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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

SUBJECT: Limerick Generating Station, Units 1 and 2
10CFR50.63, "Loss of All Alternating Current Power"
Supplemental Information

Dear Sir:

On July 21, 1988, the NRC amended its regulations in 10CFR50. A new section, 50.63, was added which requires that each light-water-cooled nuclear power plant be able to withstand and recover from a station blackout (SBO) of a specified duration. 10CFR50.63 further requires that each licensee submit the following information.

1. A proposed station blackout duration, including a justification for its selection based on the redundancy and reliability of the on-site emergency alternating current (AC) power sources, the expected frequency of loss of off-site power, and the probable time needed to restore off-site power.

2. A description of the procedures that will be implemented for station blackout events for the duration (as determined in 1 above) and for recovery therefrom.

3. A list and proposed schedule for any needed modifications to equipment and associated procedures necessary for the specified station blackout duration.

The NRC also issued Regulatory Guide 1.155, "Station Blackout," which describes a means acceptable to the NRC for meeting the requirements of 10CFR50.63. Regulatory Guide (RG) 1.155 states that the NRC has determined that the document issued by the Nuclear Utility Management and Resources Council, NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout At Light Water Reactors," also provides guidance that is in large part identical to the RG 1.155 guidance and is acceptable to the NRC for meeting the requirements of 10CFR50.63. Table 1 to RG 1.155 provides a cross-reference between RG 1.155 and NUMARC 87-00 and notes where the RG takes precedence.

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Philadelphia Electric Company (PECo) evaluated the Limerick Generating Station (LGS), Units 1 and 2 in accordance with the requirements of the SBO rule using guidance from NUMARC 87-00, except where RG 1.155 takes precedence. The results of this evaluation were submitted to the NRC as required by 10CFR50.63(c)(1) by our letter dated April 17, 1989. As a result of subsequent NRC reviews of licensee submittals and NRC discussions with NUMARC, NUMARC has requested that we supplement our April 17, 1989 submittal to the NRC indicating that 1) our April 17, 1989 submittal was based on use of the NUMARC 87-00 guidance including recently provided clarifications, and/or 2) any deviations from the accepted NUMARC 87-00 guidance have been or will be clearly indicated. Also, we are to affirm our understanding that the emergency diesel generator (EDG) target reliability is to be maintained. Accordingly, we have evaluated our April 17, 1989 submittal and LGS Units 1 and 2 with respect to the requirements of 10CFR50.63, including recent clarifications of the guidance in NUMARC 87-00.

We have verified that 1) our use of the NUMARC guidance is consistent with the recent clarifications, 2) the applicability of the NUMARC 87-00 assumptions is documented, and 3) all departures from the accepted NUMARC 87-00 methodology are identified and described below. Accordingly, this letter details the plant factors identified in the determination of the proposed station blackout coping duration. In addition, the ability of LGS Units 1 and 2 to cope with a station blackout of this proposed duration is addressed. The results of this evaluation, including a description of any departures from the NUMARC 87-00 guidance, are detailed below. Applicable NUMARC 87-00 sections are shown in parentheses.

A. Proposed Station Blackout Duration

NUMARC 87-00, Section 3 was used to determine a proposed SBO duration of four hours. The plant factors considered in determining the proposed station blackout duration and defining the proposed Alternate AC power supply are discussed in this section.

1. AC Power Design Characteristic Group is P2 based on the following.

   a. Expected frequency of grid-related loss of off-site power (LOOP) events does not exceed once per 20 years (Section 3.2.1, Part 1A, p. 3-3).

   b. Estimated frequency of LOOP events due to extremely severe weather (ESW) placed the plant in ESW Group 3 (Section 3.2.1, Part 1B, p. 3-4).

   c. Estimated frequency of LOOP events due to severe weather (SW) places the plant in SW Group 2 (Section 3.2.1, Part 1C, p. 3-7).

   d. The off-site power system is in the I1/2 Group (Section 3.2.1, Part 1D, p. 3-10). Two electrically-connected switchyards and no manual transfers are credited to determine this classification. All safe shutdown busses are transferred to the alternate power source on loss of the preferred power source.

2. The Emergency AC (EAC) power configuration group is "A" based on the following (Section 3.2.2, Part 2C, p. 3-13).

   a. There are three EAC power supplies not credited as alternate AC power sources per unit (Section 3.2.2, Part 2A, p. 3-15).

   b. One EAC power supply is necessary to operate safe shutdown equipment for an extended period following a loss of off-site power per unit (Section 3.2.2, Part 2B, p. 3-15).

   NOTES: 1. A limited amount of operator actions are credited to initiate cross-ties between electrical power sources in order to justify a one out of three EAC configuration.

   2. Note that the total shutdown load requirements for both units combined is greater than the continuous rating of one EDG in each unit. Therefore, a minimum of three EDGs are required to support simultaneous shutdown of both units.

   The proposed EAC category for LGS was determined on a per unit basis. In making this determination, the adjacent unit's systems were assumed to be operational after assuming a single failure of the most limiting component. The most limiting component at the adjacent unit was determined to be one of its EDGs.

   There are a number of mechanical systems at LGS whose functions are normally shared between units (e.g., Residual Heat Removal (RHR) Service Water and Emergency Service Water). Accordingly, the loads for certain of these systems were assumed to be powered by the adjacent unit's power source.

3. The target EDG reliability of 0.95 will be maintained.

   a. A target EDG reliability of 0.95 was selected based on having a nuclear unit average EDG reliability for the last 100 demands greater than 0.95, consistent with NUMARC 87-00, Section 3.2.4.

   Additionally, we are following the resolution of Generic Safety Issue B-56 "Diesel Reliability" and will review the guidance documents for their applicability to LGS upon completion.

4. An alternate AC (AAC) power source will be utilized at LGS Units 1 and 2 which meets the criteria specified in Appendix B to NUMARC 87-00. The AAC source is an EAC power source which meets the assumptions in Section 2.3.1 of NUMARC 87-00.

   The AAC power source is available within one hour of the onset of the station blackout event, since operator actions outside the Control Room are necessary in order to actuate circuit breakers from the Control Room. This cross-connect step will be

procedurulized as documented in Section C of this letter. Each EDG as explained in Section A.2, has sufficient capacity and capability to operate systems necessary to achieve and maintain each unit in a safe shutdown condition for the required four-hour coping duration. A dynamic loading analysis has been performed which demonstrates that the EDGs can power the required loads while maintaining the appropriate voltage and frequency standards for a LOOP/Loss of Coolant Accident (LOCA) event. Informal analyses have been performed to demonstrate that the LOOP/LOCA event bounds the station blackout event. This analysis will be revised to include the specific loading sequences due to a station blackout event. An AC independent coping analysis was performed for the one hour required to bring this AAC power source on line.

The AAC power source utilized at the LGS is one of the blacked out unit's four EAC power sources combined with three out of the four EDGs from the non-blacked out unit. After appropriate electrical cross-ties are completed, the AAC source can power all the necessary safe shutdown systems. The four EDGs that comprise the AAC power supply are each rated for 2850kw of continuous operation. This rating is sufficient to power the systems necessary to safely shutdown each unit for the expected station blackout duration of four hours. A single line diagram of the AC power system at LGS Units 1 and 2 is provided in Figures 1 through 9.

The AAC power supply is physically and electrically independent from the other three EAC power systems in the blacked out unit. In addition, this power source is not susceptible to a single point vulnerability whereby a likely weather-related event or single active failure could disable any portion of the EAC power sources or the preferred power supply, and simultaneously fail the AAC source.

Since the AAC and EAC power supplies are identical EDGs, the AAC source could power each unit's typical EAC safe shutdown loads.

B. Proposed Coping Assessment

The ability of LGS Units 1 and 2 to cope with a four-hour station blackout in accordance with NUMARC 87-00, Section 3.2.5 is assessed in this section using NUMARC 87-00, Section 7. This coping assessment considers (1) the adequacy of the condensate inventory, (2) the capacity of the Class IE batteries, (3) the station blackout compressed air requirements, (4) the effects of loss of ventilation on station blackout response equipment, and (5) the ability to maintain containment integrity.

1. Condensate Inventory For Decay Heat Removal (Section 7.2.1)

Using Section 7.2.1 of NUMARC 87-00, we have determined that 92,100 gallons of water are required per unit for decay heat removal for four hours. A calculation was performed which shows that the Condensate Storage Tank (CST) provides 138,800 gallons of water, which exceeds the required quantity for coping with a four-hour station blackout. A

leakage rate of 25 gpm per recirculation pump was assumed in this analysis.

2. Class IE Battery Capacity (Section 7.2.2)

Batteries associated with the DC system for each unit's electrical divisions are designed to have sufficient energy to supply power for four hours. As stated in the LGS Final Safety Analysis Report (FSAR), each Class IE battery bank "... has sufficient capacity without its charger to independently supply the required loads (for design basis accidents) for four hours...." Since the station blackout loads are a subset of the design basis accident loads, the station's battery capacity is sufficient to meet station blackout requirements for four hours. Four hour battery capacity is necessary since some electrical divisions are not expected to have its battery chargers powered during a station blackout. However, once the AAC power source is available, it can be used to power selected battery chargers.

3. Compressed Air (Section 7.2.3)

The AAC power supply is capable of energizing an instrument air compressor and an instrument gas compressor within one hour of a station blackout. The only air-operated valves relied upon during a station blackout are the Automatic Depressurization System (ADS) valves. These valves have sufficient backup air supplies to cope with a station blackout for one hour.

4. Effects of Loss of Ventilation (Section 7.2.4)

The AAC power source does not power cooling loads to some plant areas that contain station blackout response equipment during the hour after the onset of the station blackout event. These areas must therefore be evaluated to establish reasonable assurance of operability for station blackout equipment. This section documents that reasonable assurance of operability is provided for all dominant areas of concern and the containment.

a. Dominant Areas of Concern

The dominant areas of concern (DACs) at LGS Units 1 and 2 were chosen from rooms that, based on documented engineering judgement, (1) contained station blackout response equipment, (2) have substantial heat generation terms, and (3) lack adequate heat removal systems due to the blackout without operator action. These areas are listed in the following table along with their associated station blackout temperature, type of heatup analysis performed, and justification for reasonable assurance of operability.

AREA	TEMPERATURE	OPERABILITY ANALYSIS	JUSTIFICATION
High Pressure Coolant Injection (HPCI) Pump Room	NA	NA	Less than 10 minutes
Control Room	112 °F	Transient (non-NUMARC 87-00)	Less than 120 °F
Auxiliary Equipment Room	134 °F	NUMARC 87-00	NUMARC 87-00 Appendix F
Reactor Core Isolation Cooling (RCIC) Pump Room	139 °F	Transient (non-NUMARC 87-00)	NUMARC 87-00 Appendix F

Reasonable assurance of operability is established if the following criteria are met.

a) The temperatures in the DAC are calculated to be equal to or less than 120 °F, or

b) the system in the DAC is assumed to operate no longer than 10 minutes after the onset of the blackout (Section 7.1.2), or

c) the methodology outlined in Appendix F to NUMARC 87-00 indicates that no components in the DAC have operability limits below the calculated bulk room temperature.

The HPCI system is operated for no longer than 10 minutes at the onset of the station blackout. This abbreviated period of operation is not expected to raise the room temperature significantly. In addition, NUMARC 87-00 Section 7.1.2 indicates that an operability assessment is not necessary for equipment operated without ventilation for the first ten minutes of the transient.

A non-NUMARC 87-00 methodology transient heatup analysis was performed for the LGS Control Room and RCIC Pump Room, and a heatup analysis using the NUMARC 87-00 methodology was performed for the Auxiliary Equipment Room. In each case, the analysis results showed that operator actions such as opening room and equipment cabinet doors will 1) maintain the RCIC Pump Room and Auxiliary Equipment Room bulk air temperature below that which affect equipment operability for the one hour prior to establishing the AAC source powered ventilation and, 2) maintain the Control Room below 120°F so that it is not a DAC for the one hour prior to establishing the AAC source powered ventilation. However, we are considering the performance of additional heatup analyses with the objective of minimizing operator actions.

At this time no modifications are necessary to provide reasonable assurance of operability of equipment in the rooms discussed above. Procedure changes reflecting necessary operator actions may be needed.

b. Containment

Based on engineering judgement, we have concluded that the containment heatup during a station blackout is bounded by the design basis LOCA which leads to the maximum containment pressure and temperature. This design basis event is assumed to occur concurrent with a loss of offsite power (FSAR Section 6.2.1.1). The most severe drywell temperature condition (peak and duration) occurs for a small primary system rupture above the reactor water level that results in the blowdown of reactor steam to the drywell. For this design basis case, we assumed that there is blowdown of reactor steam to the drywell for a six hour period that is required to cooldown the reactor. The drywell temperature profile is assumed to be 340 ^{O}F for the first three hours and 320 ^{O}F for the last three hours. These temperatures were determined by the maximum steam temperature possible during the cooldown. Only one loop of RHR is used to remove heat from the containment via suppression pool cooling. Since there is no offsite power, no drywell cooling is assumed in this analysis.

For the station blackout event, decay heat is directed to the suppression pool via the Safety Relief Valves (SRVs). Suppression pool cooling is used to remove this decay heat. The only direct energy input into the drywell is from Reactor Pressure Vessel (RPV) and piping-related heat losses which are negligible compared to the energy assumed to be transferred to the drywell during a small break LOCA.

5. Containment Isolation (Section 7.2.5)

The station list of containment isolation valves has been reviewed to verify that the valves which must be capable of being closed or that must be operated (cycled) under station blackout conditions can be positioned (with indication) independent of the preferred and blacked-out unit's Class IE power supplies. The valves requiring manual actuation to ensure that appropriate containment integrity can be achieved under station blackout conditions, if necessary, are listed in the following table. The associated procedure changes are documented in Section C of this letter. This analysis incorporated the exclusion criteria listed in NUMARC 87-00, Section 7.2.5. In addition, this analysis also excluded valves that are upstream or downstream of containment isolation valves that meet the NUMARC 87-00 exclusion criteria. This evaluation includes valves that are not locked closed during operation in accordance with recent clarifications.

LIMERICK GENERATING STATION, UNITS 1 AND 2
CONTAINMENT ISOLATION VALVES THAT FAIL "AS-IS" AND DO NOT MEET
THE NUMARC EXCLUSION CRITERIA

PENETRATION DESCRIPTION	VALVE NUMBER
Main Steam Drain	*F019 or *F016
Steam to RCIC Turbine	*F008 or *F007
Steam to HPCI Turbine	*F003 or *F002
RHR Shutdown Cooling Supply	*F008 or *F009
Reactor Water Cleanup Supply	*F004 or *F001
Drywell Purge Supply	HV-57-*63
Drywell Purge Exhaust	HV-57-*61
RHR Containment Spray	*F021A,B or *F016A,B
Suppression Pool Purge Supply	HV-57-*64 or *69
Suppression Pool Purge Exhaust	HV-57-*62 or *66
RHR Pump Suction	*F004A,B,C,D
RHR Pump Test and Minimum Flow	*25A,B
RHR Suppression Pool Spray	*F027A,B
Core Spray Pump Suction	*F001A,B,C,D
Core Spray Pump Test and Flush	*F015A,B
Core Spray Minimum Flow	*F031A,B
HPCI Pump Suction	*F042
HPCI Turbine Exhaust	*F072
HPCI Pump Test and Flush	*F071
RCIC Pump Suction	*F031
RCIC Turbine Exhaust	*F060
RHR Vacuum Relief	*30 or *31
RHR Minimum Flow	*05A,B
HPCI Vacuum Relief	*F095 or *F093
HPCI Pump Minimum Flow	*F012
RHR Suppression Pool Cleanup	*27 or *28
RCIC Vacuum Relief	*F084 or *F080

* Denotes "1" for Unit 1 valves and "2" for Unit 2 valves.

The above list has been revised to include normally closed valves that fail as-is. These valves are closed during power operation and were not originally considered as degrading containment integrity during a station blackout event. Recent guidance has identified these valves as being needed to ensure containment integrity, if necessary, during a station blackout, and therefore these valves will be included in the LGS station blackout procedures.

6. Reactor Coolant Inventory (Section 2.5)

The ability to maintain adequate reactor coolant system inventory to ensure the core is cooled has been assessed for four hours. The HPCI or RCIC system is capable of supplying sufficient condensate inventory to maintain the core covered assuming a leakage rate of 25 gpm per recirculation pump.

C. Proposed Procedures and Modifications

This section documents all procedure changes and modifications which may be required to support the station blackout evaluation for LGS Units 1 and 2 described in this letter.

1. Modifications

No modifications have been determined to be necessary to cope with a four-hour station blackout.

2. Procedure Revisions

The following procedure changes may be necessary to meet the station blackout requirements.

PROCEDURE	REVISION
E-10/20: "Loss of Offsite Power"	(1) Identify operator actions necessary to maintain room temperature within analyzed limits.
	(2) Direct the operators to cross-tie the necessary busses, energize the necessary safe shutdown loads, and observe necessary EDG loading restrictions.
	(3) Identify the containment isolation valves that are required to be manually operated should containment isolation be necessary.

Note: Our April 17, 1989 submittal stated that the above described changes would be made to procedures E-1, "Station Blackout," and T-250, "Containment Isolation." However, the appropriate steps in each of these procedures will be incorporated into procedure E-10/20, "Loss of Offsite Power."

These procedure revisions will be completed one year after the notification provided by the Director, Office of Nuclear Reactor Regulation in accordance with 10 CFR 50.63(c)(3).

Very truly yours,

G. A. Hunger, Jr.

G. A. Hunger, Jr.
Manager
Licensing Section
Nuclear Services Department

cc: T. T. Martin, Administrator, Region I, USNRC
T. J. Kenny, USNRC Senior Resident Inspector, LGS

LIMERICK GENERATING STATION UNITS 1 AND 2

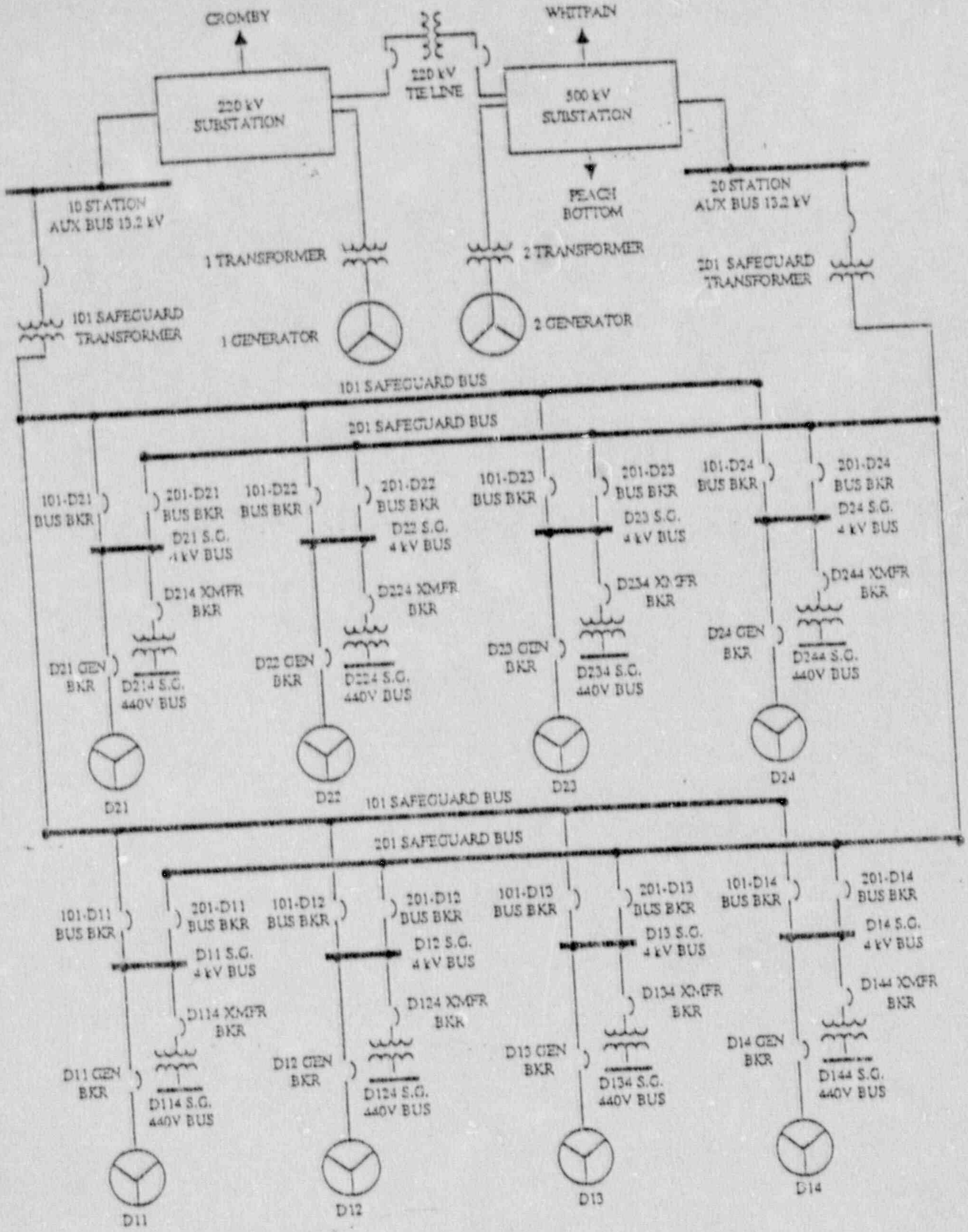

Figure 1 LGS Alternate AC Configuration

LIMERICK GENERATING STATION UNITS 1 AND 2

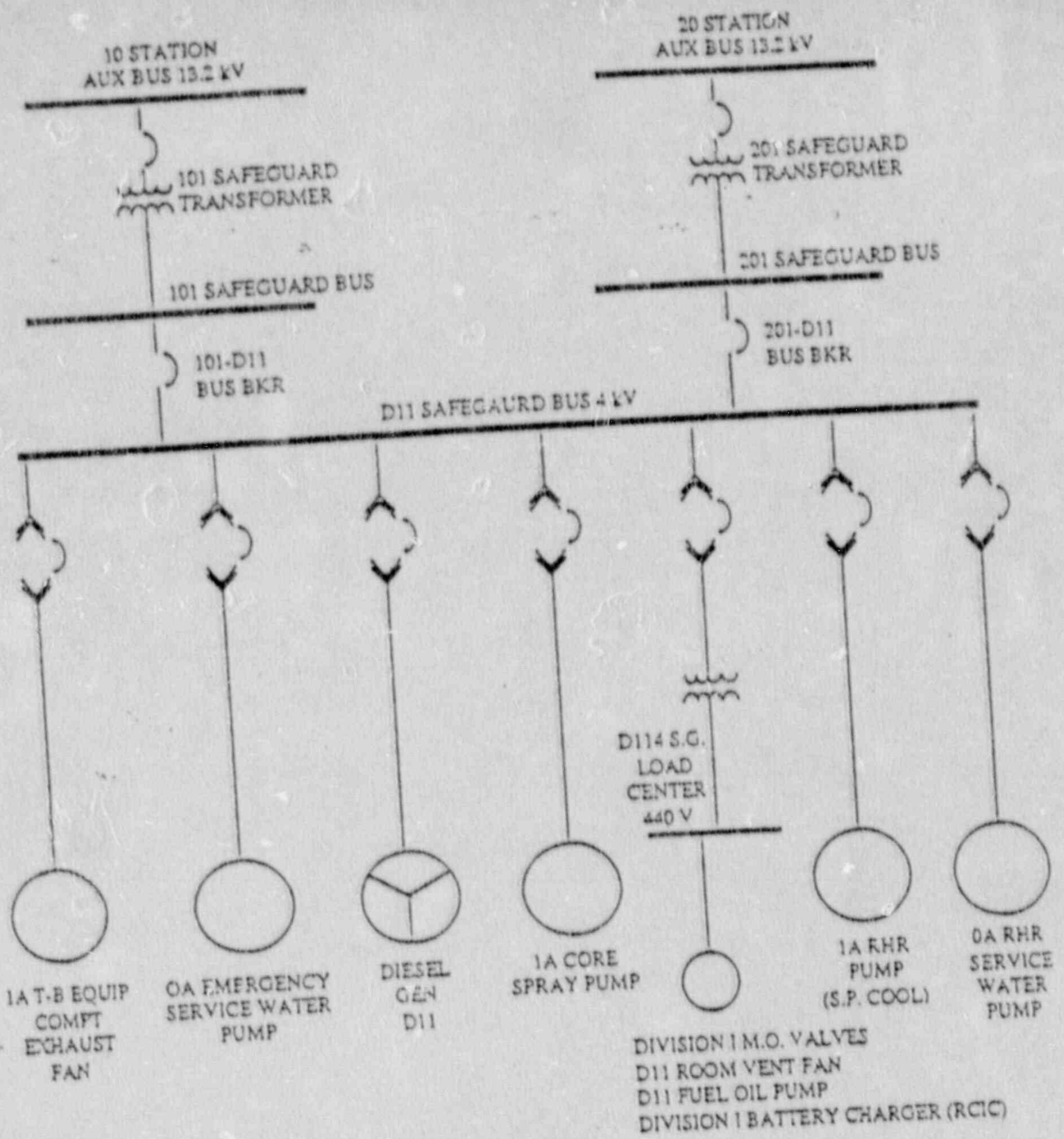

Figure 2 One Line Diagram of D11 Emergency Bus

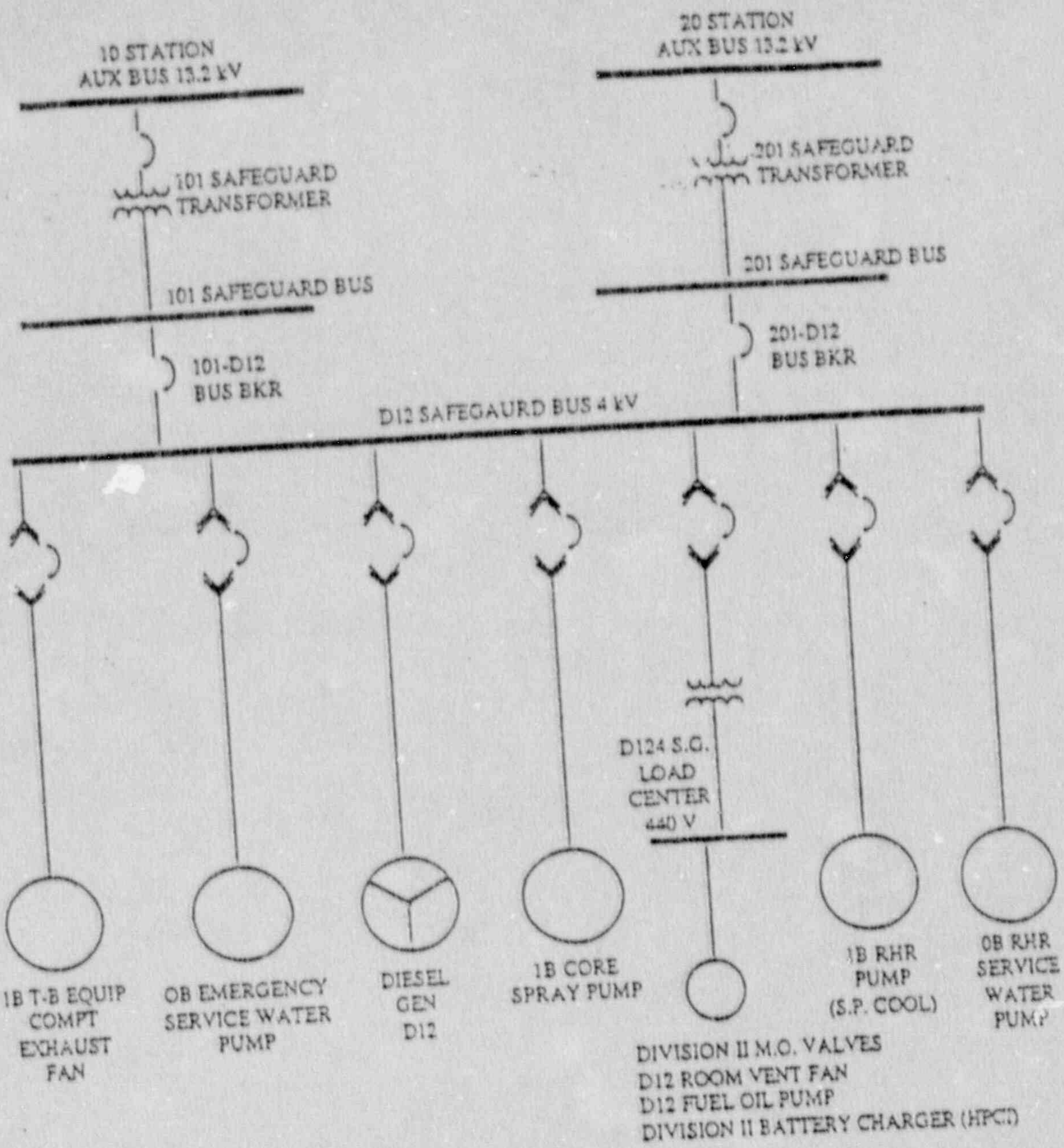

Figure 3 One Line Diagram of D12 Emergency Bus

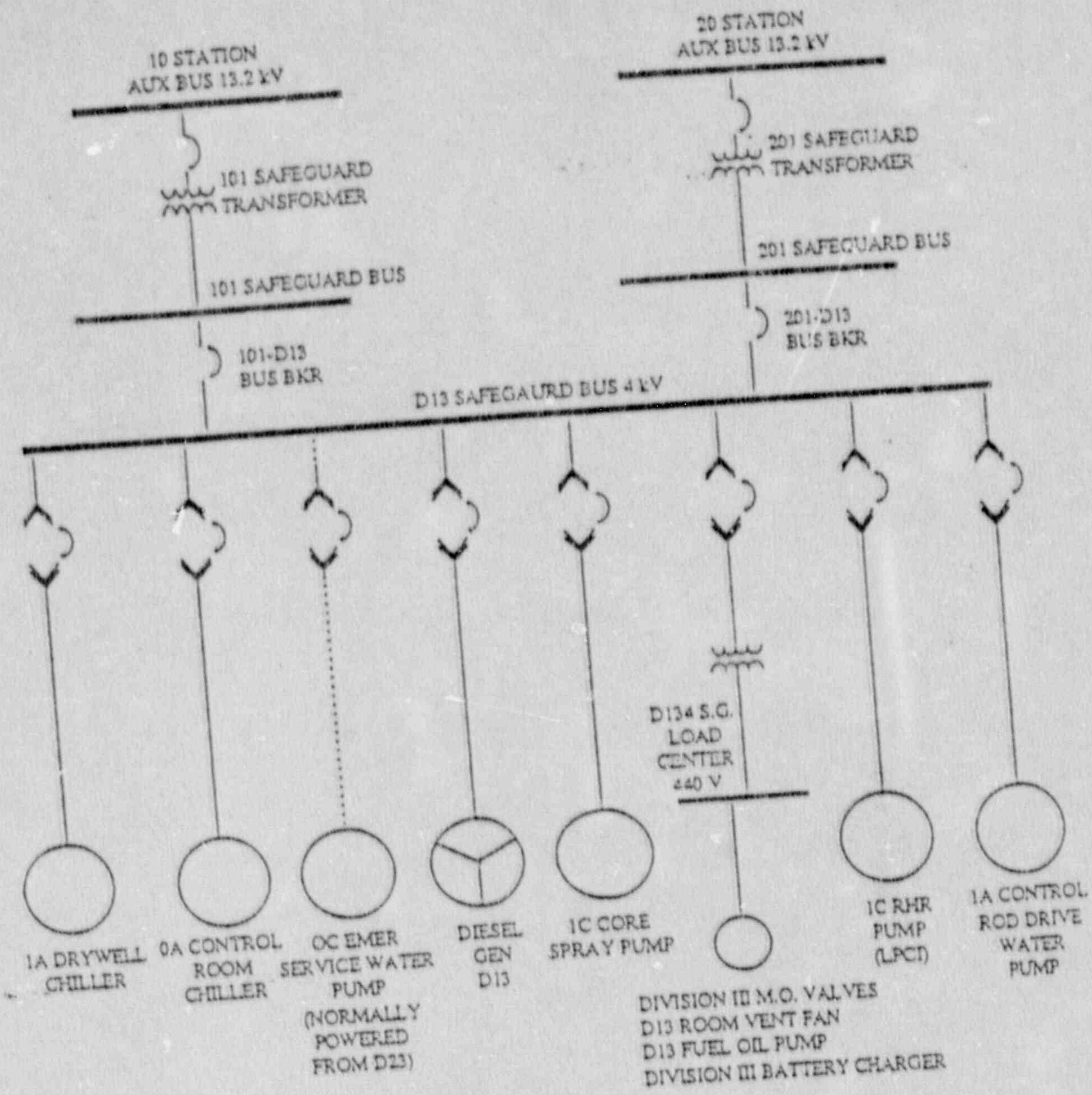

Figure 4 One Line Diagram of D13 Emergency Bus

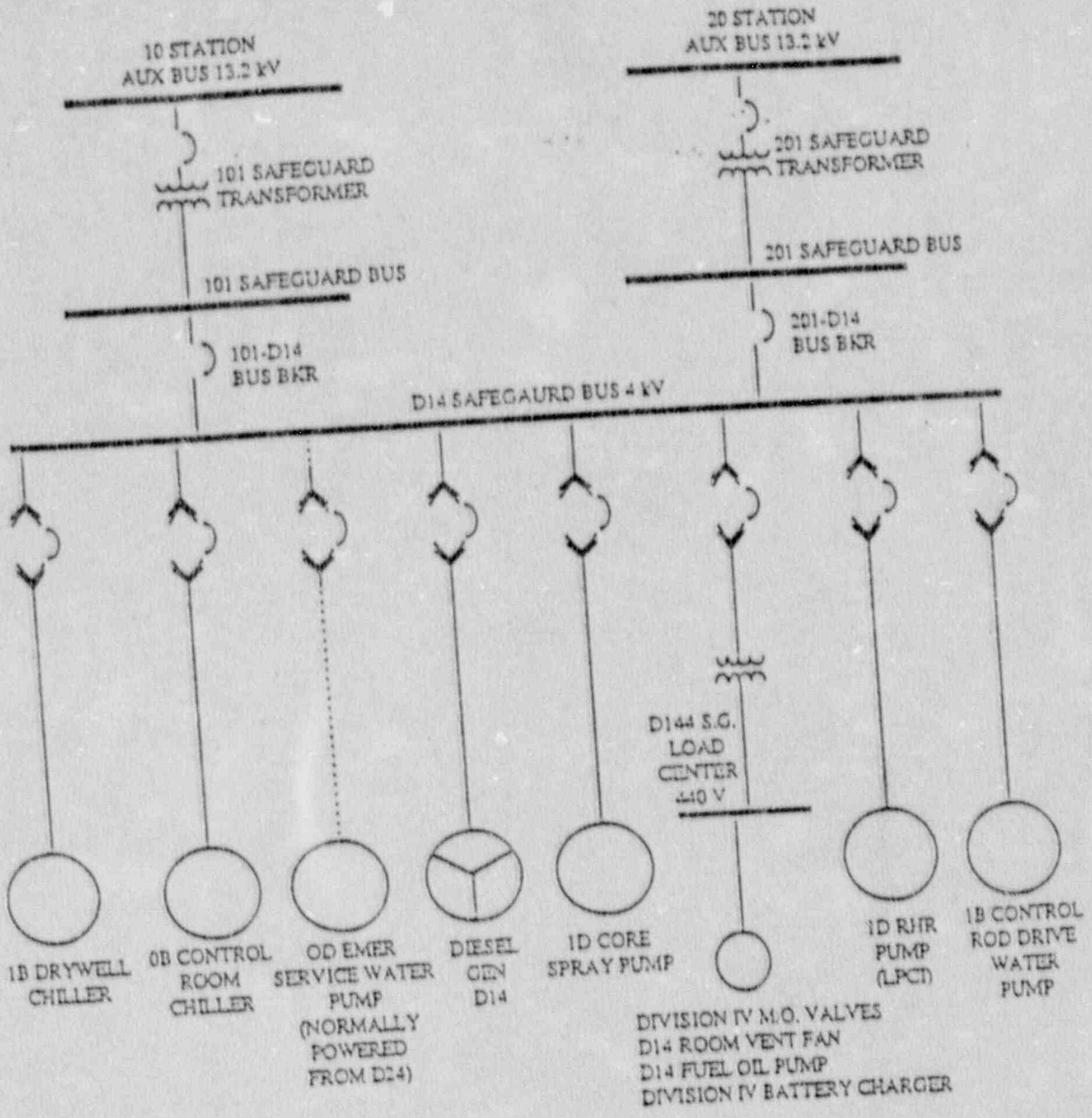

Figure 5 One Line Diagram of D14 Emergency Bus

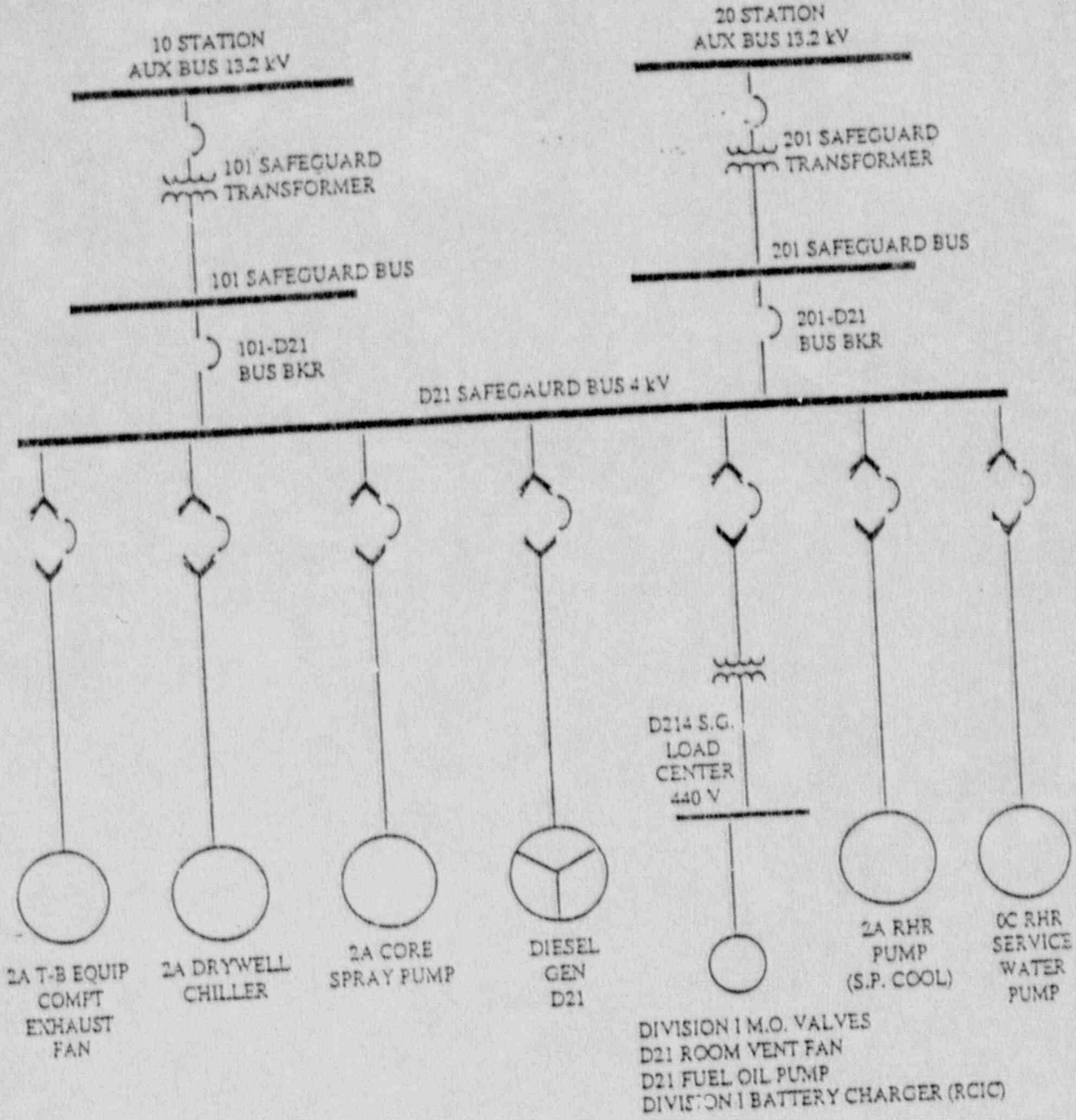

Figure 6 One Line Diagram of D21 Emergency Bus

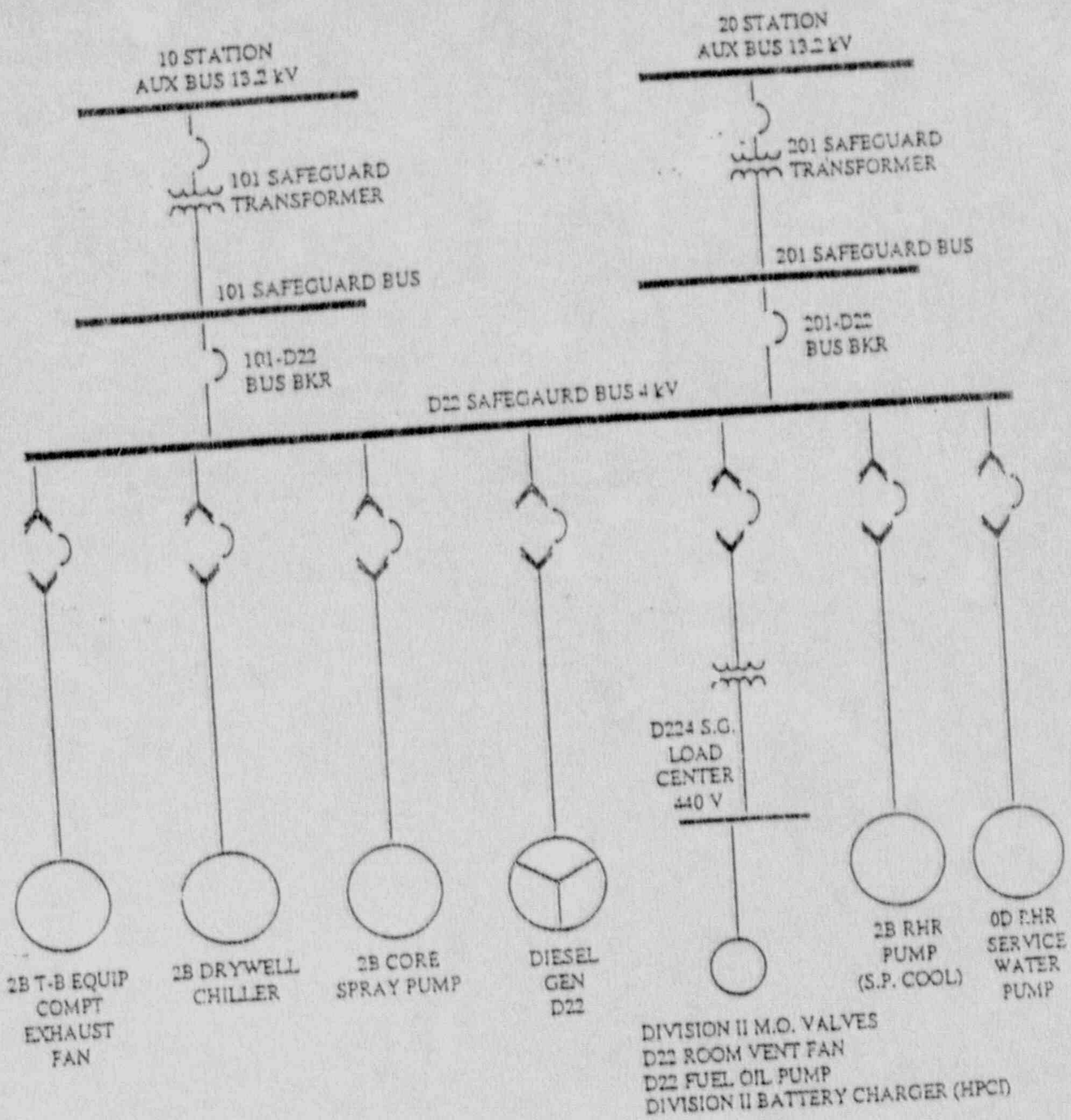

Figure 7 One Line Diagram of D22 Emergency Bus

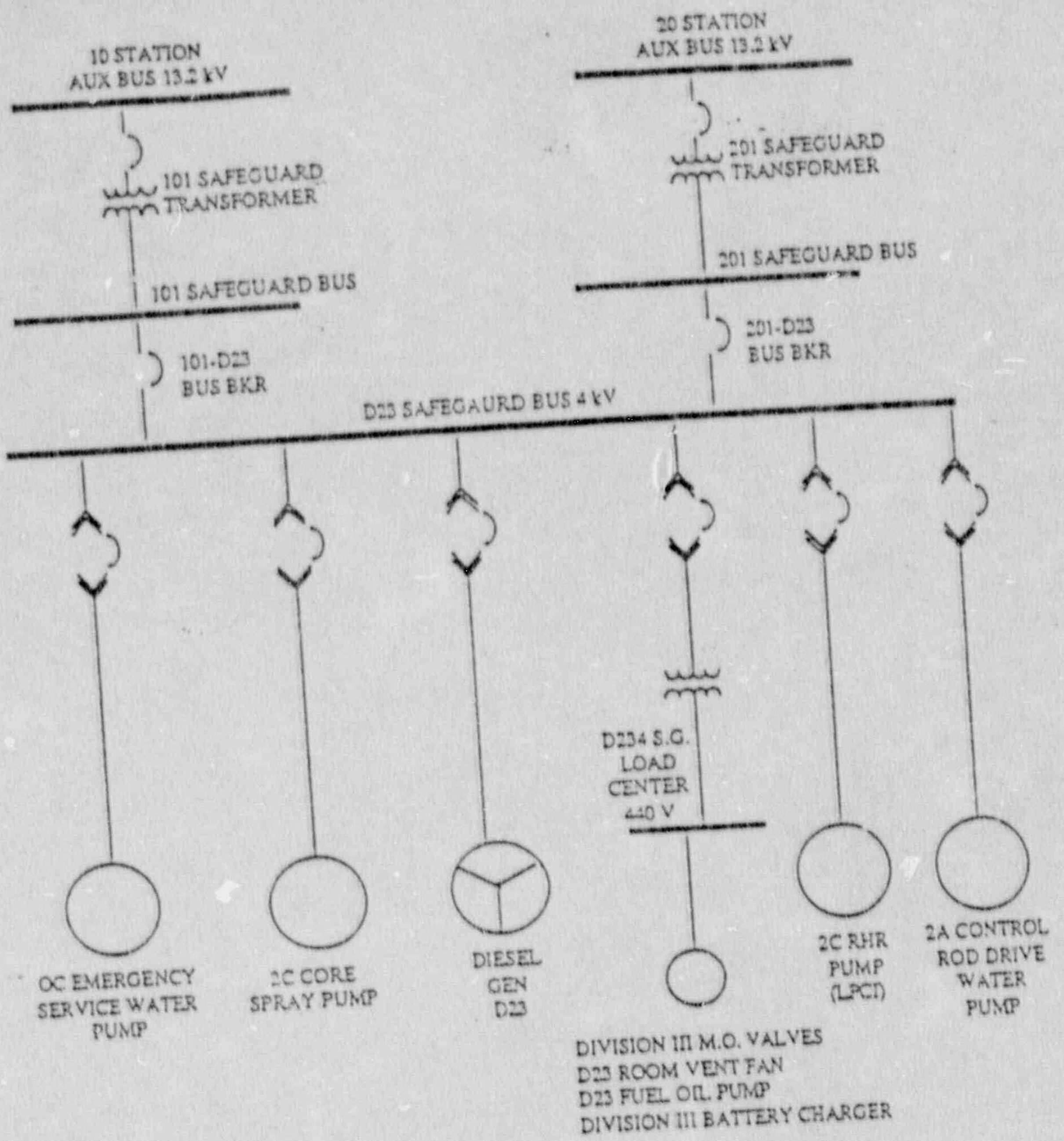

Figure 8 One Line Diagram of D23 Emergency Bus

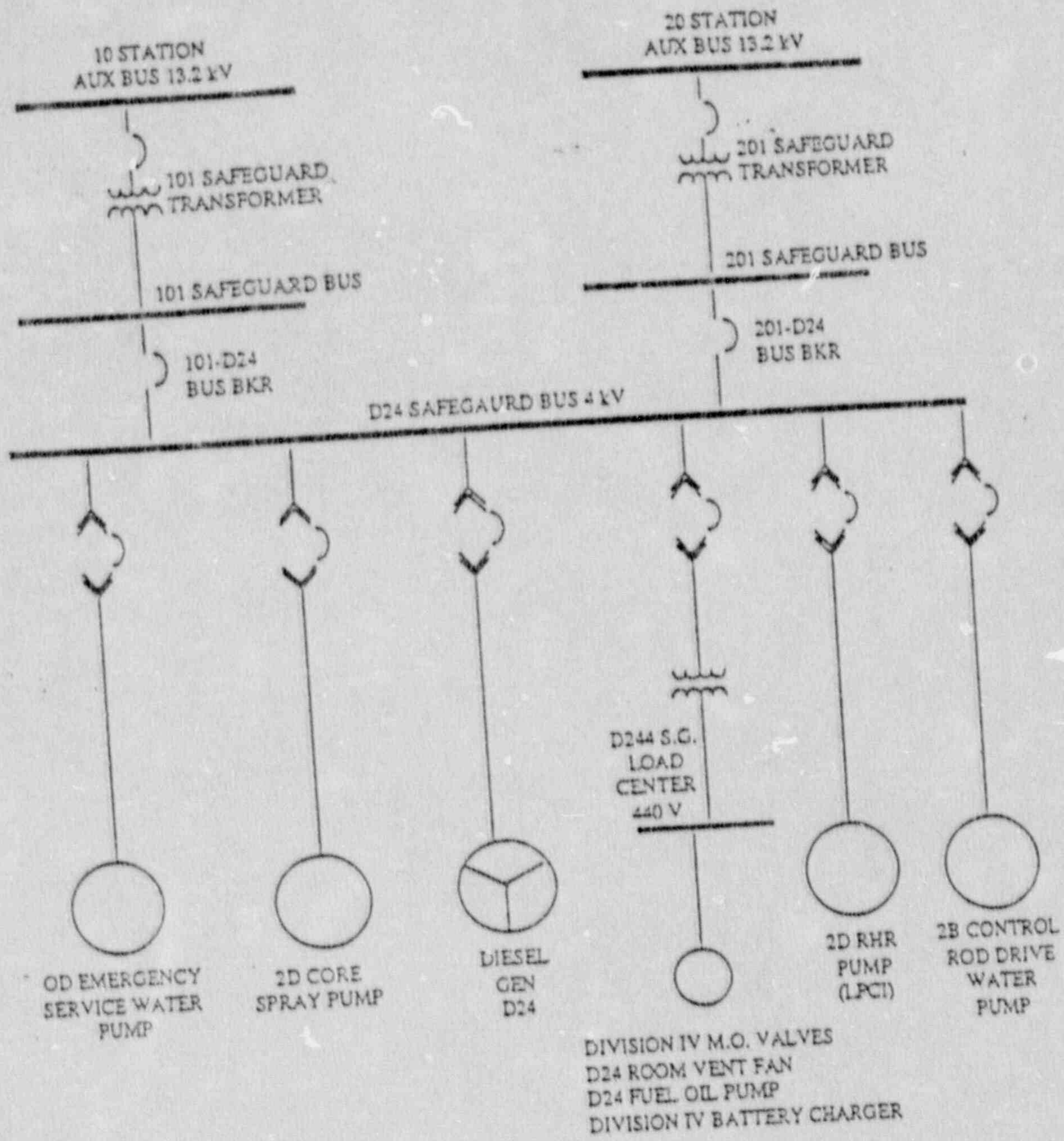

Figure 9. One Line Diagram of D24 Emergency Bus