FLORIDA POWER AND LIGHT COMPANY
TURKEY POINT UNITS 3 AND 4

AUXILIARY POWER UPGRADE
SUMMARY AND DESIGN EVALUATION
DOCKET NO'S. 50-250 AND 50-251
JPE-L84-12

May, 1984
Revision 0

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EXTERNAL INTERFACES

No External Interfaces		Quality Assurance	
General Engineering	X	Nuclear Analysis	
Nuclear Energy	X	Security	
Nuclear Plant	X	Nuclear Mutual Limited (NML)	

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1.0 INTRODUCTION & SUMMARY

On February 12, 1984, a relay problem on the Turkey Point fossil units startup transformer led to a stripping of the switchyard's northeast bus. Loss of the northeast bus resulted in a Unit 3 trip. While trying to re-energize one of Unit 3's busses, a Unit 4 plant trip occurred. A trip of both Units, initiated by relay-related events, also occurred on February 16, 1984. Appendix A provides a brief discussion of these trips.

Because of these plant trips, NRC Region II requested that FPL defer completion of implementation of the Auxiliary Power Upgrade pending NRC review. Upon completion of NRC review of the proposed change, FPL will complete implementation of the design changes. This report provides the design summary and evaluation of the Auxiliary Power Upgrade requested by the NRC.

The report is written primarily in the present tense to provide a clear, understandable presentation. In actuality, the majority of the Auxiliary Power Upgrade related work has been implemented. The major work yet to be implemented consists of the new electrical ties between the plant island and the switchyard.

The Auxiliary Power Upgrade modification moves non-safety loads to a new non-safety related C train that derives its power from a new C Bus transformer. One C Bus and its associated transformer are provided for Unit 3 and one for Unit 4.

The non-safety related loads are loads that are not necessary (i.e., vital) to assure the integrity of the reactor coolant pressure boundary; the capability to shutdown the reactor and maintain it in a safe (hot) shutdown condition, or the capability to prevent or mitigate the consequences of accidents which could result in off-site exposures comparable to the guideline exposures of 10 CFR 100. This nuclear safety related definition is the basis upon which the plant was designed, licensed and is operated. The original plant design was such that loads that are nuclear safety related and non-safety related were powered from the vital A and B busses. Only non-safety related loads are transferred to the new non-vital C Bus.

The C Bus transformer is powered by a separate feed from the switchyard. Connections in the switchyard for Units 3 and 4 are made at opposite ends of the switchyard. Breakers are provided in the switchyard to isolate the C Bus from the fossil units and from its respective units' startup transformer. A separate non-safety related DC system and 120V uninterruptible AC system is included in the design.

In February, 1984 a demand for a unit runback to 50% power upon loss of C Bus Transformer occurred. Failure to successfully runback caused unit trip. This situation is prevented in the Auxiliary Power Upgrade design by a fast auto-transfer of the Unit 3 & 4 C Bus loads. The transfer logic is similar to the fast auto transfer that currently exists between the auxiliary and startup transformers. Each C Bus transformer has two secondary windings, each winding is designed to supply all C Bus loads on one unit.

The existing station cranking diesels (non safety-related) are directly tied (electrically) to the C Bus to enhance the Turkey Point Station's blackout capability. Heretofore they could only be connected to the nuclear units via the switchyard. Interlocks prevent the accidental closing of the cranking diesels onto the C Bus. The closing of the tie between the C Bus and nuclear safety related busses is also electrically interlocked and is restricted to only Station Blackout conditions. Breakers are also to be maintained racked-out to supplement C Bus interaction protection as described in Section 3.1.1.

The Auxiliary Power Upgrade has been reviewed against the plants' Final Safety Analysis Report (FSAR) and Technical Specifications, and was shown to satisfy the plant's design basis. The design proposed offers several benefits, namely;

- o it improves the separation of safety related and non-safety related loads by moving non-safety related loads to the C Bus,
- o it eliminates AC system undervoltage operating constraints on the concurrent operation of certain major pieces of equipment that are required prior to completion of C Bus implementation,
- o it provides a direct electrical station blackout tie from the station's cranking diesels to the units' 4.16 kV busses, and
- o it provides additional electrical ties from the nuclear plants to the switchyard.

A failure mode effect analysis (FMEA) was conducted. Additionally fault trees were constructed to analyze the combinations of events that could result in loss of one or more of the 4.16 kV busses. The fault trees model the 4.16 kV system at the equipment level (i.e. breakers, transformers, etc.). The relays which control the fast transfer of bus power supply (Auxiliary to Startup Transformer for A and B busses; Auto-C Bus Transfer for 3C and 4C busses) were also included in the fault model.

The FMEA and fault tree evaluations indicate that the installation of additional circuit breakers in the switchyard will prevent a recurrence of the February 12, 1984 incident where a fossil unit malfunction caused the trip of a nuclear unit. The fault tree evaluation indicates that the C Bus provides an additional reliable power source to the facility. The calculated unavailability of the 4.16 kV vital A & B busses and non-vital C Bus are:

	UNIT 3	UNIT 4
A Bus	8.3×10^{-5}	8.2×10^{-5}
B Bus	8.1×10^{-5}	8.0×10^{-5}
C Bus	6.1×10^{-5}	6.1×10^{-5}
AxBxC busses (Loss of all 4.16 kV busses)	1.2×10^{-7}	1.2×10^{-7}

The unavailability of the C Bus with and without auto transfer is:

C Bus without auto transfer	1.8×10^{-3}
C Bus with auto transfer	6.1×10^{-5}

The unavailability numbers do not reflect the ability of the A & B busses to be supplied from the emergency diesel generators, i.e., they reflect the ability to be supplied from either the auxiliary or startup transformers. The unavailabilities do identify the increased reliability afforded by the existing fast auto transfer between the auxiliary and startup transformers, and the proposed fast auto transfers between C Bus transformers.

The design of the plant is such that sections of motor control centers (MCC) could be transferred to the C Bus as a whole. Transfer of individual 480 V loads are constrained by in situ physical and equipment constraints. Accordingly, non-vital MCC's are transferred to the C Bus and individual loads are reviewed against NRC requirements that apply to both safety related and non-safety related equipment.

The results of the evaluation provided herein indicate that the Auxiliary Power Upgrade is implementable under 10 CFR 50.59, and that a C Bus transformer availability technical specification is not required.

1.1 Background Information

The Turkey Point Units 3 and 4 electrical systems were designed prior to 1970 to provide a simple arrangement of equipment and busses sized for anticipated loading conditions. Each unit's auxiliary transformer was designed to provide the normal source of auxiliary electrical power during plant operation. During unit startup, shutdown, or after plant trip the normal source of electrical power was the respective unit's start-up transformer. (The other unit's startup transformer provided an alternate source of offsite power).

Prior to C Bus, the auxiliary load fully loaded the auxiliary transformers; certain electrical line-ups resulted in unacceptable voltage conditions; and procedural restrictions were placed on the concurrent operation of some electrical equipment. FPL originated projects for improvement of plant operations and NRC requirements necessitated the further loading of the station electrical system. As a result, the station's auxiliary and startup transformers, cable system and 4.16 kV switchgear fault interrupting ratings approached their maximum allowable capacities. Table 1 provides a listing of electrical load growth anticipated from 1981 to 1990.

The purpose of this report is to present the alternatives, design criteria, design, and safety evaluation for the electric plant modifications required for the expansion of the station's electrical system capability.

2.0 SUMMARY OF EXISTING AND ALTERNATIVE DESIGNS

2.1 Original Plant Design Considerations

Turkey Point Units 3 and 4, received their operating licenses in 1972 and 1973, respectively. The design criteria by which they were licensed included the use of draft General Design Criteria proposed by the AEC. In addition to these requirements, FPL developed additional design considerations which were included in the FSAR (see Appendix B).

2.2 Original System Design

Based on the design considerations referenced in the previous section the following original design was developed and approved for the two plants.

The 240 kV switchyard arrangement provides east and west busses which connect off-site power from FP&L's transmission network with the two fossil and two nuclear unit power lines. This assures that even if both nuclear Units 3 and 4 are inoperative, power would be available at the 240 kV switchyard from Turkey Points Unit 1 and 2 or from one of the 240 kV circuits from off-site.

The basic components of the station electrical system of 1973 are shown on the main one line diagram, Figure 1. Each nuclear unit had an auxiliary transformer to serve as a normal source of auxiliary electrical power during normal operation. Each transformer was capable of supplying all the electrical power requirements associated with its unit as well as some loads shared by both units (e.g. water treatment plant). Each auxiliary transformer provided power to an A and B 4.16 kV nuclear safety related bus under normal operating conditions. These two busses (A & B) supplied power to all loads in the nuclear plant. Redundant trains of safety-related systems were separately powered from these busses.

In addition to the auxiliary transformer, a start-up transformer was provided for each unit. The start-up transformers were connected to the 240 kV busses on the primary side, and the A and B 4.16 kV busses for its unit and the A 4.16 kV bus for its adjacent unit on the secondary side. The start-up transformer was designed to normally serve the unit during start up, shutdown, and after unit trip. The start-up transformer of one unit was adequate to simultaneously supply minimum engineered safety features of one unit, and safely shut down the other unit, without assistance from on-site power generation. The startup transformer for the adjacent nuclear unit is available as a redundant source of emergency power for the A Bus only.

Each nuclear Unit's A & B 4.16 kV Bus was fed from a separate secondary winding on its auxiliary transformer under normal operating conditions. Loss of power from the auxiliary transformer initiated a fast automatic transfer to the startup transformer. Complete loss of power at both the A & B 4.16 kV busses of either unit caused the emergency diesel-generators to start and feed power directly to the affected busses.

The two 4.16 kV busses (A & B) fed four 480 volt busses through four transformers. Two 480V transformers were energized from the 4.16 kV A Bus, and two 480V transformers were powered from the 4.16 kV B Bus.

The Auxiliary Power Upgrade design discussed in this report does not alter the basic nuclear safety related design concept licensed in 1973. It adds a new, independent, non-safety related subsystem to the system described above.

2.3 Auxiliary Power Modification Design Considerations

Design criteria associated with an upgrading of electrical system capability are:

- o Compliance with FSAR criteria and Technical Specification requirements.
- o Compliance with non-safety related NRC requirements, e.g., Appendix R.
- o Meet or exceed existing electrical load requirements.
- o Capability to provide for future electrical loads.
- o Adequate physical space to accommodate new equipment, and provide for required maintenance and surveillance activities.
- o Accommodate load rating, undervoltage and short circuit capability requirements.
- o No single failure in the switchyard will cause a nuclear unit trip concurrent with the loss of its startup transformer.
- o No single failure shall cause the loss of both nuclear units, or the loss of both startup transformers, or the loss of both C busses.
- o Loss of a C Bus with a subsequent reactor trip will not result in the loss of a startup transformer.

2.4 Alternative Designs

In order to arrive at the design modification discussed hereinafter for Turkey Point, the available design alternatives are evaluated. Basically there are four alternatives available, namely; administrative controls, cross connect to fossil units, upgrade existing equipment, or provide new equipment.These alternatives are discussed in the following paragraphs:

1. Modify use of existing system with administrative controls. Use of this alternative would restrict the loadings on the A & B busses through a continuous review of equipment power priorities and reliance on a manual load management scheme. This alternative should normally be rejected because the potential for error introduced by complex load schemes is considerable, and at best the solution provides interim relief with the potential for only limited system growth.

   Unit trips in February were initiated because of loss of the C Bus power supply to the 3B steam generator feed pump. This pump (7000

hp) and the 3C condensate pump (2500 hp) are two large non-safety related loads transferred to C Bus. They cannot be returned to the A & B busses primarily due to undervoltage and short circuit considerations associated with the A & B busses. Removal of the motors from the A & B safety related busses reduces the short circuit current to these vital busses and reduces the likelihood of unacceptable under voltage conditions on the busses. With these motors powered from the A & B busses, there are combinations of motors that can't be run simultaneously, e.g.,

Case 1

- o B & C Condensate Pumps
- o B & C Component Cooling Water Pumps
- o A & B Intake Cooling Water Pumps

Case 2

- o A & C Condensate Pumps
- o B & C Component Cooling Water Pumps
- o A & B Intake Cooling Water Pumps

Design margins are at a point where administrative controls are not a viable alternative.

II. Use the fossil unit's startup transformer to support additional Unit 3 and 4 loads. This alternative was rejected because it creates cross ties between the fossil and nuclear units, which introduce the potential for losing more than one unit due to equipment failure.

III. Upgrade existing Turkey Point system with larger size transformer, switchgear, etc. There is a basic disadvantage associated with this alternative, namely, higher rated switchgear and transformers are physically larger than those presently installed. This alternative was rejected because of space limitations, and the extensive downtime to remove and replace the plants' 4.16 k V system.

IV. Add an additional 4.16 kV bus (C Bus) to both Units 3 and 4 to provide power for additional auxiliary loads. This alternative would change the configuration which routes all loads through either the A or B safety related busses. It provides a non-safety related bus which would be used for non-safety related loads, either anticipated or presently on the system. It can be implemented in a manner that satisfies the design criteria cited above.

Several of the more viable options associated with this design approach are as follows:

(a) Feed C Bus from the high side of the main transformers. Rejected because the C Bus would not be available for a unit startup. (There is insufficient space for a generator breaker.)

(b) Feed C Bus from the startup transformers. Unacceptable because loss of C Bus could cause a loss of the startup transformer concurrent with a unit trip.

(c) Provide new switchyard bays, which would feed the new C Bus for each unit.

2.5 Selected Alternative - Auxiliary Power Upgrade

The evaluation of the available alternatives, discussed above, resulted in the selection of the C Bus, Alternative IV, option c. This alternative, is designated "Auxiliary Power Upgrade." The following considerations favor this alternative:

(1) The need for administratively controlling the load on the nuclear safety related busses is eliminated.

(2) Sufficient capacity is provided to power equipment backfitted on Turkey Point as a result of NRC requirements.

(3) Capacity is provided to power equipment being backfitted on Turkey Point to improve plant operability and reliability. For instance, the condensate polishing equipment, which has been added to improve steam generator water chemistry, will be powered from the C Bus.

(4) Margin is provided for the addition of future safety and non-safety related loads.

(5) Loads on the nuclear safety related busses and switchgear are reduced.

(6) A readily accessible source of power to the plant's 4.16 kV busses is provided to accommodate the postulated "Station Blackout" scenario (i.e., loss of both offsite power and the emergency diesel-generators). The power source for this operation is the existing Turkey Point Units 1 and 2 Cranking Diesel Generators.

(7) Additional flexibility is provided for powering non-safety related equipment.

(8) Some non-safety related loads are removed from the nuclear safety related busses thereby providing additional separation of nuclear safety related and non-safety related equipment.

(9) The modification can be made within the existing physical (spatial) constraints at the facility.

(10) The modification can acceptability accommodate present NRC requirements applicable to the Turkey Point facility.

(11) Removal of non-vital MCC's to the C Bus eliminates the need to automatically load shed these loads upon loss of offsite power.

3.0 DESIGN

The function of the Auxiliary Power Upgrade is to augment the AC and DC auxiliary electrical power system by providing new non-safety related switchgear and load centers. This new equipment accommodates the removal of some existing non-safety related equipment from the plants' nuclear safety related busses.

Existing motor control centers (MCC's) are designated vital (nuclear safety related) or non-vital (non-safety related). The physical limitations of the plant essentially preclude the physical relocation of MCC's, and the ability to install new MCC's is limited. Accordingly, a non-vital MCC is tranferred to the C Bus by removing the bus section that interconnects vital and non-vital sections of an MCC. The non-vital section is then connected to a C Bus power feed. In theory this process should be straightforward since it merely involves the physical separation of nuclear safety related and non-safety related sections of an in situ MCC. In practice,however, the separation is complicated by the fact that NRC requirements are associated with non-safety related equipment, e.g., Appendix R and TMI.

The basic design philosophy adopted for the Auxiliary Power Ugrade is to:

(1) provide a non-safety related C Bus that is not powered from the plant's nuclear safety related busses (A & B busses),
(2) place loads on the C Bus that are:
   (a) non-safety related,
   (b) not required to achieve and maintain the plant in a safe (hot) shutdown condition, and
   (c) not required to prevent or mitigate the consequences of accidents which could result in off-site exposures comparable to the guideline exposures of 10 CFR 100.
(3) assure separation of the nuclear safety related busses and the "not" nuclear safety related C Bus, and
(4) assure separation of the "not" nuclear safety related C Bus and the station's cranking diesels during operating configurations that do not require power from the cranking diesels.

The C Bus switchgear is non-safety related; located outdoors; not designed to the single failure criterion; and not procured to Class IE requirements.

3.1 Auxiliary Power Upgrade Design

Power for the Auxiliary Power Upgrade is from the Turkey Point 240 kV Switchyard (see Figure 2). Unit 3 receives power from a new Bay 3 through two oil circuit breakers; one from the Northwest Bus and one from the Northeast Bus. Unit 4 receives power from a new Bay 10 through a breaker and a half scheme off the Southwest and Southeast busses. Each unit's 240 kV feeder from the switchyard provides power to a C Bus

transformer. The Unit 3 and 4 feeders are well separated, originating from opposite ends of the switchyard.

The C Bus transformer is similar in rating to the existing startup transformer. The output of each C Bus transformer feeds the 3C and 4C busses through its two secondary windings. Normal operation provides power to the 3C Bus from the 3C transformer, and the 4C Bus from the 4C transformer. In the event that one transformer is not available, each transformer is sufficiently sized that it can supply all the 3C and 4C loads simultaneously through its dual secondary windings.

To maintain continuous power supply to important operational equipment, a fast automatic transfer between the two C Bus transformers is provided in the event that either C Bus transformer is lost. This transfer scheme is designed to occur within 10 cycles following the loss of a "C" bus transformer. A description of the operation of the fast transfer is presented for Unit 3 (refer to Figure 3), Unit 4 is similar.

The fast auto transfer between C busses allows the plant to accommodate, without trip or runback, a disruption in the power supply to a unit's C Bus transformer. The fast auto C Bus transfer would have prevented the February, 1984 unit trips that resulted from loss of a C Bus transformer. It is also shown in the failure mode effect analyses (FMEA), of Section 3.3, that a fast auto transfer can prevent simultaneous runbacks on both units that could result from a fault in either breaker 3AC01 or 4AC01. The FMEA indicates that auto transfer eliminates turbine runback as a consequence of events that cause loss of the C Bus transformer.

The fast transfer from the normal feed breaker 3AC16 to the alternate feed breaker 3AC01 will occur when the feed from breaker 3AC16 is lost due a C Bus transformer lockout or a C Bus transformer 240 kV bus lockout. The transfer will be prevented if: (1) the cranking diesel generator incoming breaker 3AC03 is closed, or (2) the tie breaker to the vital busses, breaker 3AC13 is closed, or (3) the Unit 3 C Bus is locked out, or (4) the Unit 4 C Bus transformer is locked out or (5) the sync-check permissive is not present.

The design of the transfer scheme utilizes a fast sync-check relay which will monitor the Unit 3 "C" bus decaying voltage and the Unit 4 C Bus transformer voltage, which is the alternate supply. This relay will provide a permissive contact to allow the transfer to occur. A normally closed auxiliary contact from breaker 3AC16 will initiate the transfer when the breaker is opened under the conditions described above. The transfer will be blocked if not performed within 10 cycles after breaker 3AC16 is opened. The sync-check relay is included as a protection feature which will prevent the transfer from occuring if out-of-phase conditions are present. The transfer back to the normal supply will be accomplished manually.

The C busses are comprised of 4.16 kV switchgear, 3AC and 4AC for Units 3 and 4 respectively. This switchgear is non-safety related and accomodates only non-safety related equipment loads. Switchgear 3AC and 4AC, located outdoors just east of the discharge canal, are rated for a nominal interrupting capability of 350MVA.

The C busses provide power to 480V load centers 3E, 3F and 3G for Unit 3 and 4E, 4F and 4G for Unit 4. Load centers 3E and 4E were previously powered from the vital busses whereas 3F, 3G, 4F and 4G are new outdoor load centers. In general, loads between 100 hp and 300 hp will be connected directly to the 480V load centers. Smaller loads are connected to the Motor Control Centers (MCC) which receive power from the Load Centers.

3.1.1 Station Blackout Subsystem

A Station Blackout scenario can only be postulated assuming a concurrent loss of the offsite and onsite AC power supplies. To facilitate the plants capability to accommodate such an event, the Auxiliary Power Upgrade provides an additional source of power to the A and B 4.16 kV nuclear safety related busses (See Figure 2). The power is from the Fossil Units 1 and 2 Cranking Diesel Generators through a feeder to the Units 3 and 4 C busses. This feeder is rated at 5000KVA which is basically the equivalent of two nuclear plant emergency diesel-generators. The C Bus, in turn, is capable of providing power to the A and B busses through a feeder to the existing A and B bus tie.

The Station Blackout 4.16 kV bus connections are installed for use during a station blackout condition. To prevent inadvertent breaker operation during normal operating conditions, the following design measures are provided. Electrical interlocks assure proper sequential operation of breakers to make the cross connections. In order to close the Cranking Diesel-Generator Output Breaker (4W26466), breakers 3AC03 and 4AC03 at the C busses must be open. Breakers 3AC03 or 4AC03 cannot close unless Bus 3C or 4C respectively is isolated from its transformer and breaker 4W26466 is closed. (Breakers 3AC01 and 3AC16 or 4AC01 and 4AC16 must be open to isolate the transformers from the Unit 3 or 4 C Bus.) Finally, the tie breakers, 3AC13 or 4AC13, to the nuclear safety related busses cannot be closed unless breaker 3AC03 or 4AC03 is closed. These nuclear safety related tie breakers cannot be closed if either 3AC16 or 3AC01 is closed on Unit 3, or either 4AC16 or 4AC01 is closed on Unit 4. The design of the interlocks is such that the likelihood of an inadvertent, unintentional cross connection is minimal because the C Bus would first have to be de-energized before the C Bus could be connected to the cranking diesels.

In addition, the normal operating conditions are such that Breakers 3AC03 and 4AC03 (C Bus input from the Cranking Diesel-Generators), 3AC13 and 4AC13 (connection from C busses to the A and B bus ties), 3AA09, 4AA09, 3AB22 and 4AB22 (A and B bus tie breakers) will be racked out.

3.1.2 Relay Protection

The Turkey Point Switchyard consists of East and West Operating busses as shown on Figure 2. Offsite transmission lines and onsite AC power systems are connected to these switchyard busses in a breaker and a half configuration. The east and west busses are further divided into North and South bus sections by normally closed breakers 6/7B and 5/6A. This switchyard bus segmentation scheme allows the switchyard to acceptably accommodate a fault on one of the power lines or bus sections. It also provides the necessary flexibility for performance of switchyard maintenance and modifications.

Should a fault occur on one of the four busses, the relay protection system is designed to open and lockout all the breakers connected to the bus and open the appropriate tie breaker between the North and South sections; thereby isolating the faulted bus from the three operating busses. Backup relaying is provided for all the 240 kV breakers in case one should fail to open within a preset time. This backup protection opens the next set of breakers away from the bus to clear the fault.

Protection and isolation of the switchyard from a fault on one of the lines coming from the plants is provided by primary and secondary differential relay schemes which trip associated breakers in the plant and switchyard to isolate a fault.

The failure mode evaluation in Section 3.3 and the fault tree model in Section 3.4 include the busses and oil circuit breakers in the switchyard.

3.1.3 DC System and 120V AC System Change

The Auxiliary Power Upgrade includes the installation of a new non-safety related DC system and a non-safety related 120V AC Uninterruptible Power Supply. The new 125V DC system provides DC control power for the Auxiliary Power Upgrade switchgear and future non-safety related DC loads. Additionally, some non-safety related loads transferred to the new DC system provide spare capacity to meet projected nuclear safety related load growth. The 120V AC Uninterruptible Power Supply provides for essential non-safety related loads such as the telemetering system.

3.1.4 Electrical Loads Transferred to C Bus

The Auxiliary Power Upgrade augmented the capabilities of the onsite power distribution system by providing a new non-safety related distribution system. Appendix D provides a tabulation of the loads that were transferred from the safety-related distribution system to the new non-safety related distribution system.

A basic design premise on which the plant is licensed is that only nuclear safety related (vital) items are essential to;

- o the integrity of the reactor coolant pressure boundary,
- o the capability to shutdown the reactor and maintain it in a safe (hot) shutdown condition, and
- o the capability to prevent or mitigate the consequences of accidents which could result in off-site exposures comparable to the guideline exposure of 10 CFR 100.

Items not essential to these functions are non-safety related, and are powered by non-vital power supplies, or can be separated electrically from a vital power supply.

The loads in Appendix D are reviewed to ensure NRC commitments and requirements are still met (see Section 3.2). As a result of this review, some individual non-vital loads are relocated to derive their power supply from a vital A or B bus. These include:

- o One CRDM cooler fan for Unit 4,
- o The sample pump associated with containment radiation monitors R-11 and R-12, and
- o Wide range noble gas effluent monitors installed pursuant to NUREG 0737 requirements.

3.1.5 Auxiliary Power Upgrade, Partial Implementation

Figure 4 shows the existing, interim, C Bus arrangement. It is operated with the Unit 3 C Bus transformer supplying the Unit 4 C Bus, and the Unit 4 C Bus transformer supplying the Unit 3 C Bus. The availability of the Unit 3 and 4 startup transformers is required by NRC in this operating configuration. Assuming Unit 3 is modified to derive its C Bus power source from Bay 3 of the switchyard and Unit 4 is in the interim configuration, then, normal operation would remain with the C Bus transformers cross-tied as in the interim configuration. The basis follows:

(1) loss of the Unit 3 C Bus transformer would cause Unit 4 to run back. If runback fails and the unit trips, Unit 4 would auto-transfer to its startup transformer. The Unit 3 startup transformer would not be affected, and Unit 3 would remain online,

(2) loss of the Unit 4 C Bus transformer would cause Unit 3 to run back. If runback fails and the unit trips, Unit 3 would auto-transfer to its startup transformer. The Unit 4 startup transformer could become unavailable, but Unit 4 would remain online with power from the Auxiliary Transformer,

(3) if the Unit 4 startup transformer were out of service and isolated, the Unit 4 C Bus transformer would be unavailable. Thus, Unit 3 could not be run without powering the Unit 3 C Bus from the Unit 3 C Bus transformer.

(4) if the Unit 3 startup transformer were unavailable and isolated, both Unit 3 and 4 C Bus transformers would be available. There would be no physical power limitation on either unit.

A similar scenario results if Unit 4 is modified to derive its power from Bay 10 of the switchyard, and Unit 3 is in the interim configuration.

From the above, it is concluded that the operation of the C Bus in the interim cross-tied configuration will be continued until both Unit 3 and 4 C Bus transformers feeds to switchyard Bays 3 and 10 are placed in service.

3.2 Comparison with NRC Requirements

The C Bus design and loads transferred to C Bus are reviewed against:

- o Electrical power system requirements cited in the FSAR
- o Electrical power system requirements cited in the Technical Specifications
- o Appendix R fire protection safe shutdown equipment requirements.
- o Equipment operability requirements set forth in the Technical Specification
- o Emergency Operating Procedures

The comparison with the above NRC requirements are provided in the paragraphs that follow.

3.2.1 Comparison with FSAR and Technical Specification Criteria

The FSAR and Technical Specification criteria provide for reliable, redundant power supplies to nuclear safety related equipment. The Auxiliary Power Upgrade was specifically designed to assure compliance with this criterion. The C Bus removes some non-safety related loads from the A and B nuclear safety related busses. Since these non-safety related loads are further isolated from safety related busses, the modification improves the separation between those loads vital to nuclear plant safety and those that are not. In addition, the design improves the margin in the nuclear safety related electrical system for undervoltage and overcurrent conditions.

Power for the C Bus is provided from the switchyard and is independent of the plant operating condition.

The loads transferred to the C Bus are primarily loads powered from non-vital sections of the 480V MCC's. These loads would not normally be powered from the station's emergency diesels, and thus, are not vital to maintaining the plant in a safe shutdown condition, and are not vital for

mitigating the consequences of accidents. This notwithstanding, the C Bus is provided with alternate power supplies to assure power to it during non-normal conditions, namely, from a separate winding on the other unit's C Bus transformer or from the station's cranking diesels.

A comparison of FSAR criteria and Technical Specification requirements associated with the Auxiliary Power Upgrade design is presented in Appendices B and C. The C Bus design acceptably accommodates these requirements.

The review included the Turkey Point Units 3 & 4 Technical Specifications through Amendment 102/96 dated 3/13/84.

3.2.2 Impact on Fire Protection Safe Shutdown Equipment

The fire protection modifications required by 10 CFR 50 Appendix R Section III.G (Fire Protection of Safe Shutdown Capability) and III.L (Alternative Shutdown Capability) are in the process of being designed. The schedule for completion of these modifications is presently being coordinated with the NRC. To assure that the Auxiliary Power Upgrade does not invalidate the Appendix R work, a review of the Auxiliary Power Upgrade was performed to identify its impact on the safe shutdown equipment power supplies identified in the Appendix R submittal.

Some equipment transferred to the C busses is assumed in Appendix R evaluations to be available for safe shutdown in the event of a concurrent loss of offsite power and a fire. A standby Steam Generator Feedpump is provided for each unit. It is powered directly from the C busses, and is provided to accommodate safe shutdown requirements for a fire in the Auxiliary Feedpump area. Credit was taken for powering these pumps from the cranking diesel generators in the Appendix R submittal.

The design criteria for fire protection does not assume a loss of both onsite emergency diesel generators so that the connection of the Unit 1 and 2 cranking diesel generators would be made up only to the C Bus. The safety related busses would still be separated from the C Bus with power being provided for A and B busses from the emergency diesel generator(s). In this configuration C-Bus tie breakers 3AC13 and 4AC13 remain racked out.

A review of Appendix R safe Shutdown equipment indicated that several loads (see Table 2) are powered from C-Bus, some as a result of transferring non-vital load blocks. These C Bus loads will be evaluated to determine if power supply changes are necessary. Any modifications identified will be consistent with the Appendix R requirements.

3.2.3 Emergency Operating Procedures Review

The modifications to the plant electrical distribution system described in this report have been reviewed against the Emergency Operating

Procedures (EOP's) to ensure that these procedures were not adversely affected by the design changes.

The following EOP's were included in this review:

EOP 20000	(12/22/83)	Immediate Actions and Diagnostics
EOP 20001	(02/02/84)	Loss of Reactor Coolant
EOP 20002	(01/12/84)	Loss of Secondary Coolant
EOP 20003	(04/07/83)	Steam Generator Tube Rupture
EOP 20004	(02/23/84)	Loss of Offsite Power
EOP 20005	(10/27/83)	Control Room Inaccessibility
EOP 20009	(02/02/84)	Containment Post Accident Monitoring System Operating Instructions

The purpose of this review was to verify that emergency actions identified in the EOP's could be carried out without the C Bus energized.

Each EOP was reviewed assuming that offsite power was not available. Each action required by these procedures was checked against the power availability of the emergency diesel generators. Any time a piece of equipment was called on to operate, its power source was checked to assure that it would be available when only diesel generators provided onsite power. All pump operations, valve manipulations and indication requirements were checked to ensure that power would be available during an accident recovery.

This review concluded that the minimum actions required to perform an orderly shutdown or respond to an accident could be performed when the emergency diesel generators are the only source of onsite power.

3.2.4 Comparison with Technical Specification Operability Requirements

C Bus loads have been reviewed with regard to their potential association with Plant Technical Specifications equipment operability requirements (see Table 3). The C Bus related equipment that would impose operating restrictions on the plant as specified in the Technical Specifications are the air particulate and gas monitors R-11 and R-12 which monitor containment atmosphere for purging and RCS leak detection. Loss of this equipment will require remedial action or plant shutdown.

3.3 Failure Mode Effect Analysis

A failure mode effect analysis at the equipment level was conducted for the proposed C Bus design. Equipment from the switchyard grid down to the A, B and C 4.16 kV busses was analyzed. The failure mode effect analysis (FMEA) is provided in Appendix E.

The FMEA was conducted for the plant condition where:

- o Both Units 3 & 4 are at full power
- o The auxiliary, startup and C Bus transformers are aligned in their normal configuration
- o Oil circuit breakers (OCB's) in the switchyard are in their normal position.
- o Plant loads are powered from their normal power supply.

The FMEA is a non-mechanistic, first contigency evaluation. For example, a breaker is assumed to go from its normal to its non-normal position regardless of relaying provided to prevent this action. Similarly the breaker is assumed to fault regardless of whether it is open or closed. The plant's reaction to such an event is then analyzed without additional failures. A resulting 4.16 kV bus lockout is assumed to initiate trip signals to all 4.16 kV breakers (and OCB's if necessary) required to achieve the bus lockout —the breakers are assumed to open.

Multiple failures that could cause loss of a 4.16 kV bus are provided by the fault tree evaluation in section 3.4.

From the FMEA and Figure 2 the following conclusions can be made:

(1) A fault associated with the fossil unit's startup transformer will not affect the availability of the Unit 3 or 4 startup or C Bus transformers.

(2) A fault associated with the fossil Units 1 and 2 generator or main transformer will not affect the availability of the Unit 3 or 4 startup or C Bus transformers.

(3) A single failure will not allow the cranking diesel Station Blackout tie to be closed on to the C Bus while it is powered from either unit's C Bus transformer.

(4) A single failure will not close the Station Blackout tie between the A and B, and C busses while the C Bus is powered from either unit's C Bus transformer.

(5) A fault associated with either unit's C Bus or its associated transformer, will not affect the availability of either unit's startup transformer.

(6) A fast-auto transfer between C Bus transformers reduces the likelihood of turbine runback and unit trip.

The conclusions reached by the FMEA remain valid as long as the failures are random and independent. Common cause effects that can cause multiple equipment failures from a single event, such as the door-vibration-related trips of February 16, 1984 are not addressed by an FMEA of this scope. The fault tree approach provided in Section 3.4 analyzes the effects of failure combination modes more effectively than the FMEA.

3.4 Reliability (Fault Tree) Evaluations

An evaluation was performed on the C Bus design using fault tree analysis. The fault tree technique provides a systematic method for studying the 4.16 kV system that allows for the modeling of the interaction of

components and subsystems. Evaluation of the overall system, can define failure combinations that are not apparent when a component or subsystem is evaluated as a separate entity.

The fault tree modeled the switchyard and the inplant 4.16 kV electrical system to the equipment level. It did not model explicitly all associated relaying or the diesel generator auto-transfer. Modeling of 4.16 kV and switchyard relay-related events was sufficient to define the interactions between components in the fault tree. Accordingly, the fault tree model provided by Appendix F is designed to identify combinations of events and failures that:

- o could cause loss of any 4.16 kV bus (i.e., 3A or 3B or 3C or 4A or 4B or 4C),
- o could cause loss of both C busses (3C and 4C),
- o could cause loss of all 4.16 kV busses on a unit (3A and 3B and 3C, or 4A and 4B and 4C).

Table 4 provides the equipment lineups assumed in the fault tree. The types of faults modeled include:

- o normally operating component fails in service,
- o standby component fails when demanded or during subsequent service,
- o spurious component action

The fast auto-transfer between C Bus transformers and Auxiliary to Startup Transformers was modeled to the relay level. The objective of the modeling was to ensure that the C Bus transfer availability is comparable to the availability of the existing auxiliary to startup fast auto transfer.

The analysis further assumed the current technical specifications are followed; loss of busses 3A or 3B or 4A or 4B results in a reactor/turbine-generator trip; and loss of 3C or 4C results in a turbine runback requiring quick operator action to prevent a reactor trip.

The fault tree model provided in Appendix F was quantified and solved utilizing SETS, (CDC version 1.02).

The cut sets for the 4.16 kV system indicate that there are no cut sets of order 2 that could cause loss of the main generator and offsite power supply for all three 4.16 kV busses on a unit. Or stated differently, at least 3 fault events are required to cause the concurrent loss of the A, B and C busses. The most probable concurrent three events on Unit 3 or 4 has a probability of 5.4×10^{-8}. The following must occur concurrently for this scenario:

- o C Bus local fault
- o Startup Transformer local fault
- o Unit trips after failure to runback

Even if this scenario were assumed, the A and B busses could still be supplied from the emergency diesel generators.

There are cut sets of order 3 that could cause loss of offsite power to all three 4.16 kV busses. The combined probability of any one of the twenty-six (26) scenarios occuring is 9.7×10^{-8}.

The loss of main generator and offsite power to both 4.16 kV C busses simultaneously cannot be initiated by a single event. There are forty six (46) cut sets of order two (2) that could cause this to occur. The combined probability of any one of these 46 cut sets occuring is 3.3×10^{-6}. The most probable cut set of order two (2) has a probability of occurence of 2.56×10^{-6}. All forty five (45) other cut sets are of order of magnitude 10^{-7} or less. The most probable cut set assumes the following occur simultaneously:

- o Unit 3 C Bus Transformer fault
- o Unit 4 C Bus Transformer fault

Even if both C Bus tranformers are assumed to fault concurrently, the C busses can be supplied from the station's cranking diesels.

4.0 SAFETY EVALUATION

4.1 Criteria

The following criteria were used for performing a safety evaluation of the design of the Auxiliary Power Upgrade:

- o Is there an increase in the probability or consequences of an accident previously evaluated?
- o Is there a possibility that an accident may be created which is of a different type than any previously evaluated?
- o Is there an increase in the probability of occurrence or consequences of equipment malfunctions previously evaluated?
- o Is there a possibility that an equipment malfunction may be created which is of a different type than previously evaluated?
- o Will a reduction result in the margin of safety contained in the bases for Technical Specifications?
- o Are new or modified Technical Specifications required?

4.2 Evaluation

As is indicated in Section 3.0, the Auxiliary Power Upgrade is consistent with the General Design Criteria in the FSAR Sections 1.3, 8.1 and Appendix 5A. In addition, the review of Technical Specifications associated with the electrical distribution system indicate that the Auxiliary Power Upgrade is consistent with the criteria in Sections 1.2, B3.7, and B4.8. Additionally:

- o Equipment transferred to the C Bus is not nuclear safety related. By design it is not relied upon to protect the public health and safety, and thus is not powered from the emergency diesel generators for accomodating design basis events.
- o The only inter-tie between nuclear safety related and non safety related busses incorporated in the design provides a backup power supply to the nuclear safety related busses for Station Blackout conditions.
- o The nuclear safety related system is separated from the non-nuclear safety related system by a nuclear safety related breaker at the A & B busses, and a C Bus non-safety related breaker. The latter is provided with a protective interlocking scheme to prevent closure unless Station Blackout conditions exist.
- o Component failure or loss of power to the C Bus could cause unit trip without fast auto-transfer of the C Bus.

- o Removal of loads from the nuclear safety related busses increases the ability to accommodate undervoltage conditions that can be associated with the nuclear safety related busses.

- o The C Bus design brings two new independent power sources to the nuclear plants, namely, direct ties to switchyard Bays 3 and 10, and a direct tie to the station's cranking diesels. This provides additional power sources to the nuclear units.

- o More equipment is added to the non-safety related portions of the plant design. This increases, somewhat, the likelihood of a unit trip due to interruptions in the C Bus switchyard power supply. A unit trip is an anticipated operational occurrence that is routinely accommodated by the plant.

The C Bus design improves the nuclear safety related aspects of the plant design vital to protection of public health and safety. This is achieved with some small increase in the likelihood of unit trip associated with the unavailability of the C Bus. The fault tree analysis demonstrates that this increased probability is quite small, and that the C Bus availability is as good as the A or B busses switchyard availability. Accordingly, it is concluded that any increase in the frequency of a unit trip introduced by the C Bus addition is more than offset by the increased ability of the nuclear safety related busses to accommodate undervoltage conditions.

The Appendix R safe shutdown equipment identified hereinbefore will be evaluated to ensure that the NRC Appendix R commitments remain valid.

With regard to the RCS leakage monitoring function, the Technical Specifications place a 48 hour inoperability limit on the containment gas and particulate monitor. This in effect puts a 48 hour limit on the concurrent inoperability of the C busses. Movement of this monitoring function back to a power source from the A or B busses eliminates this C Bus Technical Specification interaction.

There has been no instance identified where the Emergency Procedures have been unacceptably impacted by the transfer of loads to the C Bus. Prior to C Bus non-vital loads could be selectively aligned to the emergency diesel generators during a loss of offsite power provided sufficient diesel generator capacity was available. The non-vital loads currently powered from the C Bus cannot be aligned to the emergency diesel generators during a loss of offsite power because of the interlocking of the C Bus tie breaker(s). Since these non-vital loads are not designed to accommodate severe natural phenomenona, they are not relied upon for design basis events. A sustained loss of offsite power for other than the occurrence of severe natural phenomena, is not anticipated to last more than ½ hour. Thus, the C busses could be powered from either Bay 3 or Bay 10 of the switchyard shortly after the occurrence of the loss of offsite power event. Additionally, the cranking diesels provide a backup power supply to the C busses. The FMEA and fault tree analyses demonstrate that the C busses provide an additional reliable source of 4.16 kV power. For the majority of off-normal conditions the non-vital C Bus loads will be available.

Based on the above evaluation the following conclusions can be drawn.

- The probability of occurrence or the consequences of an accident previously evaluated will not be increased because the C Bus modification does not affect equipment associated with these events. Any loads required to follow the course, or evaluate the severity of an accident will remain on an appropriate source of power.

- An accident should not be created which is of a different type than any already evaluated because the original functions of the affected components have not changed. Although the auxiliary power source, originally supplied directly from the generator, is now supplied from both the generator and the switchyard, the types of accidents (loss of off-site power or loss of AC power) and their consequences remain unchanged.

- The probability of occurrence and consequences of equipment malfunctions vital to the nuclear safety related functions, which have already been evaluated is not increased because none of the affected components are associated with the C Bus.

- A malfunction of equipment vital to nuclear safety has not been created which is of a different type than any already evaluated because these components are not transferred to the C Bus and the design does not change the function of the components nor does it alter the consequences of their failure.

- There is some increase in the probability of a unit trip. Fast C Bus auto. transfer ensures that this increase in probability is acceptably low.

- As shown by Appendix C, the Technical Specifications are not changed by the Auxiliary Power Upgrade.

- The need for a new Technical Specification has not been identified.

- The margin of safety as defined in Technical Specifications B3.7 and B4.8 is not reduced because power requirements of the nuclear safety related loads are still met, and no increase in loads on the nuclear safety related busses has occurred. The reliability of the 4.16 kV nuclear safety related electrical system has not decreased since the modification reduced the loads on the nuclear safety related busses and the modifications do not effect the ability of the emergency diesel generators to supply nuclear safety related loads.

The result of this evaluation is that the C Bus design is implementable such that there is no unreviewed safety question and no modification of Technical Specifications associated with the Auxiliary Power Upgrade.

5.0 CONCLUSIONS

The information included in this report outlines the steps taken by FPL in response to the need for modifying the plants electrical distribution system. After the concerns regarding the adequacy of the system were identified, a review of available options was made. This review included; review of the design criteria, updating design requirements to cover new circumstances, investigation of design alternatives, and the selection of the best alternative design for the plant.

FPL believes this design meets all design criteria stated in the FSAR. The addition of the C Bus to the auxiliary power system has added a non-safety related bus to a system which previously powered all loads through nuclear safety related busses. Since only non-safety related loads will be powered by the C bus, nuclear safety related equipment will not be affected by the change.

The safety evaluation indicates that the design proposed herein is implementable under 10CFR50.59 since; (i) an unreviewed safety question has not been identified, and (ii) the need for a modification to the plants' Technical Specifications has not been identified.

FPL requests that the NRC review and approve these modifications so that the final design changes can be incorporated.

TABLE I

Anticipated Electrical Load Growth
From 1981 to 1990

ITEM	EXPECTED POWER REQUIREMENTS
Condensate Polisher	350 KVA per unit
Technical Support Center	500 KVA
Cable Spread Room Air Conditioning	15 KVA
Service Air Compressor	200 KVA per unit
Warehouses	400 KVA
Miscellaneous Motor Operated Valves	20 KVA per unit
Sewage Treatment Plant	300 KVA
Computer Room Air Conditioning	20 KVA
Nuclear Administration Building	150 KVA
Nuclear Stores Building	50 KVA
Spent Fuel Pump New Power Supply	100 KVA per unit
Instrument Air Compressors	70 KVA per unit
Control Room HVAC Upgrade	Undetermined
Security System Expansion	Undetermined
Amertap System	140 KVA per unit

TABLE 2

APPENDIX R SAFE SHUTDOWN EQUIPMENT REQUIRING EVALUATION*

Equipment	Present Power Supply
Standby Steam Generator Feedpumps	C Bus
Auxiliary Building Supply & Exhaust Fans	MCC-D (Non-Vital Section)
VCT Low-Level Isolation Valves	
LCV-3-115C	MCC-3B (Non-Vital Section)
LCV-4-115C	MCC-4B (Non-Vital Section)
Excess Letdown Valves HCV-3-137 and HCV-4-137	Lighting panel 50 (MCC-D Non-Vital Section)

*MCC feeder breakers for MCC's 3A,3B, 3C, 3E, 4A, 4B, 4C, 4E, D, F are also referenced in the Appendix R safe shutdown report submitted to NRC and will be evaluated.

TABLE 3

Comparison With Technical Specification Operability Requirements

C Bus Load	Potential Tech. Spec Association	Evaluation-Basis
Rod Control System Backup Transformers 3X18; 4X18 (MCC's 3B & 4B)	3.2-4.a - "No more than one inoperable control rod shall be permitted . . ."	A functional control rod system is required for normal plant operation. Loss of control rod power supplies will not impact safe shutdown or accident mitigation. In addition these serve as a backup power supply and loss will not affect even normal operation.
Rod Position Inverter 3YO3; 4YO3 (MCC's 3C & 4B)	3.2-5 " If . . . the rod deviation monitor alarm is not operable, rod positions shall be logged . . ."	Rod position indication is required for normal plant operation. Loss of rod position indication will not impact safe shutdown or accident mitigation. In addition, these serve as a backup power supply and loss will not affect even normal operation.
In-core drive system (MCC's 3B & 4B)	3.2-7.a "A minimum of 16 thimbles. . . (and) associated detectors shall be operable . . ."	This equipment is used to conduct surveillance of nuclear instrumentation. Loss of in-core instrumentation will not prevent safe shutdown or accident mitigation.
Steam Generator Feed Pump 3B (4B) Breakers	3.5 Instrumentation requirements include Auxiliary Feedwater Initiation on "Trip of both Main Feedwater Pump Breakers" and Feedwater Line Isolation on "Safety Injection".	Loss of the C Bus causes a loss of power to the feedwater pump and initiates Auxiliary Feedwater flow. Operation of main feedwater pump is not required for safe shutdown or accident mitigation. Securing of main feedwater flow is assumed in main steam line break analysis.

TABLE 3 (con't.)

C Bus Load	Potential Tech. Spec Association	Evaluation-Basis
VCT Charging Pump Suction Valves LCV-3-115C; LCV-4-115C (MCC's 3B & 4B)	3.6-b.1, 4; c.1,4 "A reactor shall not be made critical unless . . . two associated charging pumps shall be operable . . . "	Manual operation of this equipment would be required on loss of C Bus to assure proper charging pump suction path.
Startup Transformer 3X03; 4X03 Cooling Equipment Alternate Feed.	3.7-1a - "Either reactor shall not be started . . . without: a. the associated 239kV/4160 V startup transformer in service."	This provides an alternate source of power for transformer cooling. Normal power supply is not from the C Bus. Loss of the C Bus will not affect transformer availability.
Air Particulate & Gas Monitors R-11, R-12 (MCC's 3B & 4B)	3.1-3e "Above 2% of rated power, two leak detection systems of different principles shall be operable one of which is sensitive to radioactivity." 3.9-2.d, e. g.-d. "All radioactive waste discharged thru the plant vent shall be continuously monitored . . ." e. "The normal response of the plant vent gas monitor shall be verified . . .". g. "Containment atmosphere shall be sampled prior to purging. . ." 3.10.2. "The containment vent and purge system . . . radiation monitors shall . . . be operable . . . "	These monitors are required to monitor radioactive releases during normal discharges and accidents. R-11 and R-12 provide signals for isolation of containment purge, control room isolation and RCS leak detection. Isolation functions appear in proposed TMI Tech. Specs. Loss of C Bus will affect the operation of this equipment. Post accident vent monitoring is provided by wide range monitors as a backup to R-11 and R-12.
Waste Disposal System Gas Compressor (MCC-3C & 4C); Auxiliary Building Exhaust Fan (MCC-D)	3.4-6 "Post Accident Containment Vent System. . . All valves, interlocks, and piping associated with the above components and required for post-accident operation are operable."	Loss of C-Bus will impact operation of support equipment for Post Accident Containment Vent System. FSAR specifically allows repairs to necessary equipment because the system operation is many days after an accident.

TABLE 3 (con't.)

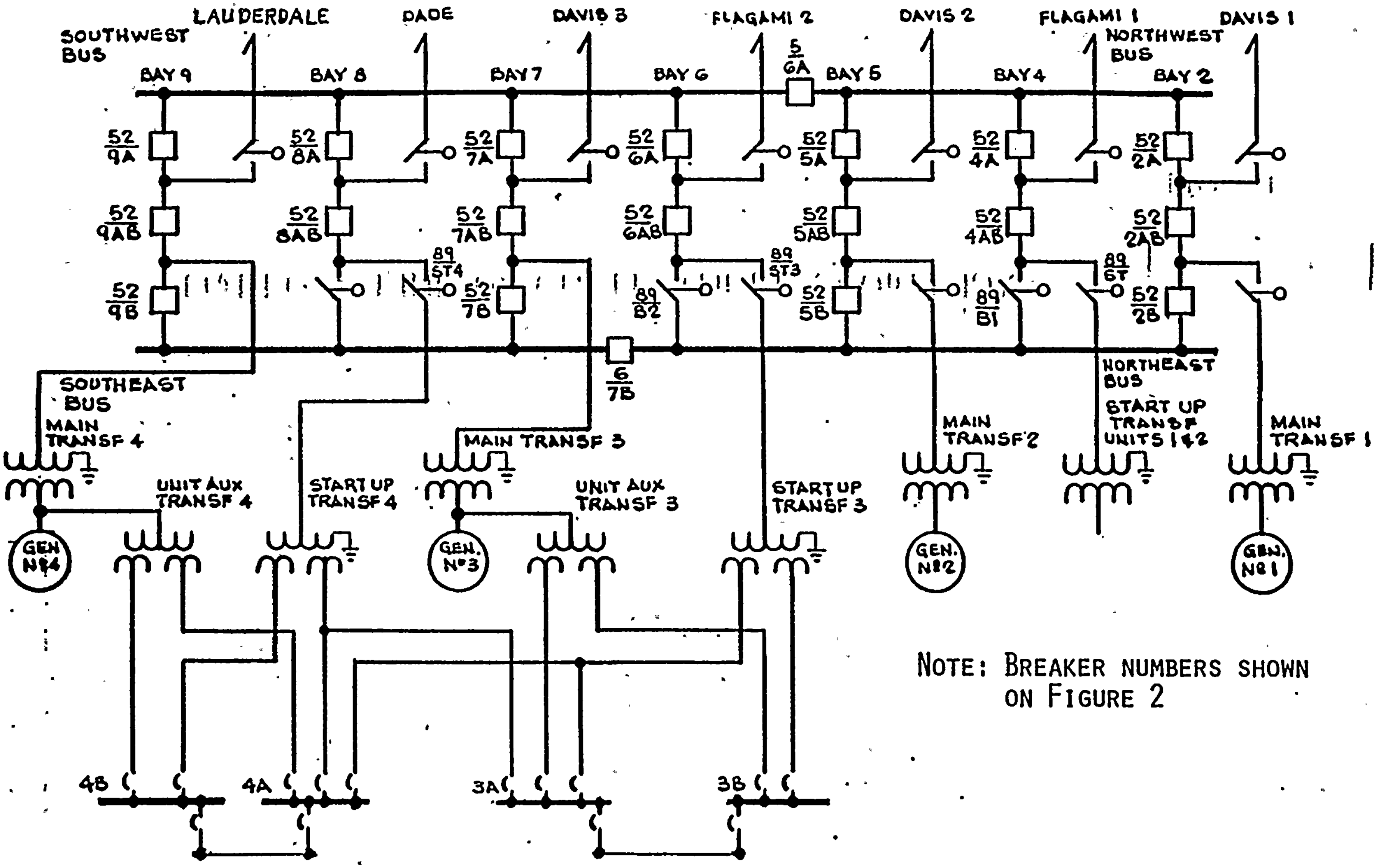
C Bus Load	Potential Tech. Spec Association	Evaluation-Basis
Screen Wash Pumps	3.14.2b "With one water supply below the minimum specified limit for one day, connect the spool piece to make the screen wash pumps available for fire water supply."	The screen wash pumps provide a backup source of fire suppression water in the event that the normal source is below its minimum level. Loss of the C Bus affects this backup source. Appendix R modifications that are presently being installed will eliminate reliance on this backup source of water.

TABLE 4

FAULT TREE EQUIPMENT LINEUP ASSUMPTIONS

Mode	Bus	Bus Supply
Normal	3A	#3 Auxiliary Transformer
	3B	#3 Auxiliary Transformer
	3C	#3 C Bus Transformer
	4A	#4 Auxiliary Transformer
	4B	#4 Auxiliary Transformer
	4C	#4 C Bus Transformer
Startup/Shutdown	3A	#3 Startup Transformer
	3B	#3 Startup Transformer
	3C	#3 C Bus Transformer
	4A	#4 Startup Transformer
	4B	#4 Startup Transformer
	4C	#4 C Bus Transformer
Auto Transfer	3A and 3B	Transfer to #3 startup on a #3 Generator trip
	3C	Transfer to #4 C Bus transformer on #3 C Bus transformer loss
	4A and 4B	Transfer to #4 startup on a #4 generator trip
	4C	Transfer to #3 C Bus transformer on #4 C Bus transformer loss

All switchyard oil circuit breakers assumed normally closed

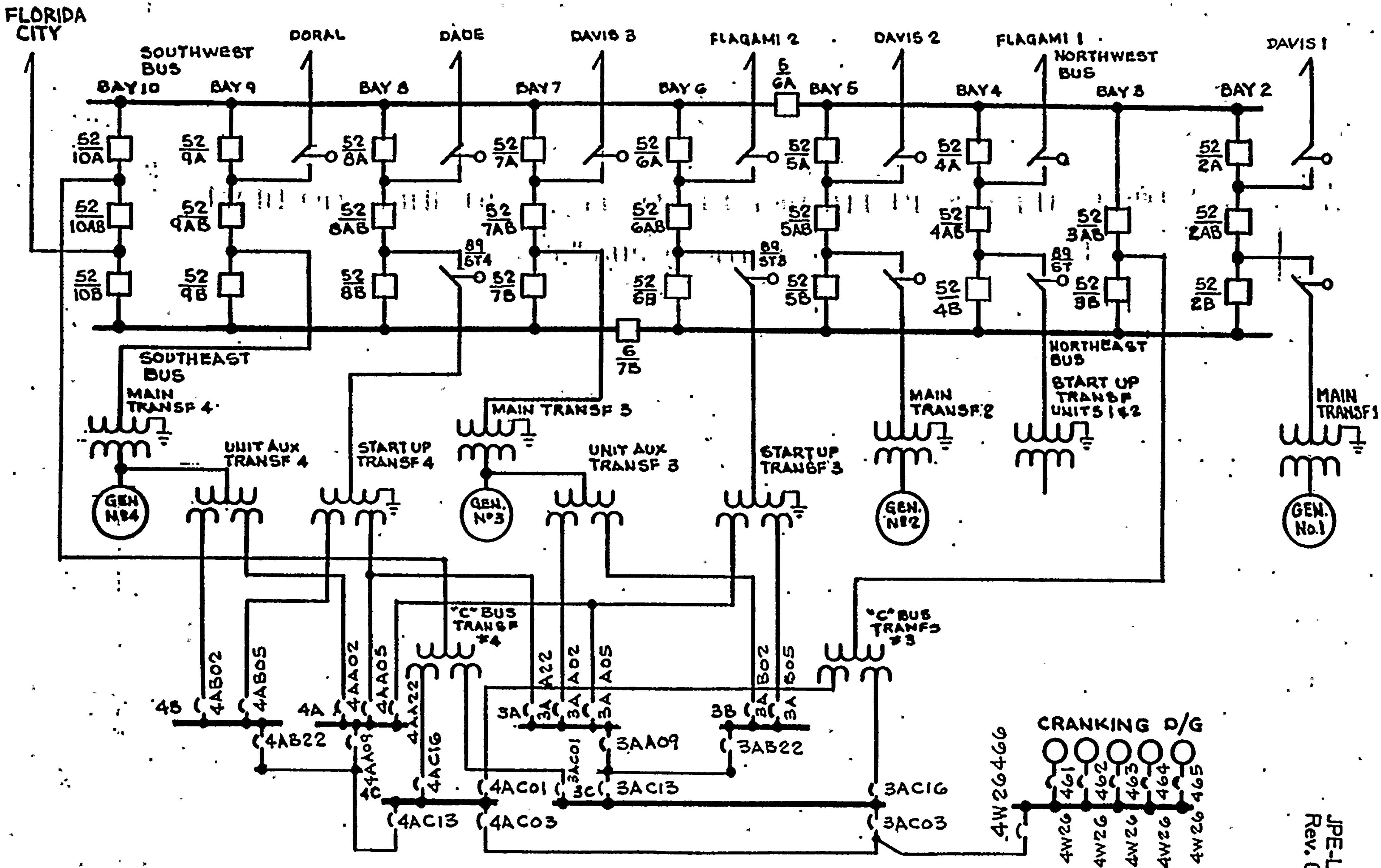


NOTE: BREAKER NUMBERS SHOWN ON FIGURE 2

FIGURE 1

JPE-L84-12
Rev. 0.

MAIN ONE LINE DIAGRAM - TURKEY POINT 1973



MAIN ONE LINE DIAGRAM - TURKEY POINT PROPOSED

FIGURE 2

"C" BUS ADDITION

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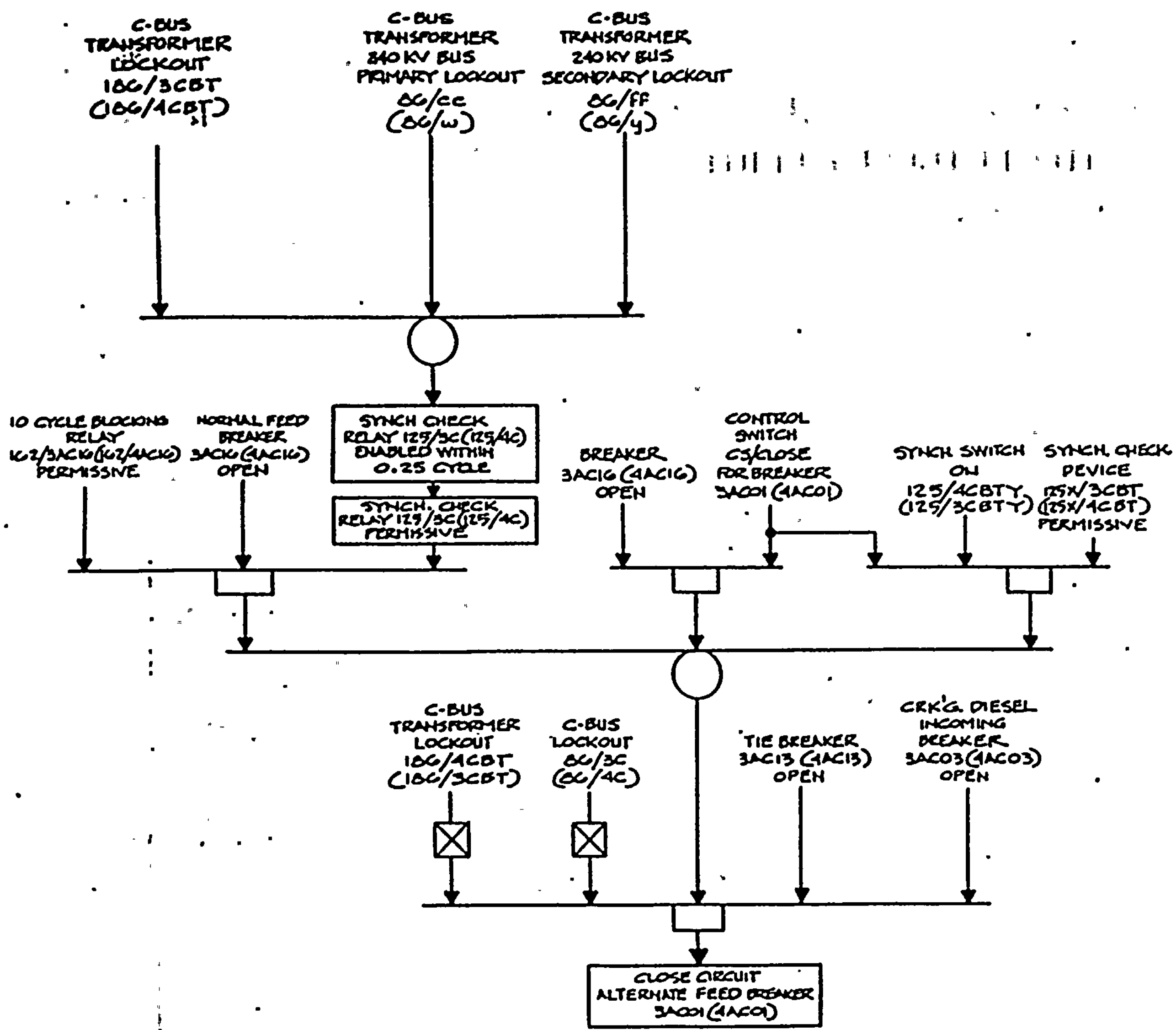
Rev. 0.



LEGEND	
SYMBOL	LOGIC FUNCTION
(AND symbol)	AND
(OR symbol)	OR
(NOT symbol)	NOT

NOTES:

1. LOGIC FOR UNIT 3 IS SHOWN. UNIT 4 IS SIMILAR.
2. DEVICE NOS. IN PARENTHESIS ARE FOR UNIT 4.

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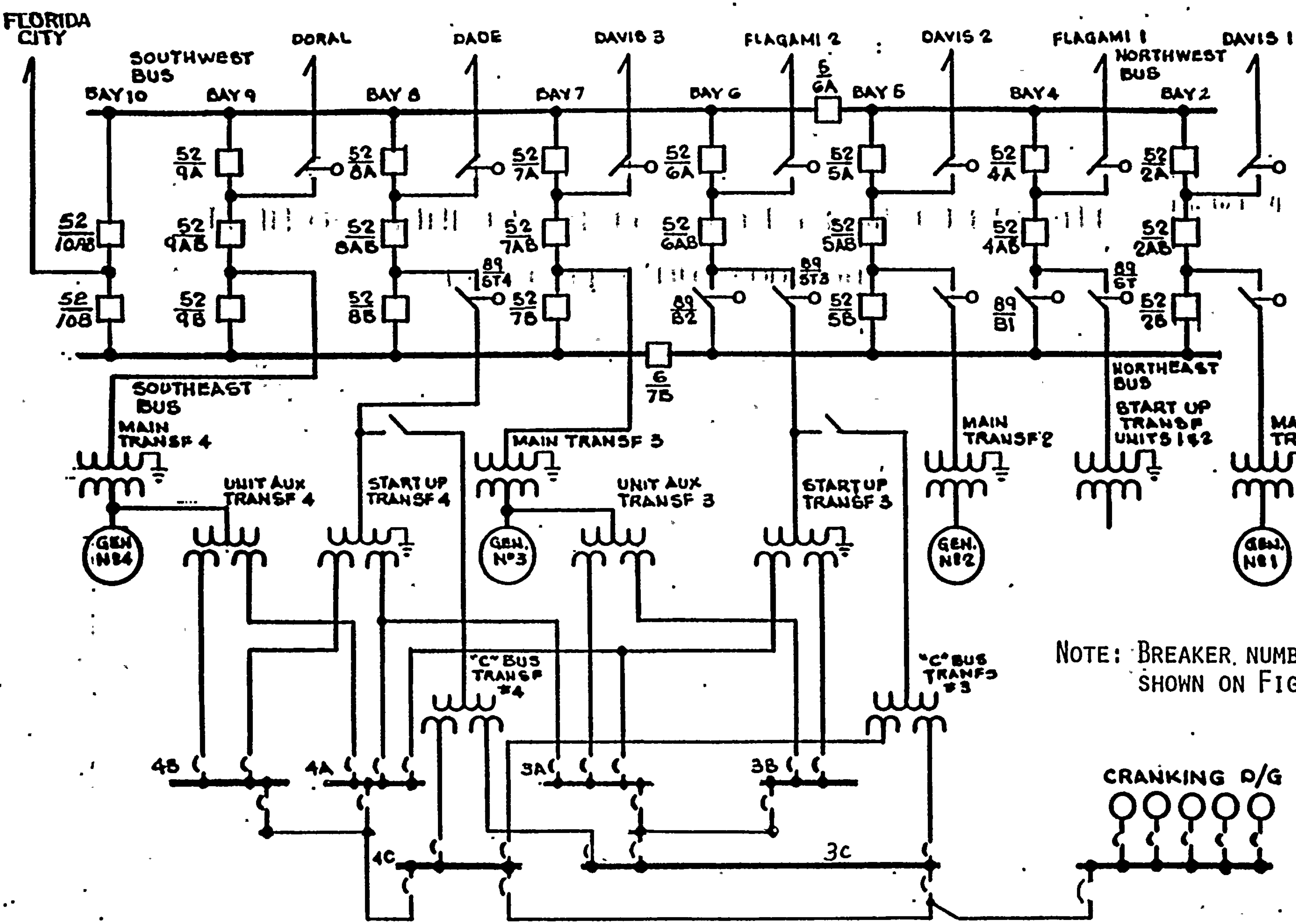
Rev. 0.

FIGURE 3

FPL FLORIDA POWER & LIGHT COMPANY

"C" BUS AUTO TRANSFER LOGIC DIAGRAM

TURKEY POINT PLANT



NOTE: BREAKER NUMBERS SHOWN ON FIGURE 2

FIGURE 4

MAIN ONE LINE DIAGRAM - TURKEY POINT PRESENT

1983-1984 "C" BUS ADDITION

FPL

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Rev. 0.

APPENDIX A

AUXILIARY POWER UPGRADE RELATED PLANT TRIPS

Prior to agreements reached with NRC Region II on February 20, 1984, the Turkey Point electrical system was as shown on Figure 4 (in text) with normal power to the Unit 3 C Bus from the Unit 3 C Bus transformer. The Unit 4's C Bus was normally powered from the Unit 4 C Bus transformer. At 6:38 AM, February 12, 1984, a relay protecting the Unit's 1 and 2 startup transformer operated causing the de-energization of the complete Northeast Bus. This resulted in loss of the Unit 3 startup transformer and C Bus transformer. The loss of the C Bus subsequently resulted in a Unit 3 reactor and turbine trip. Loss of normal offsite power resulted and the plant was placed on natural circulation. Power was provided by the emergency diesel generators to the vital busses A and B.

At 9:45 AM on the same day, while attempting to re-energize the Unit 3 C-Bus from the Unit 4 C Bus transformer, Breaker 4AC01 was closed instead of breaker 3AC01. This resulted in automatic opening of breaker 4AC16 (normal supply to Unit 4 C Bus). Loss of the Unit 4 C Bus also resulted in a Unit 4 Reactor and turbine trip. The Unit 4 startup transformer was not lost during this event and the auxiliary transformer loads were automatically transferred to the startup transformer. (Note: Normally breaker 4AC01 should not close due to the sync-check relay interlock. This interlock apparently failed and allowed closure of the breaker.)

On February 16, 1984, another plant trip (Units 3 and 4) occurred which was related to the previous plant trips on February 12, 1984. At 9:26 AM while an operator was attempting to rack out the alternate feed to the Unit 4 C Bus (breaker 4AC01), the normal supply (breaker 4AC16) opened, because of a relay actuated by jarring of the cubicle door. (Note: This relay was mounted on the door.) Loss of 4 C Bus subsequently tripped the plant. The operator then closed the door and jarred another relay causing back-up protection for breaker 4AC01. This protection isolated the Unit 3 C Bus transformer by stripping the Northeast Bus. This resulted in a Unit 3 trip and loss of offsite power to the Unit 3 start-up transformer.

As a result of these trips which challenged the plant safety systems, FPL proposed interim changes to the electrical system prior to restart. NRC Region II concurred with these interim changes, and also required FPL to submit the safety evaluation of the Auxiliary Power Upgrade contained herein to the NRC for approval prior to completing all Auxiliary Power Upgrade modifications.

The changes incorporated prior to restart of the Units after February 16, 1984 were transmitted to Region II by FPL letter L-84-36 dated February 21, 1984. A list of these commitments is recopied here for information.

1. Switch realignments will be made in Bay 6 and on the Flagami #2 line which will assure electrical isolation of the nuclear units and the fossil units, and isolation between the nuclear units in the switchyard.

2. Pending long term design changes and modifications, Units 3 and 4 will be operated with each units C Bus powered from the other units C Bus transformer. The feed breaker from each units C Bus transformer to its respective C Bus will be maintained in a racked out configuration to preclude inadvertent operation.

3. Plant procedures for the alignment and administrative control of offsite and onsite power sources will be finalized, reviewed by the Plant Nuclear Safety Committee, and required operator training will be complete.

4. Administrative controls will be in place which will assure that both startup transformers are operable whenever either nuclear unit is above 50% rated feedwater flow.

5. Three vibration sensitive relays on each of the 3C and 4C 4kV switchgear panels will be relocated to stationary panels.

6. In addition to reviews by the Plant Nuclear Safety Committee, the Company Nuclear Review Board has reviewed and concurred with the C Bus modification and proposed interim operating configuration prior to returning either unit to power operation.

For the long term, changes will be incorporated which increase the reliability of the C Bus power supply, and which separate this supply from the Units startup transformer. Additionally, relays susceptible to vibration induced plant trip will be reviewed to minimize the reoccurrence of this type of event. Accordingly, there should be fewer challenges to the plant safety systems, and a loss of the Unit 3 C Bus transformer will not result in a loss of the Unit 3 startup transformer. The design modification is presented in Section 3.0

APPENDIX B

EVALUATION OF COMPLIANCE WITH FSAR CRITERIA

Criteria

Page 1.9-2 Section 1.9 Quality Assurance Program
1.9.2 Applicability

"The systems and structures to which this program is applicable are set forth below. It is understood that such systems and structures include associated tanks, pumps, valves, piping, controls, instruments, supports, enclosures, wiring and power supplies. In general, these systems, components and structures have a vital role in the prevention or mitigation of the consequences of accidents which could cause risk to the health and safety of the public."

Page 5A-1 Section Appendix 5A Seismic Classification and Design Basis for Structures, Systems and Equipment

"The basic design criteria for the maximum hypothetical accident and earthquake conditions is that there be no loss of function if that function is related to public safety."

Evaluation

The C Bus contains no loads (see Appendix D) which have a vital role in the prevention or mitigation of the consequences of accidents which could cause risk to the health and safety of the public. The safety related systems are powered from the A and B 4.16kV busses. The breaker between C Bus and the existing A and B 4.16kV tie bus is interlocked to prevent its being closed, except under a Station Blackout abnormal condition, to preclude interaction of the C Bus and the nuclear safety related busses during normal and emergency conditions. The C Bus was classified as a non-safety related bus because it contained no nuclear safety related loads vital to maintenance of the reactor coolant pressure boundary, vital to the prevention and mitigation of accidents, and vital to achieving and maintaining hot safe shutdown conditions.

Criterion

Page 1.3-1 Section 1.3.1 Overall Requirements (GDC 1-GDC 5)

"Class I systems and components are essential to the protection of the health and safety of the public. . . All systems and components designated Class I are designed so that there is no loss of capability to perform their safety function in the event of the maximum hypothetical seismic ground acceleration. . ."

Evaluation

There has been no change in the power supply for any nuclear safety related (Class I) load. Some of the loads classified as non-Class I were removed from the A and B 4.16kV busses and put on the C Bus. Because there are no seismic class loads on the C Bus the design of the C Bus does not meet seismic criteria.

Criteria

Page 1.3-11 Section 1.3.1 Reliability and Testability of Protection Systems (GDC 19-GDC 26)

"The initiation of the engineered safety features provided for loss-of-coolant accidents is accomplished from redundant signals derived from reactor coolant system and containment instrumentation. The initiation signal for containment spray comes from coincidence of two sets of two-out-of-three high containment pressure signals. On loss of voltage at the 4160 volt busses, the diesel-generator will be automatically started and connected to the busses."

Page 1.3-12

"Redundancy in emergency power is provided in that there are two diesel-generator sets capable of supplying separate 4160 volt busses. One complete set of safety features equipment is therefore independently supplied from each diesel-generator. . . The undervoltage relay scheme is designed so that loss of 4160 volt power does not prevent the relay scheme from functioning properly . . . The ability of the diesel-generator sets to start within the prescribed time and to carry load can periodically be checked."

Evaluation

The initiation logic for the engineered safety features (ESF) and containment spray are not affected by the Auxiliary Power Upgrade. The power supply for ESF equipment is still from the A and B 4.16kV busses. On loss of voltage on these busses, the loads are shed and the diesel-generators are started and connected. The Auxiliary Power Upgrade merely removed some non-safety related loads from the A and B 4.16kV busses. Periodic testing of the diesels is unaffected by the change. No new loads were added to the diesel-generators.

Criteria

Page 1.3-19 Section 1.3.7 Engineered Safety Features (GDC 37-GDC 65)

"The units are supplied with normal, standby and emergency power sources as follows:

1. The normal source of auxiliary power during operation is the generator. Power is supplied via the unit auxiliary transformer which is connected to the isolated phase bus of the generator.

2. Power required during startup, shutdown and after reactor trip is supplied from the plant switchyard which has multiple lines running to the transmission system.

3. Two diesel-generator sets are connected to the emergency busses to supply power in the event of loss of all other a.c. auxiliary power. Each of the two diesel-generator sets is capable of supplying automatically the engineered safety features load required for any loss-of-coolant accident.

4. Emergency power supply for vital instruments, for control and for emergency lighting is supplied from 125V dc batteries.

The 4160V bus arrangement and logic network provides the capability to transfer manually component loads to the remaining diesel following the failure of one diesel-generator unit to start."

Evaluation

With the addition of the C Bus auxiliary power during operation is provided by the generator and the switchyard. All nuclear safety related equipment is still powered from the generator during normal operation. Several non-safety related loads were removed from the nuclear safety related A and B busses and placed on the C Bus. Only loads not vital to nuclear safety related functions are powered from the switchyard during normal operation.

Power required during startup, shutdown and after reactor trip is still supplied from the switchyard.

The connection of the diesel-generators to the vital busses, load sequencer and equipment needed for accident conditions is not affected by the Auxiliary Power Upgrade. Emergency power supply for vital instruments, for control and for emergency lighting is still the vital 125V DC system.

Criterion

Page 8.1-1 Section 8.1.1 Principal Design Criteria

Performance Standards

"Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or the mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice and other local site effects. The design bases so established shall reflect: (a) appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding area, and (b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as a basis for design." (GDC 2)

Evaluation

Systems and components which are essential to prevention and mitigation of accidents are still powered by the A and B 4.16kV busses. The Auxiliary Power Upgrade removed some non-safety related equipment from these busses, thereby, providing additional margin for short circuit and undervoltage conditions.

Criterion

Page 8.1-2 Section 8.1.1 Principal Design Criteria

"Alternate power systems shall be provided and designed with adequate independency, redundancy, capacity and testability to permit the functioning

required of the engineered safety features. As a minimum, the onsite power system and the offsite power system shall each, independently, provide this capacity assuming a failure of a single active component in each system." (GDC 39)

Evaluation

The criteria above is unaffected by the Auxiliary Power Upgrade. The onsite power system and the offsite power system still, independently, provide capacity for the functioning required of the engineered safety features. All engineered safety features are still supplied from the A and B 4.16kV busses. The removal of non-safety related loads from the A and B busses and placement on the C Bus did not affect any of the engineered safety features. The interconnection of the C Bus to the existing A and B tie bus provides two series breakers between the C and A bus and the C and B bus. Interlocks prevent the inadvertent closing of the breaker at the "C" bus.

Criterion

Page 8.2-1 Section 8.2.1 Network Interconnections

"Even when both nuclear Units 3 & 4 are inoperative, power will be available at the 240kV switchyard from Turkey Point Units 1 and 2 or from one of the 240kV circuits."

Evaluation

The offsite circuits have ample capacity to supply power to the required safe shutdown loads via the startup transformers. This is not affected by the Auxiliary Power Upgrade.

Criterion

Page 8.2-2 Section 8.2.2 Station Electrical System

"The station electrical system is designed to provide a simple arrangement of busses, requiring a minimum of switching to restore power to a bus in the event the normal supply to that bus is lost."

Evaluation

In all cases a minimum of switching to restore power is still maintained. The C-Bus addition does not change the validity of this criterion. The C Bus is not loaded on the generator and would not have to be switched in the event of a unit trip.

Criterion

Page 8.2-3 Section 8.2.2 Electrical System
Unit Auxiliary, Startup Transformers and C-Bus Transformer

"Each of the two units has an auxiliary transformer connected to the generator isolated phase bus to serve as the normal souce of auxiliary electrical power."

Evaluation

The auxiliary transformer still provides the normal source of auxiliary electrical power for all nuclear safety related equipment. Some non-safety related equipment which is not required to be powered from the generator is now powered from the grid via the C Bus transformer.

Criterion

Page 8.2-3 Section 8.2.2 Station Electrical System
Unit Auxiliary, Startup Transformers and C Bus Transformer

"The startup transformer serves the unit during startup, shutdown, and after a unit trip. It also constitutes a standby source of auxiliary power in the event the loss of the unit auxiliary transformer during normal operation. In the event the turbine trips, an automatic transfer connects the 4.16kV busses to the unit startup transformer."

Evaluation

The startup transformer serves the unit's A & B busses during startup, shutdown and after plant trip. It still provides a standby source of power in the event that the auxiliary transformer is lost. In the event of turbine trip the A and B 4.16kV busses automatically transfer to the startup transformer. The C Bus transformer provides power to the C Bus for normal operation, startup, shutdown or plant trip. The C Bus also provides emergency power to the A and B 4.16kV busses in the abnormal condition of station blackout. Interlocks prevent interaction between these busses during normal operations.

Criterion

Page 8.2-15 Section 8.2.3 Emergency Power
Offsite Sources

"The offsite source of power for each unit is its associated 240 - 4.16kV startup transformer. Each transformer is supplied through overhead cable leads from the 240kV switchyard which in turn is supplied by two 432 MW fossil fuel fired generating units and the two nuclear units. . .

Each startup transformer normally will be connected to a different 240kV bus. In the event of a bus fault, at least one startup transformer could be quickly restored to service. Tie breakers in the east bus, and in the west bus, are located so that the Unit 3 startup transformer will be fed from the north section

and Unit 4 transformer from the south section. Thus, a bus fault will result in the loss of only one startup transformer."

Evaluation

The offsite source of power for each unit is the startup transformer for safety related and some non-safety related loads, and the C Bus transformer for only non-safety related loads. Each of these transformers is supplied from the switchyard. Each startup transformer is normally powered from different 240kV busses to assure that a single failure will not result in the loss of both startup transformers. Thus adequate electric power is available through offsite sources. Additionally, the design of the C Bus power supply is such that a loss of the C Bus transformer will not result in the loss of a startup transformer.

APPENDIX C

EVALUATION OF COMPLIANCE WITH TECHNICAL SPECIFICATION CRITERIA

Criterion

Page 1 - 6 — Technical Specification 1.20
Safety Related Systems and Components

"Those plant features necessary to assure the integrity of the reactor coolant pressure boundary, the capability to shutdown the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents which could result in off-site exposures comparable to the guideline exposures of 10 CFR 100."

Evaluation:

The Auxiliary Power Upgrade does not change the power supply to any equipment which is necessary 1) to assure integrity of the reactor coolant pressure boundary, 2) for the safe shutdown of the reactor 3) to maintain the reactor in a safe shutdown condition, or 4) to prevent or mitigate accidents which could result in off-site exposures comparable to the guidelines in 10CFR Part 100. Appendix D is a tabulation of the loads on the C-Bus. The nuclear safety related systems meeting this technical specification definition are powered by the A and B nuclear safety related busses.

Criterion

Basis page 3.7-1 — Technical Specification 3.7
Electrical Systems

"The electrical system equipment is arranged so that no single contingency can inactivate enough safety features to jeopardize unit safety. The 480 volt equipment is supplied from 4 load centers and the 4160 volt equipment is supplied from 2 busses for each nuclear unit."

Evaluation

The Auxiliary Power Upgrade is consistent with the design philosophy that no single contingency will inactivate enough safety features to jeopardize plant safety. No safety related equipment is provided power from the C-Bus. All safety related equipment is still powered from two nuclear safety related 4160V Busses (A and B) and four nuclear safety related 480V Load Centers (A, B, C and D). This aspect of the plant design has not been altered.

Criterion

"Multiple outside sources supply power to the nuclear units. The auxiliary equipment is arranged electrically so that multiple items receive their power from the two different sources."

Evaluation

Power is available at the 240 kV switchyard from Turkey Point Units 1 or 2 or from one of several off-site 240 kV circuits. Normal power supply to nuclear safety related equipment is from the main generator, through the auxiliary transformer and two 4.16 kV Busses. The alternate source of power is the startup transformer. This aspect of plant design has not been altered.

Criterion

"One outside source of power is required to give sufficient power to run normal operating equipment. One transmission line can supply all the auxiliary power. One 239-4.16KV startup transformer can supply the auxiliary loads for its associated nuclear unit and emergency loads (MHA) for the other nuclear unit."

Evaluation

The power requirements for safety related equipment was not affected by the Auxiliary Power Upgrade since no new safety related loads were added to the plant. As such, this criterion was not affected by the modification.

Criterion

"The bus arrangements specified for operation ensure that power is available to an adequate number of safeguards auxiliaries. With additional switching, more equipment could be out of service without infringing on safety."

Evaluation

The nuclear safety related bus arrangement specified by Technical Specification 3.7.1 and 3.7.2 are not changed by the Auxiliary Power Upgrade since only non-safety related loads were transferred to the new AC and DC distribution systems.

Criterion

"Each diesel generator has sufficient capacity to start and run the required engineered safeguards for a MHA in one unit and safe shutdown of the second unit. The minimum diesel fuel oil inventory at all times is maintained to assure the operation of either diesel carrying 168 hour rated load for seven days."

Evaluation

The Auxiliary Power Upgrade neither added new safety related loads nor modified safeguard equipment. The addition of the C-Bus and associated equipment has no effect on the loading or loading sequence of the emergency diesel-generator. As such, this criterion is not affected by the modification.

Criterion

"With 4 battery chargers in service, the batteries will always be at full charge in anticipation of a loss-of-ac power incident. This ensures that adequate dc power will be available for emergency use."

Evaluation

The Auxiliary Power Upgrade included installation of a new non-safety related DC system that is independent of the existing DC systems. Some non-nuclear safety related loads were transferred from the safety related DC system and thus provided additional capacity in the nuclear safety related DC power system.

Criterion

"A unit can be safety shutdown without the use of off-site power since all vital loads (safety systems, instruments, etc.) can be supplied from an emergency diesel generator."

Evaluation

The Auxiliary Power Upgrade neither added nor modified safe shutdown equipment. As discussed in Evaluation (5) above, this criterion is not affected by the modification.

Criterion

Basis page B4.8-1 — Technical Specification 4.8
Emergency Power System Periodic Test

"The tests specified are designed to demonstrate that the diesel-generators will provide for operation of equipment. They also assure that the emergency generator system controls and the control systems for the safeguards equipment will function automatically in the event of a loss of normal power.

The testing frequency specified is often enough to identify and correct any mechanical or electrical deficiency before it can result in a system failure. The fuel supply and starting circuits and controls, are continuously monitored. Any faults are annunciated. An abnormal condition in these systems would be signaled without having to place the diesel-generators themselves on test.

Each unit, as a backup to the normal standby AC power supply is capable of sequentially starting and supplying the power requirement of the required safety features equipment. Each will assume full load within 60 seconds after the initial starting signal.[(1)(2)(3)]

The specified fuel supply will ensure power requirements for at least a week.

Station batteries will deteriorate with time, but precipitous failure will not occur. The surveillance specified is that which has been demonstrated over the years to provide an indication of a cell becoming unserviceable long before it fails.

The equalizing charge will maintain the ampere-hour capability of the battery."

Evaluation

As discussed for the previous Tech. Spec. the Auxiliary Power Upgrade did not impact the emergency diesel-generator controls or loads. The station batteries were affected only in the sense that some non-safety related loads were removed from the nuclear safety related DC system. This provides additional capacity in the nuclear safety related DC system. This Technical Specification is not changed or adversely affected by the Auxiliary Power Upgrade.

APPENDIX D

TABULATION OF C-BUS LOADS

Unit 3 C Bus

- Steam Generator Feedpump 3B
- Condensate Pump 3C
- 480V Load Center 3E
- 480V Load Center 3F
- 480V Load Center 3G
- Standby Steam Generator Feedpump
- Emergency Tie to Unit 1/2 Cranking Diesel Generators
- Emergency Tie to Vital Busses 3A and 3B

480V Load Center 3E

- MCC 3G Amertap System
- MCC 3B43 Condensate Polishing
- Non-vital Section of MCC 3B

480V Load Center 3F

- MCC F, Water Treatment Area
- MCC RB, Radwaste Building
- Tie to L.C. 4F
- Non-vital Section of MCC D (Alternate Supply)
- Tie to L.C. 3G

480V Load Center 3G

- Technical Support Center (Alternate Supply)
- Non-vital Section of MCC 3C (Fuel Area)
- Spent Fuel Pump Motor 3P212B
- Tie to L. C. 3F

MCC 3B Non-Vital Section

- Welding Receptacles No's. 17 and 17A
- Rod Control System Backup Transformer 3X18
- C-Battery Room HVAC
- Control Building Kitchen Panel DP13
- Primary Water Makeup Pump 3B (3P16B)
- Containment Sump Pump 3A (3P23A)
- Lighting Transformer 36A (3X036)
- Panel 3P82
- Battery Room A/C E16E
- Welding Receptacle No. 5
- Main Steam Penetration Cooling Fan 3A (3V31A)
- RCS Drain Tank Pump 3A (3P218A)
- Steam Generator Feedpump Room Exhaust Fan 3B (3V14B)
- Auxiliary Transformer Cooling Equipment 3 (Alternate Feed)
- Startup Transformer Cooling Equipment 3 (Alternate Feed)
- Gland Steam Condenser Exhaust Blower 3B(3V6B)

- RCP 3B Oil Lift Pump 3P232B
- Isolated Phase Bus Fan 3B (3V19B)
- Steam Generator Feedpump 3B Auxiliary Lube Oil Pump (3P34B)
- New Fuel Building Elevator 3H9
- Air Particulate and Gas Monitor 3V36
- Miscellaneous Containment Distribution Panel No. 2 (3P11) including In-Core Drive System
- Welding Receptable No.'s 6, 6A and 6B
- Sewage Pump B (P51B)
- Lighting Transfer 3X311
- Containment Lighting Transformer 36A
- Switchyard Distribution Transfer Switch DP-7, Alternate Feed
- Feedwater Penetration Cooling Fan 3A (3V32A)
- Reheater 3C Steam Block Valve MOV-3-1433
- Reheater 3D Steam Block Valve MOV-3-1434
- VCT Charging Pump Suction LCV-3-115C
- Condenser Pit Sump Pump 3B (3P28B)
- Main Transformer Cooling Equipment 3 (Alternate Feed)
- CRDM Cooler Fan 3A (3Y2A)

MCC 3C Non-Vital Section

- Gas Stripper Panel 3C30
- Fuel Area Miscallaneous Power Panel DP11 (3P12)
- Spent Fuel Pit Heat Exchanger Room Supply Fan 3V12
- Monitor Tank Pump 3 (P206A)
- Waste Evaporator Condensate Pump 3 (P221A)
- RCS Drain Tank Pump 3B (3P218B)
- Refueling Water Purifying Pump 3P209
- Lighting Transfer 39 (Spent Fuel Pit)
- Receptacle No. 8
- Fuel Tilting Winch Panel 3C09
- Space Heater Transformer 38
- Deaerated Water Transfer Pump 3P12
- RHR Room B Area Sump Pump 3A (3P26A)
- RHR Room Heat Exchanger Area Sump Pump 3A (3P24A)
- RHR Room A Area Sump Pump 3A (3P25A)
- Deaerator Vacuum Pump Oil Heater 3P35
- Rod Position Inverter 3 (3Y03)
- Lighting Transformer 37
- Waste Disposal System Basement Sump Pump 3 (P27A)
- Primary Water Makeup to Surge Tank MOV-3-832
- Gas Stripper Feedpump 3P204A
- RCP 3C Oil Lift Pump 3P232C
- Miscellaneous Containment Distribution Panel No. 1 3P10
- Boric Acid Evaporator Control Panel 3C33
- Waste Disposal System Gas Compressor 3 (C200)
- Deaerator Vacuum Pump 3P35
- CRDM Cooler Fan 3B (3V2B)
- New Fuel Storage Area Supply Fan 3V13
- Containment Sump Pump 3B (3P23B)
- Spent Fuel Pit Exhaust Fan 3V21
- Spent Fuel Pit Skimmer Pump 3P213

MCC D Non-Vital Section

- Lighting Transformer X50
- Containment Sampling Pump
- Lighting Transformer X43
- Machine Shop Power Panel B14
- Auxiliary Building Air Supply Fan 3A (V10)
- Auxiliary Building Air Supply Fan 3B (V11)
- Gas Stripper Feedpump 3S (3P204B)
- RHR Room B Area Sump Pump 3B (3P26B)
- Hold-up Tank Recirculation Pump 3 (P208)
- RHR Room B Area Sump Pump 4B (4P26B)
- Laundry Waste Water Pump P84A
- RHR Room HX Area Sump Pump 3B (3P24B)
- Spare Ammonium Hydroxide Pump
- Hydrazine Pump P21
- RHR Room A Area Sump Pump 3B (3P25B)
- Steam Generator B Addition Pump
- Waste Evaporator Feedpump 3 (P220)
- RHR Room HX Area Sump Pump 4B (4P24B)
- RHR Room A Area Sump Pump 4B (4P25B)
- Laundry Waste Water Pump P84B
- Receptacle No. 9
- Receptacle No. 10
- Lighting Transformer X80
- Drumming Station Crane H210
- Concentrates Holding Tank 3 Heater T210
- Spent Fuel Cask Crane H4
- Auxiliary Building Exhaust Fan 3B (V-8B)
- Lighting Transformer 33 (Control Room Lighting)
- Diesel Generator Building Lighting Transformer 315
- Control Building Exhaust Fan V26
- Code Call Transformer
- Recirculation Pump P53B
- Space Heater Distribution Transformer 303
- Primary Water Makeup Pump 4A (4P16A)
- Auxiliary Building Exhaust Fan 3A (V8A)
- Primary Water Makeup Pump 3A (3P16A)

MCC 3E

- MOV-3-1416 Circulating Water Pump 3A1 Discharge Valve
- MOV-3-1414 Circulating Water Pump 3B1 Discharge Valve
- Circulating Lube Water Pump 3B
- Space Heater Transformer - MCC 3E
- Chlorinator Evaporator Heater A (S1A)
- Chlorine Bottle Hoist H13
- Traveling Screen 3B1 (3F1B)
- Traveling Screen 3B2 (3F1D)
- Screen Wash Pump 3 (3P14)
- Traveling Screen 3A1 (3F1A)
- Traveling Screen 3A2 (3F1C)
- Intake Structure Bridge Crane H2

- Distribution Panel for Trash Rake Hoist H12
- Screen Wash Pump 3S (P14)
- MOV-3-1415 Circulating Water Pump 3A2 Discharging Valve
- MOV-3-1413 Circulating Water Pump 3B2 Discharging Valve
- Receptacle No. 11 and No. 12
- Lighting Transformer 314 (Lighting Panel LP314)
- Chlorinator Evaporator Heater B (S1B)

MCC F

- Water Treatment Shack Air Conditioning Unit
- Water Treatment Elevator H10C
- Caustic Pump 3A (P48A)
- Acid Pump 3B (P47B)
- Mixed Bed Air Blower 3 (V22)
- Brine Pump 3 (P45)
- Raw Water Pump 3B (P17B)
- Demineralizer Feedpump 3A (P33A)
- Demineralizer Feedpump 3B (P33B)
- Treated Water Pump 3A (P18A)
- Treated Water Pump 3B (P18B)
- Caustic Pump 3B (P48B)
- Acid Pump 3A (P47A)
- Receptacle 13
- Chemical Storage Building Lighting Transformer (Lighting Panel LP318)
- Coagulator Agitator 3 (T24)
- Lime Feed Tank Agitator 3 (T46)
- Space Heater MCC F
- Coagulator Recycle Pump 3 (P44)
- Raw Water Pump 3A (P17A)
- Caustic Storage Tank 3 Heaters (T16)

MCC RB

- Welding Receptables No.'s 1 and 2 and Trash Compactor
- Radwaste Exhaust Fan V36
- Waste Evaporator Feedpump P229C
- Monitor Tank Discharge Pump P230A
- Waste Evaporator Feedpump P229A
- Lighting Transformer X60
- Distribution Panel DP66
- Tunnel Sump Pump P-62A
- Heat Tracing Transformer 1A (X63)
- MCC RC

MCC RC

- Distillate Pump P232A
- Concentrate Pump P231A
- Control Transformer for Waste Evaporator Panel No. 1

MCC 3B43 Condensate Polishing

- Hold Pump 3P86A
- Hold Pump 3P86B
- Unit 4 C Bus Transformer Aux. Panel Alternate Feed (4X21)
- Transformer 3XAC1 (Space Heater for 3AC)
- Hold Pump 3P86C
- Hold Pump 3P86D
- Backwash Pump 3P88
- Precoat Tank Agitator 3S69
- Transformer 3x433 (Lighting Panel 3LP433)
- Demineralizer Control Panel 3C100
- Sample Cooler Chiller 3S72
- Backwash Recovery Pump 3P95A and 3P95B
- Transformer 3X83 (For DP 3P83)
- Receptacles 3RC4341A and B
- Transformer 3X111 (Back-up to Auxiliary Power Inverter 4P31)
- Monorail Hoist 3H31
- Transformer 3X25 (Backup to SPDS Inverter)
- Condensate Polishing Room AC 3S31
- Unit 3 C Bus Transformer Aux. Panel Feed (3X21)
- Secondary System Wet Layup Pump 3P92
- Secondary System Wet Layup Pump 3P91
- Demineralizer Water Degassifier Transfer Pump P80A
- Demineralizer Water Degassifier Vacuum Pump P81A
- Condensate Backwash Recovery Tank Slurry Agitator 3S212
- Precoat Room Sump Pump 3P96
- C Bus Battery Charger 3D32
- C Bus Battery Charger 3D33
- Precoat Pump 3P87

Unit 4 C Bus

- Steam Generator Feedpump 4B
- Condensate Pump 4C
- 480V Load Center 4E
- 480V Load Center 4F
- 480V Load Center 4G
- Standby Steam Generator Feedpump
- Emergency Tie to Unit 1/2 Cranking Diesel Generators
- Emergency Tie to Vital Busses 4A and 4B

480V Load Center 4E

- MCC 4G, Amertap System
- MCC 4B43, Condensate Polishing Area
- Non-vital Section of MCC 4B

480V Load Center 4F

- MCC 4E, Intake Area
- MCC RA, Radwaste Building
- Non-vital Section of MCC D
- Tie to L. C. 3F
- Tie to L. C. 4G

480V Load Center 4G

- Spent Fuel Pump Motor 4P212B
- Non-vital Section 4C (Fuel Area)
- Tie to L. C. 4F

MCC 4B Non-Vital Section

- Welding Receptacles No.'s 17 and 17A
- Rod Control System Backup Transformer 4X18
- Panel 4P82
- Containment Lighting
- Primary Water Makeup Pump 4B (4P16B)
- Containment Sump Pump 4A (4P23A)
- Lighting Transformer 46 (4X046)
- Auxiliary Building AC Panel DP14
- Main Steam Penetration Cooling Fan 4A (4V31A)
- RCS Drain Tank Pump 4A (4P218A)
- Steam Generator Feed Pump Room Exhaust Fan 4B (4V14B)
- Auxiliary Transformer Cooling Equipment 4 (Alternate Feed)
- Startup Transformer Cooling Equipment 4 (Alternate Feed)
- Gland Steam Condenser Exhaust Blower 4B (4V6B)
- RCP 4C Oil Lift Pump 4P232C
- Isolated Phase Bus Fan 4B (4V19B)
- Steam Generator Feed Pump 4B Auxiliary Lube Oil Pump (4P34B)
- New Fuel Building Elevator 4H9
- Air Particulate and Gas Monitor 4V36
- Miscellaneous Containment Distribution Panel No. 2 (4P11), including In-Core Drive System
- Lighting Transfer 411 (4X311)
- Feedwater Penetration Cooling Fan 4A (4V32A)
- Reheater 3C Steam Block Valve MOV-4-1433
- Reheater 3D Steam Block Valve MOV-4-1434
- VCT Charging Pump Suction LCV-4-115C
- Condenser Pit Sump Pump 4B (4P28B)
- Main Transformer Cooling Equipment 4 (Alternate Feed)
- CRDM Cooler Fan 4B (4V2B)
- Rod Position Indicator Inverter No. 4 (4Y03)

MCC 4C Non-Vital Section

- Gas Stripper Panel 4C30
- Fuel Area Miscellaneous Power Panel DP11 (4P12)
- Spent Fuel Pit Heat Exchanger Room Supply Fan 4V12
- Monitor Tank Pump 4 (P206B)
- Waste Evaporator Condensate Pump 4 (P221B)
- RCS Drain Tank Pump 4B (P218B)
- Refueling Water Purifying Pump 4P209
- Lighting Transformer 49 (Spent Fuel Pit)
- Battery Room Air Conditioner E16F
- Fuel Tilting Winch Panel 4B (4C09)
- Space Heater Transformer 48
- Deaerated Water Transfer Pump 4P12

- RHR Room B Area Sump Pump 4A (4P26A)
- RHR Room Heat Exchanger Area Sump Pump 4A (4P24A)
- RHR Room A Area Sump Pump 4A (4P25A)
- Deaerator Vacuum Pump Oil Heater 4P35
- Boron Injection Tank to Boric Acid Storage Tank Transfer Pump
- Lighting Transformer 47
- Waste Disposal System Basement Sump Pump 4 P27B
- Spent Fuel Pit Exhaust Fan
- Gas Stripper Feed Pump 4 (3P204C)
- RCP 4A Oil Lift Pump 4P23A
- Miscellaneous Containment Distribution Panel No. 1 4P10
- Boric Acid Evaporator Control Panel 4C33
- Waste Disposal System Gas Compressor 4 (C201)
- Deaerator Vacuum Pump 4P35
- Control Rod Drive Mechanism Cooler Fan 4 (4V2A)
- New Fuel Storage Area Supply Fan 4V13
- Primary Water Makeup to Surge Tank MOV-4-832
- Containment Sump Pump 4B (4P23B)
- Spent Fuel Pit Exhaust Fan 4V21
- Spent Fuel Pit Skimmer Pump 4P213

<u>MCC 4E</u>

- Circulating Lube Water Pump 4A (4P13A)
- Acid Dilution Pump Control Board
- Receptacle No. 15 and No. 16
- Traveling Screen 4A1 (4F1A)
- Traveling Screen 4A2 (4F1C)
- Traveling Screen 4B1 (4F1B)
- Traveling Screen 4B2 (4F1D)
- Space Heater. Transformer - MCC 4E
- MOV-4-1413 Circulating Water Pump 4B2 Discharge
- MOV-4-1414 Circulating Water Pump 4B1 Discharge
- MOV-4-1415 Circulating Water Pump 4A2 Discharge
- MOV-4-1416 Circulating Water Pump 4A1 Discharge
- Lighting Transformer 414 (Lighting Panel LP414)
- Distribution Panel for Trash Rake Hoist
- Nitrogen Compressor NC2
- Screen Wash Pump 4 (4P14)

<u>MCC RA</u>

- Welding Receptable No. 3
- Radwaste Exhaust Fan V37
- Waste Evaporator Feed Pump P229B
- Monitor Tank Discharge Pump P230B
- Radwaste Dryer
- Radwaste Washer
- Tunnel Sump Pump P-62B
- Heat Tracing Transformer 1B (X64)
- MCC RD
- MCC RE

MCC RD

- Distillate Pump P232B
- Concentrate Pump P231B

MCC RE

- Utility Panel DP67
- Overhead Crane H15
- Welding Receptacle No. 1
- Resin Dewatering Pump P57A
- Resin Dewatering Pump P57B
- Truck Door S20
- AC Fan Coil Unit E18
- Air Cooled Condenser E19
- Hoist H16
- Evaporator Bottoms Holdup Mixing Tank Pump P54B
- Vibrator Cement Silo
- Rotary Feeder Cement Silo
- Roof Exhauster Cement Plant
- Vibrator Cement Batching Tank
- Rotary Feeder Cement Batching Tank
- Rotary Feeder Additive Tank
- Cement Mixer Feed Screw Conveyor
- Cement Mixer
- Spent Resin Holdup Mixing Tank Pump
- Vibrator Cement Silo
- Rotary Feed Cement Silo
- Vibrator Cement Batching Tank
- Rotary Feeder Cement Batching Tank
- Rotary Feeder Additive Tank
- Cement Mixer Feed Screw Conveyor
- Cement Mixer
- Respirator Facility Air Handling Unit V50

MCC 4B43

- Hold Pump 4P86A
- Hold Pump 4P86B
- Unit 3-Bus Transformer Auxiliary Panel Alternate Feed (3X21)
- Transformer 4XAC1 (Space Heater for 4AC)
- Hold Pump 4P86C
- Hold Pump 4P86D
- Backwash Pump 4P88
- Precoat Tank Agitator 4S69
- Transformer 4X83 (Distribution Panel 4P83)
- Transformer 4X433 (Lighting Panel 4LP433)
- Demineralizer Control Panel 4C100
- Sample Cooler Chiller 4S72
- Backwash Recovery Pump 4P95A
- Backwash Recovery Pump 4P95B
- Receptacles 4RC4341A and B
- Transformer 4X111 (Backup to Auxiliary Power Inverter AP31)

- Monorail Hoist 4H31
- Condensate Polishing Room AC 4S31
- Unit 4 C Bus Transformer Auxiliary Panel Feed (4X21)
- Secondary System Wet Layup Pump 4P92
- Secondary System Wet Layup Pump 4P91
- Demineralizer Water Degassifier Transfer Pump P80B
- Demineralizer Water Degassifier Vacuum Pump P81B
- Precoat Room Sump Pump 4P96
- C Bus Battery Charger 4D32
- Precoat Pump 4P87
- Backwash Tank Agitator

DC Control Center 3D31

- Emergency Bearing Oil Pump 3P30
- Air Side Oil Backup Pump 3P38
- 480V Load Center 3E, 3F, 3G
- Switchgear 3C (3AC01)
- C Bus Transformer (3X21)
- C Bus Transformer Relay Panel (3C260)
- Inverter to 120V Uninterruptible Power Supply (3Y11)
- Reflasher (C256)
- SPDS Inverter (3Y25)

DC Control Center 4D31

- Emergency Bearing Oil Pump 4P30
- Air Side Seal Oil Backup Pump 4P38
- SPDS Inverter (4Y25)
- 480V Load Center 4E, 4F, 4G
- Switchgear 4C (4AC01)
- C Bus Transformer (4X21)
- C Bus Transformer Relay Panel (4C260)
- Inverter to 120V Uninterruptible Power Supply (4Y11)

120V AC Uninterruptible Panel Board 3P31

- Telemetering (C Bus Transformer)
- Fire Detection for DC Enclosure Building
- C Bus Transformer Deluge
- Security System

120V AC Uninterruptible Panel Board 4P31

- Telemetering (C Bus Transformer)
- DC Enclosure Building Ventilation
- C Bus Transformer Deluge System
- Security System

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 3AA02- NORMAL SUPPLY TO THE 3A BUS	OPEN	-LOSS OF POWER TO THE A BUS -A BUS STRIPS LOADS	UNIT 3: D/G STARTS AND PICKS UP THE A BUS LOADS; UNIT TRIPS; B BUS TRANSFERS TO THE SU TX UNIT 4: NONE
BREAKER 3AA02- NORMAL SUPPLY TO THE 3A BUS	FAULT	-LOCKOUT 3A BUS -A BUS DEAD -LOCKOUT 3 AUX TX	UNIT 3: UNIT TRIPS; B BUS TRANSFERS TO THE SU TX UNIT 4: NONE
BREAKER 3AA05- ALTERNATE SUPPLY TO THE 3A BUS	CLOSE	-A BUS SUPPLIED FROM BOTH THE AUX AND THE SU TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AA05- ALTERNATE SUPPLY TO THE 3A BUS	FAULT	-A BUS LOCKOUT -A BUS DEAD	UNIT 3: LOCKOUT SU TX; D/G PICK UP B BUS LOADS; UNIT TRIPS UNIT 4: NONE
BREAKER 3AA09- TIE BETWEEN THE A BUS AND THE B AND C BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AA09- TIE BETWEEN THE A BUS AND THE B AND C BUSSES	FAULT	-LOCKOUT OF A BUS -A BUS DEAD	UNIT 3: UNIT TRIP; B BUS AUTO TRANSFERS TO THE 3 SU TX UNIT 4: NONE
BREAKER 3AA22- ALTERNATE SUPPLY TO THE 3A BUS FROM THE 4 SU TX	CLOSE	-BUS FED FROM BOTH THE 4 SU TX AND THE 3 AUX TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AA22- ALTERNATE SUPPLY TO THE 3A BUS FROM THE 4 SU TX	FAULT	-LOCKOUT OF 3A BUS -LOCKOUT OF 4 SU TX -A BUS DEAD	UNIT 3: UNIT TRIP; B BUS AUTO TRANSFERS TO 3 SU TX UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 3AB02- NORMAL SUPPLY TO THE 3B BUS	OPEN	-LOSS OF POWER TO THE B BUS -B BUS STRIPS LOADS	UNIT 3: UNIT TRIPS; A BUS TRANSFERS TO THE SU TX; D/G STARTS AND PICKS UP THE B BUS LOADS UNIT 4: NONE
BREAKER 3AB02- NORMAL SUPPLY TO THE 3B BUS	FAULT	-LOCKOUT 3B BUS -B BUS DEAD -LOCKOUT 3 AUX TX	UNIT 3: UNIT TRIPS; A BUS TRANSFERS TO THE SU TX UNIT 4: NONE
BREAKER 3AB05- ALTERNATE SUPPLY TO THE 3B BUS	CLOSE	-B BUS SUPPLIED FROM BOTH THE AUX AND THE SU TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AB05- ALTERNATE SUPPLY TO THE 3B BUS	FAULT	-B BUS LOCKOUT -B BUS DEAD	UNIT 3: LOCKOUT SU TX; D/G PICK UP A BUS LOADS; UNIT TRIPS UNIT 4: NONE
BREAKER 3AB22- TIE BETWEEN THE B BUS AND THE A AND C BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AB22- TIE BETWEEN THE B BUS AND THE A AND C BUSSES	FAULT	-LOCKOUT OF B BUS -B BUS DEAD	UNIT 3: UNIT TRIP; A BUS AUTO TRANSFERS TO THE 3 SU TX UNIT 4: NONE
BREAKER 3AC01- ALTERNATE SUPPLY TO THE 3C BUS FROM THE 4C TX	CLOSE	-C BUS SUPPLIED FROM BOTH THE 3C TX AND THE 4C TX	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 3AC01- ALTERNATE SUPPLY TO THE 3C BUS FROM THE 4C TX	FAULT	-LOCKOUT 3C BUS -LOCKOUT 4C TX	UNIT 3: TURBINE RUNBACK UNIT 4 WITHOUT AUTO TRANSFER: LOSS OF 4C BUS; TURBINE RUNBACK UNIT 4 WITH AUTO TRANSFER: CLOSE 4AC01
BREAKER 3AC03 SUPPLY FROM THE CRANKING DIESELS	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AC03 SUPPLY FROM THE CRANKING DIESELS	FAULT	-LOCKOUT OF 3C BUS	UNIT 3: TURBINE RUNBACK UNIT 4: NONE
BREAKER 3AC13- TIE BETWEEN THE C BUS AND THE A AND B BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 3AC13- TIE BETWEEN THE C BUS AND THE A AND B BUSSES	FAULT	-LOCKOUT OF 3C BUS	UNIT 3: TURBINE RUNBACK UNIT 4: NONE
BREAKER 3AC16 NORMAL SUPPLY TO THE 3C BUS	OPEN	-LOSS OF POWER TO THE 3C BUS	UNIT 3: TURBINE RUNBACK UNIT 4: NONE
BREAKER 3AC16 NORMAL SUPPLY TO THE 3C BUS	FAULT	-LOCKOUT OF 3C BUS -LOCKOUT OF 3C TX	UNIT 3: TURBINE RUNBACK UNIT 4: NONE
BREAKER 4AA02- NORMAL SUPPLY TO THE 4A BUS	OPEN	-LOSS OF POWER TO THE A BUS -A BUS STRIPS LOADS	UNIT 4: D/G STARTS AND PICKS UP THE A BUS LOADS; UNIT TRIPS; B BUS TRANSFERS TO THE SU TX UNIT 3: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 4AA02- NORMAL SUPPLY TO THE 4A BUS	FAULT	-LOCKOUT 4A BUS -A BUS DEAD -LOCKOUT 4 AUX TX	UNIT 4: UNIT TRIPS; B BUS TRANSFERS TO THE SU TX UNIT 3: NONE
BREAKER 4AA05- ALTERNATE SUPPLY TO THE 4A BUS	CLOSE	-A BUS SUPPLIED FROM BOTH THE AUX AND THE SU TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AA05- ALTERNATE SUPPLY TO THE 4A BUS	FAULT	-A BUS LOCKOUT -A BUS DEAD	UNIT 4: LOCKOUT SU TX; D/G PICK UP B BUS LOADS; UNIT TRIPS UNIT 3: NONE
BREAKER 4AA09- TIE BETWEEN THE A BUS AND THE B AND C BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AA09- TIE BETWEEN THE A BUS AND THE B AND C BUSSES	FAULT	-LOCKOUT OF A BUS -A BUS DEAD	UNIT 4: UNIT TRIP; B BUS AUTO TRANSFERS TO THE 4 SU TX UNIT 3: NONE
BREAKER 4AA22- ALTERNATE SUPPLY TO THE 4A BUS FROM THE 3 SU TX	CLOSE	-BUS FED FROM BOTH THE 3 SU TX AND THE 4 AUX TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AA22- ALTERNATE SUPPLY TO THE 4A BUS FROM THE 3 SU TX	FAULT	-LOCKOUT OF 4A BUS -LOCKOUT OF 3 SU TX -A BUS DEAD	UNIT 4: UNIT TRIP; B BUS AUTO TRANSFERS TO 4 SU TX UNIT 3: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 4AB02- NORMAL SUPPLY TO THE 4B BUS	OPEN	-LOSS OF POWER TO THE B BUS -B BUS STRIPS LOADS	UNIT 4: UNIT TRIPS; A BUS TRANSFERS TO THE SU TX; D/G STARTS AND PICKS UP THE B BUS LOADS UNIT 3: NONE
BREAKER 4AB02- NORMAL SUPPLY TO THE 4B BUS	FAULT	-LOCKOUT 4B BUS -B BUS DEAD -LOCKOUT 4 AUX TX	UNIT 4: UNIT TRIPS; A BUS TRANSFERS TO THE SU TX UNIT 3: NONE
BREAKER 4AB05- ALTERNATE SUPPLY TO THE 4B BUS	CLOSE	-B BUS SUPPLIED FROM BOTH THE AUX AND THE SU TX	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AB05- ALTERNATE SUPPLY TO THE 4B BUS	FAULT	-B BUS LOCKOUT -B BUS DEAD	UNIT 4: LOCKOUT SU TX; D/G PICK UP A BUS LOADS; UNIT TRIPS UNIT 3: NONE
BREAKER 4AB22- TIE BETWEEN THE B BUS AND THE A AND C BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AB22- TIE BETWEEN THE B BUS AND THE A AND C BUSSES	FAULT	-LOCKOUT OF B BUS -B BUS DEAD	UNIT 4: UNIT TRIP; A BUS AUTO TRANSFERS TO THE 4 SU TX UNIT 3: NONE
BREAKER 4AC01- ALTERNAME SUPPLY TO THE 4C BUS FROM THE 3C TX	CLOSE	-C BUS SUPPLIED FORM BOTH THE 3C TX AND THE 4C TX	UNIT 4: NONE UNIT 3: NONE
BREAKER 4AC01- ALTERNATE SUPPLY TO THE 4C BUS FROM THE 3C TX	FAULT	-LOCKOUT 4C BUS -LOCKOUT OF 3C TX	UNIT 4: TURBINE RUNBACK UNIT 3 WITHOUT AUTO TRANSFER: LOSS OF 3C BUS; TURBINE RUNBACK UNIT 3 WITH AUTO TRANSFER: CLOSE 3AC01

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BREAKER 4AC03 SUPPLY FROM THE CRANKING DIESELS	CLOSE	-NONE	UNIT 4: NONE UNIT 3: NONE
BREAKER 4AC03 SUPPLY FROM THE CRANKING DIESELS	FAULT	-LOCKOUT OF 4C BUS	UNIT 4: TURBINE RUNBACK UNIT 3: NONE
BREAKER 4AC13-TIE BETWEEN THE C BUS AND THE A AND B BUSSES	CLOSE	-NONE	UNIT 3: NONE UNIT 4: NONE
BREAKER 4AC13-TIE BETWEEN THE C BUS AND THE A AND B BUSSES	FAULT	-LOCKOUT OF 4 C BUS	UNIT 4: TURBINE RUNBACK UNIT 3: NONE
BREAKER 4AC16 NORMAL SUPPLY TO THE 4C BUS	OPEN	-LOSS OF POWER TO THE 4C BUS	UNIT 4: TURBINE RUNBACK UNIT 3: NONE
BREAKER 4AC16 NORMAL SUPPLY TO THE 4C BUS	FAULT	-LOCKOUT OF 4C BUS -LOCKOUT OF 4C TX	UNIT 4: TURBINE RUNBACK UNIT 3: NONE
BUS NORTHEAST	SHORT, OR SHORT TO GROUND	-LOCKOUT OF NORTHEAST BUS BY OPENING OF BREAKERS 2B,3B,4B,5B,6B,6/7B	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BUS NORTHWEST	SHORT, OR SHORT TO GROUND	-LOCKOUT OF NORTHWEST BUS BY OPENING OF BREAKERS 2A,3AB,4A,5A,5/6A	UNIT 3: NONE UNIT 4: NONE
BUS SOUTHEAST	SHORT, OR SHORT TO GROUND	-LOCKOUT OF SOUTHEAST BUS BY OPENING OF BREAKERS 10B,9B,8B,7B,6/7B	UNIT 3: NONE UNIT 4: NONE
BUS SOUTHWEST	SHORT, OR SHORT TO GROUND	-LOCKOUT OF SOUTHWEST BUS BY OPENING OF BREAKERS 10A,9A,8A,7A,6A,5/6A	UNIT 3: NONE UNIT 4: NONE
BUS 3A	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE
BUS 3A	PHASE TO PHASE SHORT	-LOCKOUT OF 3A BUS	UNIT 3: UNIT TRIP; B BUS TRANSFERS TO SU TX UNIT 4: NONE
BUS 3B	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE
BUS 3B	PHASE TO PHASE SHORT	-LOCKOUT OF 3B BUS	UNIT 3: UNIT TRIP; A BUS TRANSFERS TO SU TX UNIT 4: NONE
BUS 3C	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
BUS 3C	PHASE TO PHASE SHORT	-LOCKOUT OF 3C BUS	UNIT 3: TURBINE RUNBACK UNIT 4: NONE
BUS 4A	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE
BUS 4A	PHASE TO PHASE SHORT	-LOCKOUT OF 4A BUS	UNIT 4: UNIT TRIP; B BUS TRANSFERS TO SU TX UNIT 3: NONE
BUS 4B	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE
BUS 4B	PHASE TO PHASE SHORT	-LOCKOUT OF 4B BUS	UNIT 4: UNIT TRIP; A BUS TRANSFERS TO SU TX UNIT 3: NONE
BUS 4C	PHASE TO GROUND SHORT	-ALARM	UNIT 3: NONE UNIT 4: NONE
BUS 4C	PHASE TO PHASE SHORT	-LOCKOUT OF 4C BUS	UNIT 4: TURBINE RUNBACK UNIT 3: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
GENERATOR UNIT 3	OPEN OR SHORT	-GENERATOR LOCKOUT BY OPENING OF BREAKERS 7B,7AB,3AA02,3AB02 -CLOSE SIGNAL TO BREAKERS 3AA05,3AB05	UNIT 3: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 4: NONE
GENERATOR UNIT 4	OPEN OR SHORT	-GENERATOR LOCKOUT BY OPENING OF BREAKERS 9B,9AB,4AA02,4AB02 -CLOSE SIGNAL TO BREAKERS 4AA05,4AB05	UNIT 4: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 3: NONE
ISO PHASE BUS UNIT 3	SHORT	-LOSS OF 3 AUX TX -TRANSFER TO 3 SU TX -OPEN BREAKERS 7AB,7B	UNIT 3: UNIT TRIP UNIT 4: NONE
ISO PHASE BUS UNIT 4	SHORT	-LOSS OF 4 AUX TX -TRANSFER TO 4 SU TX -OPEN BREAKERS 9AB,9B	UNIT 4: UNIT TRIP UNIT 3: NONE
LINE-C BUS TX UNIT 3 TO BAY 3	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 3AB,3B,3AC16 -OPEN SIGNAL TO BREAKER 4AC01	UNIT 3 WITHOUT AUTO TRANSFER: LOSS OF C BUS; TURBINE RUNBACK UNIT 3 WITH AUTO TRANSFER: CLOSE 3AC01; C BUS POWERED FROM 4C TX UNIT 4: NONE
LINE-C BUS TX UNIT 4 TO BAY 10	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 10A,10AB,4AC16 -OPEN SIGNAL TO BREAKER 3AC01	UNIT 4 WITHOUT AUTO TRANSFER: LOSS OF C BUS; TURBINE RUNBACK UNIT 4 WITH AUTO TRANSFER: CLOSE 4AC01; C BUS POWERED FROM 3C TX UNIT 3: NONE
LINE-DADE	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 8A,8AB	UNIT 3: NONE UNIT 4: NONE
LINE-DAVIS 1	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 2A,2AB	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
LINE-DAVIS 2	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 5A,5AB	UNIT 3: NONE UNIT 4: NONE
LINE-DAVIS 3	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 7A,7AB	UNIT 3: NONE UNIT 4: NONE
LINE-DORAL	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 9A,9AB	UNIT 3: NONE UNIT 4: NONE
LINE-FLAGAMI 1	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 4A,4AB	UNIT 3: NONE UNIT 4: NONE
LINE-FLAGAMI 2	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 6A,6AB	UNIT 3: NONE UNIT 4: NONE
LINE-FLORIDA CITY	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 10AB,10B	UNIT 3: NONE UNIT 4: NONE
LINE-MAIN TX UNIT 1 TO BAY 2	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 2AB,2B -OPEN APPROPRIATE LOWSIDE UNIT 1 AUX TX BREAKERS	UNIT 3: NONE UNIT 4: NONE UNIT 1: UNIT TRIP

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
LINE-MAIN TX UNIT 2 TO BAY 5	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 5AB,5B -OPEN APPROPRIATE LOWSIDE UNIT 2 AUX TX BREAKERS	UNIT 3: NONE UNIT 4: NONE UNIT 2: UNIT TRIP
LINE-MAIN TX UNIT 3 TO BAY 7	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 7AB,7B,3AA02,3AB02 -CLOSE BREAKERS 3AA05,3AB05	UNIT 3: UNIT TRIP; TRANSFER A AND B BUSSES TO SU TX UNIT 4: NONE
LINE-MAIN TX UNIT 4 TO BAY 9	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 9AB,9B,4AA02,4AB02 -CLOSE BREAKERS 4AA05,4AB05	UNIT 4: UNIT TRIP; TRANSFER A AND B BUSSES TO SU TX UNIT 3: NONE
LINE-SU TX UNIT 3 TO BAY 6	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 6AB,6B -TRIP SIGNAL TO ENSURE OPENING OF BREAKERS 3AA05,3AB05,4AA22	UNIT 3: NONE UNIT 4: NONE
LINE-SU TX UNIT 4 TO BAY 8	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 8AB,8B -TRIP SIGNAL TO ENSURE OPENING OF BREAKERS 4AA05,4AB05,3AA22	UNIT 3: NONE UNIT 4: NONE
LINE-SU TX UNITS 1&2 TO BAY 4	SHORT OR SHORT TO GROUND	-OPEN BREAKERS 4AB,4B -OPEN APPROPRIATE LOWSIDE SU TX BREAKERS	UNIT 3: NONE UNIT 4: NONE
OCB 2A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 2A	SHORT TO GROUND	-LOCKOUT OF NORTHWEST BUS BY OPENING OF BREAKERS 2AB,3AB,4A,5A,5/6A -LOSS OF DAVIS 1 LINE	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 2AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 2AB	SHORT TO GROUND	-OPENING OF BREAKERS 2A,2B -OPENING OF LOWSIDE UNIT 1 AUX TX BREAKERS -LOSS OF DAVIS 1 LINE	UNIT 3: NONE UNIT 4: NONE UNIT 1: UNIT TRIP
OCB 2B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 2B	SHORT TO GROUND	-LOCKOUT OF NORTHEAST BUS BY OPENING OF BREAKERS 2AB,3B,4B,5B,6B,6/7B -OPENING OF LOWSIDE UNIT 1 AUX TX BREAKERS	UNIT 3: NONE UNIT 4: NONE UNIT 1: UNIT TRIP
OCB 3AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 3AB	SHORT TO GROUND	-LOCKOUT OF NORTHWEST BUS BY OPENING OF BREAKERS 2A,3B,4A,5A,5/6A,3AC16 -OPEN SIGNAL TO BREAKER 4AC01	UNIT 3 WITHOUT AUTO TRANSFER: TURBINE RUNBACK UNIT 3 WITH AUTO TRANSFER: CLOSE 3AC01 UNIT 4: NONE
OCB 3B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 3B	SHORT TO GROUND	-LOCKOUT OF NORTHEAST BUS BY OPENING OF BREAKERS 2B,3AB,4B,5B,6B,6/7B,3AC16 -OPEN SIGNAL TO BREAKER 4AC01	UNIT 3 WITHOUT AUTO TRANSFER: TURBINE RUNBACK UNIT 3 WITH AUTO TRANSFER: CLOSE 3AC01 UNIT 4: NONE
OCB 4A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 4A	SHORT TO GROUND	-LOCKOUT OF THE NORTHWEST BUS BY OPENING BREAKERS 2A,3AB,4AB,5A,5/6A -LOSS OF FLAGAMI 1 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 4AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 4AB	SHORT TO GROUND	-OPENING OF BREAKERS 4A,4B,LOWSIDE BREAKERS ON THE UNIT 1&2 SU TX -LOSS OF FLAGAMI 1 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 4B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 4B	SHORT TO GROUND	-LOCKOUT OF THE NORTHEAST BUS BY OPENING BREAKERS 2B,3B,4AB,5B,6B,6/7B,LOWSIDE BREAKERS ON UNIT 1&2 SU TX	UNIT 3: NONE UNIT 4: NONE
OCB 5/6A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 5/6A	SHORT TO GROUND	-LOCKOUT OF WEST BUS BY OPENING OF BREAKERS 2A,3AB,4A,5A,6A,7A,8A,9A,10A	UNIT 3: NONE UNIT 4: NONE
OCB 5A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 5A	SHORT TO GROUND	-LOCKOUT OF THE NORTHWEST BUS BY OPENING BREAKERS 2A,3AB,4A,5AB,5/6A -LOSS OF DAVIS 2 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 5AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 5AB	SHORT TO GROUND	-OPENING OF BREAKERS 5A,5B -OPENING OF LOWSIDE UNIT 2 AUX TX BREAKERS -LOSS OF DAVIS 2 LINE	UNIT 3: NONE UNIT 4: NONE UNIT 2: UNIT TRIP
OCB 5B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 5B	SHORT TO GROUND	-LOCKOUT OF THE NORTHEAST BUS BY OPENING BREAKERS 6/7B,6B,5AB,4B,3B,2B -OPENING OF LOWSIDE UNIT 2 AUX TX BREAKERS	UNIT 3: NONE UNIT 4: NONE UNIT 2: UNIT TRIP

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 6/7B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 6/7B	SHORT TO GROUND	-LOCKOUT OF EAST BUS BY OPENING OF BREAKERS 2B,3B,4B,5B,6B,7B,8B,9B,10B	UNIT 3: NONE UNIT 4: NONE
OCB 6A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 6A	SHORT TO GROUND	-LOCKOUT OF THE SOUTHWEST BUS BY OPENING BREAKERS 10A,9A,8A,7A,6AB,5/6A -LOSS OF FLAGAMI 2 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 6AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 6AB	SHORT TO GROUND	-OPENING OF BREAKERS 6A,6B -ENSURE LOCKOUT OF 3 SU TX BY OPENING OF BREAKERS 3AA05,3AB05 -OPEN SIGNAL TO BREAKER 4AA22 -LOSS OF FLAGAMI 2 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 6B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 6B	SHORT TO GROUND	-LOCKOUT OF THE NORTHEAST BUS BY OPENING BREAKERS 6/7B,6AB,5B,4B,3B,2B, -ENSURE LOCKOUT OF 3 SU TX BY OPENING 3AA05,3AB05 -OPEN SIGNAL TO BREAKER 4AA22	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 7A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 7A	SHORT TO GROUND	-LOCKOUT OF THE SOUTHWEST BUS BY OPENING BREAKERS 10A,9A,8A,7AB,6A,5/6A -LOSS OF DAVIS 3 LINE	UNIT 3: NONE UNIT 4: NONE
OCB 7AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 7AB	SHORT TO GROUND	-OPENING OF BREAKERS 7A,7B -LOCKOUT OF 3 AUX TX BY OPENING OF BREAKERS 3AA02,3AB02 -CLOSE BREAKERS 3AA05,3AB05 -LOSS OF DAVIS 3 LINE	UNIT 3: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 4: NONE
OCB 7B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 7B	SHORT TO GROUND	-LOCKOUT OF THE SOUTHEAST BUS BY OPENING BREAKERS 10B,9B,8B,7AB,6/7B -LOCKOUT 3 AUX TX BY OPENING BREAKERS 3AA02,3AB02 -CLOSE 3AA05,3AB05	UNIT 3: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 4: NONE
OCB 8A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 8A	SHORT TO GROUND	-LOCKOUT OF THE SOUTHWEST BUS BY OPENING BREAKERS 10A,9A,8AB,7A,6A,5/6A -LOSS OF DADE LINE	UNIT 3: NONE UNIT 4: NONE
OCB 8AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 8AB	SHORT TO GROUND	-OPENING OF BREAKERS 8A,8B -ENSURE LOCKOUT OF 4 SU TX BY OPENING OF BREAKERS 4AA05,4AB05 -OPEN SIGNAL TO BREAKER 3AA22 -LOSS OF DADE LINE	UNIT 3: NONE UNIT 4: NONE
OCB 8B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 8B	SHORT TO GROUND	-LOCKOUT OF THE SOUTHEAST BUS BY OPENING BREAKERS 10B,9B,8AB,7B,6/7B -ENSURE LOCKOUT BY OPENING OF BREAKERS 4AA05,4AB05 -OPEN SIGNAL TO BREAKER 3AA22	UNIT 3: NONE UNIT 4: NONE
OCB 9A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 9A	SHORT TO GROUND	-LOCKOUT OF THE SOUTHWEST BUS BY OPENING BREAKERS 10A,9AB,8A,7A,6A,5/6A -LOSS OF DORAL LINE	UNIT 3: NONE UNIT 4: NONE
OCB 9AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 9AB	SHORT TO GROUND	-OPENING OF BREAKERS 9A,9B -LOCKOUT OF 4 AUX TX BY OPENING OF BREAKERS 4AA02,4AB02 -CLOSE BREAKERS 4AA05,4AB05 -LOSS OF DORAL LINE	UNIT 4: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 3: NONE
OCB 9B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 9B	SHORT TO GROUND	-LOCKOUT OF THE SOUTHEAST BUS BY OPENING BREAKERS 10B,9AB,8B,7B,6/7B -LOCKOUT 4 AUX TX BY OPENING BREAKERS 4AA02,4AB02 -CLOSE 4AA05,4AB05	UNIT 4: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 3: NONE
OCB 10A	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 10A	SHORT TO GROUND	-LOCKOUT OF SOUTHWEST BUS BY OPENING OF BREAKERS 10AB,9A,8A,7A,6A,6/7A,4AC16 -OPEN SIGNAL TO BREAKER 3AC01	UNIT 4 WITHOUT AUTO TRANSFER: TURBINE RUNBACK UNIT 4 WITH AUTO TRANSFER: CLOSE 4AC01 UNIT 3: NONE
OCB 10AB	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 10AB	SHORT TO GROUND	-OPENING OF BREAKERS 10A,10B,4AC16 -OPEN SIGNAL TO BREAKER 3AC01 -LOSS OF FLORIDA CITY LINE	UNIT 4 WITHOUT AUTO TRANSFER: TURBINE RUNBACK UNIT 4 WITH AUTO TRANSFER: CLOSE 4AC01 UNIT 3: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
OCB 10B	OPEN	-NONE	UNIT 3: NONE UNIT 4: NONE
OCB 10B	SHORT TO GROUND	-LOCKOUT OF THE SOUTHEAST BUS BY OPENING BREAKERS 10AB,9B,8B,7B,6/7B -LOSS OF FLORIDA CITY LINE	UNIT 3: NONE UNIT 4: NONE
TX AUX UNIT 3	OPEN OR SHORT	-LOCKOUT 3AUX TX BY OPENING OF BREAKERS 7B,7AB,3AA02,3AB02 -CLOSE BREAKERS 3AA05,3AB05	UNIT 3: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 4: NONE
TX AUX UNIT 4	OPEN OR SHORT	-LOCKOUT 4 AUX TX BY OPENING BREAKERS 9B,9AB,4AA02,4AB02 -CLOSE BREAKERS 4AA05,4AB05	UNIT 4: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 3: NONE
TX C UNIT 3	OPEN OR SHORT	-LOCKOUT C TX BY OPENING OF BREAKERS 3B,3AB,3AC16 -OPEN SIGNAL TO BREAKER 4AC01	UNIT 3 WITHOUT AUTO TRANSFER: LOSS OF C BUS; TURBINE RUNBACK UNIT 3 WITH AUTO TRANSFER: CLOSE 3AC01 UNIT 4: NONE
TX C UNIT 4	OPEN OR SHORT	-LOCKOUT C TX BY OPENING OF BREAKERS 10A,10AB,4AC16 -OPEN SIGNAL TO BREAKER 3AC01	UNIT 4 WITHOUT AUTO TRANSFER: LOSS OF C BUS; TURBINE RUNBACK UNIT 4 WITH AUTO TRANSFER: CLOSE 4AC01 UNIT 3: NONE
TX MAIN UNIT 3	OPEN OR SHORT	-LOCKOUT OF MAIN TX BY OPENING OF BREAKERS 7B,7AB,3AA02,3AB02 -CLOSE BREAKERS 3AA05,3AB05	UNIT 3: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 4: NONE
TX MAIN UNIT 4	OPEN OR SHORT	-LOCKOUT OF MAIN TX BY OPENING OF BREAKERS 9B,9AB,4AA02,4AB02 -CLOSE BREAKERS 4AA05,4AB05	UNIT 4: UNIT TRIP; A AND B BUSSES AUTO TRANSFER TO SU TX UNIT 3: NONE

FAILURE MODE EFFECT ANALYSIS

PART	MODE	LOCAL EFFECT	SYSTEM EFFECT
TX SU UNIT 3	OPEN OR SHORT	-LOCKOUT SU TX BY OPENING OF BREAKERS 6B,6AB,3AA05,3AB05 -OPEN SIGNAL TO BREAKER 4AA22	UNIT 3: NONE UNIT 4: NONE
TX SU UNIT 4	OPEN OR SHORT	-LOCKOUT SU TX BY OPENING OF BREAKERS 8B,8AB,4AA05,4AB05 -OPEN SIGNAL TO BREAKER 3AA22	UNIT 3: NONE UNIT 4: NONE

APPENDIX F

RELIABILITY (FAULT TREE) EVALUATION

INTRODUCTION AND PURPOSE

This appendix provides the results of a reliability evaluation performed for the Turkey Point 4.16 kV electric power distribution system. A fault tree model of this system was constructed, quantified and solved in order to identify the combinations of events and equipment failures leading to loss of the normal offsite power supply to the plant's 4.16 kV busses. While the Failure Modes and Effects Analysis (Appendix E) identifies the effects of single equipment failures, the fault tree process provides a deeper understanding of the interactions between equipment and the effect of multiple failures on the system. The assignment of probability values to the fault tree events provides an estimate of the system's numerical availability and also of the relative importance of the components comprising the system.

METHODOLOGY

The Turkey Point Plant electric power distribution system is typical in that it employs an arrangement of relaying designed to ensure a high availability of power at the 4.16 kV busses and to provide reliable, localized isolation of faulted equipment. The fault tree modeling process was chosen for this reliability evaluation due to its ability to explicitly and graphically depict combinations of equipment failures which may initiate a bus/supply fault and may result in its further propagation. The failure events identified by the model were assigned probabilities based primarily on generic, industry-wide, data sources (References 1, 2 and 4). The fault tree was solved and quantified by application of the Set Equation Transformation System (SETS) computer code. This analysis code has been used in NRC-sponsored Probabilistic Risk Assessments, such as the Interim Reliability Evaluation Program, and is a powerful tool for the solution of large fault models.

ASSUMPTIONS

The 4.16 kV distribution system fault tree was constructed in accordance with the general guidelines defined by NUREG - 0492, Fault Tree Handbook (Reference 3). In general, the following types of faults are considered:

- normally operating component fails in service
- standby component fails when demanded or during subsequent operation
- spurious (premature) component action

The specific equipment failures identified are typical in that they include shorts, open circuits and ground faults. Unspecified faults of normally operating equipment (e.g., transformer fault) are assumed to result in a demand for protective relay action. The following list of assumptions are specific to this fault tree:

- o The 4.16 kV busses are normally aligned and auto-transfer as shown in Table 4 of the report.
- o All switchyard oil circuit breakers (OCB's) are normally closed
- o Component unavailability contributions due to test or maintenance are not included.
- o External Events (e.g., Lightning) are not explicitly included
- o Turbine Runback is assumed operable, but requires rapid operator action. However, for this analysis, a failure probability of 1.0 is assigned to this event.
- o Pipe Cable Cooling System faults are not included
- o 4.16 kV bus unavailability is defined as:
  - 4.16 kV bus fault or,
  - Loss of offsite and/or generator supply to the bus
- o Passive components (such as bus bar, transmission lines) are grouped together where possible (e.g., the overhead line to the switchyard includes the cables, supports, insulators, etc.)
- o The only relays identified as tripping circuit breakers or inhibiting auto-transfer are those which appear on the circuit breaker elementary diagrams
- o Operator action to restore power to a dead bus is not included
- o Potential Interactions between Units and the grid are not included (e.g. Unit trip results in grid instability).

ELECTRIC POWER DISTRIBUTION SYSTEM FAULT TREE

The fault tree constructed for this system appears as Figure F1. The top event depicted is the unavailability of any nuclear unit 4.16 kV bus (3A, 3B, 3C, 4A, 4B, 4C). For the purposes of this analysis, however, the following combinations of 4.16 kV bus failure were considered and minimal cutsets obtained for each:

- o 4.16 kV Bus 3A Unavailable (Table F3.)
- o 4.16 kV Bus 3B Unavailable (Table F4.)
- o 4.16 kV Bus 3C Unavailable (Table F5.)
- o 4.16 kV Bus 4A Unavailable (Table F6.)
- o 4.16 kV Bus 4B Unavailable (Table F7.)
- o 4.16 kV Bus 4C Unavailable (Table F8.)
- o All Unit 3 4.16 kV Busses Unavailable (Table F9.)
- o All Unit 4 4.16 kV Busses Unavailable (Table F10.)
- o 3C and 4C Busses Unavailable (Table F11.)

In addition, a comparison of C Bus unavailability was made with and without the automatic bus transfer.

The fault tree was initially constructed to include the major equipment fault combinations leading to 4.16 kV bus unavailability. Inclusive in the definition of major equipment are:

- o Transformers
- o Circuit Breakers
- o Bus Bar

- o Disconnect Switches
- o Cable
- o Overhead Transmission Lines
- o Pipe Cable

Events which challenge the automatic transfer capability of bus power supply are explicitly included (i.e. Reactor/Turbine Generator Trip results in demand for transfer of A and B bus supply from the Auxiliary to the Startup Transformer). The relays which effect this auto-transfer were also included in the fault model. The intent of this additional level of detail is to identify combinations of protective relay failures leading to bus unavailability and potential common mode failures such as occurred on the February 12, 1984 Turkey Point Unit 3 and 4 trips.

The fault model boundaries are identical to those of the FMEA. Included are the 4.16 kV busses, their normal and alternate power supplies, the Turkey Point Plant switchyard and the offsite transmission lines. Bus or supply faults in combination with a single stuck circuit breaker were considered. A fault in combination with failure of the primary and secondary fault clearing breakers was not considered and not modelled.

FAULT TREE STRUCTURE

This section describes the structure of the electric power distribution system fault tree (Figure F1). 4.16 kV busses 3A, 3B, 4A and 4B have similar equipment arrangements (supply components, protective and auto-transfer relaying) as do busses 3C and 4C. The fault logic is described below for busses 3A and 3C and is typical of the other busses.

Bus 3A Fault Logic

Bus 3A is normally supplied through the No. 3 Auxiliary Transformer when the unit is on-line. Any event causing Reactor/Turbine-Generator (RTG) trip will result in an attempt to automatically transfer supply to the No. 3 Startup Transformer. However, local bus faults or certain signals resulting in spurious opening of circuit breaker 3AA02 will deenergize the bus and not permit auto-transfer. The top logic of the bus sub-tree reflects this arrangement. The event "Bus 3A Deenergizes/Lockout" identifies the single failures and spurious relay actions which do not allow auto-transfer. The event "3A Supply Failure" then develops the combinations of events which result in failure of both the normal (Aux. Transformer) and alternate (Startup Transformer) supplies. As discussed above, any event leading to RTG trip will result in an auto-transfer attempt. An interaction between busses exists here since failure of the normal 3A or 3B bus supply or failure of 3C bus supply (with turbine runback failure) will result in RTG trip and subsequent loss of the 3A bus normal supply. This logic is modeled under the event "Unit 3 RTG Trip (3A)".

The alternate supply to bus 3A can fail if the normal supply breaker (3AA 02) sticks closed, if there are faults in the auto-transfer circuitry, or if the alternate supply is unavailable. Faults developed under these events include relay failures (auto-transfer), alternate supply breaker (3AA05) opens spuriously following auto-transfer and Startup Transformer and its supply faults.

Supply failures to both the Startup and Auxiliary Transformers are developed back to the Switchyard bays. The protective relay logic is modeled implicitly here. A fault occurring on a switchyard bus is assumed to result in opening of all oil circuit breakers (OCB's) required to clear the fault. If one OCB sticks closed (in response to a fault event), the next (OCB's) required to clear the fault is assumed to open. Using this implicit logic, single and double faults resulting in loss of Transformer supply are identified. In addition, to identify potential common mode failures, single and double faults which result in loss of the east or west bay supply to a transformer were modeled. For example, a fault on the Units 1 and 2 Startup Transformer in combination with a stuck OCB 4B will result in a loss of east supply to both the #3 Startup Transformer and the #3C Transformer. The west supply of these transformers remains energized, however, and additional faults are required to lose the west supply.

Bus 3C Fault Logic

Bus 3C is similar to 3A in that there are a number of local bus or spurious relay action faults which may result in deenergization of the bus without permitting auto-transfer. The 3C bus supply does not auto-transfer on RTG trip. Loss of the 3C transformer or its supply will initiate an auto-transfer to a secondary winding of the 4C transformer. The fault sub-tree develops faults of the normal and alternate supply as well as faults of the auto transfer circuitry. The switchyard bay faults developed are similar to those of Bus 3A.

FAULT TREE EVENT QUANTIFICATION

The fault tree allows an estimate of the numerical system failure probability to be calculated by combining the system's equipment failure probabilities. For this analysis, the distribution system average unavailability is the parameter calculated. Unavailability is defined as the probability that the system or equipment is unable to perform its intended function. For this system, most of the equipment is normally energized with some equipment in standby (Startup Transformers and associated circuit breakers). To calculate the average unavailability of a normally in-service component the following equation is used:

$$\overline{Q} = \frac{\lambda \times ADT}{8760 \text{ hrs/year}}$$

where

$\overline{Q}$ = Average Unavailability

λ = Equipment Failure Rate (failure/year)

ADT = Average Equipment Down Time (hours)

The primary data source for both failure rates and down time was IEEE-STD-493-1980 (Reference 1). Turkey Point Plant Startup/Shutdown Logs were used to obtain information about the Reactor/Turbine-Generator trip frequency and subsequent outage duration. EPRI-NP-2230 (Ref. 4) was used to obtain the spurious Safety Injection frequency.

For components which must change state on demand (circuit breakers, control relays), a per demand failure probability was obtained from the Interim Reliability Evaluation Program data base. Table F1 provides a summary of the unavailability values obtained for the various equipment and events appearing in the fault tree. Table F2 lists the event specific failure probabilities.

FAULT TREE QUANTIFICATION

The electric power distribution system fault tree was solved and quantified by use of the Set Equation Tranformation System (SETS) code (CDC Version 1.02). Minimal cutsets were obtained for the bus failure combinations listed above. For each bus, minimal cutsets (combinations of events leading to the top event) were obtained up to and including order 4 (4 fault events occurring simultaneously) and without regard to cutset probability. The remaining events (loss of all Unit 3 busses, loss of all Unit 4 busses, and loss of both C busses) were limited to cutsets of order 4 and to probability of greater than 1×10^{-11}.

RESULTS

The fault tree analysis performed for the 4.16 kV electric power distribution system provides two types of results: numerical unavailability estimates and qualitative system failure insights. The calculated unavailabilities for the events modeled are as follows:

	Unit 3	Unit 4
4 kV Bus A	8.3×10^{-5}	8.2×10^{-5}
4 kV Bus B	8.1×10^{-5}	8.0×10^{-5}
4 kV Bus C	6.1×10^{-5}	6.1×10^{-5}
Loss of all busses	1.2×10^{-7}	1.2×10^{-7}
Loss of both C Busses	3.3×10^{-6}	

Tables F3 through F11 provide listings of the dominant cutsets and their probabilities. Table F12 identifies each primary event abbreviation and its description. Table F13 summarizes the cutsets obtained through the truncation process described above.

The fault tree neglects the ability of the diesel generators to supply power to the A and B busses. Although single failures of the offsite transmission lines appear in the model, the total loss of all 8 offsite circuits (loss of grid) is not included. Thus the fault tree examines the availability of power at the 4.16 kV bus level based on the availability of the unit and the switchyard and is conditional on the availability of the offsite grid.

From the table above, it is seen that the A and B bus unavailabilities are not significantly different. The C Bus is shown to be slightly more reliable (from offsite power sources). Examination of the cutsets reveals that the loss of the Auxiliary Transformer supply to A and B busses on Reactor/Turbine-Generator (RTG) trip provides the primary difference in availability.

The dominant cutsets for A and B busses of both units are identical. The following six events contribute 88% of the total bus unavailability:

a) Inadvertent Opening of the Normal Supply Breaker (41%)
(3AA02SPR, 3AB02SPR, 4AA02SPR, 4AB02SPR)

b) Local Bus Fault causing Bus Lockout (30%)
(B3ALF, B3BLF, B4ALF, B4BLF)

c) Unit Trip with Startup Transformer Unavailable (6%)
(U3TR x 3SUXMERF, U4TR x 4SUXMERF)

d) Unit Trip with Failure of Startup Feeder Breaker To Close (4%)
(U3TR x 3AA05LCL, U3TR x 3AB05LCL, U4TR x 4AA05LCL, U4TR x 4AB05LCL)

e) Unit Trip with Failure of Auxiliary Transformer Feeder Breaker to Open (4%)
(U3TR x BK3AA02SC, U3TR x BK3AB02SC, U4TR x BK4AA02SC, U4TR x BK4AB02SC)

f) Startup and Auxiliary Transformer Unavailable (3%)
(3AXMERF x 3SUXMERF, 4AXMERF x 4SUXMERF)

The remaining cutsets each contribute less than 2% to the total bus unavailability. Cutsets 24 through 31 (21 through 28 for Busses 4A and 4B) represent spurious relay actions which open the normal supply breaker and do not permit auto-transfer to take place.

The dominant cutsets for the C Busses are also identical. They include the following:

a) Inadvertent Opening of the Normal Supply Breaker (55%)
(3AC16SPR, 4AC16SPR)

b) Local Bus Fault (31%)
(B3CLF, B4CLF)

c) 3C and 4C Transformers Unavailable (4%)
(4CXMERF x 3CXMERF)

d) Faulted Normal Supply Transformer and Alternate Supply Breaker Fails to Close (3%)
(3CXMERF x 3AC01LCL, 4CXMERF x 4AC01LCL)

e) Faulted Normal Supply Transformer and Normal Supply Breaker Fails to Open (3%)
(3CXMERF x BK3AC16SPR, 4CXMERF x BK4AC16SPR)

The remaining cutsets contribute less than 1% each to the total bus unavailability. Note that cutsets 10 through 16 are single events leading to bus unavailability. These events are spurious relay actions which trip the normal feed breaker without allowing auto-transfer.

Simultaneous loss of offsite power to the three 4.16 kV busses of a unit is dominated by the following two scenarios:

a) Inadvertent Opening of Normal Feeder Breaker to 3C Bus, Failure of the Unit to Runback (Unit Trips) and Unavailable Startup Transformer (47%) (3AC16SPR x U3TRF x 3SUXMERF, 4AC16SPR x U4TRF x 4SUXMERF)

b) Local C Bus Fault/Lockout, Failure of the Unit to Runback and Unavailable Startup Transformer (26%)
(B3CLF x U3TRF x 3SUXMERF, B4CLF x U4TRF x 4SUXMERF)

The remaining major cutsets are similar to the above in that they involve a faulted C Bus (with no auto-transfer permitted), failure of turbine runback and an unavailable Startup Transformer or its supply. As noted above, the turbine runback failure probability was assumed to be 1.0 for this study. Since all dominant cutsets contain this term, an improvement in the reliability of runback would have a major benefit in preventing loss of offsite power to the 4.16 kV busses.

The simultaneous unavailability of both C busses is dominated by the unavailability of both C transformers(78%) (4CXMERF x 3CXMERF). The remaining cutsets generally involve the unavailability of one C transformer in combination with faults in the supply to the other C tranformer.

Although a fault tree was not constructed for the C Bus without auto-transfer, the unavailability of such a scheme can be estimated by considering the major equipment unavailabilities:

Failure Event	Probability
C Bus Local Fault	1.9×10^{-5}
Supply Breaker Opens (Spur.)	3.4×10^{-5}
Transformer Unavailable	1.6×10^{-3}
Pipe Cable	2.5×10^{-5}
Disconnect Switch (x2)	1.2×10^{-4}
	1.8×10^{-3}

Comparing this value to that of a C Bus with auto-transfer shows an unavailibility improvement of almost two orders of magnitude by utilization of the auto-transfer feature.

References

1. IEEE-STD 493-1980, IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems.

2. Component Failure Rates for Nuclear Plant Safety System Reliability Analysis, Nuclear Regulatory Commission (Draft report issued 9/23/80 for use by IREP).

3. NUREG - 0492, Fault Tree Handbook, January 1981.

4. EPRI-NP-2230, ATWS: A Reappraisal, Part 3: Frequency of Anticipated Transients. Electric Power Research Institute, January 1982.

Equipment/ Component		Failure Mode (If Applicable)	Unavailability/ Failure Probability
Bus:	A		2.5×10^{-5}
	B		2.3×10^{-5}
	C		1.9×10^{-5}
	IsoPhase		3.6×10^{-6}
	Switchyard		6.0×10^{-6}
Circuit Breaker	(All)	Stuck (Fail to Open)	1.0×10^{-3}
		Failed in Service	3.4×10^{-5}
		Failed To Close	1.0×10^{-3}
Transformer:	Main		1.9×10^{-4}
	Auxiliary		1.6×10^{-3}
	Startup		1.6×10^{-3}
	C		1.6×10^{-3}
Cable:	Swgr-Xmer (Aux., C)		8.4×10^{-7}
	Swgr-Xmer (S/U)		1.8×10^{-6}
	Overhead to Swyd.		2.5×10^{-5}
	Pipe Cable		2.5×10^{-5}
Disconnect Switch			6.1×10^{-5}
Relays:	Active	Fail To Transfer	1.0×10^{-4}
	Passive	NC Contacts Fail Open	1.1×10^{-7}
Fuses		Fail Open	1.2×10^{-5}
Unit 3 RTG Trip			3.3×10^{-3}
Unit 4 RTG Trip			3.1×10^{-3}
Spurious Safety Injection			1.8×10^{-5}
Turbine Runback Failure			1.0
Offsite Power Supplies (Single Circuit)			3.5×10^{-4}
Unit 1 TG Trip			3.6×10^{-3}
Unit 2 TG Trip			3.3×10^{-3}

Table F1 — Equipment Unavailability Assumed For Fault Tree Quantification (Sht. 1 of 1)

1.9E-5	B3CLF
2.3E-5	B3BLF
2.5E-5	B4ALF
2.3E-5	B4BLF
1.9E-5	B4CLF
2.5E-5	B3ALF

4.16KV Bus Faults

1.6E-3	3CXMERF
1.6E-3	4CXMERF
1.6E-3	3AXMERF
1.9E-4	3MXMERF
1.6E-3	4SUXMERF
1.6E-3	3SUXMERF
1.6E-3	4AXMERF
1.9E-4	4MXMERF
1.6E-3	12SUXFT

Transformer Faults

6.0E-6	SEBFT
6.0E-6	SWBFT
6.0E-6	NEBFT
6.0E-6	NWBFT

Switchyard Bus Faults

3.1E-3	U4TR
3.3E-3	U3TR
3.3E-3	U2FT
3.3E-3	U1FT

Unit Trip Unavailability

3.5E-4	DAV3FT
3.5E-4	FLORFT
3.5E-4	FLAG2FT
3.5E-4	DAV1FT
3.5E-4	FLAG1FT
3.5E-4	DAV2FT
3.5E-4	DORFT
3.5E-4	DAD1FT

Transmission Line Faults

1.0	U3TRF
1.0	U4TRF

Turbine Runback Failure

Table F2 - Electric Power Distribution System Fault Tree Basic Event Probabilities (Sheet 1 of 4)

6.1E-5	DSE3ABF
6.1E-5	DSW3BF
6.1E-5	DSW10ABF
6.1E-5	DSE10AF
6.1E-5	DSW7BF
6.1E-5	DSE7ABF
6.1E-5	DS23FT
6.1E-5	DSW7ABF
6.1E-5	DSE7BF
6.1E-5	DSE6ABF
6.1E-5	DSW6BF
6.1E-5	DSW6ABF
6.1E-5	DSE6BF
6.1E-5	DSW3ABF
6.1E-5	DSE3BF
6.1E-5	DSE10ABF
6.1E-5	DS24FT
6.1E-5	DSE8ABF
6.1E-5	DSW8BF
6.1E-5	DSW8ABF
6.1E-5	DSE8BF
6.1E-5	DSW9BF
6.1E-5	DSE9ABF
6.1E-5	DSW9ABF
6.1E-5	DSE9BF

Disconnect Switch Faults

1.2E-5	3AA05FU
1.2E-5	3AB05FU
1.2E-5	4AA05FU
1.2E-5	4AB05FU

Fuse Faults

1.8E-5	U3SISPR
1.8E-5	U4SISPR

Spurious Safety Injection

8.4E-7	3AATCF
8.4E-7	3C3CTCF
8.4E-7	3C4CTCF
8.4E-7	3BATCF
8.4E-7	4BATCF
8.4E-7	4AATCF
8.4E-7	4C4CTCF
8.4E-7	4C3CTCF
1.8E-6	3BSUCF
1.8E-6	3ASUCF
1.8E-6	4BSUCF
1.8E-6	4ASUCF
2.5E-5	3CPCF
2.5E-5	4CPCF
2.5E-5	3MTB70F
2.5E-5	3STB60F
2.5E-5	4SUB80F
2.5E-5	4MTB90F

Cable Faults

1.0E-4	3AA02-B
1.0E-4	162-3A2
1.0E-4	152Z-3A5
1.0E-4	3AB02-B
1.0E-4	162-3B2
1.0E-4	152Z-3B5
1.0E-4	4AA02-B
1.0E-4	162-4A2
1.0E-4	152Z-4A5
1.0E-4	4AB02-B
1.0E-4	162-4B2
1.0E-4	152Z-4B5
1.0E-4	162-3AC16
1.0E-4	3AC16-B
1.0E-4	125-3C
1.0E-4	152Z-3C1
1.0E-4	162-4AC16
1.0E-4	4AC16-B
1.0E-4	125-4C
1.0E-4	152Z-4C1

Relay (Active) Faults

Table F2 (Sheet 2 of 4)

1.0E-3	BK3AA02SC
1.0E-3	BK3AB02SC
1.0E-3	BK3AC16SC
1.0E-3	07BSC
1.0E-3	07ABSC
1.0E-3	07ASC
1.0E-3	067BSC
1.0E-3	08BSC
1.0E-3	09BSC
1.0E-3	010BSC
1.0E-3	06BSC
1.0E-3	06ABSC
1.0E-3	06ASC
1.0E-3	05BSC
1.0E-3	04BSC
1.0E-3	02BSC
1.0E-3	03BSC
1.0E-3	03ABSC
1.0E-3	02ASC
1.0E-3	04ASC
1.0E-3	05ASC
1.0E-3	056ASC
1.0E-3	010ASC
1.0E-3	010ABSC
1.0E-3	08ASC
1.0E-3	09ASC
1.0E-3	BK4AA02SC
1.0E-3	08ABSC
1.0E-3	BK4AC16SC
1.0E-3	BK4AB02SC
1.0E-3	09ABSC
1.0E-3	3AA05LCL
1.0E-3	3AB05LCL
1.0E-3	4AA05LCL
1.0E-3	4AB05LCL
1.0E-3	3AC01LCL
1.0E-3	4AC01LCL

Circuit Breaker Faults
(fail to transfer)

3.4E-5	03BF
3.4E-5	03ABF
3.4E-5	010AF
3.4E-5	010ABF
3.4E-5	07ABF
3.4E-5	07BF
3.4E-5	06ABF
3.4E-5	06BF
3.4E-5	08ABF
3.4E-5	08BF
3.4E-5	09ABF
3.4E-5	09BF
3.4E-5	3AA02SPR
3.4E-5	3AA05SPR
3.4E-5	3AB02SPR
3.4E-5	3AB05SPR
3.4E-5	4AA02SPR
3.4E-5	4AA05SPR
3.4E-5	4AB02SPR
3.4E-5	4AB05SPR
3.4E-5	3AC16SPR
3.4E-5	3AC01SPR
3.4E-5	4AC16SPR
3.4E-5	4AC01SPR

Circuit Breaker Faults
(fail in service, spurious
opening)

1.1E-7	86GT-G3
1.1E-7	286-G3
1.1E-7	186X-3A
1.1E-7	150A3B
1.1E-7	151-A3A
1.1E-7	151-A3A1
1.1E-7	SI3-11X
1.1E-7	186-ST3
1.1E-7	127X1-3AB3
1.1E-7	86BU-ST3
1.1E-7	86G
1.1E-7	150-S3A
1.1E-7	151-S3A3
1.1E-7	151-S3A13
1.1E-7	3A5152-HH
1.1E-7	186X-3B
1.1E-7	150B3B
1.1E-7	151-B3A
1.1E-7	151-B3A1
1.1E-7	SI3B2
1.1E-7	127Z1-3AB3
1.1E-7	150-S3B
1.1E-7	151-S3B3
1.1E-7	151-S3B13
1.1E-7	3B5152-HH
1.1E-7	86GT-G4
1.1E-7	286-G4
1.1E-7	186X-4A
1.1E-7	150A4B
1.1E-7	151-A4A
1.1E-7	151-A4A1
1.1E-7	SI4-11X
1.1E-7	186-ST4
1.1E-7	127X1-4AB3
1.1E-7	86BU-ST4
1.1E-7	86K
1.1E-7	150-S4A
1.1E-7	151-S3A4
1.1E-7	151-S3A14
1.1E-7	4A5152-HH
1.1E-7	186X-4B
1.1E-7	150-B4B
1.1E-7	151-B4A
1.1E-7	151-B4A1
1.1E-7	SI4B2

1.1E-7	127Z1-4AB3
1.1E-7	150-S4B
1.1E-7	151-S3B4
1.1E-7	151-S3B14
1.1E-7	4B5152-HH
1.1E-7	186-3C
1.1E-7	186-3CBT
1.1E-7	127X-3C1
1.1E-7	86-EE
1.1E-7	86-FF
1.1E-7	150-3CBTX
1.1E-7	151-3CBTX
1.1E-7	151-3CBTX1
1.1E-7	3152-TOC
1.1E-7	186-4CBT
1.1E-7	3AC03-B
1.1E-7	3AC13-B
1.1E-7	86-W
1.1E-7	86-Y
1.1E-7	150-4CBTY
1.1E-7	151-4CBTY
1.1E-7	151-4CBTY1
1.1E-7	186-4C
1.1E-7	127X-4C1
1.1E-7	150-4CBTX
1.1E-7	151-4CBTX
1.1E-7	151-4CBTX1
1.1E-7	4152-TOC
1.1E-7	4AC03-B
1.1E-7	4AC13-B
1.1E-7	151-3CBTY1
1.1E-7	150-3CBTY
1.1E-7	151-3CBTY
1.1E-7	174-4C1
1.1E-7	174-4C6
1.1E-7	174-3C1
1.1E-7	174-3C6
1.1E-7	174-3A2
1.1E-7	174-3A5
1.1E-7	174-3B2
1.1E-7	174-3B5
1.1E-7	174-4A2
1.1E-7	174-4A5
1.1E-7	174-4B2
1.1E-7	174-4B5

Relay (passive) faults

Table F2 (Sheet 4 of 4)

		4KV3A =
1	3.4000E-05	3AA02SPR +
2	2.5000E-05	B3ALF +
3	5.2800E-06	3SUXMERF * U3TR +
4	3.3000E-06	U3TR * 3AA05LCL +
5	3.3000E-06	U3TR * BK3AA02SC +
6	2.5600E-06	3AXMERF * 3SUXMERF +
7	1.6000E-06	3AXMERF * 3AA05LCL +
8	1.6000E-06	3AXMERF * BK3AA02SC +
9	3.3000E-07	U3TR * 152Z-3A5 +
10	3.3000E-07	U3TR * 162-3A2 +
11	3.3000E-07	U3TR * 3AA02-B +
12	3.0400E-07	3MXMERF * 3SUXMERF +
13	2.0130E-07	DSW6BF * U3TR +
14	2.0130E-07	DSE6ABF * U3TR +
15	2.0130E-07	DS23FT * U3TR +
16	1.9000E-07	3MXMERF * 3AA05LCL +
17	1.9000E-07	3MXMERF * BK3AA02SC +
18	1.6000E-07	3AXMERF * 152Z-3A5 +
19	1.6000E-07	3AXMERF * 162-3A2 +
20	1.6000E-07	3AXMERF * 3AA02-B +
21	1.1220E-07	U3TR * 3AA05SPR +
22	1.1220E-07	06BF * U3TR +
23	1.1220E-07	06ABF * U3TR +
24	1.1000E-07	SI3-11X +
25	1.1000E-07	150A3B +
26	1.1000E-07	127X1-3AB3 +

Table F3 4KV Bus 3A Cutsets (Sheet 1 of 2)

27	1.1000E-07	174-3A5 +
28	1.1000E-07	151-A3A1 +
29	1.1000E-07	186X-3A +
30	1.1000E-07	174-3A2 +
31	1.1000E-07	151-A3A +
32	9.7600E-08	3AXMERF * DSW6BF +
33	9.7600E-08	3AXMERF * DSE6ABF +
34	9.7600E-08	3AXMERF * DS23FT +
35	9.7600E-08	DSE7ABF * 3SUXMERF +
36	9.7600E-08	DSW7BF * 3SUXMERF +
37	8.2500E-08	3STB60F * U3TR +
38	6.1000E-08	DSE7ABF * 3AA05LCL +
39	6.1000E-08	DSW7BF * 3AA05LCL +
40	6.1000E-08	DSE7ABF * BK3AA02SC +
41	6.1000E-08	DSW7BF * BK3AA02SC +
42	5.4400E-08	3AXMERF * 3AA05SPR +
43	5.4400E-08	3AXMERF * 06BF +
44	5.4400E-08	3AXMERF * 06ABF +
45	5.4400E-08	3SUXMERF * 3AB02SPR +
46	5.4400E-08	07BF * 3SUXMERF +
47	5.4400E-08	07ABF * 3SUXMERF +
48	5.4400E-08	3SUXMERF * U3TRF * 3AC16SPR +
49	4.0000E-08	3AXMERF * 3STB60F +
50	4.0000E-08	3MTB70F * 3SUXMERF +

Table F3 (Sheet 2 of 2)

4KV3B =

1	3.4000E-05	3AB02SPR +
2	2.3000E-05	B3BLF +
3	5.2800E-06	3SUXMERF * U3TR +
4	3.3000E-06	U3TR * 3AB05LCL +
5	3.3000E-06	U3TR * BK3AB02SC +
6	2.5600E-06	3AXMERF * 3SUXMERF +
7	1.6000E-06	3AXMERF * 3AB05LCL +
8	1.6000E-06	3AXMERF * BK3AB02SC +
9	3.3000E-07	U3TR * 152Z-3B5 +
10	3.3000E-07	U3TR * 162-3B2 +
11	3.3000E-07	U3TR * 3AB02-B +
12	3.0400E-07	3MXMERF * 3SUXMERF +
13	2.0130E-07	DSW6BF * U3TR +
14	2.0130E-07	DSE6ABF * U3TR +
15	2.0130E-07	DS23FT * U3TR +
16	1.9000E-07	3MXMERF * 3AB05LCL +
17	1.9000E-07	3MXMERF * BK3AB02SC +
18	1.6000E-07	3AXMERF * 152Z-3B5 +
19	1.6000E-07	3AXMERF * 162-3B2 +
20	1.6000E-07	3AXMERF * 3AB02-B +
21	1.1220E-07	U3TR * 3AB05SPR +
22	1.1220E-07	06BF * U3TR +
23	1.1220E-07	06ABF * U3TR +
24	1.1000E-07	SI3B2 +
25	1.1000E-07	150B3B +
26	1.1000E-07	127Z1-3AB3 +

Table F4 4KV Bus 3B Cutsets (Sheet 1 of 2)

27	1.1000E-07	174-3B5 +
28	1.1000E-07	151-B3A1 +
29	1.1000E-07	186X-3B +
30	1.1000E-07	174-3B2 +
31	1.1000E-07	151-B3A +
32	9.7600E-08	3AXMERF * DSW6BF +
33	9.7600E-08	3AXMERF * DSE6ABF +
34	9.7600E-08	3AXMERF * DS23FT +
35	9.7600E-08	DSE7ABF * 3SUXMERF +
36	9.7600E-08	DSW7BF * 3SUXMERF +
37	8.2500E-08	3STB60F * U3TR +
38	6.1000E-08	DSE7ABF * 3AB05LCL +
39	6.1000E-08	DSW7BF * 3AB05LCL +
40	6.1000E-08	DSE7ABF * BK3AB02SC +
41	6.1000E-08	DSW7BF * BK3AB02SC +
42	5.4400E-08	3AXMERF * 3AB05SPR +
43	5.4400E-08	3AXMERF * 06BF +
44	5.4400E-08	3AXMERF * 06ABF +
45	5.4400E-08	3SUXMERF * 3AA02SPR +
46	5.4400E-08	07BF * 3SUXMERF +
47	5.4400E-08	07ABF * 3SUXMERF +
48	5.4400E-08	3SUXMERF * U3TRF * 3AC16SPR +
49	4.0000E-08	3AXMERF * 3STB60F +
50	4.0000E-08	3SUXMERF * B3ALF +

Table F4 (Sheet 2 of 2)

		4KV3C =
1	3.4000E-05	3AC16SPR +
2	1.9000E-05	B3CLF +
3	2.5600E-06	4CXMERF * 3CXMERF +
4	1.6000E-06	3CXMERF * 3AC01LCL +
5	1.6000E-06	3CXMERF * BK3AC16SC +
6	1.6000E-07	3CXMERF * 152Z-3C1 +
7	1.6000E-07	3CXMERF * 125-3C +
8	1.6000E-07	3CXMERF * 3AC16-B +
9	1.6000E-07	3CXMERF * 162-3AC16 +
10	1.1000E-07	151-3CBTX +
11	1.1000E-07	150-3CBTX +
12	1.1000E-07	127X-3C1 +
13	1.1000E-07	186-3C +
14	1.1000E-07	174-3C6 +
15	1.1000E-07	151-3CBTX1 +
16	1.1000E-07	174-3C1 +
17	9.7600E-08	DSE10AF * 3CXMERF +
18	9.7600E-08	DSW10ABF * 3CXMERF +
19	9.7600E-08	4CXMERF * DSW3BF +
20	9.7600E-08	4CXMERF * DSE3ABF +
21	6.1000E-08	DSW3BF * 3AC01LCL +
22	6.1000E-08	DSE3ABF * 3AC01LCL +
23	6.1000E-08	DSW3BF * BK3AC16SC +
24	6.1000E-08	DSE3ABF * BK3AC16SC +
25	5.4400E-08	O10ABF * 3CXMERF +
26	5.4400E-08	O10AF * 3CXMERF +

Table F5 4KV Bus 3C Cutsets (Sheet 1 of 2)

27	5.4400E-08	3CXMERF * 3AC01SPR +
28	5.4400E-08	4CXMERF * 03ABF +
29	5.4400E-08	4CXMERF * 03BF +
30	4.0000E-08	4CPCF * 3CXMERF +
31	4.0000E-08	4CXMERF * 3CPCF +
32	3.4000E-08	03ABF * 3AC01LCL +
33	3.4000E-08	03BF * 3AC01LCL +
34	3.4000E-08	03ABF * BK3AC16SC +
35	3.4000E-08	03BF * BK3AC16SC +
36	2.5000E-08	3CPCF * 3AC01LCL +
37	2.5000E-08	3CPCF * BK3AC16SC +
38	6.1000E-09	DSW3BF * 1522-3C1 +
39	6.1000E-09	DSE3ABF * 1527-3C1 +
40	6.1000E-09	DSW3BF * 125-3C +
41	6.1000E-09	DSE3ABF * 125-3C +
42	6.1000E-09	DSW3BF * 3AC16-B +
43	6.1000E-09	DSE3ABF * 3AC16-B +
44	6.1000E-09	DSW3BF * 162-3AC16 +
45	6.1000E-09	DSE3ABF * 162-3AC16 +
46	3.7210E-09	DSW3BF * DSE10AF +
47	3.7210E-09	DSE3ABF * DSE10AF +
48	3.7210E-09	DSW3BF * DSW10ABF +
49	3.7210E-09	DSE3ABF * DSW10ABF +
50	3.4000E-09	03ABF * 125-3C +

Table F5 (Sheet 2 of 2)

		4KV4A =
1	3.4000E-05	4AA02SFR +
2	2.5000E-05	B4ALF +
3	4.9600E-06	4SUXMERF * U4TR +
4	3.1000E-06	U4TR * 4AA05LCL +
5	3.1000E-06	U4TR * BK4AA02SC +
6	2.5600E-06	4SUXMERF * 4AXMERF +
7	1.6000E-06	4AXMERF * 4AA05LCL +
8	1.6000E-06	4AXMERF * BK4AA02SC +
9	3.1000E-07	U4TR * 152Z-4A5 +
10	3.1000E-07	U4TR * 162-4A2 +
11	3.1000E-07	U4TR * 4AA02-B +
12	3.0400E-07	4SUXMERF * 4MXMERF +
13	1.9000E-07	4MXMERF * 4AA05LCL +
14	1.9000E-07	4MXMERF * BK4AA02SC +
15	1.8910E-07	U4TR * DSW8BF +
16	1.8910E-07	U4TR * DSE8ABF +
17	1.8910E-07	U4TR * DS24FT +
18	1.6000E-07	4AXMERF * 152Z-4A5 +
19	1.6000E-07	4AXMERF * 162-4A2 +
20	1.6000E-07	4AXMERF * 4AA02-B +
21	1.1000E-07	150A4B +
22	1.1000E-07	SI4-11X +
23	1.1000E-07	127X1-4AB3 +
24	1.1000E-07	174-4A5 +
25	1.1000E-07	186X-4A +
26	1.1000E-07	151-A4A1 +

Table F6 4KV Bus 4A Cutsets (Sheet 1 of 2)

27	1.1000E-07	151-A4A +
28	1.1000E-07	174-4A2 +
29	1.0540E-07	U4TR * 4AA05SPR +
30	1.0540E-07	U4TR * 08BF +
31	1.0540E-07	U4TR * 08ABF +
32	9.7600E-08	4AXMERF * DSW8BF +
33	9.7600E-08	4AXMERF * DSE8ABF +
34	9.7600E-08	4AXMERF * DS24FT +
35	9.7600E-08	4SUXMERF * DSE9ABF +
36	9.7600E-08	4SUXMERF * DSW9BF +
37	7.7500E-08	U4TR * 4SUB80F +
38	6.1000E-08	DSE9ABF * 4AA05LCL +
39	6.1000E-08	DSW9BF * 4AA05LCL +
40	6.1000E-08	DSE9ABF * BK4AA02SC +
41	6.1000E-08	DSW9BF * BK4AA02SC +
42	5.4400E-08	4AXMERF * 4AA05SPR +
43	5.4400E-08	4AXMERF * 08BF +
44	5.4400E-08	4AXMERF * 08ABF +
45	5.4400E-08	4SUXMERF * 4AB02SPR +
46	5.4400E-08	4SUXMERF * 09BF +
47	5.4400E-08	4SUXMERF * 09ABF +
48	5.4400E-08	4SUXMERF * U4TRF * 4AC16SPR +
49	4.0000E-08	4AXMERF * 4SUB80F +
50	4.0000E-08	4SUXMERF * 4MTB90F +

Table F6 (Sheet 2 of 2)

		4KV4B =
1	3.4000E-05	4AB02SPR +
2	2.3000E-05	B4BLF +
3	4.9600E-06	4SUXMERF * U4TR +
4	3.1000E-06	U4TR * 4AB05LCL +
5	3.1000E-06	U4TR * BK4AB02SC +
6	2.5600E-06	4SUXMERF * 4AXMERF +
7	1.6000E-06	4AXMERF * 4AB05LCL +
8	1.6000E-06	4AXMERF * BK4AB02SC +
9	3.1000E-07	U4TR * 152Z-4B5 +
10	3.1000E-07	U4TR * 162-4B2 +
11	3.1000E-07	U4TR * 4AB02-B +
12	3.0400E-07	4SUXMERF * 4MXMERF +
13	1.9000E-07	4MXMERF * 4AB05LCL +
14	1.9000E-07	4MXMERF * BK4AB02SC +
15	1.8910E-07	U4TR * DSW8BF +
16	1.8910E-07	U4TR * DSE8ABF +
17	1.8910E-07	U4TR * DS24FT +
18	1.6000E-07	4AXMERF * 152Z-4B5 +
19	1.6000E-07	4AXMERF * 162-4B2 +
20	1.6000E-07	4AXMERF * 4AB02-B +
21	1.1000E-07	150-B4B +
22	1.1000E-07	SI4B2 +
23	1.1000E-07	127Z1-4AB3 +
24	1.1000E-07	174-4B5 +
25	1.1000E-07	186X-4B +
26	1.1000E-07	151-B4A1 +

Table F7 4KV Bus 4B Cutsets (Sheet 1 of 2)

27	1.1000E-07	151-B4A +
28	1.1000E-07	174-4B2 +
29	1.0540E-07	U4TR * 4AB05SPR +
30	1.0540E-07	U4TR * 08BF +
31	1.0540E-07	U4TR * 08ABF +
32	9.7600E-08	4AXMERF * DSW8BF +
33	9.7600E-08	4AXMERF * DSE8ABF +
34	9.7600E-08	4AXMERF * DS24FT +
35	9.7600E-08	4SUXMERF * DSE9ABF +
36	9.7600E-08	4SUXMERF * DSW9BF +
37	7.7500E-08	U4TR * 4SUB80F +
38	6.1000E-08	DSE9ABF * 4AB05LCL +
39	6.1000E-08	DSW9BF * 4AB05LCL +
40	6.1000E-08	DSE9ABF * BK4AB02SC +
41	6.1000E-08	DSW9BF * BK4AB02SC +
42	5.4400E-08	4AXMERF * 4AB05SPR +
43	5.4400E-08	4AXMERF * 08BF +
44	5.4400E-08	4AXMERF * 08ABF +
45	5.4400E-08	4SUXMERF * 4AA02SPR +
46	5.4400E-08	4SUXMERF * 09BF +
47	5.4400E-08	4SUXMERF * 09ABF +
48	5.4400E-08	4SUXMERF * U4TRF * 4AC16SPR +
49	4.0000E-08	4AXMERF * 4SUB80F +
50	4.0000E-08	4SUXMERF * B4ALF +

Table F7 (Sheet 2 of 2)

4KV4C =

1	3.4000E-05	4AC16SPR +
2	1.9000E-05	B4CLF +
3	2.5600E-06	4CXMERF * 3CXMERF +
4	1.6000E-06	4CXMERF * 4AC01LCL +
5	1.6000E-06	4CXMERF * BK4AC16SC +
6	1.6000E-07	4CXMERF * 152Z-4C1 +
7	1.6000E-07	4CXMERF * 125-4C +
8	1.6000E-07	4CXMERF * 4AC16-B +
9	1.6000E-07	4CXMERF * 162-4AC16 +
10	1.1000E-07	151-4CBTX +
11	1.1000E-07	150-4CBTX +
12	1.1000E-07	127X-4C1 +
13	1.1000E-07	186-4C +
14	1.1000E-07	174-4C6 +
15	1.1000E-07	151-4CBTX1 +
16	1.1000E-07	174-4C1 +
17	9.7600E-08	DSE10AF * 3CXMERF +
18	9.7600E-08	DSW10ABF * 3CXMERF +
19	9.7600E-08	4CXMERF * DSW3BF +
20	9.7600E-08	4CXMERF * DSE3ABF +
21	6.1000E-08	DSE10AF * 4AC01LCL +
22	6.1000E-08	DSE10AF * BK4AC16SC +
23	6.1000E-08	DSW10ABF * 4AC01LCL +
24	6.1000E-08	DSW10ABF * BK4AC16SC +
25	5.4400E-08	D10ABF * 3CXMERF +
26	5.4400E-08	D10AF * 3CXMERF +

Table F8 4KV Bus 4C Cutsets (Sheet 1 of 2)

27	5.4400E-08	4CXMERF * 4AC01SPR +
28	5.4400E-08	4CXMERF * 03ABF +
29	5.4400E-08	4CXMERF * 03BF +
30	4.0000E-08	4CPCF * 3CXMERF +
31	4.0000E-08	4CXMERF * 3CPCF +
32	3.4000E-08	010ABF * 4AC01LCL +
33	3.4000E-08	010ABF * BK4AC16SC +
34	3.4000E-08	010AF * 4AC01LCL +
35	3.4000E-08	010AF * BK4AC16SC +
36	2.5000E-08	4CPCF * 4AC01LCL +
37	2.5000E-08	4CPCF * BK4AC16SC +
38	6.1000E-09	DSE10AF * 152Z-4C1 +
39	6.1000E-09	DSE10AF * 125-4C +
40	6.1000E-09	DSE10AF * 4AC16-B +
41	6.1000E-09	DSE10AF * 162-4AC16 +
42	6.1000E-09	DSW10ABF * 152Z-4C1 +
43	6.1000E-09	DSW10ABF * 125-4C +
44	6.1000E-09	DSW10ABF * 4AC16-B +
45	6.1000E-09	DSW10ABF * 162-4AC16 +
46	3.7210E-09	DSW3BF * DSE10AF +
47	3.7210E-09	DSE3ABF * DSE10AF +
48	3.7210E-09	DSW3BF * DSW10ABF +
49	3.7210E-09	DSE3ABF * DSW10ABF +
50	3.4000E-09	010AF * 152Z-4C1 +

Table F8 (Sheet 2 of 2)

UNIT34KV =

1	5.4400E-08	3SUXMERF * U3TRF * 3AC16SPR +
2	3.0400E-08	3SUXMERF * U3TRF * B3CLF +
3.	4.0960E-09	4CXMERF * 3SUXMERF * 3CXMERF * U3TRF +
4	2.5600E-09	3SUXMERF * 3CXMERF * U3TRF * 3AC01LCL +
5	2.5600E-09	3SUXMERF * 3CXMERF * U3TRF * BK3AC16SC +
6	2.0740E-09	DSW6BF * U3TRF * 3AC16SPR +
7	2.0740E-09	DSE6ABF * U3TRF * 3AC16SPR +
8	2.0740E-09	DS23FT * U3TRF * 3AC16SPR +
9	1.1590E-09	DSE6ABF * U3TRF * B3CLF +
10	1.1590E-09	DS23FT * U3TRF * B3CLF +
11	1.1590E-09	DSW6BF * U3TRF * B3CLF +
12	1.1560E-09	06BF * U3TRF * 3AC16SPR +
13	1.1560E-09	06ABF * U3TRF * 3AC16SPR +
14	8.5000E-10	3STB60F * U3TRF * 3AC16SPR +
15	6.4600E-10	06ABF * U3TRF * B3CLF +
16	6.4600E-10	06BF * U3TRF * B3CLF +
17	4.7500E-10	3STB60F * U3TRF * B3CLF +
18	2.5600E-10	3SUXMERF * 3CXMERF * U3TRF * 152Z-3C1 +
19	2.5600E-10	3SUXMERF * 3CXMERF * U3TRF * 125-3C +
20	2.5600E-10	3SUXMERF * 3CXMERF * U3TRF * 3AC16-B +
21	2.5600E-10	3SUXMERF * 3CXMERF * U3TRF * 162-3AC16 +
22	1.7952E-10	3SUXMERF * U3TR * 3AC16SPR +
23	1.7600E-10	3SUXMERF * U3TRF * 151-3CBTX +
24	1.7600E-10	3SUXMERF * U3TRF * 151-3CBTX1 +
25	1.7600E-10	3SUXMERF * U3TRF * 127X-3C1 +
26	1.7600E-10	3SUXMERF * U3TRF * 186-3C +

Table F9 Unit 3 4KV Busses' (All) Cutsets (Sheet 1 of 2)

27	1.7600E-10	3SUXMERF * U3TRF * 174-3C1 +
28	1.7600E-10	3SUXMERF * U3TRF * 174-3C6 +
29	1.7600E-10	3SUXMERF * U3TRF * 150-3CBTX +
30	1.5616E-10	4CXMERF * DSW3BF * 3SUXMERF * U3TRF +
31	1.5616E-10	4CXMERF * DSE3ABF * 3SUXMERF * U3TRF +
32	1.5616E-10	DSE10AF * 3SUXMERF * 3CXMERF * U3TRF +
33	1.5616E-10	DSW10ABF * 3SUXMERF * 3CXMERF * U3TRF +
34	1.5616E-10	4CXMERF * DSW6BF * 3CXMERF * U3TRF +
35	1.5616E-10	4CXMERF * DSE6ABF * 3CXMERF * U3TRF +
36	1.5616E-10	4CXMERF * DS23FT * 3CXMERF * U3TRF +
37	1.0032E-10	3SUXMERF * U3TR * B3CLF +
38	9.7600E-11	DSW3BF * 3SUXMERF * U3TRF * 3AC01LCL +
39	9.7600E-11	DSE3ABF * 3SUXMERF * U3TRF * 3AC01LCL +
40	9.7600E-11	DSW3BF * 3SUXMERF * U3TRF * BK3AC16SC +
41	9.7600E-11	DSE3ABF * 3SUXMERF * U3TRF * BK3AC16SC +
42	9.7600E-11	DSW6BF * 3CXMERF * U3TRF * 3AC01LCL +
43	9.7600E-11	DSE6ABF * 3CXMERF * U3TRF * 3AC01LCL +
44	9.7600E-11	DS23FT * 3CXMERF * U3TRF * 3AC01LCL +
45	9.7600E-11	DSW6BF * 3CXMERF * U3TRF * BK3AC16SC +
46	9.7600E-11	DSE6ABF * 3CXMERF * U3TRF * BK3AC16SC +
47	9.7600E-11	DS23FT * 3CXMERF * U3TRF * BK3AC16SC +
48	8.7040E-11	4CXMERF * O3BF * 3SUXMERF * U3TRF +
49	8.7040E-11	O10ABF * 3SUXMERF * 3CXMERF * U3TRF +
50	8.7040E-11	O10AF * 3SUXMERF * 3CXMERF * U3TRF +

Table F9 (Sheet 2 of 2)

UNIT44KV =

1	5.4400E-08	4SUXMERF * U4TRF * 4AC16SPR +
2	3.0400E-08	4SUXMERF * U4TRF * B4CLF +
3	4.0960E-09	4CXMERF * 4SUXMERF * U4TRF * 3CXMERF +
4	2.5600E-09	4CXMERF * 4SUXMERF * U4TRF * 4AC01LCL +
5	2.5600E-09	4CXMERF * 4SUXMERF * U4TRF * BK4AC16SC +
6	2.0740E-09	U4TRF * DSW8BF * 4AC16SPR +
7	2.0740E-09	U4TRF * DSE8ABF * 4AC16SPR +
8	2.0740E-09	U4TRF * DS24FT * 4AC16SPR +
9	1.1590E-09	U4TRF * DSE8ABF * B4CLF +
10	1.1590E-09	U4TRF * DS24FT * B4CLF +
11	1.1590E-09	U4TRF * DSW8BF * B4CLF +
12	1.1560E-09	U4TRF * 08BF * 4AC16SPR +
13	1.1560E-09	U4TRF * 08ABF * 4AC16SPR +
14	8.5000E-10	U4TRF * 4SUB80F * 4AC16SPR +
15	6.4600E-10	U4TRF * 08ABF * B4CLF +
16	6.4600E-10	U4TRF * 08BF * B4CLF +
17	4.7500E-10	U4TRF * 4SUB80F * B4CLF +
18	2.5600E-10	4CXMERF * 4SUXMERF * U4TRF * 152Z-4C1 +
19	2.5600E-10	4CXMERF * 4SUXMERF * U4TRF * 125-4C +
20	2.5600E-10	4CXMERF * 4SUXMERF * U4TRF * 4AC16-B +
21	2.5600E-10	4CXMERF * 4SUXMERF * U4TRF * 162-4AC16 +
22	1.7600E-10	4SUXMERF * U4TRF * 151-4CBTX +
23	1.7600E-10	4SUXMERF * U4TRF * 151-4CBTX1 +
24	1.7600E-10	4SUXMERF * U4TRF * 127X-4C1 +
25	1.7600E-10	4SUXMERF * U4TRF * 186-4C +
26	1.7600E-10	4SUXMERF * U4TRF * 174-4C1 +

Table F10 Unit 4 4KV Busses' (All) Cutsets (Sheet 1 of 2)

27	1.7600E-10	4SUXMERF * U4TRF * 174-4C6 +
28	1.7600E-10	4SUXMERF * U4TRF * 150-4CBTX +
29	1.6864E-10	4SUXMERF * U4TR * 4AC16SPR +
30	1.5616E-10	DSE10AF * 4SUXMERF * U4TRF * 3CXMERF +
31	1.5616E-10	DSW10ABF * 4SUXMERF * U4TRF * 3CXMERF +
32	1.5616E-10	4CXMERF * DSW3BF * 4SUXMERF * U4TRF +
33	1.5616E-10	4CXMERF * DSE3ABF * 4SUXMERF * U4TRF +
34	1.5616E-10	4CXMERF * U4TRF * DSW8BF * 3CXMERF +
35	1.5616E-10	4CXMERF * U4TRF * DSE8ABF * 3CXMERF +
36	1.5616E-10	4CXMERF * U4TRF * DS24FT * 3CXMERF +
37	9.7600E-11	DSE10AF * 4SUXMERF * U4TRF * 4AC01LCL +
38	9.7600E-11	DSW10ABF * 4SUXMERF * U4TRF * 4AC01LCL +
39	9.7600E-11	DSE10AF * 4SUXMERF * U4TRF * BK4AC16SC +
40	9.7600E-11	DSW10ABF * 4SUXMERF * U4TRF * BK4AC16SC +
41	9.7600E-11	4CXMERF * U4TRF * DSW8BF * 4AC01LCL +
42	9.7600E-11	4CXMERF * U4TRF * DSE8ABF * 4AC01LCL +
43	9.7600E-11	4CXMERF * U4TRF * DS24FT * 4AC01LCL +
44	9.7600E-11	4CXMERF * U4TRF * DSW8BF * BK4AC16SC +
45	9.7600E-11	4CXMERF * U4TRF * DSE8ABF * BK4AC16SC +
46	9.7600E-11	4CXMERF * U4TRF * DS24FT * BK4AC16SC +
47	9.4240E-11	4SUXMERF * U4TR * B4CLF +
48	8.7040E-11	010AF * 4SUXMERF * U4TRF * 3CXMERF +
49	8.7040E-11	4CXMERF * 03ABF * 4SUXMERF * U4TRF +
50	8.7040E-11	4CXMERF * 03BF * 4SUXMERF * U4TRF +

Table F10 (Sheet 2 of 2)

		CBUSSES =
1	2.5600E-06	4CXMERF * 3CXMERF +
2	9.7600E-08	4CXMERF * DSW3BF +
3	9.7600E-08	4CXMERF * DSE3ABF +
4	9.7600E-08	DSE10AF * 3CXMERF +
5	9.7600E-08	DSW10ABF * 3CXMERF +
6	5.4400E-08	4CXMERF * O3BF +
7	5.4400E-08	O10ABF * 3CXMERF +
8	5.4400E-08	O10AF * 3CXMERF +
9	5.4400E-08	4CXMERF * O3ABF +
10	4.0000E-08	4CXMERF * 3CPCF +
11	4.0000E-08	4CPCF * 3CXMERF +
12	3.7210E-09	DSW3BF * DSE10AF +
13	3.7210E-09	DSE3ABF * DSE10AF +
14	3.7210E-09	DSW3BF * DSW10ABF +
15	3.7210E-09	DSE3ABF * DSW10ABF +
16	2.0740E-09	DSW3BF * O10ABF +
17	2.0740E-09	DSE3ABF * O10ABF +
18	2.0740E-09	DSW3BF * O10AF +
19	2.0740E-09	DSE3ABF * O10AF +
20	2.0740E-09	O3ABF * DSE10AF +
21	2.0740E-09	O3BF * DSE10AF +
22	2.0740E-09	O3ABF * DSW10ABF +
23	2.0740E-09	O3BF * DSW10ABF +
24	1.5250E-09	4CPCF * DSW3BF +
25	1.5250E-09	4CPCF * DSE3ABF +
26	1.5250E-09	DSE10AF * 3CPCF +

Table F11 Unit 3 & 4C Busses' Cutsets (Sheet 1 of 2)

27	1.5250E-09	DSW10ABF * 3CPCF +
28	1.1560E-09	03ABF * 010AF +
29	1.1560E-09	03BF * 010AF +
30	1.1560E-09	03ABF * 010ABF +
31	1.1560E-09	03BF * 010ABF +
32	1.1560E-09	3AC16SPR * 4AC16SPR +
33	8.5000E-10	4CPCF * 03ABF +
34	8.5000E-10	4CPCF * 03BF +
35	8.5000E-10	010ABF * 3CPCF +
36	8.5000E-10	010AF * 3CPCF +
37	6.4600E-10	B4CLF * 3AC16SPR +
38	6.4600E-10	B3CLF * 4AC16SPR +
39	6.2500E-10	4CPCF * 3CPCF +
40	5.6000E-10	FLORFT * 010ABSC * 3CXMERF +
41	3.6100E-10	B3CLF * B4CLF +
42	1.7600E-10	3CXMERF * 86-Y +
43	1.7600E-10	4CXMERF * 86-EE +
44	1.7600E-10	3CXMERF * 186-4CBT +
45	1.7600E-10	4CXMERF * 86-FF +
46	1.7600E-10	4CXMERF * 186-3CBT +
47	1.7600E-10	3CXMERF * 86-W +
48	5.4400E-11	4CXMERF * 3AC16SPR * 4AC01LCL +
49	5.4400E-11	3CXMERF * 3AC01LCL * 4AC16SPR +
50	5.4400E-11	3CXMERF * BK3AC16SC * 4AC16SPR +

Table F11 (Sheet 2 of 2)

LIST OF THE 255 PRIMARY EVENTS AND THEIR DESCRIPTIONS

BK3AA02SC	BKR 3AA02 STUCK CLOSED
BK3AB02SC	BKR 3AB02 STUCK CLOSED
BK3AC16SC	BK 3AC16 STUCK CLOSED
BK4AA02SC	BKR 4AA02 STUCK CLOSED
BK4AB02SC	BKR 4AB02 STUCK CLOSED
BK4AC16SC	4AC16 STUCK CLOSED
B3ALF	BUS 3A LOCAL FAULTS
B3BLF	BUS 3B LOCAL FAULTS
B3CLF	BUS 3C LOCAL FAULTS
B4ALF	BUS 4A LOCAL FAULTS
B4BLF	BUS 4B LOCAL FAULTS
B4CLF	BUS 4C LOCAL FAULTS
DAD1FT	DADE-1 FAULT
DAV1FT	DAVIS 1 FAULT
DAV2FT	DAVIS 2 FAULT
DAV3FT	DAVIS-3 FAULT
DORFT	DORAL FAULT
DSE10ABF	DISC SW E10AB FAULT
DSE10AF	DISC SW E10A FAULTS
DSE3ABF	DISC SW E3AB FAULTS
DSE3BF	DISC SW E 3B FAULTS
DSE6ABF	DISC SW E6AB FAULTS

Table F12 Fault Tree Primary Events & Descriptions (Sheet 1 of 12)

DSE6BF	DISC SW E6B FAULTS
DSE7ABF	DISC SW E7AB FAULTS
DSE7BF	DISC SW E7B FAULTS
DSE8ABF	DISC SW E8AB FAULTS
DSE8BF	DISC SW E8B FAULTS
DSE9ABF	DISC SW E9AB FAULT
DSE9BF	DISC SW E9B FAULTS
DSW10ABF	DISC SW W10AB FAULTS
DSW3ABF	DISC SW W3AB FAULTS
DSW3BF	DISC SW W3B FAULTS
DSW6ABF	DISC SW W6AB FAULTS
DSW6BF	DISC SW W6B FAULTS
DSW7ABF	DISC SW W7AB FAULT
DSW7BF	DISC SW W7B FAULTS
DSW8ABF	DISC SW W8AB FAULTS
DSW8BF	DISC SW W8B FAULTS
DSW9ABF	DISC SW W9AB FAULTS
DSW9BF	DISC SW W9B FAULTS
DS23FT	DISC SW 240J26423 FAULTS
DS24FT	DISC SW 240J26424 FAULTS
FLAG1FT	FLAGAMI-1 FAULT
FLAG2FT	FLAGAMI-2 FAULT

Table F12 (Sheet 2 of 12)

FLORFT	FLORIDA CITY FAULT
NEBFT	NE BUS FAULT (LOCAL)
NWBFT	NW BUS FAULT (LOCAL)
O10ABF	OCB 10AB FAULTS
O10ABSC	OCB 10AB STUCK CLOSED
O10AF	OCB 10A FAULTS
O10ASC	OCB 10A STUCK CLOSED
O10BSC	OCB 10B STUCK CLOSED
O2ASC	OCB 2A STUCK CLOSED
O2BSC	OCB 2B STUCK CLOSED
O3ABF	OCB 3AB FAULTS
O3ABSC	OCB 3AB STUCK CLOSED
O3BF	OCB 3B FAULTS
O3BSC	OCB 3B STUCK CLOSED
O4ASC	OCB 4A STUCK CLOSED
O4BSC	OCB 4B STUCK CLOSED
O5ASC	OCB 5A STUCK CLOSED
O5BSC	OCB 5B STUCK CLOSED
O56ASC	OCB 5/6A STUCK CLOSED
O6ABF	OCB 6AB FAULTS
O6ABSC	OCB 6AB STUCK CLOSED
O6ASC	OCB 6A STUCK CLOSED

Table F12 (Sheet 3 of 12)

06BF	OCB 6B FAULTS
06BSC	OCB 6B STUCK CLOSED
067BSC	OCB 6/7B STUCK CLOSED
07ABF	OCB 7AB FAULTS
07ABSC	OCB 7AB STUCK CLOSED
07ASC	OCB 7A STUCK CLOSED
07BF	OCB 7B FAULTS
07BSC	OCB 7B STUCK CLOSED
08ABF	OCB 8AB FAULTS
08ABSC	OCB 8AB STUCK CLOSED
08ASC	OCB 8A STUCK CLOSED
08BF	OCB 8B FAULTS
08BSC	OCB 8B STUCK CLOSED
09ABF	OCB 9AB FAULTS
09ABSC	OCB 9AB STUCK CLOSED
09ASC	OCB 9A STUCK CLOSED
09BF	OCB 9B FAULTS
09BSC	OCB 9B STUCK CLOSED
SEBFT	SE BUS FAULT (LOCAL)
SI3B2	SI RELAY 3B2
SI3-11X	SI RELAY 3-11X
SI4B2	SI RELAY 4B2
SI4-11X	SI RELAY 4-11X

Table F12. (Sheet 4 of 12)

SWBFT	SW BUS FAULT (LOCAL)
U1FT	UNIT 1 FAULT
U2FT	UNIT 2 FAULT
U3SISPR	UNIT 3 SPURIOUS SI
U3TRF	UNIT 3 TURB RUNBACK FAILS
U3TR	UNIT 3 RX-T-G TRIPS(GEMS)
U4SISPR	UNIT 4 SPURIOUS SI
U4TRF	UNIT 4 TURB. RUNBACK FAILS
U4TR	UNIT 4 RX-T-G TRIPS (GEMS)
12SUXFT	UNIT 1,2 S/U XMER FAULT
125-3C	SYNC. CHK. 125-3C
125-4C	SYNC. CHK. 125-4C
127X1-3AB3	LOSS OF VOLT. 127X1-3AB3
127X1-4AB3	LOSS OF VOLT. 127X1-4AB3
127X-3C1	LOSS OF VOLT. 127X-3C1
127X-4C1	LOSS OF VOLT. 127X-4C1
127Z1-3AB3	LOSS OF VOLT. 127Z1-3AB3
127Z1-4AB3	LOSS OF VOLT. 127Z1-4AB3
150A3B	FAULT PROT. 150A3B AND A3B-GF
150A4B	FAULT PROT. 150A4B AND A4B-GF
150B3B	FAULT PROT. 150B3B AND B3B-GF
150-B4B	FAULT PROT. 150B4B AND B4B-GF
150-S3A	FAULT PROT. 150-S3A AND S3A-6F

Table F12 (Sheet 5 of 12)

150-S3B	FAULT PROT. 150-S3B AND S3B-6F
150-S4A	FAULT PROT. 150-S4A AND S4A-6F
150-S4B	FAULT PROT. 150-S4B AND S4B-6F
150-3CBTX	FAULT PROT. 150-3CBTX, GF
150-3CBTY	FAULT PROT. 150-3CBTY, GF
150-4CBTX	FAULT PROT. 150-4CBTX, GF
150-4CBTY	FAULT PROT. 150-4CBTY, GF
151-A3A1	BU OVERCURRENT 151-A3A1
151-A3A	OVERCURRENT 151-A3A
151-A4A1	BU OVERCURRENT 151-A4A1
151-A4A	OVERCURRENT 151-A4A
151-B3A1	BU OVERCURRENT 151-B3A1
151-B3A	OVERCURRENT 151-B3A
151-B4A1	BU OVERCURRENT 151-B4A1
151-B4A	OVERCURRENT 151-B4A
151-S3A13	BU OVERCURRENT 151-S3A1-3
151-S3A14	BU OVERCURRENT 151-S3A1-4
151-S3A3	OVERCURRENT 151-S3A-3
151-S3A4	OVERCURRENT 151-S3A-4
151-S3B13	BU OVERCURRENT 151-S3B1-3
151-S3B14	BU OVERCURRENT 151-S3B1-4
151-S3B3	OVERCURRENT 151-S3B-3

Table F12 (Sheet 6 of 12)

151-S3B4	OVERCURRENT 151-S3B-4
151-3CBTX1	BU OVERCURRENT 151-3CBTX1
151-3CBTX	OVERCURRENT 151-3CBTX
151-3CBTY1	BU OVERCURRENT 151-3CBTY1
151-3CBTY	OVERCURRENT 151-3CBTY
151-4CBTX1	BU OVERCURRENT 151-4CBTX1
151-4CBTX	OVERCURRENT 151-4CBTX
151-4CBTY1	BU OVERCURRENT 151-4CBTY1
151-4CBTY	OVERCURRENT 151-4CBTY
152Z-3A5	152Z-3A5 SHORT CIRCUIT
152Z-3B5	152Z-3B5 SHORT CIRCUIT
152Z-3C1	RELAY 152Z-3C1 SHORT
152Z-4A5	152Z-4A5 SHORT CIRCUIT
152Z-4B5	152Z-4B5 SHORT CIRCUIT
152Z-4C1	RELAY 152Z-4C1 SHORT
162-3AC16	162-3AC16 BLOCK RELAY FAULT
162-3A2	162-3A2-IC-TDDO FAULT
162-3B2	162-3B2-IC-TDDO FAULT
162-4AC16	162-4AC16 BLOCK RELAY FAULT
162-4A2	162-4A2-IC-TDDO FAULT
162-4B2	162-4B2-IC-TDDO FAULT
174-3A2	3A LOCKOUT INITIATOR-174-3A2
174-3A5	3A LOCKOUT INITIATOR-174-3A5

Table F12 (Sheet 7 of 12)

174-3B2	3B LOCKOUT INITIATOR-174-3B2
174-3B5	3B LOCKOUT INITIATOR-174-3B5
174-3C1	3C LOCKOUT INITIATOR 174-3C1
174-3C6	3C LOCKOUT INITIATOR 174-3C6
174-4A2	4A LOCKOUT INITIATOR-174-4A2
174-4A5	4A LOCKOUT INITIATOR-174-4A5
174-4B2	4B LOCKOUT INITIATOR-174-4B2
174-4B5	4B LOCKOUT INITIATOR-174-4B5
174-4C1	4C LOCKOUT INITIATOR 174-4C1
174-4C6	4C LOCKOUT INITIATOR 174-4C6
186X-3A	3A BUS LO 186-3A
186X-3B	3B BUS LO 186-3B
186X-4A	4A BUS LO 186-4A
186X-4B	4B BUS LO 186-4B
186-ST3	3 SU XMER LO 186-ST3
186-ST4	4 SU XMER LO 186-ST4
186-3CBT	3C XMER LO 186-3CBT
186-3C	BUS 3C LO 186-3C
186-4CBT	4C XMER LO 186-4CBT
186-4C	BUS 4C LO 186-4C
286-G3	GEN.3 LO 286-G3 (SECONDARY)
286-G4	GEN.4 LO 286-G4 (SECONDARY)

Table F12 (Sheet 8 of 12)

3AATCF	3A-3 AUX T CABLE FAULTS
3AA02SPR	BKR 3AA02 OPENS SPURIOUSLY
3AA02-B	CONTACTS 3AA02-B FAIL TO CLOSE
3AA05FU	3AA05 CC FUSE FAILS OPEN
3AA05LCL	BKR 3AA05 FAILS TO CLOSE (LOCAL)
3AA05SPR	BKR 3AA05 OPENS SPURIOUSLY
3AB02SPR	BKR 3AB02 OPENS SPURIOUSLY
3AB02-B	CONTACTS 3AB02-B FAIL TO CLOSE
3AB05FU	3AB05 CC FUSE FAILS OPEN
3AB05LCL	BKR 3AB05 FAILS TO CLOSE (LOCAL)
3AB05SPR	BKR 3AB05 OPENS SPURIOUSLY
3AC01LCL	BKR 3AC01 FAILS TO CLOSE
3AC01SPR	BKR 3AC01 OPENS SPURIOUSLY
3AC03-B	AUX CONT 152-3AC03-B
3AC13-B	AUX CONT 152-3AC13-B
3AC16SPR	BKR 3AC16 OPENS SPURIOUSLY
3AC16-B	AUX CONT 3AC16
3ASUCF	3A-3S/U CABLE FAULTS
3AXMERF	3 AUX XMER FAULTS
3A5152-HH	3A5-152-HH 2-2T CONTACTS FAIL OPEN
3BATCF	3B-3 AUX T CABLE FAULTS
3BSUCF	3B-3S/U CABLE FAULTS
3B5152-HH	3B5-152-HH 2-2T CONTACTS FAIL OPEN

Table F12 (Sheet 9 of 12)

3CPCF	3C PIPE CABLE FAULTS
3CXMERF	3C XMER FAULTS
3C3CTCF	3C-3C XMER CABLE FAULTS
3C4CTCF	3C - 4C XMER CABLE FAULTS
3ISOPFT	3ISOPHASE BUS FAULTS
3MTB7OF	3 MT-BAY 7 OVHD FAULTS
3MXMERF	3 MAIN XMER FAULTS
3STB6OF	3S/U-BAY6 OVHD FAULTS
3SUXMERF	3 S/U XMER FAULTS (LOCAL)
3152-TOC	AUX CONT. 3-152-TOC
4AATCF	4A-4 AUX T CABLE FAULTS
4AA02SPR	BKR 4AA02 OPENS SPURIOUSLY
4AA02-B	CONTACTS 4AA02-B FAIL TO CLOSE
4AA05FU	4AA05 CC FUSE FAILS OPEN
4AA05LCL	BKR 4AA05 FAILS TO CLOSE (LOCAL)
4AA05SPR	BKR 4AA05 OPENS SPURIOUSLY
4AB02SPR	BKR 4AB02 OPENS SPURIOUSLY
4AB02-B	CONTACTS 4AB02-B FAIL TO CLOSE
4AB05FU	4AB05 CC FUSE FAILS OPEN
4AB05LCL	BKR 4AB05 FAILS TO CLOSE (LOCAL)
4AB05SPR	BKR 4AB05 OPENS SPURIOUSLY
4AC01LCL	BKR 4AC01 FAILS TO CLOSE
4AC01SPR	BKR 4AC01 OPENS SPURIOUSLY

Table F12 (Sheet 10 of 12)

4AC03-B	AUX CONT 152-4AC03-B
4AC13-B	AUX CONT 152-4AC13-B
4AC16SPR	BKR 4AC16 OPENS SPURIOUSLY
4AC16-B	AUX CONT 4AC16
4ASUCF	4A-4S/U CABLE FAULTS
4AXMERF	4AUX XMER FAULTS
4A5152-HH	4A5-152-HH 2-2T CONTACTS FAIL OPEN
4BATCF	4B-4AUX T CABLE FAULTS
4BSUCF	4B-4S/U CABLE FAULTS
4B5152-HH	4B5-152-HH 2-2T CONTACTS FAIL OPEN
4CPCF	4C PIPE CABLE FAULTS
4CXMERF	4C XMER FAULTS
4C3CTCF	4C-3C XMER CABLE FAULTS
4C4CTCF	4C-4C XMER CABLE FAULTS
4ISOPFT	4 ISOPHASE BUS FAULTS
4MTB9OF	4 MT-BAY 9 OVHD FAULTS
4MXMERF	4 MAIN XMER FAULTS
4SUB8OF	4S/U - BAY 8 OVHD FAULTS
4SUXMERF	4 S/U XMER FAULTS (LOCAL)
4152-TOC	AUX CONT. 4-152-TOC
86BU-ST3	RELAY 86BU-ST3
86BU-ST4	RELAY 86BU-ST4

Table F12 (Sheet 11 of 12)

86GT-G3	GEN. 3 LO 86GT-G3 (PRIMARY)
86GT-G4	GEN. 4 LO 86GT-G4 (PRIMARY)
86G	RELAY 86-G OR 86-R
86K	RELAY 86-K
86-EE	C XMER PRI. LO 86-EE
86-FF	C XMER SEC. LO 86-FF
86-W	4C XMER PRI. LO 86-W
86-Y	4C XMER SEC. LO 86-Y

Table F12 (Sheet 12 of 12)

FAULT EVENT	CUT SET ORDER*			
	1	2	3	4
4 kV bus 3A	10	528	474	5622
4 kV bus 3B	10	528	474	5622
4 kV Bus 3C	9	230	178	560
Unit 3 4 kV (All)	0	0	26	56
4 kV Bus 4A	10	528	487	5512
4 kV Bus 4B	10	528	487	5512
4 kV Bus 4C	9	230	152	469
Unit 4 4 kV (All)	0	0	26	56
C-Busses	0	46	13	2

* Cut set order is the number of fault events appearing in each cut set

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TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
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JPE-L84-12	REV. O
TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER PAGE 2	DATE 84/04/20

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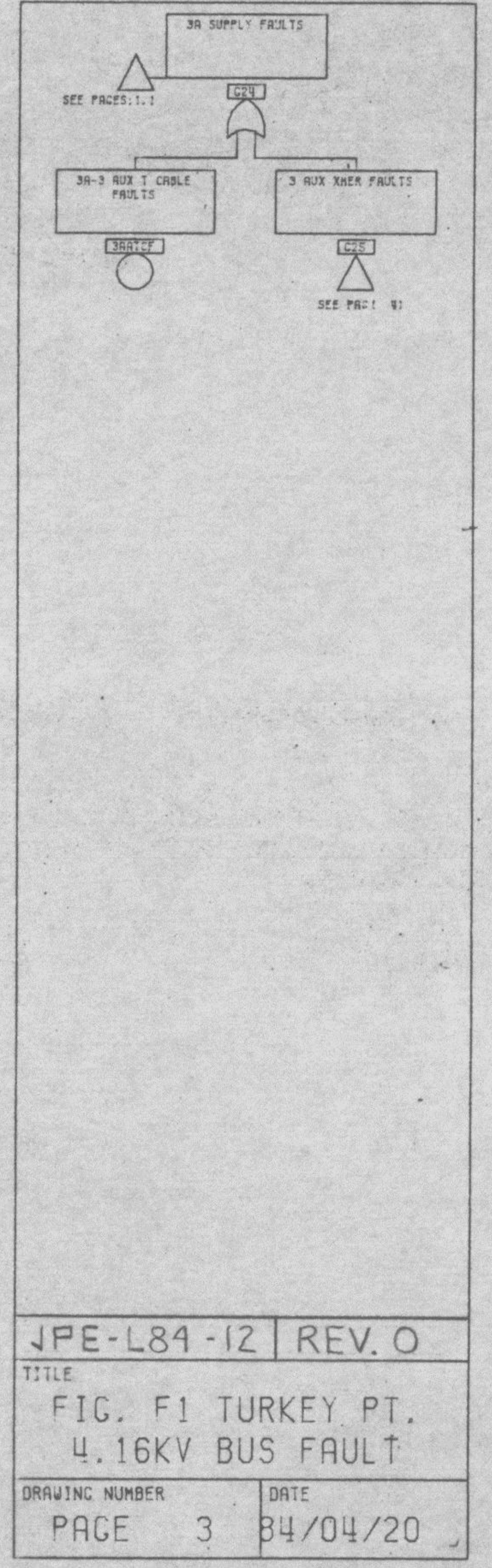
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FIG. F1 TURKEY PT.
4.16KV BUS FAULT
DRAWING NUMBER
PAGE 3
DATE
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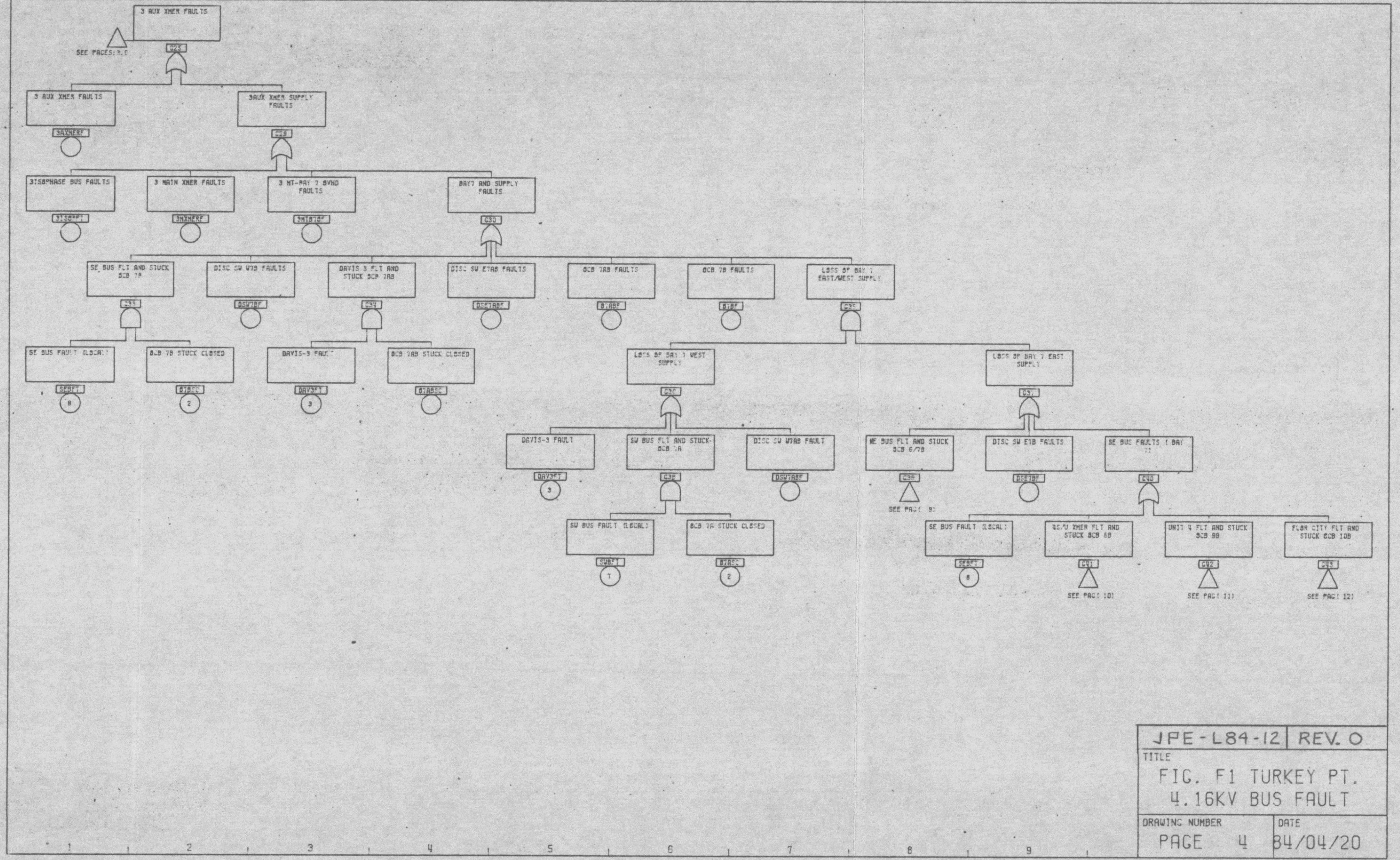
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FIG. F1 TURKEY PT.
4.16KV BUS FAULT
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DATE
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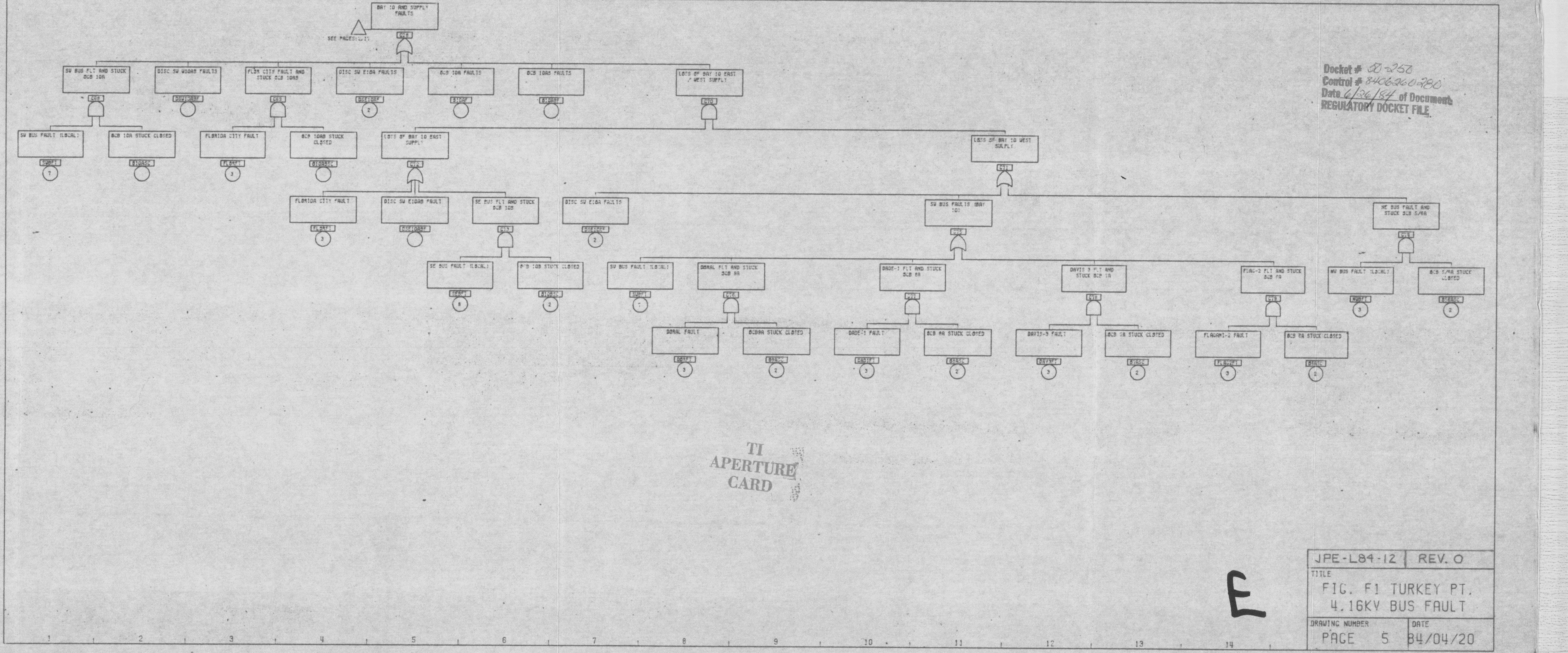
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FIG. F1 TURKEY PT.
4.16KV BUS FAULT
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PAGE 5
DATE
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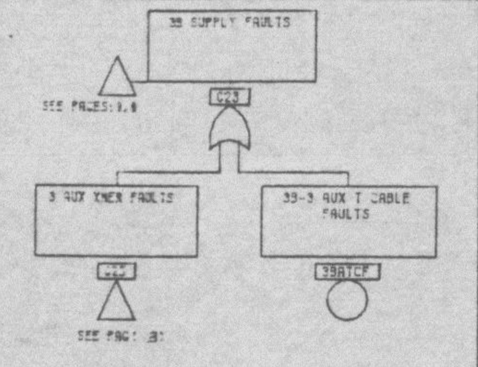

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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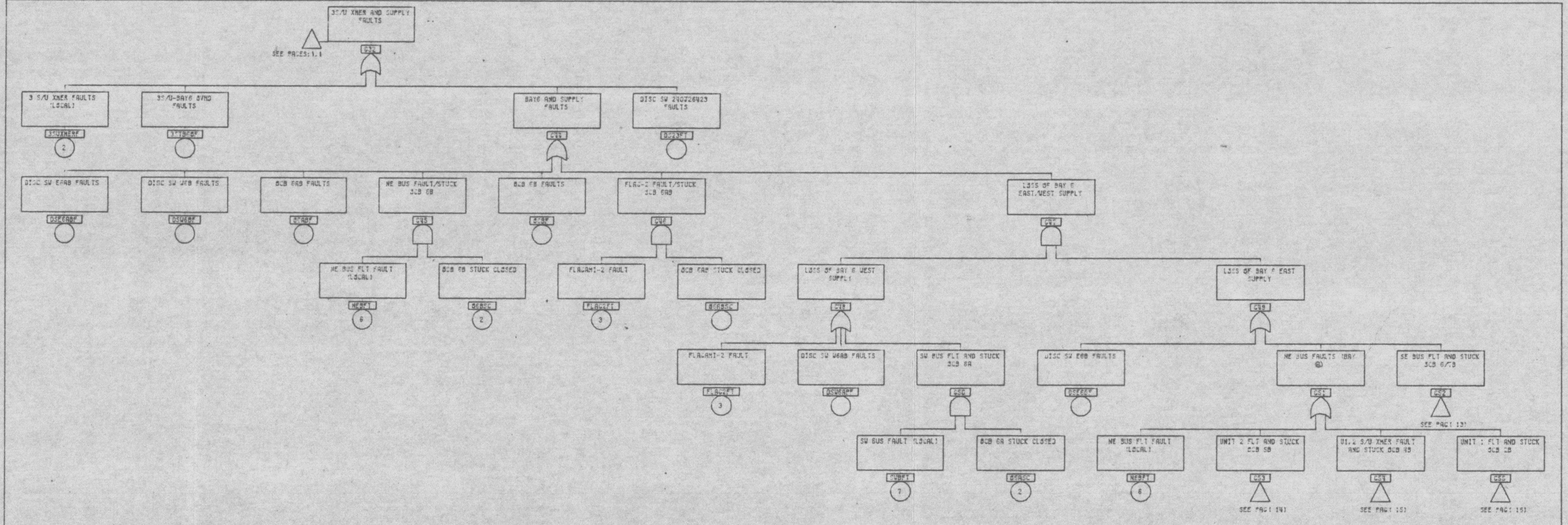

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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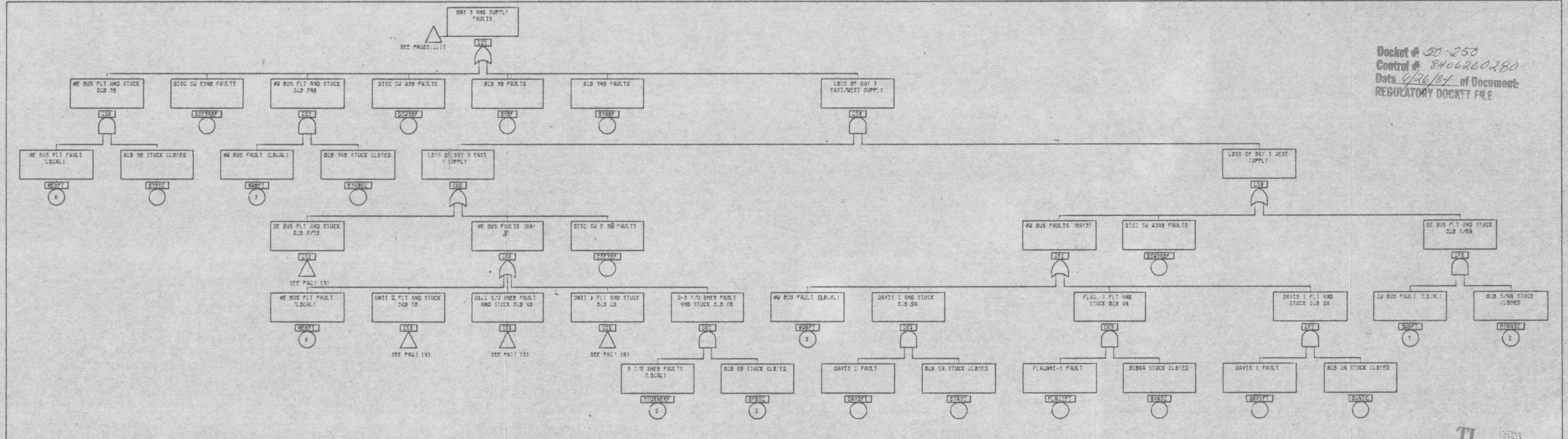

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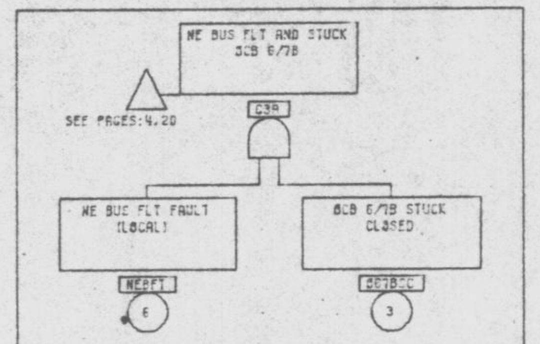
TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

DRAWING NUMBER: PAGE 8 | DATE: 84/04/20



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TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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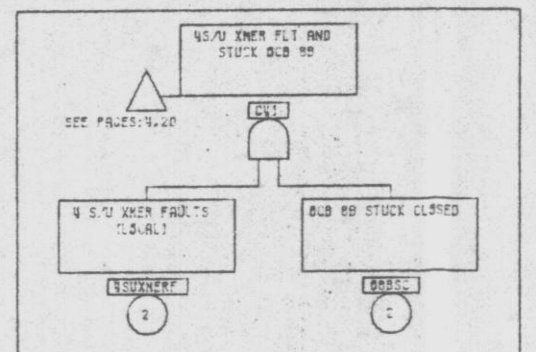

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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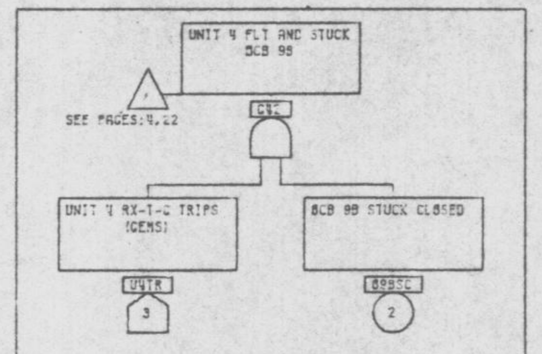

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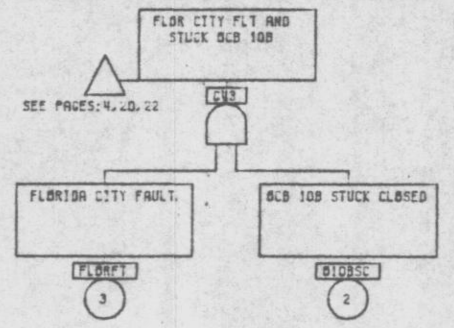
TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

DRAWING NUMBER: PAGE 11 | DATE: 84/04/20



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TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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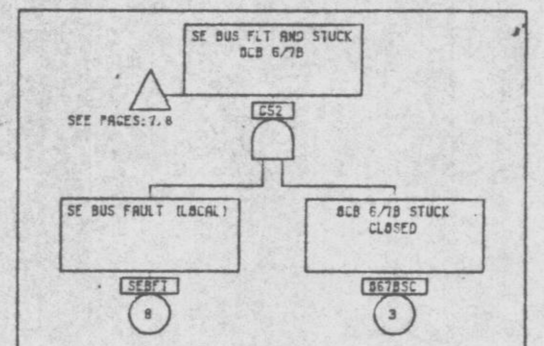

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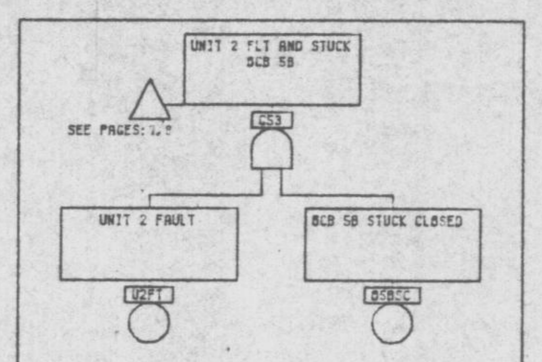
TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

DRAWING NUMBER: PAGE 13 | DATE: 84/04/20



JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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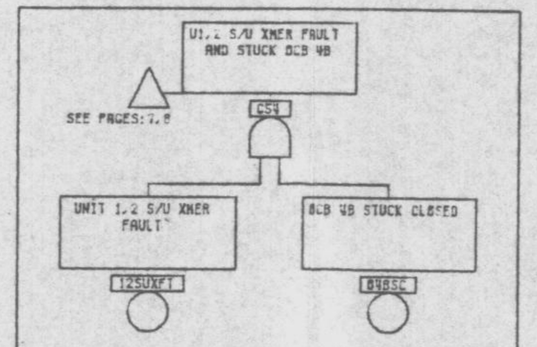

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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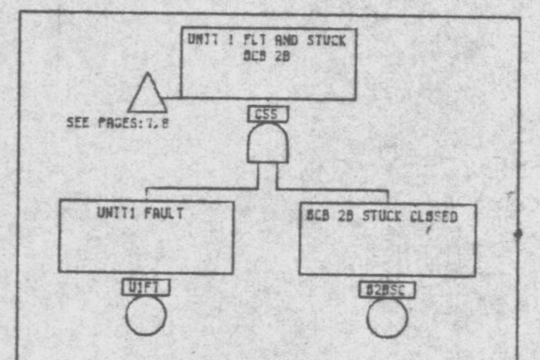

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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Control # 8406260280
Date 6/20/84 of Document
REGULATORY DOCKET FILE

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JPE-L84-12	REV. 0
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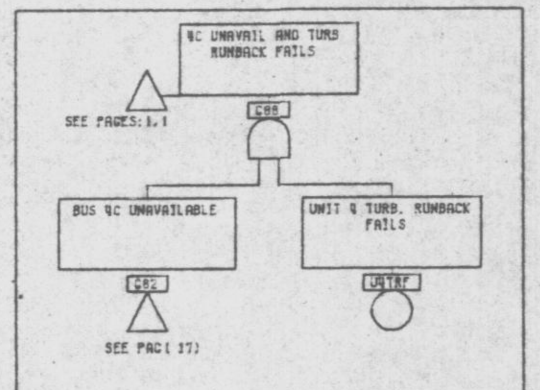
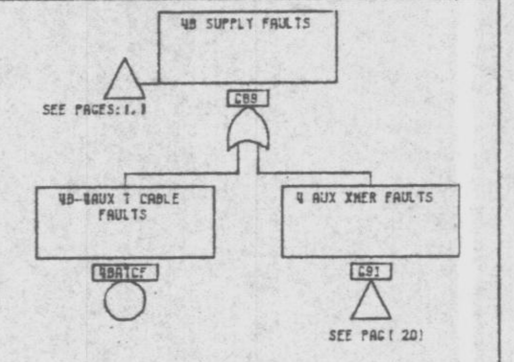
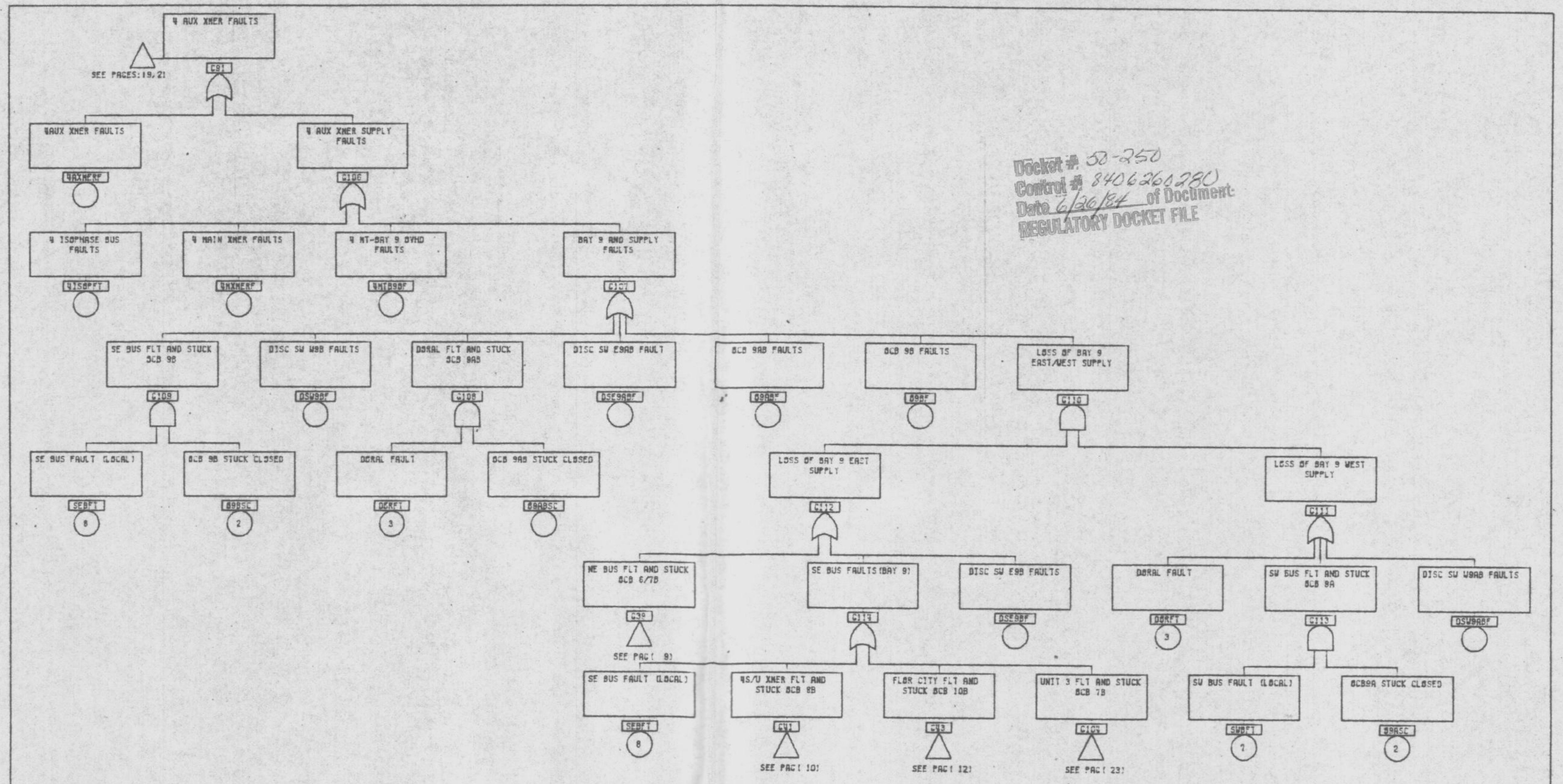


JPE-L84-12	REV. O
TITLE: FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER: PAGE 18	DATE: 84/04/20



JPE-L84-12	REV. O
TITLE: FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER: PAGE 19	DATE: 84/04/20



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TITLE: FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
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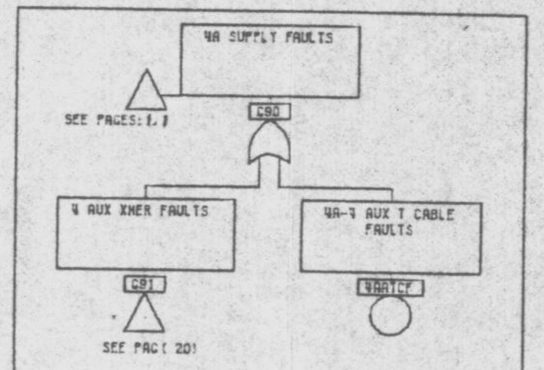
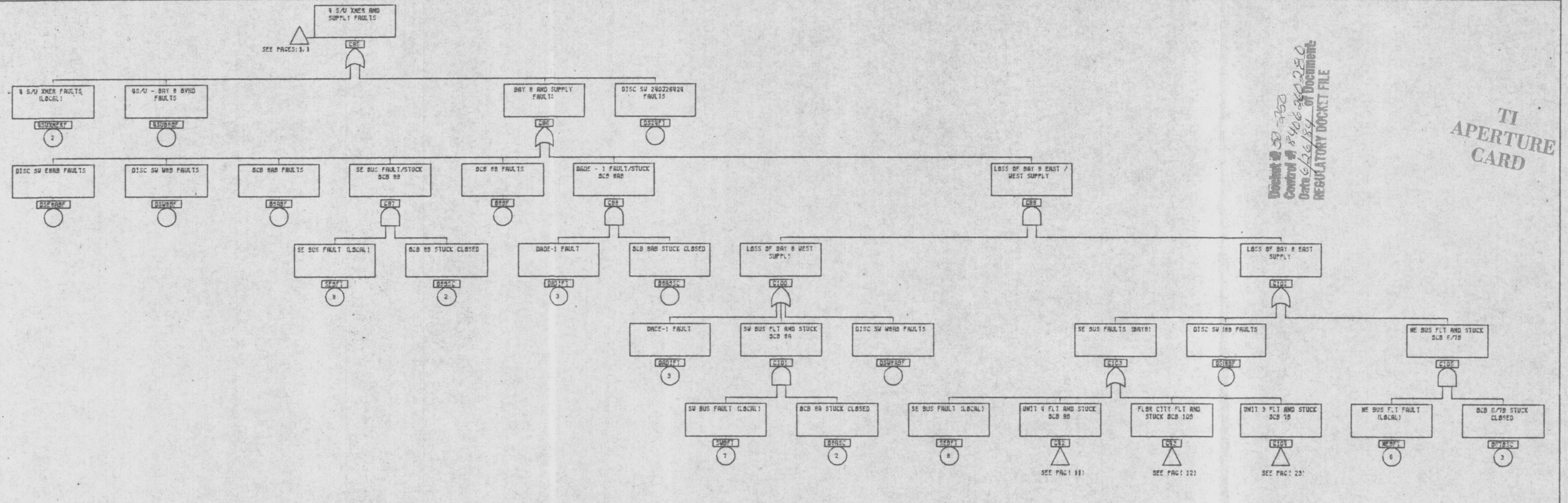


JPE-L84-12	REV. O
TITLE: FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER: PAGE 21	DATE: 84/04/20



JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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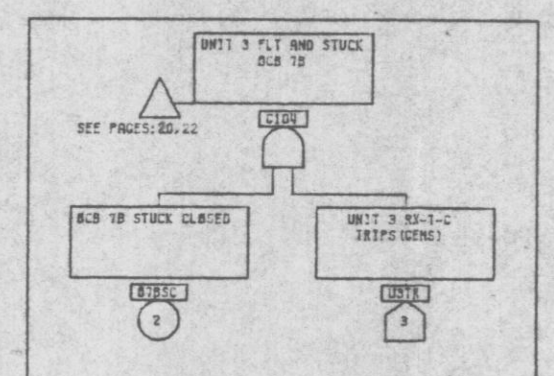

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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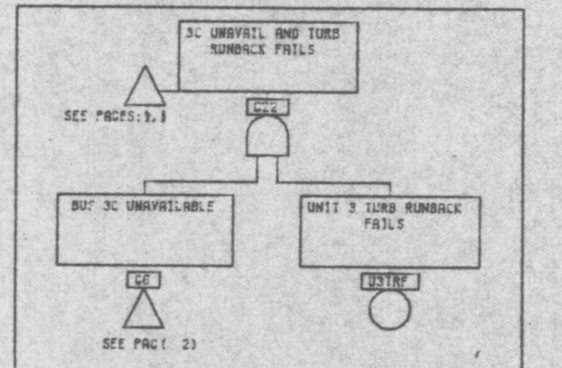

JPE-L84-12 | REV. 0

TITLE
FIG. F1 TURKEY PT.
4.16KV BUS FAULT

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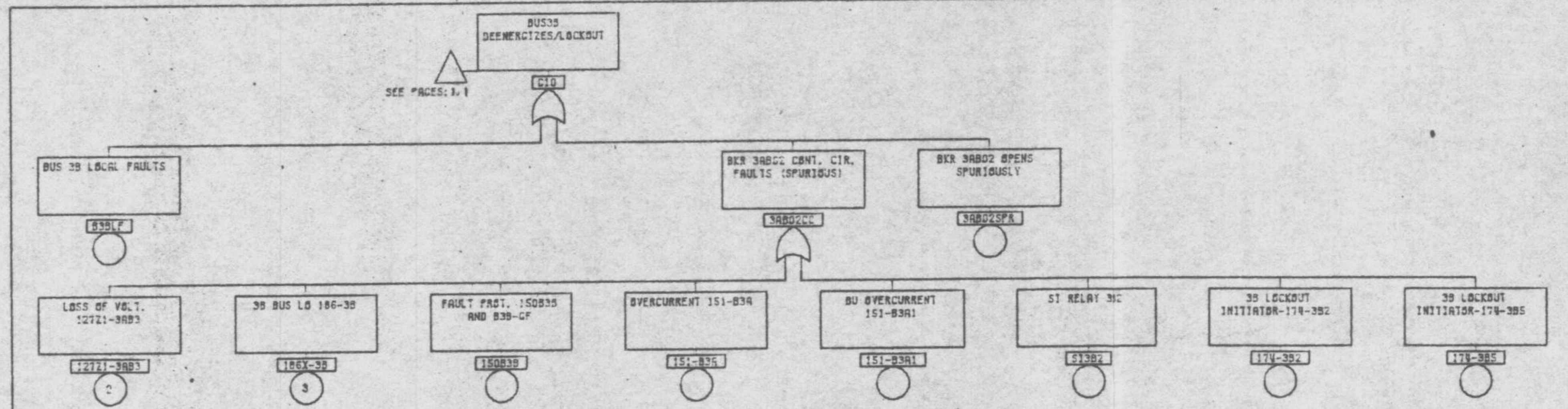
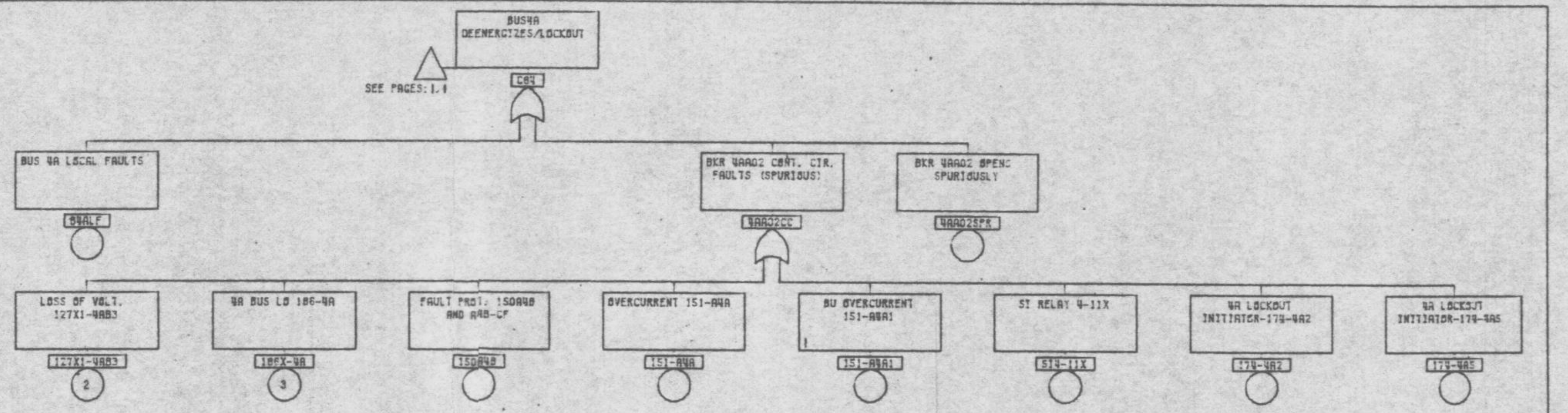


JPE-L84-12	REV. O
TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER PAGE 25	DATE 84/04/20



JPE-L84-12	REV. O
TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER PAGE 26	DATE 84/04/20

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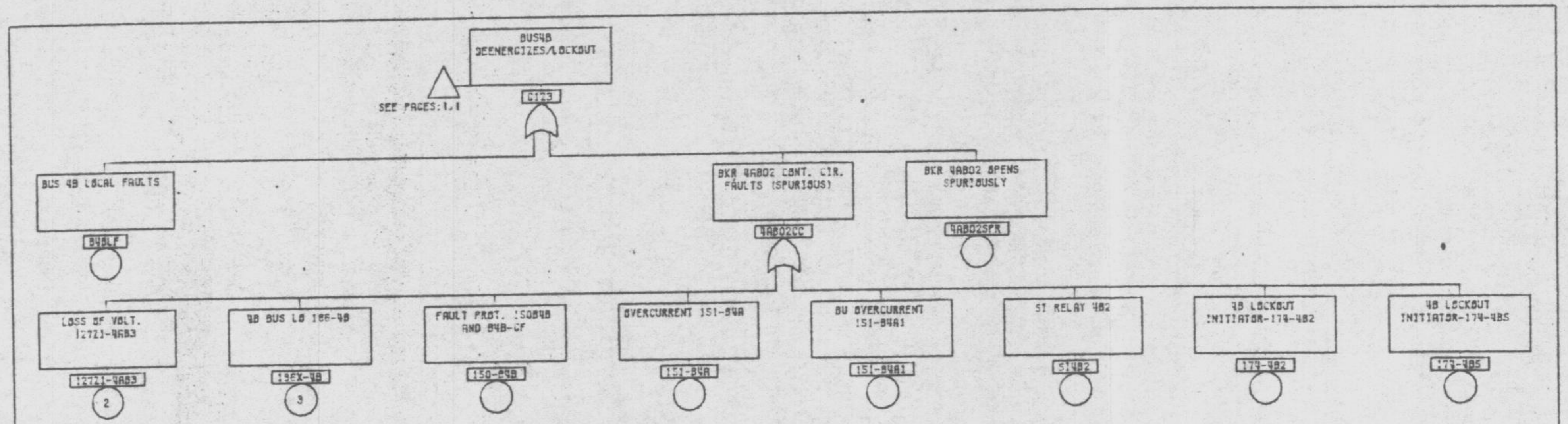
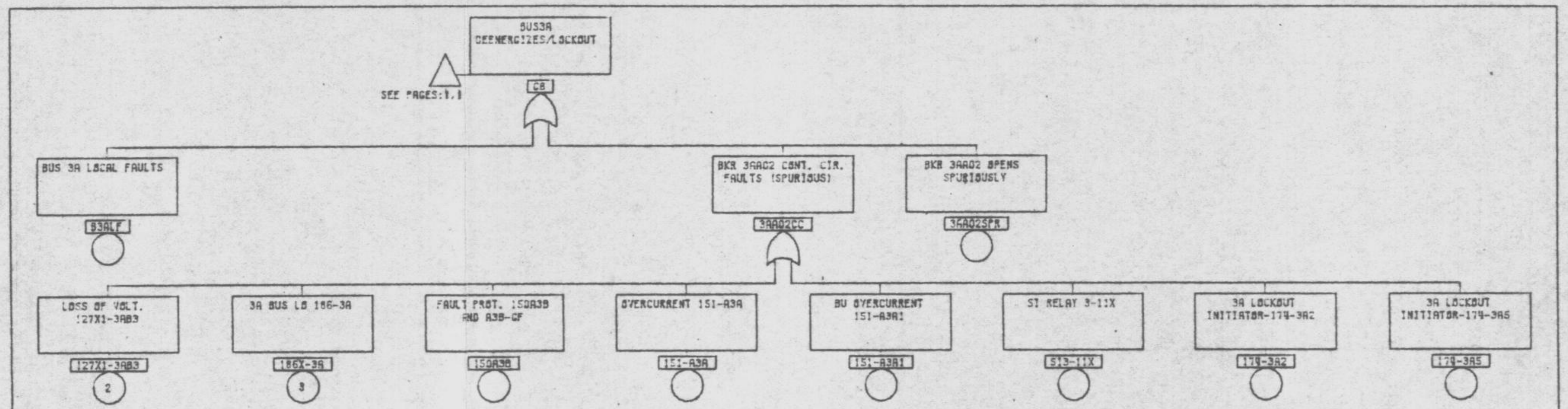


JPE-L84-12	REV. O
TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER PAGE 27	DATE 84/04/20

1 2 3 4 5



JPE-L84-12	REV. O
TITLE FIG. F1 TURKEY PT. 4.16KV BUS FAULT	
DRAWING NUMBER PAGE 28	DATE 84/04/20

1 2 3 4 5

D

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