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50-287 Oconee Nuclear Station, Unit 3, Duke Power Co. 05000287
AUTH.NAME AUTHOR AFFILIATION
HAMPTON,J.W. Duke Power Co.
RECIP.NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

SUBJECT: Special rept:on 920407,calculated voltage found to be less than mfg required min rated voltage.Caused by design deficiency.All S breakers declared inoperable & overhead power path tested for operability.

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IA-2

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DUKE POWER

May 7, 1992

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Site
Docket Nos. 50-269, -270, -287
Special Report Concerning Calculated
Control Voltage Safety-Related Breakers
Less Than Manufacturer's Specifications

Gentlemen:

This report is provided for information regarding calculated control voltage safety-related breakers less than manufacturer's specifications.

If you have any questions, please contact S. G. Benesole at (803) 885-3518.

Very truly yours,

Joe M Davis
for J. W. Hampton
Vice President

/ftr

Attachment

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Oconee Nuclear Site

A047

NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104

EXPIRES: 4/30/92

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, All Units	0 5 0 0 0 2 6 9	1 OF 1 1

TITLE (4) Design Deficiency Results In Calculated Control Voltage To Safety-Related Breakers In Emergency Power Paths Less Than Manufacturer's Specifications

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 4	0 7	9 2	9 2	SPECIAL	0 0	0 5	0 7	9 2	Oconee, Unit 2	0 5 0 0 0 2 7 0
									Oconee, Unit 3	0 5 0 0 0 2 8 7

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)					
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)		
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)		
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X	OTHER (Specify in Abstract below and in Text, NRC Form 366A)	
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)		SPECIAL REPORT	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)			
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)			

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
S. G. Benesole, Oconee Safety Review Group	AREA CODE 8 0 3 — 8 8 5 - 3 5 1 8

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

ABSTRACT

With all Oconee units operating at 100%, on April 7, 1992 at 1615 hours, Oconee Site Engineering Division performed voltage calculations in response to an open item from the 125 VDC Vital Instrumentation and Control System Design Basis Document to determine the adequacy of the supplied control voltage to close Unit 3's Standby Breakers ("S"). This calculated voltage was found to be less than the manufacturer's required minimum rated voltage. It was also discovered that similar voltage conditions could exist on the Unit 1 and Unit 2's "S", all Startup Breakers ("E") and the Standby Keowee Breakers ("SK"). Eight breakers were tested to determine actual minimum closing voltage, and it was found to be less than the manufacturer's required minimum voltage. Calculations were performed to determine the past operability of the breakers at the times when the DC System was degraded. These calculations proved past and present operability of the breakers under degraded DC conditions. However, modifications were made to enhance the closing circuitry by adding a relay to each circuit to ensure adequate voltage to the closing coil of all three unit's "S", "E", and "SK" breakers. This report is being submitted as a Special report. The root cause of this event is classified as Design Deficiency.

BACKGROUND

The normal source of power to the Main Feeder Bus (MFB)(EIIS:EA) is the unit generator via the Auxiliary Transformer. The Start Up ("E") breakers provide power to the MFB from the Start Up Transformer when the normal source is not available during unit shutdowns or accident situations. The Standby ("S") breakers provide power to the MFB from the Standby Bus when the normal and startup sources are not available during unit shutdowns or accident situations. The Standby Keowee ("SK") breakers provide emergency power to the Standby Bus from the Keowee Hydro Units. (Attachment 1)

For each unit, two independent and physically separated 125 VDC batteries and DC buses are provided for the Vital Instrumentation and Control Power System (EIIS:EJ). Technical Specifications allow one of the six available batteries to be out of service during three unit operations without entering a Limiting Condition for Operation (LCO). A combination of 4 of 6 batteries in service will place the station in an LCO. Three battery chargers are also supplied, with two serving as normal supplies to the bus sections with the batteries floating on the bus. The batteries supply the loads without interruption should the chargers or the AC source fail. Four separate 125 VDC Instrumentation and Control panelboards are also provided for each unit. Each panel board receives its power through an auctioneering network of two isolating diode assemblies. The closing coils of the "E", "S", and "SK" breakers are powered from these panelboards. (Attachment 2)

In order to close the "E", "S", and "SK" breakers in either the manual or automatic mode, sufficient DC voltage must be supplied to the closing coil relay from the 125 VDC Vital Instrumentation and Control System. The breaker manufacturer (I-T-E) states the minimum requirement for proper operation as 90 VDC.

Applicable Technical Specifications are Limiting Conditions for Operation 3.0 and Auxiliary Electrical System 3.7.1(b):

> Two independent on-site emergency power paths shall be operable and consist of:
>
> 1. One Keowee hydro unit; through the underground feeder path; through transformer CT 4; through the Keowee standby bus feeder breakers ("SK1 and SK2") to the standby buses; and capable of supplying emergency power through the standby bus to main feeder bus breakers ("S1 and S2").
> 2. The other (redundant) Keowee hydro unit; through the Keowee main step-up transformer and breaker PCB-9; the 230 KV switchyard yellow bus and safety related PCB-18, -27, or -30; through the respective operating unit's start-up transformer (CT-1, 2, or 3) or aligned and connected alternate start-up transformer; and capable of supplying emergency power through the start-up transformer to the main feeder bus breakers ("E1 and E2"). One start-up transformer may not be aligned to supply more than one unit.

and 3.7.2(a):

1. One of the two independent on-site emergency power paths, as defined in 3.7.1(b), may be inoperable for periods not to exceed 72 hours, provided the alternate path is operable for test or maintenance, provided the alternate power path is verified operable within one hour of the loss and every eight hours thereafter.

EVENT DESCRIPTION

On April 7, 1992 at 1615 hours, a determination was made by Oconee Site Engineering Division that the supplied voltage from the 125 VDC Vital Instrumentation and Control (I&C) System to safety-related power source breakers could be less than the manufacturer's (I-T-E) recommended minimum value of 90 VDC during certain scenarios. In response to an open item from the 125 VDC Vital I&C System Design Bases Document, an analysis of the adequacy of the control voltage to all safety-related DC breakers was performed. The bases to perform the analysis used the following conservative assumptions:

1) worst case battery capacity (and voltage) with four batteries with each having only 58 of 60 cells operable
2) the worst case panelboard voltage which will occur at 3DID when its battery, 3CB, is the single failure
3) all of the 3DID current will be supplied by 1DCB through the auctioneering diodes

During this analysis, it was discovered that the control voltage to close the Unit 3 Standby ("S") breakers would be lower than I-T-E's minimum rated voltage. As a conservative measure, Unit 3's breakers were declared inoperable. The design of a modification was begun to correct the potential problem. At this time, additional calculations were begun to address the operability of the Unit 1 and 2's "S" breakers.

At 1830 hours, Operations Group at Oconee was informed of the analysis of Unit 3's breakers and in response, conservatively declared all "S" breakers inoperable, thus making the underground power path inoperable.

At 1852 hours, the overhead path was tested satisfactorily. During the review of the Technical Specifications (TS) requirements, it was recognized that during the design basis event, Loss of Coolant Accident/Loss of Offsite Power (LOCA/LOOP) (where the main feeder bus of the LOCA unit is aligned to the standby bus), power from the underground path will not be available if the "S" breakers fail to close. In addition, the Emergency Power Switching Logic, sensing that the standby buses are energized, would prevent transfer of the main feeder bus to the overhead and the start-up transformer. All three units were placed under a 12 hour Limiting Condition for Operation (LCO) per Technical Specifications (TS) 3.0.

At 2050 hours, Operations began to remove the Standby Buses from service to prevent the Standby Buses from being energized, and a 72 hour LCO was entered per TS 3.7.1(a)(1).

At 2320 hours, TS 3.0 LCO was exited upon the completion of the Standby Bus isolation.

On April 8, 1992, at 1430 hours, the Engineering calculations indicated that similar low voltage condition might exist during certain conditions for Unit 1 and 2's "S" breakers and the Standby Keowee ("SK") breakers. I-T-E indicated that similar new breakers had been tested and closed under control voltages as low as 60 VDC. This is below I-T-E's requirement of 90 VDC; however, I-T-E is unwilling to guarantee operation below the recommended 90 VDC value.

Work Request 54045L was written to perform a low voltage operability test for the "SK" and "S" breakers. This test was conducted to determine the actual minimum voltage required to operate the breakers. The results are recorded in Attachment 3 under column labeled "ACTUAL".

At 1830 hours, testing began on Unit 3's "S" breakers. Eight breakers ("S" and "SK") were tested for minimum close voltage. Seven of the eight tested had minimum close voltages of 58.5 VDC or less. The eighth breaker had a minimum close voltage of 63.5 VDC ("S11" Breaker). The consistency of the results for the breakers which were tested indicated no reason to believe that the untested "E" breakers for each unit would behave any differently. Based on this information, voltages and calculated minimum voltages for the battery conditions, all breakers were determined to be operable for the existing battery and cable length conditions.

On April 9, 1992 at 0200 hours, implementation of modifications to Unit 3's "S" breakers began. This modification consisted of installing and wiring a close-interposing relay, relocating cable conductors and internal wiring in "S13" and "S23" and performing functional tests of close circuits for the "S13" and "S23" breakers.

At 1800 hours, modifications to "S13" and "S23" breakers were completed. Also, preparations were being made to modify and test Unit 1 and Unit 2's "S" breakers at the same time. Calculations also indicated that Unit 1, 2 and 3's "E" breakers may be subjected to the same low voltage condition as the "S" and "SK" breakers. Based on these calculations a decision was made to test and modify the "E" and "SK" breakers beginning April 13, 1992.

On April 10, 1992, at 0130 hours, modification and testing of Unit 1, 2 and 3's "S" breakers were completed.

At 0609 hours, the Standby Bus was returned to service and the 72 hour LCO was exited.

On April 13, 1992, at 0946 hours, a 72 hour LCO, per TS 3.7.2(a)(1), was entered, when the underground on-site emergency power path for all 3 units was taken out of service for the modification of the "SK1" breaker.

At 1746 hours, "SK1" modification and testing was completed. "SK1" was returned to service. The underground power path remained out of service while the modifications and testing was being performed on "SK2" breaker.

At 2100 hours, "SK2" breaker was returned to service after completion of the modifications and testing.

On April 14, 1992 at 0008 hours, the operability test of the underground on-site emergency power path was completed.

At 0821 hours, after the completion of the modification and testing of the "SK1" and "SK2" breakers, the underground on-site emergency power path was declared operable and the 72 hour LCO was exited.

On April 14, 1992 at 0848 hours, a 72 hour LCO, per TS 3.7.2(a)(1) was entered, when the overhead on-site emergency power path was taken out of service for the modification of the "E11", "E12" and "E13" breakers. While out of service for modifications, the actual minimum close voltages on the two "E" breakers for each unit was determined. (See Attachment 3). Test results for all breakers indicated that the six breakers tested had minimum close voltages of 60.3 VDC or less.

At 1635 hours, modifications and testing were completed on "E12" breaker.

At 1650 hours, modifications and testing were completed on "E13" breaker.

At 1708 hours, a 72 hour LCO, per TS 3.7.2(a)(1), was entered, when the overhead on-site emergency power path was taken out of service for the modification of the "E23" breaker.

At 1800 hours, a 72 hour LCO, per TS 3.7.2(a)(1) was entered, when the overhead on-site emergency power path was taken out of service for the modification of the "E21" and "E22 breakers.

At 1835 hours, modifications and testing were completed on "E11" breaker.

At 2100 hours, modifications and testing were completed on "E23" breaker.

On April 15, 1992 at 1022 hours, modifications and testing were completed on "E22" breaker.

At 1122 hours, modifications and testing were completed on "E21" breaker.

At 1232 hours, the emergency power path was declared operable and the LCO was exited.

Subsequently, Site Engineering revised the calculations for the expected available voltages at the breaker close coil. The initial calculations had used the worst case cable lengths for cabling up to the individual breaker control cabinets, but used assumed lengths for wiring within the breaker control circuits. The final calculations used the actual lengths of the control circuit wiring. In each case, this reduced the margin between the expected available voltages and the actual test voltages. However, the expected available voltage remained above the actual test voltage for each breaker, as shown in Attachment 3, and therefore, the revision had no affect on the conclusions reached.

CONCLUSION

The root cause of this event is classified as Design Deficiency, unanticipated interaction of systems or components, design oversight because, during the initial design, the line losses were not considered in the calculations for available minimum voltage at the close coil relay. Oconee Nuclear Station unknowingly operated for many years with the breaker control voltage potentially less than the manufacturer's specification. However, the consistency of the results for the breakers which were tested indicated there was no reason to believe that the breakers would have failed. Based on this information, test voltages and calculated minimum available voltages, all breakers were determined to be operable.

The calculations were performed to determine the past operability of the system at times when the DC system was degraded less than all six station batteries available. (See Attachment 3) The modifications were performed to increase the available closing control voltage at the breakers to above the I-T-E minimum rating of 90 VDC.

There were no equipment malfunctions or component failures involved in this discovery, therefore, this event is not NPRDS reportable. A review of the Problem Investigation Reports that have been generated over the last two years revealed several events that reported postulated failures on emergency power paths. These events were discovered by Duke Power Company in the Design Basis Documentation effort:

LER 4-090-0035 (Design Deficiency/Unanticipated Interaction of System Results in the Potential Closure of the Startup Transformer "E" Breaker on to a Degraded (Low Voltage Switchyard)

LER 4-090-0074 (Potential Overload Conditions May Result in Inadequate On-Site Emergency Power Source During a LOCA/LOOP Event Due to Design Deficiency)

LER 4-091-0003 (Potential Single Failure During a LOCA/LOOP Event May Result in the Loss of Emergency Power Due to Design Deficiency)

LER 4-091-0039 (Technical Inoperability of Oconee Backup Electrical Power Sources Results From Deficiently Designed Circuit Breaker Arrangement of Keowee Hydro Auxiliary Loads)

Based on these reported events, where one or more emergency power paths were potentially inoperable due to design deficiency for certain accident scenarios, this event is considered recurring. Since this event originated in the initial design of the Standby Bus, the corrective actions for previously identified problems could not be expected to have corrected this situation. This event was identified during a response to an open item from the 125 VDC Vital Instrumentation and Control System Design Bases Document to determine the adequacy of the supplied control voltage to close coil of the Standby Breakers. This review, along with other enhancements in the Oconee Site Engineering Division policies, administrative procedures and equipment modifications, should limit the probability of similar occurrences in the future.

There were no radioactive releases, radiation exposures, or personnel injuries resulting from this event.

CORRECTIVE ACTIONS

Immediate

1. Operations Group at Oconee declared all "S" breakers inoperable, thus making the underground power path inoperable.

2. The overhead power path was tested for operability.

Subsequent

1. When Standby Buses were removed from service, preventing the Standby Buses from being energized, the problem with the Emergency Power Switching Logic affecting the overhead power path was resolved.

2. Low voltage operability test were performed for the "SK", "E", and "S" the breakers.

3. Modifications of the "S", "E" and "SK" breakers completed.

4. Performed past operability evaluation to determine the adequacy of the close coil available voltages.

Planned

None

SAFETY ANALYSIS

The 125 VDC Vital Instrumentation and Control (I&C) Power System is required to be operable for a variety of plant conditions and design basis events including the Loss of Coolant Accident/Loss of Offsite Power (LOCA/LOOP) event. Because the conservatively calculated available voltage was below the manufacturer's designed minimum voltage, the possibility existed for a common failure of the "E", "S" and "SK" breakers, if needed, to respond to an accident. The addition of the close-interposing relay in the standby bus breakers will ensure that these breakers close when required and will not adversely affect the ability of the standby bus or the main feeder bus to provide power in the event of a design basis accident. Also, this modification will not affect the time requirements for providing power to the LOCA unit, or initiating the minimum High Pressure Injection (EIIS:BG) or Low Pressure Injection (EIIS:BP) flow rates.

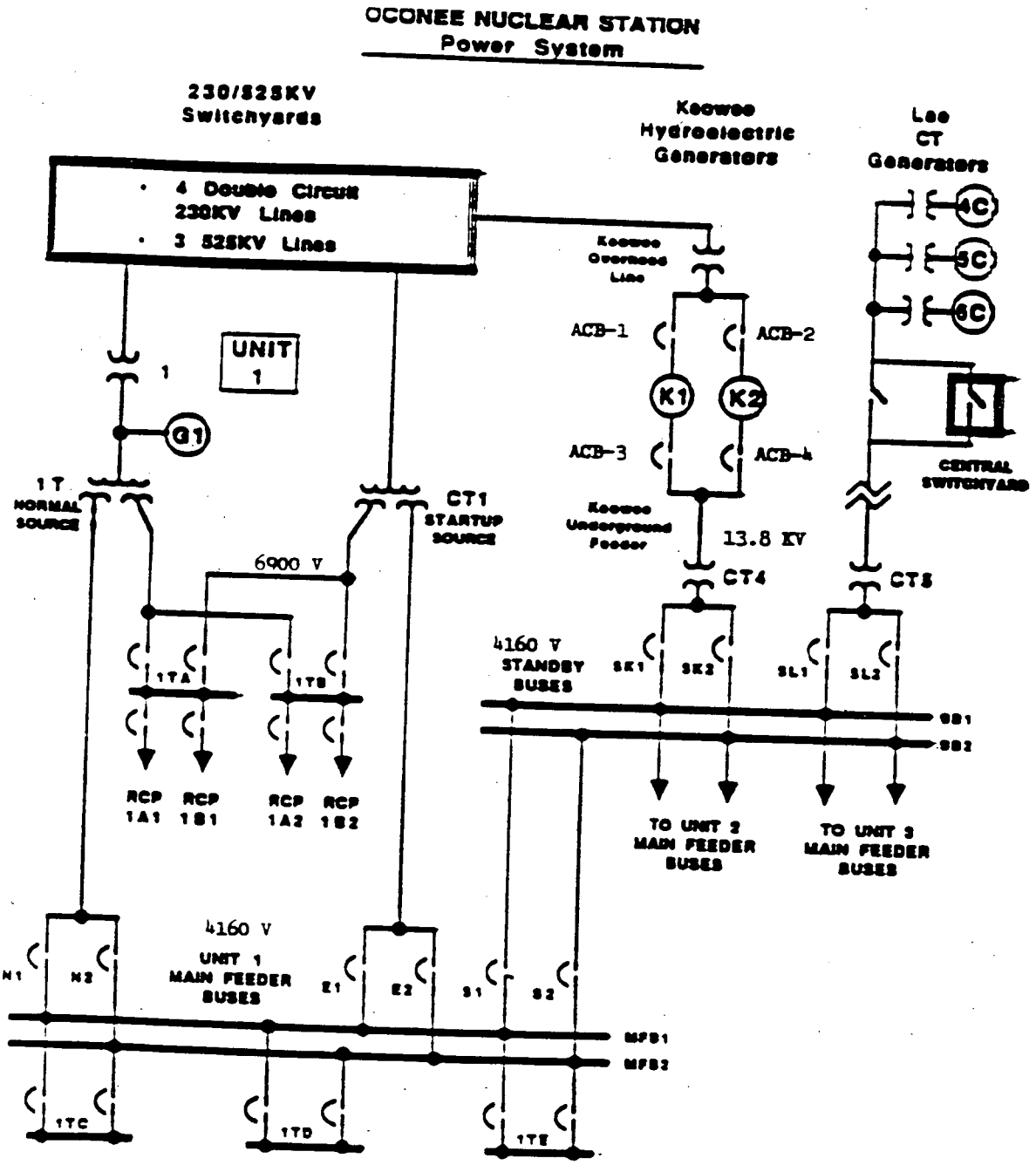
The Technical Specifications (TS) allow all three units to operate with five batteries with no Limiting Conditions for Operation (LCO), or four batteries in a LCO. The 125 VDC Vital I&C Design Basis Document states that a battery is considered operable if it has 58 of its 60 cells operable. Therefore, the worst case battery capacity (and voltage) will occur when there are four batteries with only 58 cells each operable.

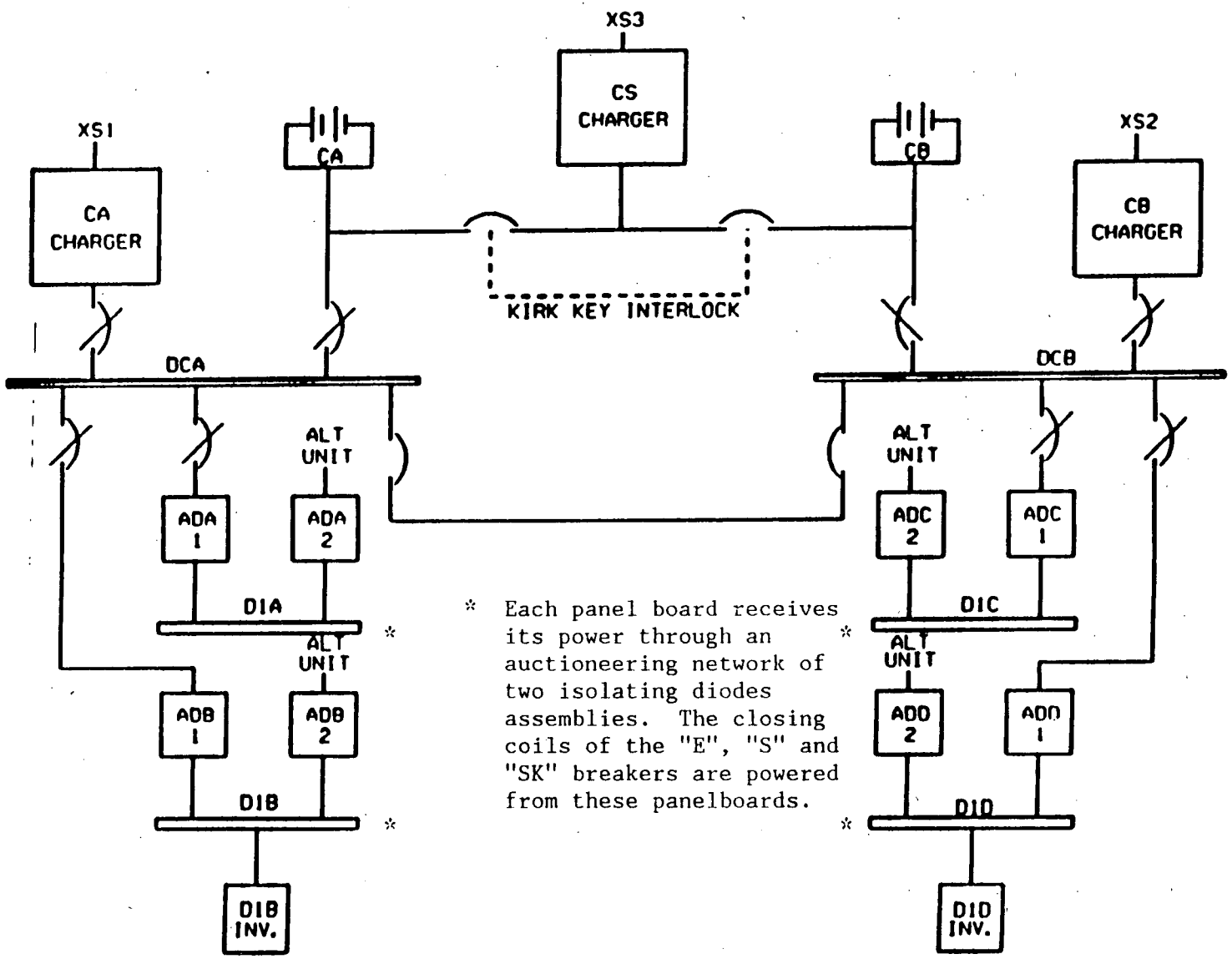
The worst case minimum expected control voltage at each of the breakers close coils was calculated. These voltages range from 72.7 VDC to 59.8 VDC, the lowest being the "SK2". In all cases the available closing coil voltage was greater than the required minimum voltage for operation of the close coil.

Based on the tested minimum close voltage capabilities of the breakers, as well as the conservative calculated minimum expected voltages available at the close coils, the "E", "S", and "SK" breakers for all three units are judged to be operable under all 125 VDC Vital I&C system conditions allowed by TS. Therefore, all of the affected breakers would have been capable of performing all required safety functions during any design basis event.

The health and safety of the public were not found to have been compromised by the discovery of this postulated event.

Attachment 1




XS3
CS CHARGER
XS1
CA
CB
XS2
CA CHARGER
CB CHARGER
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DCA
DCB
ALT UNIT
ADA 1
ADA 2
ADC 2
ADC 1
DIA
DIC
ADB 1
ADB 2
ADD 2
ADD 1
DIB
DID
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* Each panel board receives its power through an auctioneering network of two isolating diodes assemblies. The closing coils of the "E", "S" and "SK" breakers are powered from these panelboards.
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REF. 0-705
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Attachment # 3

BREAKER CLOSING VOLTAGE			
BREAKERS	INITIAL CALCULATIONS@	FINAL CALCULATIONS#	ACTUAL TEST VOLTAGES
E11	69.1	67.8	55.0
E21	69.1	65.2	57.0
S11	78.5	67.8	63.5
S21	78.5	65.2	47.0
E12	69.1	64.8	49.1
E22	69.1	62.4	56.5
S12	78.5	74.1	52.5
S22	78.5	72.7	55.0
SK1	69.7	67.6* 64.4 60.4	56.6
SK2	69.7	67.6* 64.2 59.8	53.7
E13	65.93	64.8	56.0
E23	65.93	62.4	53.0
S13	63.27	62.9	42.9
S23	63.27	60.4	56.0

@ Calculations use 4 of 6 batteries, 58 of 60 cells, and the length of cable to the worst case panelboard. Used nominal lengths of wiring in breaker control circuits.

Same as Initial Calculations, except used actual lengths of wiring in breaker control circuits.

* (no change)