety related instrument and control systems. The emergency procedures should include:

    A. The diagnostics/alarms/indicators/symptom resulting from the review and evaluation conducted per item 1 above.

    B. The use of alternate indication and/or control circuits which may be powered from other non-class 1E or class 1E instrumentation and control buses.

    C. Methods for restoring power to the bus.

Describe any proposed design modification or administrative controls to be implemented resulting from these procedures, and your proposed schedule for implementing the changes.

RESPONSE

2.A. An alarm book is provided in each Salem control room. The book includes information pertaining to the overhead annunciator alarms described in the response to Item 1. Whenever an alarm occurs, the operator may refer to this book for additional information and guidance. The alarm book contains information pertaining to:

1. Probable causes of the alarm.
2. Automatic actions which result due to the alarm.
3. Immediate actions to be performed.
4. Supplemental actions to be performed.

B. Information related to this topic is included as part of the response to Item 1.

C. Methods for restoring power to a VIB or essential controls panel are included as part of the required operator actions mentioned in Part A.

Until a decision is reached regarding any design modifications and implementation of those modifications, the results of the analysis, in tabular form, will be provided to the Salem Operations Department to be used in conjunction with existing operating procedures. Any required revisions to existing station operating procedures and/or preparation of new procedures will be accomplished according to a schedule consistent with that of any design modifications deemed advantageous.

NRC REQUEST

3. Re-review IE Circular No. 79-02, Failure of 120 Volt Vital AC Power Supplies, dated January 11, 1979 to include both class 1E and non-class 1E safety related power supply inverters. Based on a review of operating experience and your re-review of IE Circular 79-02, describe any proposed design modifications or administrative controls to be implemented as a result of the re-review.

RESPONSE

3. The analysis performed as required by NRC IE Circular 79-02 has been re-reviewed with no new information to report. Since the inverters used to supply the essential controls panels (11 MAC and 12 MAC) are of the same type model/manufacturer as utilized to supply the VIB's, the circular response is applicable to 11 and 12 MAC Panel inverters. The original response to IE Circular 79-02 is attached (Attachment B).

As a result of inverter operating histories at Salem 1, the Engineering Department is presently engaged in a progam to improve the availability and reliability of VIB bus and MAC Panel inverters utilized at both Salem Units.

RB:lb

6/16/80

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ATTACHMENT A - BUS FAILURE ANALYSIS

1A VIB

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Auxiliary Feedwater*	#11 AFW Pump Suct. Press. Disch. Press. XMTRS Pwr. Supply	Loss of Info. Only. Pump Start-Stop Not Inhibited. S.G. Inlet VA's (13AF21 + 14AF21) Prevented From Opening Due to Loss of Disch. Press. Sig.	S.G. Level Ind., Pump Start-Stop + Motor Amps Ind. Available on Control Console. #12 and 13 AFW Pumps Operation and Indication Available. Manual Press. Override (Manual Operation) Available.	None
	#13 + 14 S.G. AFW Flow XMTRS. Pwr. Supply.	Loss of Indication Only No Sys. Malfunction.	S.G. Lvl. Ind. Available on Cont. Console	None
	#13 + 14 S.G. Inlet Valves (13AF21 + 14AF21) Control	Loss of Valve Control	S.G. Lvl. Ind. Available on Cont. Console #12 + 13 AFW Pumps Available	None
	AFW Storage Tk. Lvl. XMTR Pwr. Supply	Loss of Indication Only	Local Indication Available	None
Chemical and Volume Control	Letdown Line Temp. Indicator Controller	Letdown Flow Diverted From Mixed Bed Demin.'s to VCT, Loss of Normal Letdown Flow Path	None	None
	Primary Water Storage Tk. Lvl. XMTR Pwr. Supply	#11 + 12 Prim. Wtr. M-U Pumps Stop if in Auto	Local Lvl. Ind. Available Prim. Wtr. M-U Pumps can be Operated in Manual Mode.	None
	B.A. Magnetic Flow XMTR. + Indicator Pwr. Supply	Loss of B.A. Flow Control. Flow Cont. VA. ICV172 Opens. Fully Supplying B.A. Blender + Chg. Pmps. Loss of all B.A. Flow Indication in C.R.	None	None
	VCT LO-LO Lvl. Alarm	Alarm Activated + Causes Isolation of Chg. Pumps From VCT and Opening of ISJ1 + ISJ2. Chg. Sys. Draws Suction From RWST. Boron Now Injected Via Chg. PMP/PMPS @2000 PPM Minimum.	None	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Component Cooling*	#11 CCW HX Temp. Controller	Loss of all #11 CCW HX Temp. Ind.	High Temp. Alarms for Equip. Supplied are Operational. LO-CCW Flow Alarms on Equip. Supplied by System Available. #12 CCW HX Available	None
	CCW Pmps Low Disch. Press to #11 HX Alarm	Alarm Caused by Ckt Loss. No System Malfunction.	#12 CCW HX Available	None
Containment Ventilation*	CH. I Cont. Press Indicator + XMTR Pwr. Supply	Loss of Indication	CH's II, III, IV Available	None
	#11 Fan Coil Unit Outlet Temp + Flow XMTRS Pwr. Supply	Loss of Indication Only. No System Malfunction.	#12, 13, 14, 15 F.C. Units + Ind's. Available	None
	#11 Fan Coil Unit S.W. Control Flow XMTR. Pwr. Supply	Loss of All S.W. Flow Control. Speed Control Available	#'s 12,13,14,15 F.C. Units + Indication Available	None
	#11,12,13,14,15 Fan Coil Units Leak Detect. Ind's. + 11 F.C. Unit Leak Detect. XMTR. Pwr. Supply	Loss of Leak Detection Information	None	None
Main Steam	Atmos. Relief Va. 11MS10 Press XMTR. Pwr Supply	Valve Receives Signal to Close	Remote Manual (Cont. Console) Control Functional. Local Control Available. Safety Valves Functional.	None
	CH. II 1st Stage Turb. Press. Indicator Pwr. Supply	Loss of 1st Stage CH. II Press. Indication No System Malfunction	CH. I Indication Available	None
Pressurizer	PRZ Press. CH. I XMTR + Indicator Pwr. Supply	Loss of CH. I Info. No System Malfunction Due to Pwr. Loss	CH's II, III, IV Indication Available	None
	PRZ Press Signal Comparator	Loss of Ability to Open, in Auto Mode, Pwr. Oper. Relief VA. 1PR2	1PR2 can be Operated in Manual. 1PR1 Operation Available.	None
	# 13 Spray Line Temp. Ind. + 11 Spray Line Temp. Ind. + XMTR. Pwr. Supply, PRZ Liquid Temp. Indicator + XMTR + Vapor Temp. Indicator Pwr. Supply	Loss of Info. No System Malfunction.	PRZ Press., Lvl + Surge Line Temp. Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Pressurizer (Cont'd)	PRZ Lvl CH. I XMTR + Indicator Pwr. Supply	Loss of CH. I Info. No System Malfunction.	CH's II + III Indication Available	None
Protection System	Demultiplexer Power Supply	Loss of all Indication on Status Panel Pertaining to Reactor Trip Logic	None	None
Reactor Coolant	11, 12, 13, 14 RC Loops CH. I Flow XMTRS + Indicators Power Supply	Loss of CH. I Indication. No System Malfunction.	CH's II + III Indication Available on Cont. Console	None
	11 RC Loop Diff. Temp. Diff. Temp. Setpoints XMTRS. + Indicators W.R. Hot Leg Temp. W.R. Cold Leg Temp. Indicators Power Supply	Loss of all Loop 11 Temp. Information	None	None
	RCS Temp. + Press Indicators Pwr. Supply	Loss of Temp. + Press. Ind. for "POPS"	Alternate Temp. + Press. Indication Available on Cont. Console	None
	RC Hot Leg Press. XMTR. PT-405	Loss of PT-405 Functions. Loss of POPS CH. I Loss of Opening Permissive For RHR Cool Down Isolation Valve 1RH2. Loss of Hot Leg Press Ind.	Pops CH II Available. To Open 1RH2, Must Restore Pwr. to Ckt. or Bypass Permissive Contact in Valve Motor Control Ckt. Problem with 1RH2 Identified in LER 76-04. Alternate Hot Leg Press Ind. Available on Cont. Console	None
Residual Heat Removal*	#11 RHX Outlet Flow + #11 RHR Injection Flow Indicators + XMTRS. Power Supply	Loss of Indication for 11 RHR Loop	#12 RHR Loop Available	None
	11 RHR Loop Cooldown Control Valve 11RH18	Loss of Valve Control. Valve Remains in last Position.	#12 RHR Loop Available	None
	11 RHR Pump C.C.W. Flow Switch	Receive Low CCW Flow Alarm on Cont. Console. Alarm is Due to Pwr. Loss.	#12 RHR Loop Available	None
	Containment Sump Lvl. Indication Ckt.	Loss of Cont. Sump Lvl. Ind.	Alternate Level Indication Available on Cont. Console	None
	11 RHR Pump Disch. Press. Indicator Pwr. Supply	Loss of Disch. Press. Indication	#12 RHR Loop Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Safety Injection*	11 SI Pump C.C.W. Flow Switch	Receive Low CCW Flow Alarm. Alarm is Due to Power Loss.	12 SI Pump Available	None
	#'s 11 + 12 Accumulators Level + Press. XMTRS. + Indicators Power Supply	Loss of 11 + 12 Accum. Lvl. + Press Ind.	Alternate Ind. Available on Cont. Console for 11 + 12 Accum. Lvl. + Press.	None
Service Water*	#12 S.W. HDR. Press XMTR + Indicator Pwr. Supply (Unit 1 Only)	Loss of all Cont. Room Ind. for #12 SW HDR. #'s 14, 15, 16 SW Pumps Auto Control Remains Functional	#11 HDR Press Ind. Available in Cont. Room	None
	#21 SW HDR Press. XMTR + Indicator Power Supply (Unit 2 Only)	Loss of all Cont. Room Ind. for #21 SW HDR. S.W. Pumps 21, 22, 23 Auto Control Remains Functional	#22 HDR Press Ind. Available in Cont. Room	None
Steam Generator	#'s 11, 12, 13, 14 S.G.'s CH. I Steam Flow F.W. Flow Press. Level XMTRS + Indicators Power Supply (Not All Parameters For All SG's on CH. I)	Loss of CH I Indications (Where Applicable)	Alternate Indications for all Parameters Available on CH's II, III, or IV	None

* Due to the loss of this bus, SEC Train A is lost. Therefore, no ESF Train A equipment will automatically start/shift modes of operation (if required). Adequate redundancy is provided for all systems affected (SEC Train B and SEC Train C functional). Manual control for all affected equipment is available.

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Auxiliary Feedwater*	#12 AFW Pump Suct. Press. Disch. Press. XMTRS. Pwr. Supply	Loss of Info. Only. Pump Start-Stop not Inhibited. S.G. Inlet VA's (11AF21 + 12AF21) Prevented From Opening Due to Loss of Disch. Press Sig.	S.G. Lvl. Ind., Pump Start-Stop + Motor Amps. Ind. Available on Cont. Console. #'s 11 + 13 AFW Pumps Operation and Indication Available. Manual Press. Override (Manual Operation) Available.	None
	#11 + 12 AFW Flow XMTRS.. Pwr. Supply	Loss of Indication Only No Sys. Malfunction Due to CKT. Loss.	S.G. Lvl. Ind. Available on Cont. Console	None
	#11 + 12 S.G. Inlet Valve (11AF21 + 12AF21) Control	Loss of Valve Control	S.G. Lvl. Ind. Available on Cont. Console #'s 11 + 13 AFW Pumps Available	None
	AFW Pumps Suct. Press. XMTR. Pwr. Supply	Loss of Indication. No Sys. Malfunction Due to Ckt Loss.	Individual Suct. Press. Ind. for all AFW Pumps Except #12 (See Above) Available on Cont. Console	None
	#11 Chg. Pump CCW Flow Switch.	Low CCW Flow Alarm. Alarm is Due to Pwr. Loss.	#'s 12 + 13 Chg Pumps Available	None
Chemical and Volume Control	Excess Letdown HX Outlet Flow Control Valve 1CV132	Loss of Valve Control. Valve Normally Closed + Remains in Last Position. Loss of Excess Letdown Flowpath.	None	None
	Excess Letdown Temp. + Press XMTRS + Indicators Power Supply	Loss of all Excess LTDN. Indication	None	None
	Letdown Isolation Valves 1CV3, 1CV4, 1CV5, 1CV277	Loss of Normal Letdown Flowpath.	None	None
	#11 B.A. Tank Lvl. + Temp. XMTRS. + Ind's. Pwr. Supply, Recirc. Flow Control Valve 11CV160 Control	Loss of All Indication for #11 B.A. Tank. Loss of Control 11CV160. Valve Remains in Last Position	#12 B.A. Tank + Recirc. Control Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Component Cooling*	#12 CCW HX Temp. Ind. Controller, Disch. Temp., Disch. Press to #12 HX (Alarm) XMTRS. + Indicators Pwr. Supply	Loss of Temp. Ind., Loss of High Temp. Alarm, Receive Low Disch. Press. Alarm.	11 CCW HX Available. High Temp Alarms for Equip Supplied are Operational.	None
Containment Ventilation*	CH. II Containment Pressure XMTR + Indicator Pwr. Supply	Loss of Indication	CH's I, III, IV Indication Available	None
	#'s 12 + 14 Fan Coil Units S.W. Flow Control XMTRS Pwr. Supply	Loss of All Flow Control. Speed Control Available.	#'s 11, 13, 15 F.C. Units + Indication Available	None
	#12 Fan Coil Unit Leak Detection XMTR Pwr. Supply	Loss of Indication Only	#'s 11, 13, 14, 15 F.C. Units Leak Detection Indication Available	None
	#'s 12 + 14 Fan Coil Units Outlet Wtr. Temp. + Flow XMTRS Pwr. Supply	Loss of Indication Only. No System Malfunction.	#'s 11,13,15 F.C. Units + Ind's Available	None
Main Steam	CH. II First Stage Turbine Press XMTR. Power Supply	Ckt. Loss Makes Up Some Permissives for Steam Dump	CH. I Ind. + Functions Available	None
	Atmos. Steam Relief Valve 12MS10 Press. XMTR. Pwr. Supply	Valve Receives Signal to Close	Remote-Manual (Cont. Console) Control Functional Local Control Available. Safety Valves Operable	None
Pressurizer	Pressurizer Level CH. II XMTR. + Indicator PWR Supply	Loss of CH. II Ind.	CH's I + III Ind. Available	None
	PRZ Press. CH. II XMTR + Indicator Pwr. Supply	Loss of CH. II Ind.	CH's I, III, IV Ind. Available	None
	PRZ Press. Signal Comparator	Loss of Ability to Open in Auto Mode Pwr. Oper. Relief Valve 1PR1	1PR2 Operation Available. 1PR1 can be Operated in Manual.	None
	PRZ Htrs.	Pwr Loss Causes Low PRZ Lvl. Alarm Which Removes PRZ Htr Bkr. Close Permissive on Regular + B-U Htrs.	Local Control for Controlled Group Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Pressurizer (Cont.)	PRZ Relief Tank Level Press. Temp. XMTRS + Indicators Pwr. Supply	Loss of all PRT Indication Except Associated Valve Position Indications.	None	None
Reactor Coolant	#'s 11, 12, 13, 14 RC Loops CH. II Flow MTRS. + Indicators Pwr. Supply	Loss of CH. II Indication No System Malfunction Due to Ckt. Loss.	CH's I & III Indication Available on Cont. Console	None
	#12 RC Loop Diff. Temp. Dif. Temp. Setpoints XMTRS + Indicators, W.R. Hot Leg Temp. W.R. Cold Leg Temp. Indicators Pwr. Supply	Loss of all Loop 12 Temp. Information	None	None
	RCS Temp. + Press. XMTRS. + Indicators Pwr. Supply	Loss of Temp + Press Ind.	Alternate Temp. + Press Ind. Available on Cont. Console	None
	R.C. Hot Leg Press XMTR. PT-403	Loss of PT-403 Functions Loss of Pops CH. II Loss of Opening Permissive For RHR Cooldown Isolation Valve 1RH1. Loss of Hot Leg Press. Ind.	Pops CH. I Available to Open 1RH1. Must Restore Pwr. to Ckt. or Bypass Permissive Contact in Valve Motor Control Ckt. Problem with 1RH1 Identified in LER 76-04. Alternate Hot Leg Press Ind. Available on Cont. Console.	None
Residual Heat Removal*	#12 RHX Outlet Flow XMTR. + Indicator + #12 RHR Injection Flow Indicator Power Supply	Loss of Indication for 12 RHR Loop	#11 RHR Loop Available	None
	12 RHR Loop Cooldown Control Valve 12 RH18	Loss of Valve Control. Valve Remains in Last Position.	#11 RHR Loop Available	None
	12 RHR Pump C.C.W. Flow Switch	Receive Low CCW Flow Alarm on Cont. Console. Alarm is Due to Pwr. Loss	#11 RHR Loop Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Residual Heat Removal*(Cont.)	Containment Sump Lvl. Indication Ckt.	Loss of Containment Sump Level Indication	Alternate Level Indication Available on Cont. Console	None
	#12 RHR Pump Disch. Press XMTR + Indicator Pwr. Supply	Loss of Indication	11 RHR Pump Available	None
	RHR Cooldown Recirc. Flow XMTR + Indicator Pwr. Supply	Loss of RHR Sys. Cooldown Flow Indication.	#11 RHR Loop Flow Indication Available. Other Flow Paths for 11 RHR Loop Must be Isolated (Min. Recirc., Etc.) For Flow Ind. to be Accurate.	None
Safety Injection*	RWST Level XMTR + Indicator Pwr. Supply	Loss of RWST Level Ind.	Alternate Level Indication Available on Cont. Console	None
	#'s 11 + 12 Accumulators Level + Press. XMTRS + Indicators Pwr Supply	Loss of Indication	Alternate Level + Press Indication Available on Control Console	None
	Chg. Pumps SI Disch. Flow XMTR + Indicator Pwr Supply	Loss of SI Disch Flow for Chg Pumps	BIT Disch. Press Ind Available on Cont. Console	None
Steam Generator	#'s 11, 12, 13, 14 S.G.'s CH. II Steam Flow F.W. Flow Press Level XMTRS + Indicators Power Supply (Not All Parameters For all S.G.'s on CH. II)	Loss of CH. II Indications (Where Applicable)	Alternate Indications for all Parameters Available on CH's I, III, or IV	None
	#12 S.G. Steam Dump to ATMOS. CH II Valve Demand XMTR Pwr Supply	Loss of Auto Control 12 MS10.	Must take Manual Control of Valve	None

* Due to the loss of this bus, SEC Train B is lost. Therefore, no ESF Train B equipment will automatically start/shift modes of operation (if required). Adequate redundancy is provided for all systems affected (SEC Train A and SEC Train C functional). Manual control for all affected equipment is available.

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Auxiliary Feedwater	#13 AFW Pump Suct. Press. Disch. Press. Steam Press. Speed Speed Demand XMTRS. Power Supply	Loss of all Indication Loss of Remote Speed Control	#11 + 12 AFW Pumps Operable with Indication Available Local Speed Control Available	None
	S.G. Inlet Valves 11AF11 12AF11 13AF11 14AF11 Control Ckts. Pwr. Supply	Loss of Valve Control Valves Normally Open	#11 + 12 AFW Pumps Operable With Indication + Valve Controls Available	None
	AFW Alternate Suct. Press. XMTR. Pwr Supply	Loss of Alt. Suct. Press Ind.	Individual Suct. Press. Ind. Available for #11 + 12 AFW Pumps. Suct. Press. Ind. for 13 AFW Pump Affected by Loss of this Bus	None
Chemical + Volume Control	#12 B.A. Tk. Temp. Ind. Controller Pwr. Supply	Loss of #12 B.A. Tk. Temp. Ind. in Control Room Loss of Auto Htr. Control	Manual Htr. Control Available #11 B.A. Tk. Available	None
Component Cooling*	C.C.W. Flow Alarms for #12 SI Pump + #12 Chg. Pump	Receive Low CCW Flow Alarms. Alarms Due to Pwr. Loss.	#11 SI + #11 Chg Pumps Available	None
	C.C.W. Surge Tk. A Level XMTR + Indicator Power Supply	Loss of Ind. in Cont. Room.	Local Indication Available B C.C. Surge Tk + Indication Available	None
	#11 CCW HX Outlet Temp. XMTR + Indicator Power Supply	Loss of Temp. Ind. in Cont. Room	#12 CCW HX Available	None
	#11 RHX CCW Outlet Flow XMTR + Indicator Pwr. Supply	Loss of Ind. in Cont. Room	#12 RHX Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Containment Ventilation*	Containment Press. CH. III XMTR. + Indicator Pwr. Supply	Loss of CH. III Press. Ind.	CH's I, II, IV Indication Available in Control Room	None
	#13 Fan Coil Unit Leak Detection XMTR. Pwr. Supply	Loss of Ind. in Cont. Room	#11, 12, 14, 15 F.C. Unit Leak Detection Indication Available in Cont. Room	None
	Cont. Diff. Press. Alarm XMTR. Pwr Supply	Loss of Diff. Press. Ind. in Cont. Room Loss of Hi-Diff. Press. Alarm	Cont. Press. Ind. Available in Cont. Room	None
	#'s 13 + 15 Fan Coil Units S.W. Control Ckt.	Loss of all Flow Control Speed Control Remains Operational	#'s 11, 12, 14 F.C. Units S.W. Control Operational	None
	#'s 13 + 15 F.C. Units Outlet Wtr. Temp. + Flow XMTRS Pwr. Supply	Loss of Indication No Sys. Malfunction Due to Ckt. Loss.	#'s 11, 12, 14 F.C. Units Available with Indication	None
Main Steam	Steam Dump Control	Steam Dump Capability Lost for both Train A and B Due to Loss of "Circulators in Service" Permissive	Atmos. Relief Valves MS10's Can be Used (11MS10 + 14MS10)	None
	Atmos. Steam Relief Valves 12MS10, 13MS10 Control	Loss of Auto or Remote Manual Control of 12MS10 + 13MS10. Loss of Control May Cause S.G. Diff. Press. SI	11MS10 + 14MS10 Available for Operation. Local Control 12MS10 + 13MS10 Available. Safety Valves Operable.	None
	Atmos. Steam Relief Valves 13MS10 + 14MS10 Press. XMTRS. Pwr. Supply	14MS10 Receives Signal to Close, Loss of Control (see above) 13MS10	11MS10 Available for Auto-Man. Control. Local Control All MS10 Valves Available. Safety Valves Operable.	None
	Atmos. Steam Relief Valve 12MS10 Setpoint + Demand Indicators Pwr. Supply	Loss of Indication	S.G.'s Press. Indication Available	None
Pressurizer	PRZ Press CH. III XMTR + Indicator Power Supply	Loss of CH. III Indication	CH's I, II, + IV Indication Available in Cont. Room	None
	PRZ LVL. CH. III XMTR. + Indicator Pwr. Supply	Loss of CH. III Indication	CH's I, II Indication Available in Cont. Room	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Pressurizer (Cont'd)	PRZ Pwr. Oper. Relief Va. 1PR2 Control	Loss of Auto - Open Capability for 1PR2	1PR1 Operation Available	None
	PRZ Spray Valves 1PS1 + 1PS3 Control + R.C. Press. Demand XMTR + Indicator Pwr. Supply	Loss of Auto-Man. Cont. 1PS1 + 1PS3 Valves Normally Closed Loss of PRZ HTR. Control	Manual Htr. Control Available on Cont. Console	None
	PRZ Spray Line Temp. LOOP 13 + Vapor Temp XMTRS. Pwr. Supply	Loss of all Pertinent Spray Info Except PRZ Liq. Temp + Surge Line Temp Indications	None	None
	PRZ Safety Valve Disch. Temp. Loop 12 XMTR Pwr. Supply	Loss of Ind. in Cont. Room	Loops 11 + 13 Indication Available in Cont. Room	None
Reactor Coolant	#'s 11, 12, 13, 14 R.C. Loops CH. III Flow XMTRS + Indicators Pwr. Supply	Loss of CH. III Indication No Sysem Malfunction Due to Ckt. Loss	CH's I + II Indication Available on Cont. Console	None
	#13 RC Loop Diff. Temp. Diff. Temp. Setpoints XMTRS + Indicators W.R. Hot Leg Temp. W.R. Cold Leg Temp. Indicators Pwr. Supply	Loss of all Loop 13 Temp. Information	None	None
	R.C. Press XMTR + Indicator Pwr Supply	Loss of Press. Ind.	Alternate Press Ind. Available on Cont. Console	None
	R.C. Loop's 11, 12, 13, 14 Avg Temp Indicators + Signal Comparators Pwr Supply	Loss of Tavg. Indication for all Loops (Indicators + Recorders Affected)	Diff. Temp. Indication Available for Loops 11, 12, 14	None
Residual Heat Removal*	#11 RHR Pump Disch. Press. XMTR. Pwr. Supply	Loss of Indication	11 RHR Loop Flow Indications Available in Cont. Room	None
	#12 RHR Loop Injection Flow XMTR. Pwr Supply	Loss of Indication	Alternate 12 RHR Inj. Flow Ind. Available on Cont. Console	None
Safety Injection*	#'s 13 + 14 Accumulators Level + Pres. XMTRS + Indicators Pwr. Supply	Loss of Indication	Alternate Indication Available on Control Console	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Safety Injection (Cont)	#12 SI Pump Disch. Press. Disch. Flow XMTRS. + Indicators Pwr Supply	Loss of Indication No Sys. Malfunction Due to ckt. Loss Pump Control Available	Start-Stop, Motor Amps Indication Available on Cont. Console. #11 SI Pump Available	None
Service Water*	#11 + 12 S.W. HDR Press RCDR Pwr. Supply	Loss of Recorder on 1RP1	#12 S.W. HDR. Press. Ind. Available	None
	#11 SW HDR Press XMTR + Indicator Pwr Supply (Unit 1 Only)	Loss of #11 SW HDR. Press. Ind. #'s 11, 12, 13 SW Pumps Auto Control not Affected by Ckt. Loss	#12 SW HDR. Press. Ind. Available	None
	#22 SW HDR Press. XMTR + Indicator Pwr. Supply (Unit 2 Only)	Loss of All #22 SW HDR Press. Ind. #'s 24,25,26 SW Pumps Auto Control Not Affected by Ckt. Loss	#21 SW HDR Press. Ind. Available	None
Steam Generator	#'s 11, 12, 13, 14 SG's CH. III Steam Flow F.W. Flow Press. Level XMTRS + Indicators Power Supply (Not All Parameters For All S.G.'s on CH. III)	Loss of CH. III Indications (Where Applicable)	Alternate Indications Available on CH's I, II, or IV	None
	#'s 11, 12, 13, 14 S.G.'s W.R. Lvl. XMTRS. Pwr. Supply	Loss of W.R. Lvl. Indication	Narrow Range Lvl. Ind. Available on Cont. Console	Pending resolution of design for long term TMI item review

* Due to the loss of this bus, SEC Train C is lost. Therefore, no ESF Train C equipment will automatically start/shift modes of operation (if required). Adequate redundancy is provided for all systems affected (SEC Train A and SEC Train B functional). Manual control for all affected equipment is available.

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Component Cooling	C.C. Surge Tk. B Lvl. XMTR. + Indicator Pwr. Supply	Loss of Indication in Cont. Room	A CC Surge Tk. + Indication Available	None
Containment Ventilation	Cont. Press. CH. IV XMTR + Indicator Pwr. Supply	Loss of CH. IV Indication	CH's I, II, III Indication Available on Cont. Console	None
	#'s 14 + 15 Fan Coil Units Leak Detection XMTRS. Pwr. Supply	Loss of F.C. Unit Leak Detection Indication. No System Malfunction Due to Ckt. Loss.	#'s 11, 12, 13 F.C. Units + Leak Detection Indication Available	None
Chemical and Volume Control	#13 Chg. Pump Speed + Flow Control Ckt.	Loss of Pump Speed Control. Pump Remains at Last Speed.	#'s 11 + 12 Centrifugal Chg. Pumps Available	None
	Chg. Sys. Seal. Press XMTR. + Indicator Pwr. Supply	Loss of Chg Seal Press. Indication	None	None
	Chg. Line Seal Press. Control Valve 1CV71	Loss of Remote Manual Control of 1CV71. Valve Remains in Last Position.	None	None
	Chg. Flow XMTR. + Flow Control Valve 1CV55	Loss of Chg Flow Indication Loss of Remote Man + Auto Control 1CV55 Valve Remains in Last Position.	None	None
	Letdown Isolation Va's. 1CV2, 1CV3, 1CV4, 1CV5 Control	Valves Fail Closed. Loss of Normal Letdown Flowpath.	Excess Letdown Flowpath Available.	None
	Letdown from RHX's Flow Control Valve 1CV8	Loss of Letdown Capability from RHX's. Valve Remains in Last Position Valve Normally Closed	Excess Letdown Flowpath Available	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Chemical and Volume Control (Cont)	Rapid Borate Flow XMTR. + Indicator Pwr. Supply	Loss of Rapid Borate Flow Indication	None	None
	#12 B.A. Tk. Lvl. + Temp. XMTRS + Ind. Pwr. Supply, Recirc Flow Cont. Va 12CV160 Control	Loss of all Indication for #12 B.A. Tk. Loss of Control 12CV160 Valve Remains in Last Pos.	#11 B.A. Tk. + Recirc Control Available	None
	BIT B-U Strip Htr Cont. Ckt. + Temp. XMTR.	Loss of BIT Temp Ind. Loss of BIT B-U Htrs.	Normal Strip Htr. Control Available	None
Main Steam	Steam Dump Train B Control Ckt.	Loss of Train B Steam Dump Capability	Steam Dump Train A Available	None
	CH. 1 First Stage Turbine Press XMTR., Tref + S.G. Lvl.Setpoint Cont. Ckt.	Loss of Thermal Pwr Tref for Rod Control Loss of Tref. for Steam Dump	CH. II First Stage Press Indication + Functions Available Tavg. Steam Dump Mode Remains Available Atmos. Steam Relief Valves (12MS10 + 13MS10) Available	None
	Atmos. Steam Relief Valves 11MS10 + 14MS10 Control	Loss of Auto or Manual Control	12MS10 + 13MS10 Local + Remote Control Available. Local Control 11MS10 + 14MS10 Available. Steam Dump Available. Safety Valves Operable.	None
	Atmos. Steam Relief Valves 11MS10, 13MS10, 14MS10 Setpoint + Demand Indicators Power Supply	Loss of Indication	S.G.'s Press. Indication Available	None
Pressurizer	PRZ. Lvl. Control XMTR. Pwr. Supply	Pwr. Loss Causes Erroneous Lo-lo Lvl. Signal Which Automatically Trips the PRZ Htr. Control + B-U Groups	None	None
	PRZ. Lvl. Cold Cal. XMTR. + Indicator Pwr. Supply	Loss of PRZ. Lvl. Cold Cal. Indication in Cont. Room.	None	None
	PRZ. Surge Line Temp. + Loops 11, 13 Safety Valve Disch. Temp., XMTRS. + Indicators, Loop 12 Indicator Pwr. Supply	Loss of Surge Line Temp. + Safety Valve Disch. Temp. All Loops Indication in Cont. Room.	None	None
	PRZ. Relief Valve 1PR2 Disch. Temp. XMTR. + Indicator Pwr. Supply + 1PR2 Auto Control (High Press)	Loss of Temp. Ind. for 1PR2 Loss of Operation 1PR2	1PR1 + all Indication Available in Cont. Room	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Reactor Coolant	#14 R.C. Loop Diff. Temp. Diff. Temp. Setpoints XMTRS. + Indicators W.R. Hot Leg Temp. W.R. Cold Leg Temp. Indicators Pwr. Supply	Loss of all Loop 14 Temp. Information	None	None
Residual Heat Removal	RHX's Bypass Control Valve 1RH20	Loss of Manual Valve Control Valve Remains in Last Position. Valve Normally Closed	RHR Loops Flow Indication Available	None
Rod Control	Bank Control Rod Position Recorders Pwr. Supply	Loss of Recorders	Rod Position Indication Available on Cont. Console. Rod Bottom Lights Operational.	None
	T Auct. Rod Control	Loss of all Inputs to Rod Control and Rod Speed Control. Loss of Auto-Man. Bank Selector Switch Operation. Rod Control Urgent Failure Alarm in Cont. Room Rods Remain in Last Position	Reactor Trip Capability Remains Operational	None
Safety Injection	RWST Lvl. XMTR. + Indicator Pwr. Supply	Loss of RWST Level Indication	Alternate RWST Level Indication Available on Cont. Console	None
	#'s 13 + 14 Accumulators Level + Press. XMTRS. + Indicators Pwr. Supply	Loss of Level + Press. Indications	Alternate Level + Press Indications Available on Control Console.	None
	# 11 SI Pump Disch. Press. + Flow XMTRS. + Indicators Power Supply	Loss of Loops 11 + 14 SI Flow + Press. Indication	#12 SI Pump Disch. Press. + Disch. Flow Ind. Available on Cont. Console	None

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Steam Generator	#'s 11, 12, 13, 14 S.G.'s CH. IV Steam Flow F.W. Flow Press Level XMTRS. + Indicators Power Supply (Not All Parameters For All S.G.'s on CH. IV)	Loss of CH. IV Indications (Where Applicable)	Alternate Indications for all Parameters Available on CH's I, II, or III	None

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SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Auxiliary Feedwater	#11 AFW Pump Suct. Press. Disch. Press. Motor Amps. Indicators Power Supply	Only pump start-stop indication remains. Loss of indication only. Cannot determine if pump is cavitating. Pump operation not affected by ckt. loss.	Local indication available. #12 AFW pump indication and operation available.	Change Power Supply for Suct. and Disch. Press Indicators to 1A VIB.
	#13 & 14 S.G.'s AFW Flow Indicators Power Supply	Loss of indication only. No system malfunction due to ckt. loss.	S.G. level indication available.	Change Power Supply to 1A VIB.
	AFW S.G. Inlet Valves (13AF21, 14AF21) Indicator Power Supply	Loss of indication only. No system malfunction due to ckt. loss.	S.G. level indication available.	Change Power Supply to 1A VIB.
	#13 AFW Pump Pump Speed Speed Demand Suct. Press. Alt. Suct. Press. Disch. Press. Steam Press. Indicators Power Supply	Loss of all Control Room indication pertaining to #13 AFW pump. No system malfunction due to ckt. loss. If pump required to operate, local operation necessary.	Local indication available. Refer to S.G. level indicator's to determine adequate delivery.	Change Power Supply to 1C VIB.
	AFW Storage Tank Level Indicator Power Supply	Loss of AFW storage tank level indication.	Local indication available.	Change Power Supply to 1A VIB.
Component Cooling	#11, 12, & 13 CCP's Motor Amps Indicators Power Supply	Loss of indication only.	Start-stop indication available. Alarms available.	None.
	LTDN Temp. Cont. VA. 1CC71 Pos. Ind. Ckt.	Loss of pos. indication only, no valve operation due to failure.	Hi-temp alarm operable.	None.
Chemical and Volume Control	B.A. Flow Control VA. 1CV172 and Primary Water Flow Control VA. Position Indicating Circuits.	Loss of voltage results in opening of valve position mult. relay contacts causing:	Must take manual control of Primary Water M-U Pumps.	None.
		Loss of Supply from B.A. Blender to Chg. Pumps. Loss of M-U to VCT from B.A. Blender. Loss of M-U to B.A. Blender from Primary Water Storage Tank. Loss of Auto Start for 11 & 12 Primary Water M-U Pumps.		None.
	Primary Water Storage Tank Level Indicator Power Supply	Loss of indication only.	Local indication available.	None.

11 MAC PANEL

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
	Boric Acid Flow Register and Primary Water Flow Register Power Supply	Loss of primary water M-U & B.A. Flow auto-stop function from registers.	Must take manual control of Primary Water M-U pumps, B.A. flow & Primary Water flow indications available on cont. console.	None.
Condensate	#'s 11, 12, and 13 Cond. Hotwell Level Indicators, Abs. Press Indicators, M-U Flow Recorder, Vacuum Recorder Power Supply	Loss of indication only. No effect on steam dump capability.	Condenser vacuum indicating light available on status panel, local indication available.	None.
Containment Spray	#'s 11 and 12 Motor Amps Indicators Power Supply	Loss of Control Room indication only, no effect on system operation.	Can verify operation VIA pump start-stop indication, NaOH additive tank outflow indication, decreasing tank level indication.	None.
Control Air	1A & 1B Hdr. Press. Transmitters and Hdr. Press. Recorder Power Supply	All Control Room information pertaining to control air system lost. Operator forced to declare loss of control air accident. Loss of this ckt. also causes loss of #1 Emergency Control Air, Air Comp., air dryer. Only indication is lost due to this failure. System will not malfunction.	Local indication available.	1A Hdr. XMTR. and indicator Power Supply to be separated from 1B HDR XMTR. and indicator Power Supply to avoid erroneous indicated loss of control air accident.
Diesel Generators	1A and 1C D.G.'s Volts Frequency Watts Amps Indicators Power Supply	Loss of all operating parameters indication. If necessary to operate D.G.'s, local operation possible. Failure of ckt. does not effect D.G. availability.	Local indication available.	Change 1A D.G. indicators Power Supply to 1A VIB. Change 1C D.G. indicators Power Supply to 1C VIB.
Main Steam	Atmos. Relief VA's 12MS10 and 13MS10 Position Indicating Relays	Loss of position indication only, valve control not affected by ckt. loss.	Steam generator pressure indication available in Control Room.	None.
Pressurizer	#'s 11 and 12 Spray Control Valves (1PS1 & 1PS3) Position Indicating Relays	Loss of indication only. Valve control not affected by ckt. loss.	Pressurizer pressure indication available in Control Room	None.
Reactor Coolant	#'s 11 and 13 RCP's Motor Amps Indicators Power Supply	Loss of indication only. Pump operation not affected by ckt. loss.	Pump start-stop indication and loop flow indication available in Control Room.	None.

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SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Residual Heat Removal	#'s 11 and 12 RHR Pumps Motor Amps Indicators Power Supply	Loss of indication only, system operation not affected by ckt. loss.	Pump operation may be verified via disch. press. indication in Control Room.	None.
	#11 RHX Outlet Control Valve 11RH18 Position Indicating Relays	Loss of Open-Close position indication.	#12 RHR loop available.	None.
Rod Control	Control & Shutdown Rod Position Indicators Power Supply	Loss of indication only. All indicators fail mid-scale. Ckt. loss has no effect on rod control circuitry.	Step counters, position & insertion limits recorder available on Control Console. Core flux indication available in Control Room.	None.
Safety Injection	#'s 11 and 12 SI Motors Amps Indicators Power Supply	Loss of indication only. Ckt. loss has no effect on system operation.	Disch. Press. and Disch. Flow Indication available on Control Console.	None.
Service Water	#'s 11, 12, 15, and 16 Pumps Motor Amps Indicators Power Supply	Loss of indication only. Ckt loss has no effect on system operation.	#'s 11 and 12 Hdr. Press indication available on Control Console.	None.
Station Air	#1 Station Air Comp. Control Ckt. (Unit #1 Only)	Loss of #1 Station Air Compressor (if running).	#2 and #3 Station Air Compressors available.	None.
	#2 Station Air Comp. Control Ckt. (Unit 2 Only)	Loss of #2 Station Air Compressor (if running).	#1 and #3 Station Air Compressors available.	None.
Penetration Area Ventilation	Inlet and Exhaust Dampers 1CAV8 1CAV9 1CAV12 1CAV13	Penetration area may be subjected to higher temp. causing alarms. Loss of ckt. and damper closures cause penetration area exhaust fans to turn off.	None.	Design to allow dampers to fail open upon loss of power. Must be evaluated with respect to fire protection system reqts.
Containment Ventilation	#'s 11, 13 and 15 Fan Coil Units Outlet Water Temp. and Flow indicators Power Supply	Loss of indication only. Ckt. loss has no effect on system operation. Service water supply remains.	S.W. indication for #'s 12 + 14 F.C. units available on Cont. Console.	None

12 MAC PANEL

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Auxiliary Feedwater	#12 AFW Pump Suct. Press. Discharge Press. Motor Amps. Indicators Power Supply	Only pump start-stop indication remains. Loss of indication only. Cannot determine if pump is cavitating. Pump operation not affected by ckt. loss.	Local indication available. #11 and 13 AFW pumps indication and operation available.	Change Power Supply for Suct. and Disch. Press. Indicators to 1B VIB.
	#11 and 12 S.G.'s AFW Flow Indicators Power Supply	Loss of indication only. No system malfunction due to ckt. loss.	S.G. level indication available.	Change Power Supply to 1B VIB.
	AFW S.G. Inlet Valves (11AF21, 12AF21) Indicators Power Supply	Loss of indication only. No system malfunction due to ckt. loss.	S.G. level indication available.	Change Power Supply to 1B VIB.
	Aux. Feed Pumps Suction Press. Indicator Power Supply	Loss of indication only. No system malfunction due to ckt. loss.	Individual AFW pump suct. press. indication available except #12 AFW pump suct. press. indication as noted above.	None.
Chemical and Volume Control	#'s 11 and 12 Chg. Pumps Motor Amps. Indicators Power Supply	Loss of motor amps indication only. Start-stop indication and control still available in Control Room.	Chg. flow indication available to verify operation.	None.
	Chg. Seal Press. Cont. VA. 1CV71 Pos. Indicating Relays and Chg. Flow Cont. VA. 1CV55 Position Indicating Relays	Loss of pos. ind. only. Valve control remains.	Chg. system seal press. and flow indication available on Control Console.	None.
	Letdown Press. Cont. VA. 1CV18 Pos. Indicating Relays	Loss of pos. ind. only. Valve control remains.	Letdown press. ind. available on Control Console. Hi-press. alarm remains operable.	None.
	Letdown Flow Cont. VA. 1CV8 (from RHX's) Pos. Indicating Relays	Loss of pos. ind. only. Valve control remains.	Letdown from RHX demand indication available on Control Console.	None.
	#'s 11 and 12 B.A. Tank's Recirc. Valves 11CV160 & 12CV160 Pos. Ind. Relays	Loss of pos. ind. only. Valve control remains.	B.A. Recirc. demand indication available on Control Console.	None.
Control Air	1A and 1B HDR. Press. Indicators Power Supply	Loss of indication only. Loss of ckt. has no effect on system operation.	1A and 1B Control Air Hdr. Press. RCDR on 1RP1 operable.	None.

12 MAC PANEL

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Diesel Generator	1B Diesel Generator Volts Frequency Watts Amps Indicators Power Supply	Loss of all 1B D.G. operating parameters ind. If necessary to operate, local operation a necessity. Failure of ckt. does not affect D.G. availability.	Local indication available. Control Room indication available for 1A and 1C D.G.'s.	Change Indicators Power Supply to 1B VIB.
Main Steam	Atmos. Relief VA's 11MS10 and 14 MS10 Position Indicating Relays	Loss of pos. ind. only. Valve control not affected by ckt. loss.	Steam Generator pressure indication available on Control Console.	None.
Pressurizer	Control Heaters A, B, C Amps. Indicators Power Supply	Loss of Amps. Ind. only. Heater control not affected by ckt. loss.	Prz. level and press. ind. available on Control Console.	None.
Reactor Coolant	#'s 11, 12, 13, 14 R.C. Loops Hot & Cold Legs Temp. Indicators Power Supply	Loss of temp. ind. Information necessary as part of SI termination criteria for MSLB.	Avg. temp. ind. and ΔT ind. for all loops available on Control Console.	Change 11 RC loop ind. Power Supply to 1A VIB. Change 12 RC loop indicator Power Supply to 1B VIB. Change 13 RC loop ind. Power Supply to 1C VIB. Change 14 RC loop ind. Power Supply to 1D VIB.
Residual Heat Removal	RHX's By-Pass Valve 1RH20 Position Indicating Relays	Loss of pos. ind. only. Valve control remains. Valve does not change position when ckt. lost.	#'s 11 + 12 RHR loops flow ind. and control valves operation available.	None.
	#12 RHX Outlet Cont. VA. 12 RH18 Position Indicating Relays	Loss of pos. ind. only. Valve control not affected by ckt. lost.	#11 RHR loop available.	None.
Rod Control	Rod Bottom Lights	Loss of rod bottom lights.	Rod position indicators, step counters, position and insertion limits RCDR available in Control Room.	None.
Service Water	#'s 13 and 14 SW Pumps Motor Amps. Indicators Power Supply	Loss of indication only. Ckt. loss has no effect on system operation.	#'s 11 and 12 Hdr. press. ind. available on cont. console.	None.
Station Air	#3 Station Air Comp. Control Ckt. (Unit 1 Only)	Loss of #3 Station Air Compressor (if running).	#'s 1 and 2 Station Air Compressors available.	None.

12 MAC PANEL

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Station Air (Cont'd)	#1 Station Air Compressor Motor Amps. Indicator Power Supply (Unit 1 Only)	Loss of motor amps. indication only. Ckt. loss has no effect on compressor availability.	All remaining compressor indication and alarms operable.	None.
	A and B Station Air Hdrs. Press. Indicators Power Supply	Loss of press. ind. only. Ckt. loss has no effect on system availability.	Alarms and valve position indications available.	None.
Station Communications	Power Supply to station P.A. System Cabinets	P.A. system rendered inoperable.		A back-up power supply and capability to quickly transfer the system.
Steam Generator	#'s 11, 12, 13, 14 S.G. Wide Range Level Recorders Power Supply	Loss of all wide range level indication in Control Room.	Narrow range level indication available on Control Console.	Pending resolution of design for long-term TMI item review.
Containment Ventilation	#'s 12 and 14 Fan CoilUnits Outlet Water Temp. and Flow Indicators Power Supply	Loss of indication only. Ckt.loss has no effect on system operation. Service water supply remains.	S.W. indication for #'s 11, 13, 15 F.C. units available on cont. console.	None.

13 MAC PANEL

SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Condensate	Condenser Abs. Press. XMTR. Vacuum XMTR. Hotwell Level XMTRS. Power Supply	Loss of all Control Room indication pertaining to condenser. Steam Dump capability not affected by ckt. loss.	Local ind. available.	None.
Control Air	#'s 11 and 12 Control Air Dryers	All solenoids fail closed causing loss of #'s 11 and 12 control air dryers.	#'s 13 and 14 control air dryers operational.	None.
	Service Water By-Pass Valves (11SW49 and 12SW49) Alarm Relays (Unit 1 Only)	Loss of OHA alarm window which notifies operator of valve operation. If valve opens fully the amount of water bypassed is equivalent to the flow of one S.W. pump. The amount bypassed is not significant enough to cause problems in equipment supplied by the S.W. system. Ckt. Loss also causes loss of by-pass elapsed time indicators on recorder panel 1RP1.	None.	None.
Station Air	A and B Hdr. Press. Transmitters	Loss of hdrs. press. ind. only. System availability not affected by ckt. loss.	Local indication available. System low press. alarms functional.	None.

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SYSTEM	COMPONENT	EFFECT OF FAILURE	ALTERNATE INDICATION/ EQUIPMENT AVAILABLE	DESIGN MODIFICATION TO BE EVALUATED
Station Air	#2 Emergency Comp. Air Dryer Solenoids (Unit 1 Only)	Loss of #2 Emergency Comp.	Normal station air compressors available.	None.

ATTACHMENT B

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
ENGINEERING AND CONSTRUCTION DEPARTMENT

DATE: April 26, 1979
RESPONSE DUE:

TO: E. N. Schwalje
Manager - Quality Assurance

FROM: F. A. Christiana
Chief Controls Engineer

SUBJECT: SALEM NUCLEAR GENERATING STATION
UNITS NO. 1 AND 2
RESPONSE TO IE CIRCULAR NO. 79-02
DESIGN FEATURES OF UNINTERRUPTABLE 120 VOLT
VITAL AC POWER SOURCES

The design of the Salem 120 volt uninterruptable power supplies has been examined in the perspective of problems experienced with Arkansas Nuclear One - Unit 2. The initiating event was a degradation of both independent offsite power sources. This would cause the DC link to be powered from the batteries, which is similar to the Salem design.

The four questions which the circular recommends be reviewed are answered below with a brief perspective provided.

1. Determine whether or not time delay circuitry is used in your inverter units. If so, have they been adjusted to the appropriate set point as required by equipment and the integrated system designs?

   The description of circumstances notes that the Arkansas Nuclear 1 - Unit 2 design provides for a low DC link voltage to trip both input breakers (Battery and AC to power supply), after an adjustable time delay, and that the settings had not been verified. The Garrett inverter does not provide circuitry of any form to trip the DC or AC input breakers. Therefore, there are no adjustments to be verified. The description further notes that the purpose of the adjustable time delay is to permit the battery to recover from transient demands which might cause the battery voltage to fall below 104VDC. The Salem 125VDC battery supply system is designed to preclude the battery being subjected to such a severe transient. This is essential to system design as the inverter is not designed to operate below 105VDC.

2. Determine if the AC input voltage and transformer tap settings are optimized to prevent exceeding the inverter component nameplate maximum rated DC input voltage in the event of a high AC input voltage transient.

The description of circumstances notes that a DC fuse within one inverter was blown and the failure attributed to an inductive input transient caused when a static switch transferred. It is further noted that the static switch is designed to transfer to an alternate source on inverter output overcurrent or undervoltage. The Garrett Inverter Power Supply is conservatively designed to absorb input transients without causing misoperation. Garrett and PSE&G experience with this inverter design typically shows fuse failure to be caused by the simultaneous firing of two opposing thyristers, generally caused by logic circuit malfunction. PSE&G is planning to reduce input voltage to the inverter power supply in order to reduce DC link voltage, but this will be primarily to reduce steady state stress on inverter components, for increased reliability.

3. If an alternate 120 volt source is used in your design, determine if the protection transfer circuitry of the inverter has been optimized within design limits to ensure maximum possible availability of the inverter system during transient loading conditions. An operating history of inexplicable transfers may be indicative of the above.

The discussion notes that the SCI inverter provides a one-way transfer on inverter output undervoltage or overcurrent, and that this circuit is adjustable. The Garrett circuit provides for automatic transfer in both directions. The transfer point is established by circuitry which is essentially not adjustable.

The load is transferred from alternate source to inverter when inverter output voltage is present. The load normally will be transferred back to the alternate source when inverter output is lost. However, if output current is high, indicating a possible short circuit, transfer is blocked.

The transfer points are not presently subject to verification. The inverter is designed to run from 109 - 125VAC, and is lightly loaded (significantly less than 100% current). Therefore, the transfer circuitry has been "optimized" for maximum reliability.

The NRC has required the circuit breaker for the alternate 120 VAC source to be administratively open. Any transfer would be to a dead bus.

4. Determine if the administrative controls employed by your facility ensures operability of safety systems after its subcomponents (e.g., time delay relays, switches, etc.) have been subjected to maintenance or testing.

Voltage readings on the DC link and AC output voltage and current periodically recorded. The exact transfer point of the transfer circuitry is not measured. No time delays are used.

Original signed by
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JJS:sab