

AEOD/E510

AEOD ENGINEERING EVALUATION REPORT\*

DISABLING OF A SHARED DIESEL GENERATOR SET  
DUE TO ELECTRICAL POWER SUPPLY ARRANGEMENT  
FOR SUPPORT AUXILIARIES

Reactor Operations Analysis Branch

Office for Analysis and Evaluation  
of Operational Data

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\*This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible NRC program office.

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## SUMMARY

This Engineering Evaluation Report provides information concerning electrical power supply arrangements for support auxiliaries associated with shared diesel generator sets.

The referenced licensee event report describes a situation whereby for a certain condition of the onsite power system, the engine louvers associated with the swing diesel generator set at the Surry Station would not be provided with electrical power necessary for operation. This situation is significant since without the louvers opening the swing diesel would overheat, and thus, be unable to perform its safety function.

In view of the potential significance of this situation, five additional facilities which use shared diesel generator sets were reviewed so as to determine if a similar concern was also applicable to these facilities. One result of this review was that the identified or similar concern does not appear to be applicable to these facilities. Based on this result and the knowledge that certain support auxiliaries must be supplied with electrical power in order for proper operation of a diesel generator set, we believe that the concern identified for the Surry Station is not a concern for most nuclear facilities which use shared diesel generator sets. However, as shown in the attached Appendix, there are a number of additional plants which share diesel generator sets and for which the identified or a similar concern may be applicable. In view of this possibility, the report suggests that it would be appropriate for awareness purposes to include a discussion of the referenced licensee event report in a future issue of Power Reactor Events.

## DISCUSSION

The referenced licensee event report (LER) provides a description of a potentially significant deficiency involving an emergency diesel generator (EDG) at the Surry Station. As shown on Figure 1, the Surry Station has three emergency diesel generators which are designed to supply power to two reactor units. The number 3 EDG is a swing set that can supply power to an emergency bus associated with either Unit Number 1 or Number 2. During an accident, the number 3 EDG will be automatically dedicated to the unit experiencing the accident. As described in the referenced LER, during a review of 10 CFR 50 Appendix R compliance, Vepco was informed by a contractor of a potentially significant deficiency in the louver control system for the number 3 EDG that would result in an unanalyzed condition. Specifically, the safety analysis requires the assumption of a single failure in the onsite emergency power system along with worst case parameters or conditions such as environment, loading and loss of all offsite power. Thus, during a design basis event on Unit Number 2 including a loss of offsite power accompanied by a failure of the number 2 EDG to start, the number 3 EDG could overheat within 5 to 7 minutes due to failure of its engine louvers to open. These louvers would not open for this condition since electrical power to open them is supplied by the 1J 480 volt emergency bus associated with Unit 1 which for this case would be de-energized. (Note from Figure 1, that the power source for the 1J 480 volt emergency bus is either the offsite power network or the number 3 EDG by way of a 4160/480 volt transformer.) Upon discovery of this condition, the immediate corrective action was to mechanically block open the engine louvers for the number 3 EDG. As a long term corrective action, appropriate modifications will be evaluated and implemented as necessary.

Based on the information contained in the referenced LER, five additional reactor facilities which have shared diesel generator sets between two reactor units were reviewed. The purpose of this review was to determine that when such diesel generator sets are required to perform their safety function, electrical power necessary for operating all support auxiliaries would be provided under all conditions including loss of offsite power to both reactor units. This determination would aid in making some assessment of the generic implications of the concern identified for the Surry Station. The facilities selected for further review were Hatch, Zion, Brunswick, Browns Ferry, and Prairie Island. The Architect Engineers for Hatch, Zion, Brunswick, Browns Ferry, and Prairie Island facilities are Bechtel, Sargent and Lundy Engineers, United Engineers and Constructors, Tennessee Valley Authority, and Fluor Power Services respectively.

The attached Figure 2 is a simplified electrical single line diagram for the swing diesel generator set at the Edwin I. Hatch Station. It is noted that this diagram is intended to aid in understanding how the controls are designed for the power source for the support auxiliaries, and as such, much of the information normally contained on a single line diagram is not shown. As shown on this diagram, the electrical power source for support auxiliaries is a 600 volt motor control center (MCC) identified as 1B. If the swing diesel generator set is not connected to bus 1F or 2F, then the normal source of power for MCC 1B is bus 1F. (Note for this condition, bus 1F would be powered by the offsite power network.) Bus 1F is associated with Unit Number 1 (bus 2F is associated with Unit Number 2). The controls for the swing diesel are such that it will automatically be dedicated to the unit experiencing an accident.

This being the case, the swing diesel is available and will automatically connect to bus 1F if Unit Number 1 is experiencing an accident and similarly is available to automatically connect to bus 2F if Unit Number 2 is experiencing an accident. The controls for circuit breakers identified as 3, 4, 5 and 6 are such that if the swing diesel generator set connects to a bus, either 1F or 2F, then that bus is the power source for MCC 1B. Accordingly, MCC 1B is referred to as a swing MCC. The control power for the six circuit breakers identified as 1 through 6 on Figure 2 is from a single 125 volt direct current distribution system. Our review of the applicable electrical schematics as well as the information provided in the Final Safety Analysis Report for the Hatch Station indicated that the support auxiliaries requiring electrical power are supplied from the 1B swing MCC. In view of this finding, the concern stated above does not apply to the Hatch Station.

Figure 3 is a simplified electrical single line diagram for the swing diesel generator set at the Zion Station. As shown on this diagram, the electrical power sources for the support auxiliaries are the two motor control centers identified as MCC 1371 and 2371. The controls for the 'O' swing diesel generator set at the Zion Station are such that this set will be dedicated to the unit which is experiencing an accident. In addition, the controls for the circuit breakers and starter contactors are such that if power is available to MCC 1371, then this MCC is the power source for the support auxiliaries. Also, included are design features such that the power source for the support auxiliaries will change automatically from MCC 1371 to MCC 2371 in the event of a loss of power to MCC 1371. The power supply provided for the various circuit breaker operations is a 125 volt direct current distribution system. With this control arrangement, it is possible for the 'O' swing diesel generator set to provide power to bus 247 (associated with Unit Number 2) and its support auxiliaries be powered from MCC 1371 (associated with Unit Number 1). However, even in view of this situation, our review of the applicable electrical schematics along with the information provided in the Final Safety Analysis Report for the Zion Station indicates that the support auxiliaries which require electrical power are supplied from an appropriate MCC. This being the case, the concern identified at Surry does not apply to the Zion Station.

Figure 4 is a simplified electrical single line diagram for the emergency onsite power system at the Brunswick Station. As shown, the Brunswick Station has four emergency diesel generator sets provided for two reactor units. Each of these four emergency diesel generator sets identified as A, B, C and D normally serve separate emergency buses identified as E1, E2, E3 and E4 respectively. These four diesel generator sets are effectively set up as two per reactor unit. This means that most of the emergency loads which may connect to diesel generator sets A and B by way of emergency buses E1 and E2 are associated with Unit Number 1, and most of the emergency loads which may connect to diesel generator sets C and D by way of emergency buses E3 and E4 are associated with Unit Number 2. However, the arrangement for emergency loads is such that each of the four emergency buses provide electrical power to emergency loads associated with both Unit 1 and Unit 2. The tie breakers between emergency buses E1, E2, E3 and E4, and redundant Division I and II Unit Substations are normally open. Effectively then, this arrangement may be described as an emergency power system for two reactor units consisting of four electrically independent trains. As such, normally when an emergency diesel generator connects to its associated emergency bus, electrical power necessary to operate support auxiliaries is provided by that diesel generator set.



Control power required for various control and circuit breaker operations associated with these four electrical trains is provided by four 125/250 volt direct current distribution systems. (That is, one 125/250 volt direct current distribution system is provided for each of these electrical trains.) Based on the above and other applicable information provided in the Final Safety Analysis Report for the Brunswick Station, we believe that the condition identified for the Surry Station is not relevant to the Brunswick Station.

Figure 5 is a simplified electrical single line diagram which shows four of the eight diesel generator sets at the Browns Ferry Station. The four diesel generator sets shown are primarily associated with Reactor Units 1 and 2 in that attendant 4kV shutdown boards A and C normally provide power to electrical loads which are primarily associated with Unit 1, and 4kV shutdown boards B and D normally provide power to electrical loads which are primarily associated with Unit 2. Moreover, as indicated on the diagram, each of these four 4kV boards may be connected to one of four 4kV shutdown boards which normally provides power to electrical loads primarily associated with Unit 3. Also, two 480 volt diesel auxiliary boards provide power for support auxiliaries associated with these four diesel generator sets. Such support auxiliaries associated with diesel generator sets A, B, C and D are arranged so that either of the two 480 volt diesel auxiliary boards A or B may provide the power necessary for their operation. Normally, when the emergency diesel generator sets are connected to the 4kV shutdown boards, the A and D sets provide power to the A and B 480 volt diesel auxiliary boards respectively. Further, as indicated on the diagram, the A or B 480 volt auxiliary board may be transferred to the B diesel generator set and provisions to accomplish such transfers are included. Also, each 480 volt diesel auxiliary board is provided with circuitry which will annunciate a loss of voltage condition. Control power necessary for various control and circuit breaker operations for each of the four 4kV shutdown boards and attendant equipment items is provided by four 250 volt direct current distribution systems. (One direct current system is provided for each of the 4kV boards and attendant equipment items.) Based on the above and other applicable information provided in the Final Safety Analysis Report for the Browns Ferry Station, we believe the condition identified for the Surry Station is not relevant to the Browns Ferry Station.

Figure 6 is a simplified electrical single line diagram for the onsite emergency power system at the Prairie Island Station. As shown, each of the two diesel generator sets may provide power to one of the two electrical trains which are associated with each of the two reactor units. That is, diesel generator set 'D1' may provide power to 4160 volt buses 15 and 26 which are associated with Reactor Units 1 and 2 respectively. Similarly, diesel generator set 'D2' may provide power to 4160 volt buses 25 and 16 which are associated with Reactor Units 2 and 1 respectively. Support auxiliaries for diesel generator set 'D1' which require a 480 volt power source are normally supplied by 480 volt load center bus 110. In a like manner, support auxiliaries for diesel generator set 'D2' which require a 480 volt power source are normally supplied by 480 volt load center bus 120. Buses 1 and 2 may be manually transferred to 480 volt load centers 210 and 220 respectively and provisions are included to accomplish such transfers. The tie breakers between redundant buses 110 and 120, and 210 and 220 are normally open. With this arrangement then, when a diesel generator set connects to an attendant 4160 volt emergency bus, power for associated support auxiliaries are provided by that set or the offsite network. The above arrangement may be described as an

emergency onsite power system for two reactor units which consist of two electrically independent alternating current trains. Control power required for various control and circuit breaker operations is provided by two independent 125 volt direct current distribution systems (one system for each train). In view of the above information, the concern identified for the Surry Station is not relevant to the Prairie Island Station.

Based on our review of the applicable information obtained for the five additional stations and the knowledge that certain support auxiliaries must be supplied with electrical power in order for proper operation of a diesel generator set, we believe that the concern identified for the swing diesel generator set at the Surry Station is not a concern for most shared diesel generator sets. However, as shown in the Appendix, there are a number of additional plants which share diesel generator sets, and thus, the identified or a similar concern may be applicable to a shared diesel generator set at a few other plants.

## FINDINGS

In view of the preceding discussion and the results of follow-up activities conducted for the referenced report, the following findings are provided:

1. The problem identified at the Surry Station involving the power supply arrangement for a support auxiliary provided for the swing diesel generator set is a potentially significant safety concern, since failure to provide electrical power to the engine louvers (support auxiliary) will result in the inability of the set to perform its safety function due to overheating under certain conditions.
2. In general, the arrangement for the power supply provided for support auxiliaries associated with a shared diesel generator set are plant specific. The conditions of various buses (energized or de-energized) and breakers (opened or closed) are factors used in determining how the support auxiliaries are to be powered.
3. The result of our review of applicable electrical diagrams and information provided in Final Safety Analysis Reports for the additional stations is that these plant designs do provide for supplying power to shared diesel generator auxiliaries under all operating conditions. That is, the safety concern identified above is not applicable to these stations.



#### CONCLUSION AND SUGGESTION

Based on the results obtained from our review and follow-up activities conducted for the referenced licensee event report, we believe that the concern identified for the swing diesel generator set at the Surry Station is not of concern for those plants reviewed which use shared diesel generator sets. However, since a number of additional nuclear plants use shared diesel generator sets (see Appendix), the identified or similar concern may exist for a shared diesel generator set. In view of this possibility, it would be appropriate to specifically discuss the referenced licensee event report in Section 2.0 (Excerpts of Selected Licensee Event Reports) of a future issue of Power Reactor Events.

Reference

1. Virginia Electric and Power Company, Licensee Event Report 84-011  
Docket No. 50-281, dated May 8, 1984.

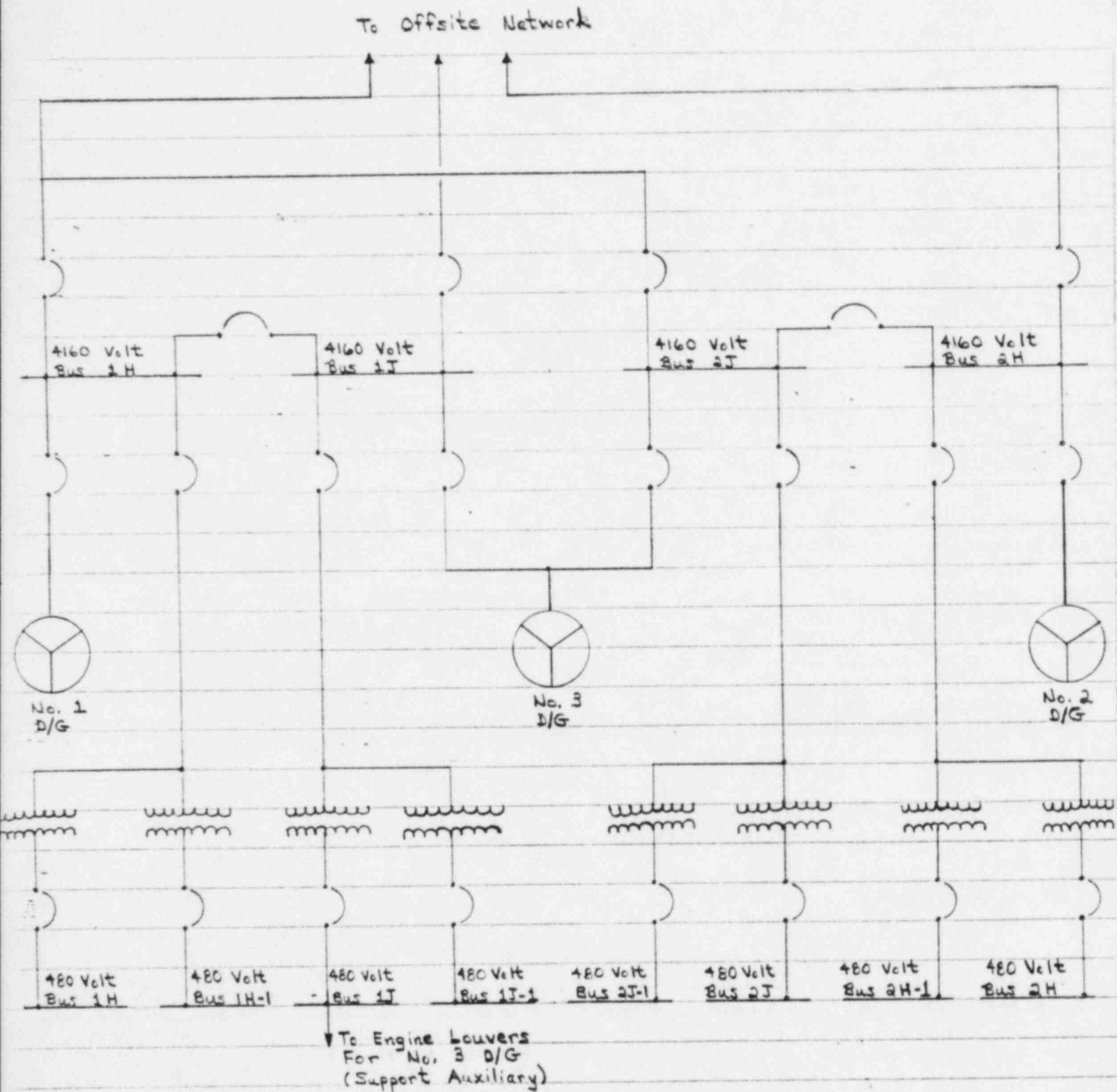
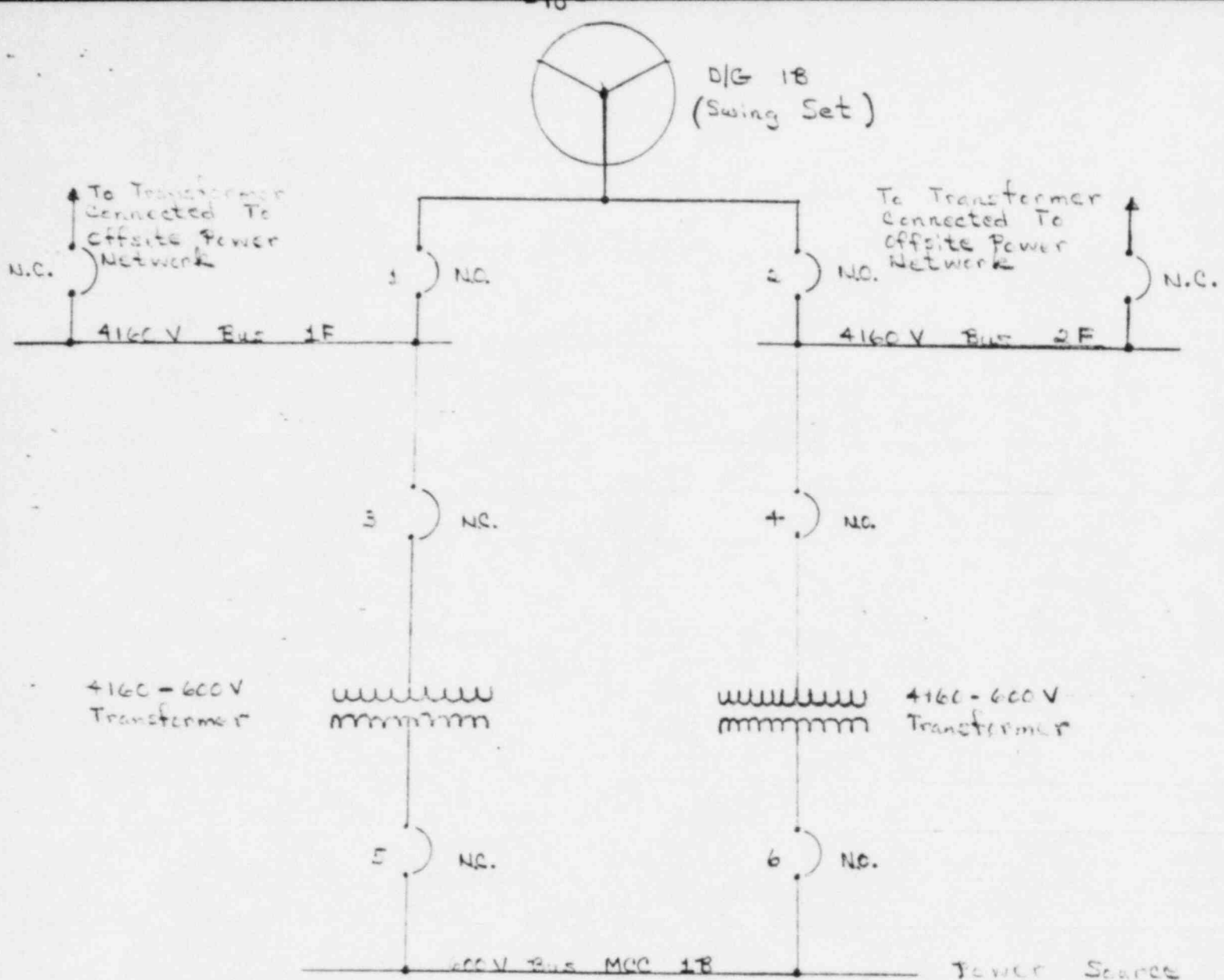


Figure 1 - Simplified Electrical Single Line Diagram Showing The Swing Diesel Generator Set At The Surry Station



Note: N.C. denotes normally closed  
N.O. denotes normally open

Power Source  
For Support  
Auxiliaries

Figure 2 - Simplified Electrical Single Line Diagram  
For The Swing Diesel Generator Set  
At The Edwin I. Hatch Station

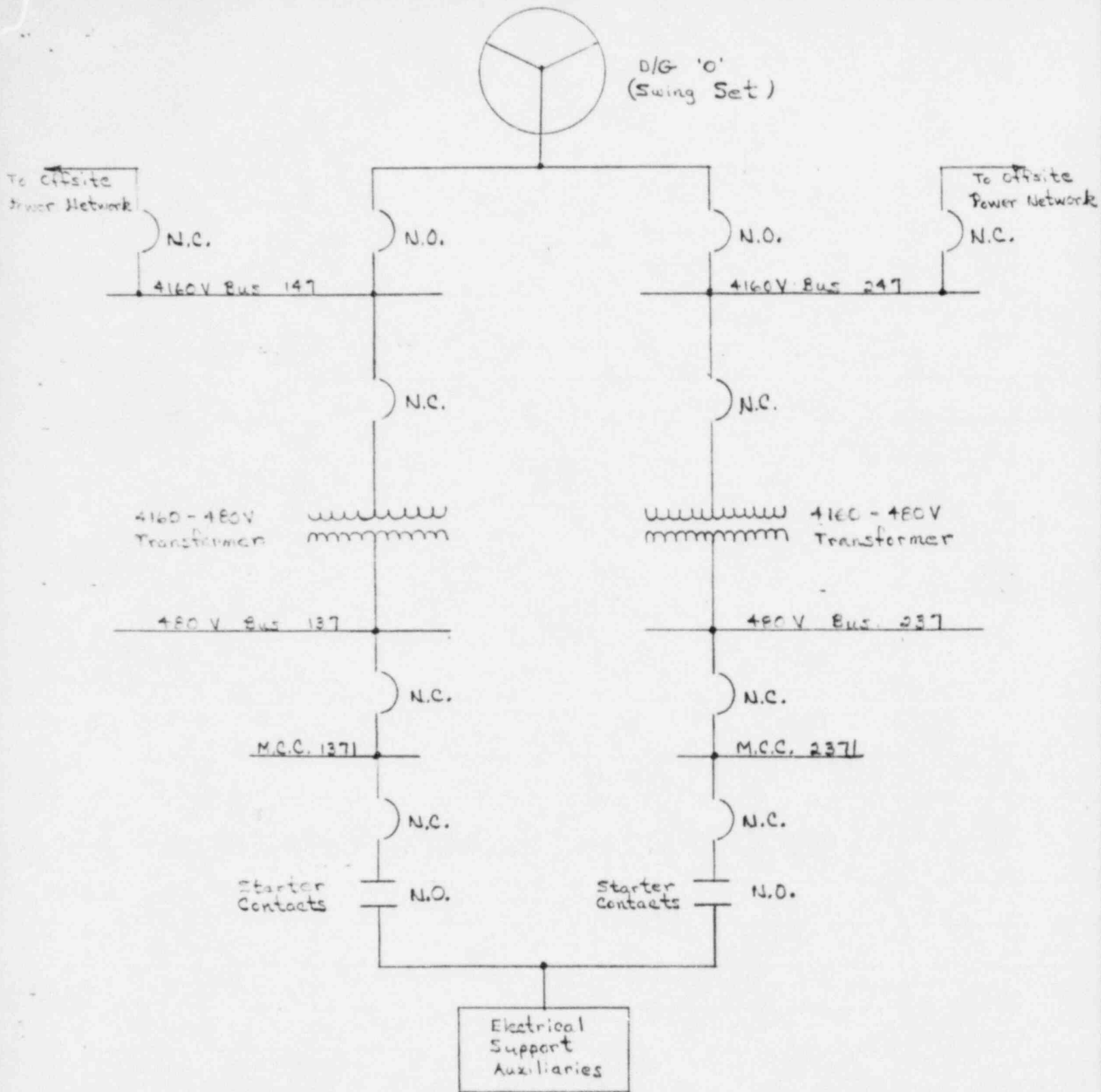
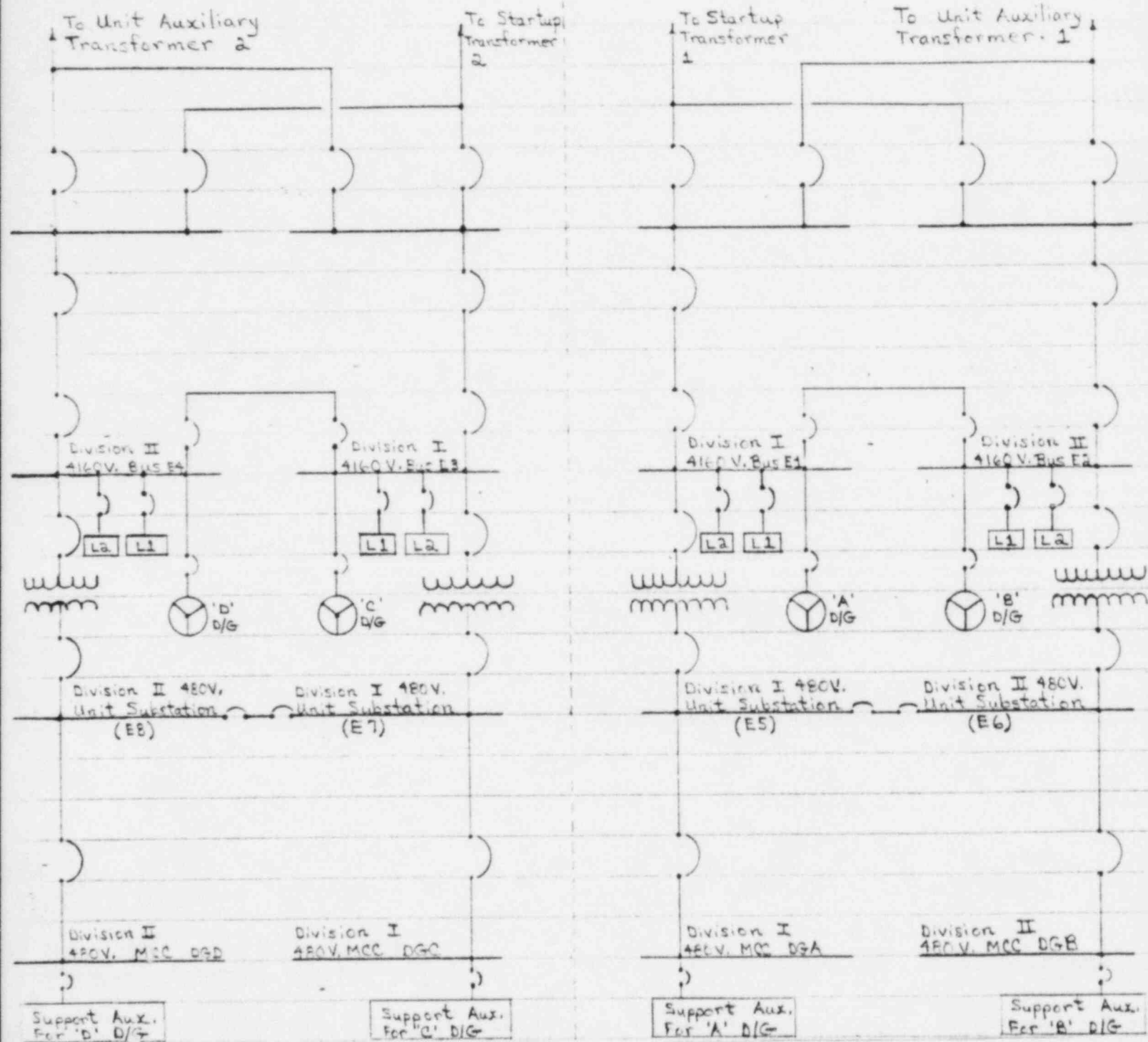


Figure 3 - Simplified Electrical Single Line Diagram  
For The Swing Diesel Generator Set  
At The Zion Station

Unit 2

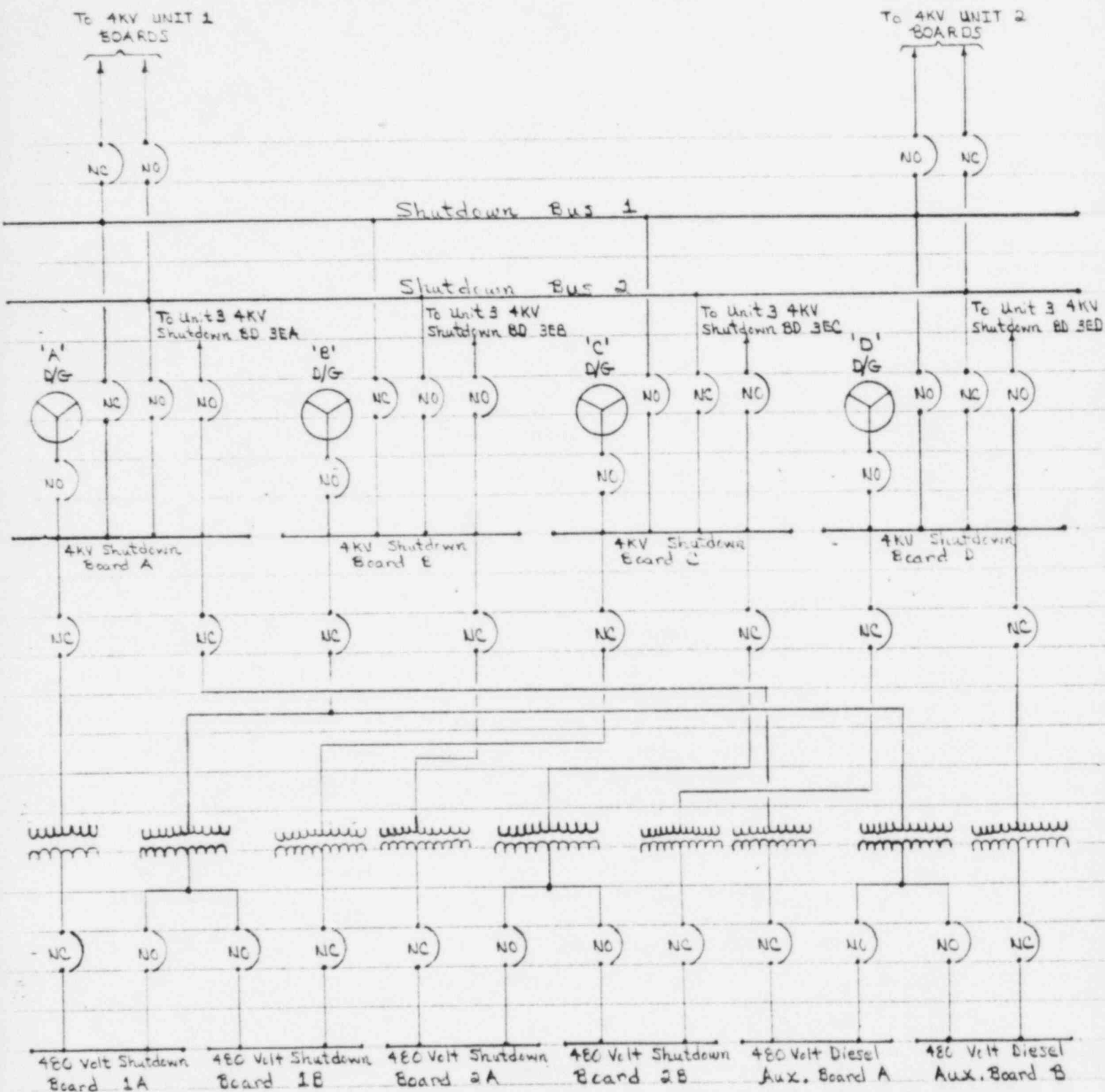
Unit 1



[L1] denotes loads associated with Unit No. 1 : [L2] denotes loads associated with Unit No. 2

Figure 4 - Simplified Electrical Single Line Diagram For The Shared Diesel Generator Sets At The Brunswick Station





NO - denotes normally open  
 NC - denotes normally closed

Figure 5 - Simplified Electrical Single Line Diagram  
 For Shared Diesel Generator Sets  
 At Browns Ferry Unit Numbers 1 And 2

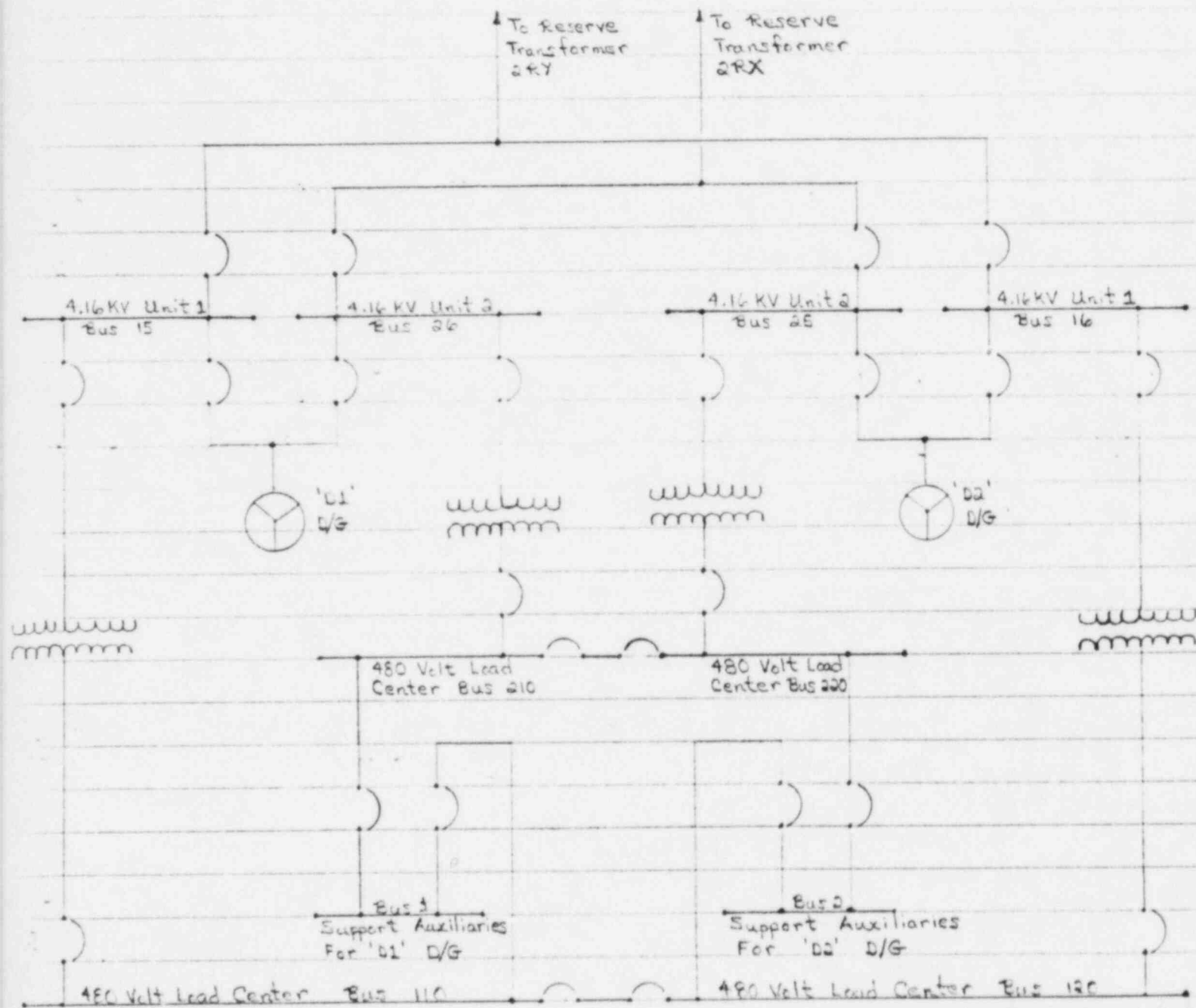


Figure 6 - Simplified Electrical Single Line Diagram  
For The Shared Diesel Generator Sets At  
The Prairie Island Station

Appendix

I. List of Additional Plant Names Which Share Diesel Generator Sets 1/

1. Point Beach 1 and 2
2. Turkey Point 3 and 4
3. Dresden 2 and 3
4. Quad-Cities 1 and 2
5. Calvert Cliffs 1 and 2
6. Joseph M. Farley 1 and 2
7. Sequoyah 1 and 2
8. Susquehanna 1 and 2 2/

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1/ List of additional plant names were obtained from NUREG/CR-2989  
"Reliability of Emergency AC Power Systems at Nuclear Power Plants."

2/ This plant name was not obtained from NUREG/CR-2989.