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AUTH.NAME AUTHOR AFFILIATION
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BARRON,H.B. Duke Power Co.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 91-004-00:on 910506,tech inoperability of emergency electrical power path occurred due to incorrect relay trip setpoints.Caused by inappropriate action.Emergency power path through CT-4 proven operable.W/910605 ltr.

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DUKE POWER

June 5, 1991

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 269/91-04

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 269/91-04 concerning the technical inoperability of an emergency electrical power path.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(v)(D). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron

H. B. Barron
Station Manager

RSM/ftr

Attachment

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110014



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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

# LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)
Oconee Nuclear Station, Unit 1

DOCKET NUMBER (2)
0 5 0 0 0 2 6 9

PAGE (3)
1 OF 1 2

TITLE (4)
Technical Inoperability of an Emergency Electrical Power Path Due to Incorrect Relay Trip Setpoints Results From Inappropriate Action

| 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 5 | 0 6 | 9 1 | 9 1 | 0 0 4 | 0 0 | 0 6 | 0 5 | 9 1 | Oconee, Unit 2 | 0 5 0 0 0 2 7 |
| | | | | | | | | | Oconee, Unit 3 | 0 5 0 0 0 2 8 |

OPERATING MODE (9): N

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

| | | | |
|---|---|---|---|
| 20.402(b) | 20.405(c) | 50.73(a)(2)(iv) | 73.71(b) |
| 20.405(a)(1)(i) | 50.36(c)(1) | X 50.73(a)(2)(v) (d) | 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) | 50.72(b)(2)(iii)( |
| 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: Henry R. Lowery, Chairman Oconee Safety Review Group

TELEPHONE NUMBER — AREA CODE: 8 0 3 — 8 8 5 - 3 0 3

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)

YES (If yes, complete EXPECTED SUBMISSION DATE)

X NO

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

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

On May 6, 1991, at approximately 1500 hours with all three Oconee units operating at 100 percent full power, it was discovered during a review of relay setpoints that zone protection differential relays in the 230 KV switchyard were incorrect. The review had been initiated as an action item associated with a Design Basis Document preparation. As a result of subsequent investigations, the Unit 1 startup transformer (CT-1) and the electrical bus which provides an emergency power path to all three units (yellow bus), both of which are required by Technical Specifications, were found to be subject to inadvertent lockouts if a fault occurred on certain non-safety related equipment. At 1800 hours on May 6, 1991, CT-1 was declared technically inoperable. The yellow bus was declared technically inoperable at 1030 hours on May 7, 1991. After correcting the relay setpoints, all emergency power equipment was declared operable on May 7, 1991 at 1740 hours. The root cause of this event was inappropriate action, inattention to detail, on the part of the personnel who calculated the trip setpoints for relay replacement in August, 1987. The review of safety related relay trip setpoints will continue.

BACKGROUND

Each unit at Oconee Nuclear Station has several sources of electrical power available to supply essential station equipment (see Attachment 1). The sources are listed below in the order of preferred choice:

1) The 230 kilovolt (KV) transmission network (switchyard) [EIIS:FK] through the Oconee units' normal (1,2,3T) or startup (CT-1,2,3) transformer [EIIS:EA].

2) One of two Keowee Hydro units [EIIS:EK] through the 230 KV switchyard.

3) The other Keowee Hydro unit through an underground circuit and transformer CT-4 [EIIS:EK].

4) A dedicated 100 kv line from gas turbines at Lee Steam Station (located 30 miles from Oconee Nuclear Station) through transformer CT-5 [EIIS:EK].

5) The startup transformer of another Oconee unit.

6) The CT-5 transformer from the Central Switchyard.

Both CT-4 and CT-5 supply standby buses which can be connected to each unit's 4160V Main Feeder Buses (MFBs) [EIIS:EB]. CT-5 is normally energized from the Central switchyard which does not have degraded grid protection.

Power to the MFBs is normally supplied from the 230 KV switchyard. When an Oconee unit is operating above 15 percent full power it is usually supplied via its normal 1,2,3 T transformer. When the unit is below 15 percent power, power is usually supplied from its startup (CT-1,2,3) transformer.

The 230 KV switchyard is divided into a safety related yellow bus and a non-safety related red bus (See Attachment 1). These buses are separated by three power circuit breakers (PCBs) [EIIS:EA]. Incoming lines and feeder loads are always separated from the buses by at least one PCB.

Protective relaying is used in the switchyard to detect electrical faults. The switchyard is divided into different relaying zones. Current transformers measure the current into and out of each zone. When a current mismatch occurs, indicating a fault, a differential relay is actuated which provides a permissive to isolate all inputs and outputs to that zone.

A disadvantage of this arrangement is that differential relays can be sensitive to faults occurring adjacent to the protective zone. As the current passing through the protected zone to the fault changes the relay can actuate and unnecessarily isolate the zone. The manufacturer of the differential relays have provided adjustable relay setpoints which, when

properly set, prevent the relay from mistakenly actuating under these circumstances.

Technical Specifications require that each unit's startup transformers be available as part of the 230KV overhead power path from Keowee Hydro Station. If a startup transformer is not available, the unit may continue operation for seventy two hours, provided the underground power path is proven operable within one hour and tested operable once every eight hours thereafter.

EVENT DESCRIPTION

Duke Design Engineering has been performing a review of 230 Kilovolt (KV) switchyard relay setpoints as part of an action item associated with the Design Basis Document (DBD) review of the 230 KV switchyard. Due to problems found during that review, Design Engineering committed to review all safety related relay setpoints at Oconee, the 230 KV switchyard, and Keowee Hydro Station. On May 6, 1991 at approximately 1500, Design Engineer A discovered a discrepancy with the setpoints of transformer CT-1 bus differential relays 87TB -X,-Y,-Z. These safety related relays provide fault protection for the three phases of power circuit breakers (PCBs) 17 and 18 and the line connecting these PCBs to transformer CT-1 (See Attachment 2). The relays are General Electric Type PVD21D differential relays. Each PVD21D relay has two component relays: an 87L, which measures the differential voltage generated between the protective zone current transformers, and an 87H, which responds to overcurrent generated in the relay circuit due to a fault in the protective zone. The actual setpoints, as specified on drawing OEE-081-32, did not agree with the manufacturer's recommendations as found in General Electric manual GEK-45405. The 87H setpoints were incorrectly set too low. Design Engineer A notified Design Engineering Supervisor A of the discrepancy at approximately 1500 hours.

An evaluation was performed to determine if the incorrect setpoints made the CT-1 transformer inoperable. It was found that, with the incorrect setpoints, a fault on non-safety related equipment (for instance, the 230 KV red bus) could inadvertently actuate the 87TB relays which would initiate a lockout of the CT-1 transformer. At 1800, Design Engineering Supervisor A notified Oconee Operations Shift Supervisor A and the Operations Support Manager that CT-1 was technically inoperable. A Limiting Condition for Operation (LCO) was entered for Unit 1 under Technical Specification 3.7.2.i.2. Unit 1 was operating at 100 percent full power. The underground power path was proven operable, as required by Technical Specifications. A review of other safety related type-87 differential relays continued.

On May 7, 1991 by 1030 hours, the setpoints of all safety related differential zone protection relays had been reviewed. It was found that the 87H setpoints were also incorrect on the relays protecting the transmission lines and associated PCBs from CT-2 and CT-3 to the 230 KV

switchyard. However, analysis showed that an adjacent fault on non-safety related equipment would not inadvertently trip these relays. Differential voltage relays 87BY-X,-Y,-Z, which provide fault protection for the 230 KV switchyard yellow bus (see Attachment 3), were also found to have incorrect setpoints associated with their 87H components. Analysis showed that an adjacent fault on non-safety related equipment could inadvertently isolate the entire yellow bus. This made the overhead emergency power path to the startup transformers on all three units technically inoperable.

At 1030 hours, the Operations Support Engineer and Shift Supervisor B were notified by Design Engineering Supervisor A that the overhead emergency power path was technically inoperable. All units were operating at 100 percent full power at this time. Each unit entered a seventy two hour LCO under Technical Specification 3.7.2.a.1.

At 1430, the implementation of Exempt Change OE-3875 was initiated. The 87TB relays on CT-1 were reset according to Design Engineering calculations based on manufacturer's recommendations. At 1630, the 87BL relays on the 230 KV yellow bus were reset using revised setpoints. The overhead emergency power path was declared operable on May 7, 1991 at 1740 and all three units exited from the corresponding LCOs.

Further research discovered that the problem had existed since 1987 when all of the 230 KV switchyard differential voltage relays had been replaced. The CT-1 relays were replaced on August 10, 1987 and the yellow bus relays were replaced on August 14, 1987. The previous relays were General Electric type PV11C1A. They were replaced with the PVD21D types because it was found that the current and voltage ratings for the PV11C1A relays were inadequate. Design Engineering has stated that these inadequate relay ratings did not result in the inoperability of safety related equipment. In 1983, Exempt Change OE-0567 had been prepared which changed the relay setpoints in anticipation of the actual relay change. A calculation of the new setpoints was performed by Duke Transmission Department Engineer A for this exempt change. The calculation was verified by Design Engineer B of Duke Design Engineering.

The General Electric manual (GEK-45405) for the PVD21D relays contains a graphical method for determining the 87H setpoints. The 87L setpoint is first obtained from a relay circuit formula. It is used to determine from a graph (see Attachment 4) the appropriate 87H setpoint. The graph has two scales on the x-axis, one for PVD21B relays and one for PVD21D relays. The incorrect relay setpoints corresponded to the setpoints which would have been obtained by using the PVD21B scale. This was true for all 87-type differential voltage relays in the 230 KV switchyard. Transmission Department Engineer A stated that he failed to notice the second scale.

CONCLUSIONS

The CT-1 transformer had been technically inoperable since August 10, 1987. The overhead emergency power path had been technically inoperable since August 14, 1987. Both components were returned to operable status as of 1740 hours, May 7, 1991. During the periods of inoperability, incorrectly calculated zone protection relay setpoints made CT-1 and the 230 Kilovolt (KV) yellow bus subject to unnecessary lockouts due to postulated faults on nearby non-safety related equipment.

The root cause of this event is improper action, action chosen was incorrect because of a lack of attention to detail, on the part of Transmission Department Engineer A, who performed the PVD21D relay setpoint calculation, and Design Engineer B, who verified the calculation. A mitigating factor is that the text of the General Electric manual does not warn the user that the graph has two scales. Nevertheless, the graph is legible and the scales are clearly labeled. Strict attention to detail would have prevented the occurrence of this event. Since 1983, the procedures for preparation and review of design engineering calculations have been improved to require the use of checklists and specific design criteria. However, manufacturer's instruction manuals must still be consulted and careful adherence to these documents is required. Design Engineering now performs these setpoint calculations for safety related equipment.

A review of Problem Investigation Reports over the last two years indicate that several events have occurred with a root or contributing cause of inappropriate action. However, none of these events have been caused by an inappropriate action of Design Electrical Engineering personnel. The ongoing review of safety related relay trip setpoints has led to several discoveries of degraded electrical power distribution capability. These events have been caused primarily by an unanticipated interaction of systems during design. None were attributable to inappropriate action by Design Engineering. Therefore this event is considered non-recurring.

This event did not involve a radioactive release or radiation exposure. It did not involve equipment failure and is not NPRDS reportable.

CORRECTIVE ACTIONS

Immediate

1. The emergency power path through CT-4 was proven operable as required by Technical Specifications after declaring CT-1 technically inoperable.

Subsequent

1. Trip setpoints for 87TB -X, -Y, -Z relays, protecting the transmission line from the CT-1 transformer to the 230 KV switchyard were reset to manufacturer's recommendations.

2. Trip setpoints for 87BY -X, -Y, -Z relays, protecting the 230 KV yellow bus, were reset to manufacturer's recommendations.

Planned

1. A summary of this report will be routed to Design Engineering personnel involved in relay trip setpoint determination for awareness.

2. The review of safety related switchyard relay trip setpoints will continue.

SAFETY ANALYSIS

This event discovered that the CT-1 transformer on Unit 1 and the entire 230 KV yellow bus had been technically inoperable since August, 1987. A fault on non-safety related equipment (i.e. the 230 KV switchyard red bus) could have lead to the unnecessary isolation of this equipment. Such an event did not occur during the time of inoperability.

The significance of this event is that one of two emergency electrical power sources could have been made unavailable by a failure of non-safety related equipment. The likelihood of this is small, since non-safety related equipment (red bus) is similar to the yellow bus in construction. According to Table 8.3-2, "Single Failure Analysis for the Emergency Electrical Power Systems", of the Final Safety Analysis Report (FSAR), a loss of the yellow bus would result in the automatic alignment of power from Keowee Hydro to the Oconee Main Feeder Buses (MFBs) through CT-4 transformer. If a Loss of Coolant Accident (LOCA) occurred simultaneously on one of the Oconee units such that Engineered Safeguards (ES) actuation occurred, automatic shedding of unnecessary loads would occur to maintain power demand below the maximum rating of the CT-4 transformer.

If the single failure criterion of FSAR Section 8.3.1.2, "AC Power Systems Analysis", is applied to the CT-4 transformer during the above scenario, then no further automatic switching of power sources will occur. Manual action is necessary to restore power to the MFBs. The operator will be required to align the CT-5 transformer to the MFBs. There is adequate procedural guidance for performing this action in AP/A/1700/11, "Loss of Power" procedure. Power to CT-5 would originally be available from the Central switchyard. Although the Central switchyard lacks degraded grid protection, it is allowed as a power source by AP/A/1700/11. A dedicated

line from gas turbines at Lee Steam Station could be aligned to CT-5 transformer within one hour.

At the same time, operators would investigate the cause of the yellow bus lockout by observing relay targets in the 230 KV switchyard and consulting with the system dispatcher and Transmission Department personnel. Since, during the hypothesized event, no actual fault occurred on the protected lines, the yellow bus or CT-1 transformer could be reenergized from either the switchyard or an available Keowee Hydro unit.

If the cause of this event was an unnecessary lockout of the CT-1 transformer with a simultaneous LOCA on Unit 1, the startup transformers from the other units could also be manually aligned to supply Unit 1 MFBs.

The time required to perform these manual operations cannot be accurately predicted. The emergency core coolant flow could have been interrupted. Given this situation, fuel damage resulting in a radioactive release to the containment could occur. The FSAR states that without Reactor Building Spray [EIIS:BE] and Reactor Building Cooling Systems [EIIS:BK] the reactor building pressure would not exceed the design pressure for the containment following the LOCA. If power could be restored within 60 minutes of its loss, it is expected that the reactor building leak rate would not exceed the LOCA analysis rate. Dose rates may be higher due to the loss of filtered ventilation until unit power is restored. A Design Engineering containment response evaluation has shown that equipment qualification conditions would not be exceeded in under two hours for the expected temperature and pressure resulting from this event. Therefore, reactor building equipment should be operable if unit power is restored within this time frame.

If the above scenario occurred without a concurrent LOCA event, the design of the Emergency Feedwater System [EIIS:BA] and the Emergency Condenser Cooling Water System [EIIS:SG] would provide for extended core cooling ability as outlined in FSAR section 15.8.3., "Loss of All Station Power Analysis". This will allow the operator at least 20 hours to return a power source to operable status before core uncovery. This is sufficient time to regain an emergency power path. Furthermore, the Standby Shutdown Facility [EIIS:BA], which has its own safety related diesel generator, is capable of maintaining hot shutdown conditions with a loss of offsite power on all three Oconee units for seventy two hours.

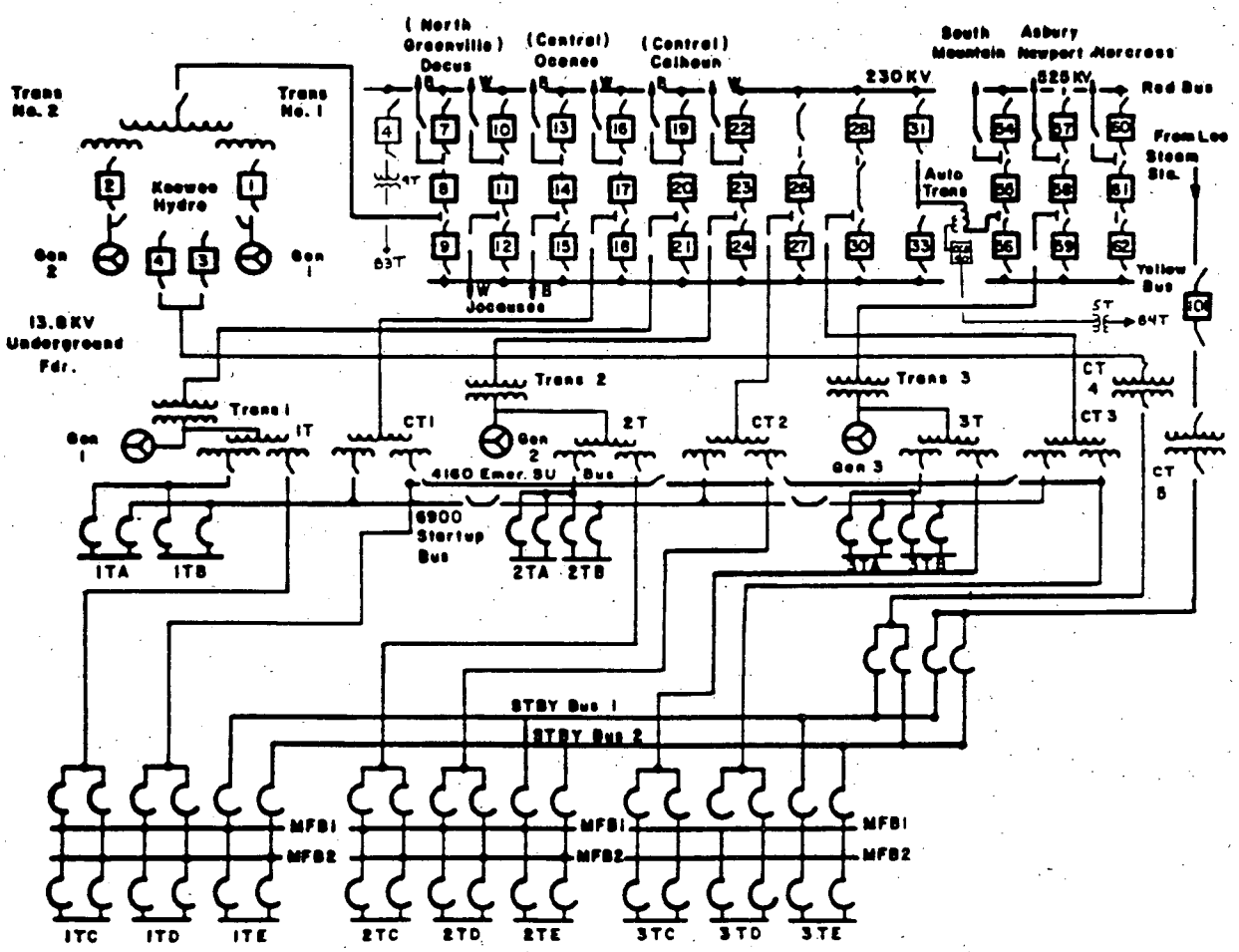
It is concluded that fuel damage and radioactive releases could occur only in the unlikely event that the hypothesized failure of the yellow bus or CT-1 transformer occurred in conjunction with a LOCA on an affected unit and a simultaneous failure of the CT-4 transformer. Furthermore, manual action to restore or recover available power sources would also have to fail.

This event did not lead to the release of radioactive material, exposure to radiation, or personnel injury. It did not compromise the health and safety of the public.

DUKE POWER COMPANY

ATTACHMENT 1

OCONEE OVERHEAD NORMAL AND EMERGENCY ELECTRICAL POWER DISTRIBUTION



DUKE POWER COMPANY

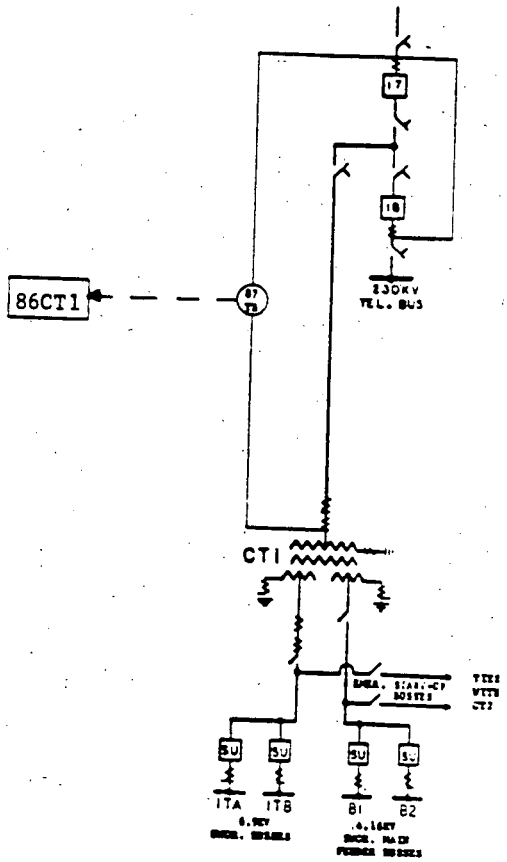
ATTACHMENT 2

CT-1 TRANSFORMER PROTECTIVE ZONE

Electrical fault protection for PCB's 17 and 18 and for the line connecting them to Transformer CT1 is provided by the Start-up Transformer Bus Differential Relays 87TB X-Y-Z.

Current is supplied to these relays from current transformers on the Red Bus side of PCB 17, on the Yellow Bus side of PCB 19, and in the 230 KV bushings of CT1.

When the comparison of these currents shows a fault in the protected area, Relays 87TB will pick up and initiate the Transformer CT1 Lockout Relay 86CT1.



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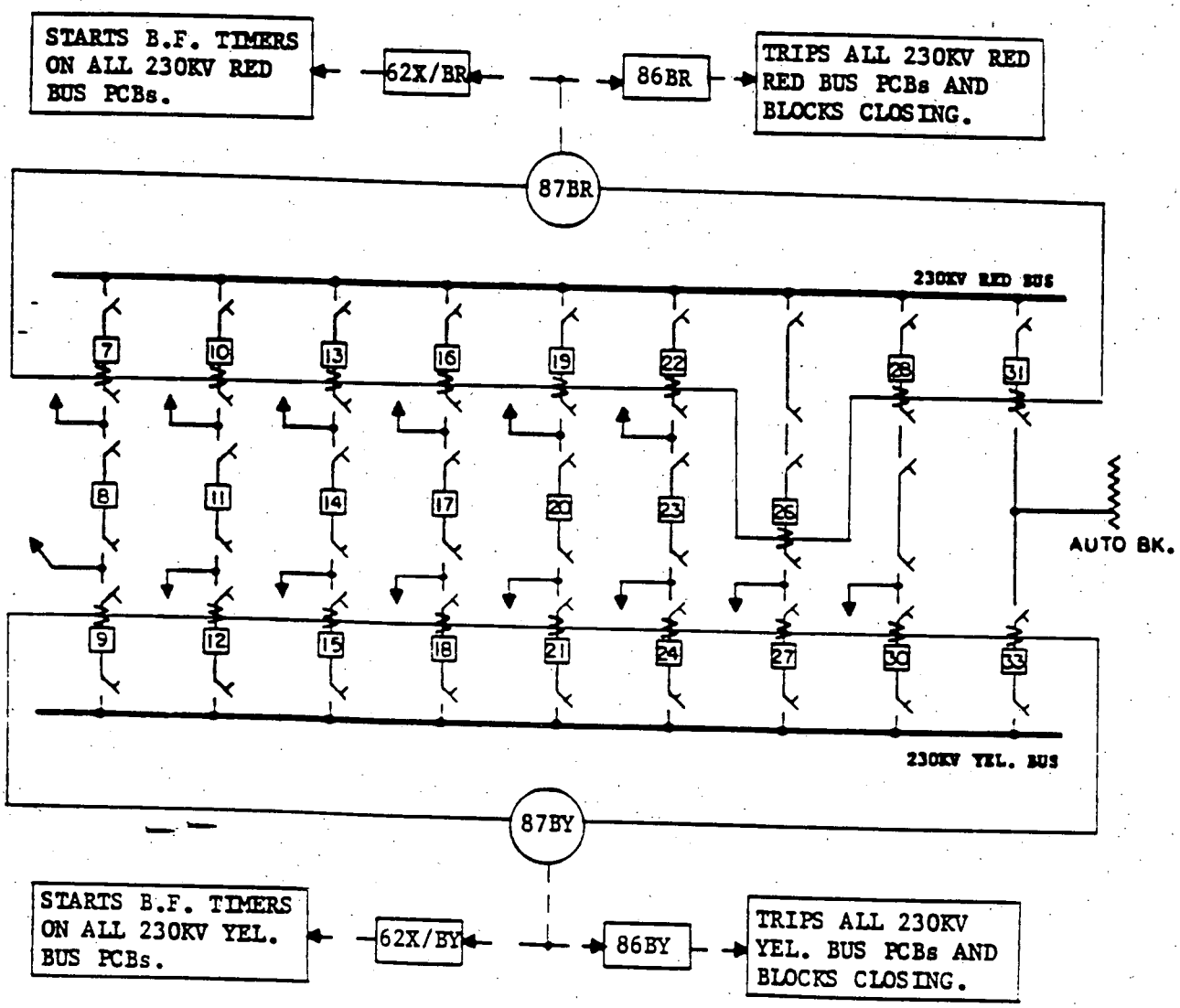
ATTACHMENT 3

YELLOW BUS PROTECTIVE ZONE



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ATTACHMENT 4

87H DIFFERENTIAL RELAY OVERCURRENT SETPOINT GRAPH
(from General Electric manual GEK-45405)