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DRAWINGS CITED IN THIS CHAPTER*

*The listed drawings are included as "General References" only; i.e., refer to the drawings to obtain additional detail or to obtain background information. These drawings are not part of the UFSAR. They are controlled by the Controlled Documents Program.

DRAWING*	SUBJECT
12E-2C	Plan View of Transmission Lines 34kV, 138kV & 345kV Switchyards
12E-2328	Single Line Diagram, Emergency Power System
12E-2322B	Overall Key Diagram, 125V DC Distribution Centers
12E-2324-2	Key Diagram & Elevation 48/24 VDC Distribution for Neutron Monitoring Unit 2
12E-2325-1	Key Diagram, 120 & 120/240V AC Distribution Essential, Instrument & Reactor Protection Buses
12E-3322B	Overall Key Diagram, 125V DC Distribution Centers

8.0 ELECTRICAL POWER

8.1 INTRODUCTION

Dresden Station, Units 2 & 3, generates and transmits the electric power to the Mid-American Interconnected Network (MAIN), a regional council of the North American Electric Reliability Council (NERC). Dresden Unit 1 was shut down in October, 1978, and reference to it is limited only to its active interfaces with Units 2 and 3.

8.1.1 Design Bases

The offsite power system connection, described in Section 8.2, to Dresden Station are designed to provide a diversity of reliable power sources that are physically and electrically isolated so that any single failure will affect only one source of supply and not the other sources. The onsite power systems, described in Section 8.3, are designed to provide electrical and physical independence of redundant power supplies for systems that are important to safety. In the event of a total loss of offsite power (LOOP), auxiliary AC power required for safe shutdown will be supplied from diesel generators located onsite. These diesel generators are electrically and physically independent. Redundant station batteries provide a source of DC power for specific safety related loads.

8.1.2 Offsite Power Systems - Summary Description

Commonwealth Edison Company's transmission system is interconnected with the MAIN region utilities. Electric energy generated at the station is stepped up to 345-kV by the main power transformers (Transformers 2 and 3) and fed into the station's 345-kV transmission terminal ring buses. The 345-kV buses are connected directly to seven 345-kV transmission lines and indirectly to six 138-kV transmission lines via Transformer 81, Transformer 83, and the 138-kV buses (Figure 8.2-1). Additionally, there are three 34-kV transmission lines that are connected to a 34-kV bus that is fed from the 138-kV buses via Transformer 10. The 34-kV lines supply the power for towns and rural areas near Dresden Station.

The 345-kV ring buses also provide power to two reserve auxiliary transformers (RATs), one per unit. Each of these transformers is supplied from separate sections of the 345-kV ring bus. The Unit 2 RAT is fed from the 345-kV switchyard via TR 86 (345-kV/138-kV) and the Unit 3 RAT is fed directly from the 345-kV switchyard.

Auxiliary power for each unit is also supplied from the unit auxiliary power transformer (UAT), which is connected to the generator leads (see Figure 8.2-1).

Each auxiliary transformer (UAT or RAT) was originally designed to handle the auxiliary power requirements of one unit plus the emergency power requirements of the other unit. Current philosophy does not consider the UAT to be a source for the emergency power requirements of the other unit when the UAT is connected to the generator. When necessary, the RAT of one unit can be connected to the Division II emergency auxiliary equipment of the other unit via circuit breaker switching. Thus, the RAT of one unit can serve as a redundant source of offsite power for the other unit.

Under single transformer operation, administrative controls ensure adequate system voltages are maintained and equipment ratings and/or short-time overload capabilities are not exceeded.

8.1.3 Onsite Power Systems - Summary Description

The onsite ac distribution system has nominal ratings of 4160-V, 480-V, and 208/120-V. The station auxiliary power system is designed to provide reliable power to those auxiliaries necessary for power generation and to those auxiliary systems important to safety. In the event of total loss of auxiliary power, the auxiliary power required for safe shutdown is supplied from three standby diesel generators located onsite. There is one dedicated diesel generator for each unit plus a swing generator that can be utilized by either unit. For further information about onsite ac distribution refer to Section 8.3.1. For specific ac loads refer to Tables 8.3-1, 8.3-2, and 8.3-3.

Startup auxiliary power is provided through the RATs via any one or combination of the 345-kV and 138-kV transmission lines which connect the station to the offsite system.

In addition to the ac power system, each unit has four dc power systems, each with separate batteries (nominally safety related 250-Vdc, non safety related 250-Vdc, 125-Vdc, and 24/48-Vdc), that provide power to dc loads such as motor-driven pumps and valves, control power for equipment such as relays and circuit breakers, and power to the nuclear monitoring systems. Section 8.3.2 describes the dc distribution system.

An alternate AC power source, with a voltage rating of 4160-V, is provided by the Station Blackout diesel generator system. This system is described in Section 9.5.9. This system is non-safety-related.

8.2 OFFSITE POWER SYSTEMS

The CECo offsite transmission system connections to Dresden Station are designed to provide a diversity of reliable power sources which are physically and electrically isolated. Thus, any single failure can affect only one source of supply and cannot propagate to alternate sources. This section describes the offsite power systems at Dresden Station and summarizes the analyses that were performed to demonstrate offsite power reliability and availability.

8.2.1 Description

Dresden Station is connected to the CECo transmission network via CECo-owned substations and transmission lines. Power is supplied to or from the transmission network through the switchyard. The switchyard is rated at 345-kV and distributes auxiliary power to Units 2 and 3. The switchyard consist of the buswork, disconnects, and breakers necessary to control station power inputs and outputs. Electric energy generated by Units 2 and 3 is transformed from generator voltage to transmission voltage by the main power transformers and is transmitted out to the 345-kV system via intermediate transmission towers.

8.2.1.1 Transmission Systems

The transmission lines which interconnect the station and the transmission network leave on two separate transmission corridors and then diverge through the CECo transmission network. The probability of losing the offsite electric power supply has been minimized by the design of the CECo generation and transmission systems. Interconnections to neighboring systems also increase reliability.

8.2.1.1.1 345-kV System

The 345-kV system consists of two ring buses (one for each operational unit) and a normally open tie breaker connecting them. It receives the output of the two units and supplies seven 345-kV transmission circuits (see Figure 8.2-1). The seven 345-kV transmission lines leave Dresden on four separate rights-of-way as shown on Figure 8.2-2. Two lines to Electric Junction and two lines to Elwood Energy Center are on double-circuited towers.

8.2.1.1.2 138-kV System

The 138-kV system is comprised of four bus sections. The four bus sections are connected by two normally closed circuit breakers and one normally open circuit breaker, as shown in Figure 8.2-1. The system receives power from the 345-kV system and supplies six 138-kV transmission circuits via autotransformers TR81 and TR83 (see Figure 8.2-1). The six 138-kV transmission lines leave the station on four different rights-of-way, as shown on Figure 8.2-2. Two lines to Joliet Station and two lines to Mazon Station are on double-circuited towers.

8.2.1.2 Transmission Interconnections

Commonwealth Edison Company is a member of the Mid-America Interconnected Network (MAIN). In general, all electric utilities in Illinois, northern and eastern Missouri, Upper Michigan, and the eastern half of Wisconsin are members of MAIN.

8.2.1.3 Switchyards

Units 2 and 3 each have two independent sources of offsite power available. The normal source of offsite power for Unit 3 is supplied by the 345-kV switchyard through reserve auxiliary transformer (RAT) 32. The alternate source of offsite power for Unit 3 is supplied through the 4-kV crosstie between safety buses 34-1 and 24-1 or safety buses 23-1 and 33-1. The normal source of offsite power for Unit 2 is supplied by the 345-kV switchyard through transformer 86 and RAT 22. The alternate source of offsite power for Unit 2 is supplied through the 4-kV crosstie between safety buses 24-1 and 34-1 or safety buses 23-1 and 33-1. No single bus fault or accidental opening of one breaker will directly result in a complete loss of power to one unit.

An additional source of off-site power is available when the main generator is off-line by backfeeding through the main power/unit auxiliary transformers. The backfeed operation must be manually performed and involves removal of flexible link connections between the main generator and main power/ unit auxiliary transformer. Minor control and protective relay changes are controlled by procedure.

The 138-kV and 345-kV switchyards are interconnected by two 138-kV - 345-kV autotransformers (TR81 and TR83), which are connected to separate sections of the 138-kV bus. A 40-MVA 138-kV - 34-kV transformer also connects to a section of the bus. There are also transformers between the 138-kV and 345-kV systems at Electric Junction, Lombard, and Goodings Grove.

The output from the 138-kV - 34-kV transformer (TR10) is sent to one 34-kV bus. The three 34-kV lines connected to this bus supply power for towns and rural areas near Dresden Station. A tap off one of these 34-kV lines also feeds a standby transformer for Unit 1 (TR13).

Two sources of dc power for breaker control are provided by the 345kV switchyard system 1 and system 2 125V batteries. Any redundant cables to the switchyard are run in separate conduits. For more information on the dc systems refer to Section 8.3.2.

8.2.1.3.1 Switchyard Component Separation

The 138-kV and 345-kV switchyards are separated by a distance of approximately 1000 feet. The bus positions for the main and auxiliary transformers for both units are separated by at least one unrelated bus position in the 345-kV switchyard. Incoming lines to the switchyard are separated by at least one bus position. Because of the above separation, a bus section which is damaged by fire or mechanical means can be isolated and will not affect the entire switchyard. The switchyards have not been designed to withstand natural disasters such as earthquakes and tornadoes.

The main power transformers (MPT), RATs, and unit auxiliary transformers (UATs) for Unit 2 and Unit 3 are separated by a distance of more than 350 feet. The RAT for Unit 2 is 50 feet away from the main and unit transformers. The RATs for Units 1 and 2 are separated by a concrete block firewall. TR 86 is separated from both Units 2 and 3 transformers by more than 1000 feet. Separation of the Unit 3 transformers is similar to that given above for Unit 2. Refer to Drawing 12E-2C for a plan view of the switchyards.

In addition, each of the transformers (MPT, RAT, and UAT) for Units 2 and 3 has a deluge system for fire protection. Provisions have been made to prevent local damage due to fire or mechanical means from affecting more than one component. The transformers have not been designed to cope with natural disasters, such as earthquakes and tornadoes.

The combined microwave and meteorological tower is located away from the transmission lines and switchyards so that it cannot cause failure of the offsite power sources.

8.2.1.3.2 Auxiliary Power Connections to the Switchyards

The auxiliary power supply for Unit 2 is split between UAT 21, which is connected to the Unit 2 generator leads, and RAT 22, which is connected to the 345-kV switchyard via transformer 86.

RAT 22 is connected to the 138-kV output of Transformer 86 via a short transmission line and a 138-kV circuit breaker. Transformer 86 is a 345-kV to 138kV auto transformer located adjacent to the 345-kV switchyard and connected to the 345-kV switchyard through the circuit breakers.

The auxiliary power supply for Unit 3 is split between UAT 31, which is connected to the generator leads, and RAT 32, which is connected to the 345-kV switchyard.

The auxiliary transformers (UAT and RAT) step the generator and transmission voltages, down to the station 4160-V system level. The auxiliary power supplies from the 345-kV transmission system is protected against the effect of unplanned outages by the diversity of seven separate 345-kV circuits, and two major generating units feeding into the 345 switchyard at the Dresden site. Each unit has adequate auxiliary power available from the 345-kV switchyard from the diesel generators.

Protection of the RATs, including their secondary circuits and devices, from lightning and surges is provided by surge arresters applied on the primary side of the transformers.

The failure of any one component in the 345-kV transmission systems would not cause a simultaneous outage of both buses at Dresden.

8.2.2 Analysis

The CECo transmission network has been designed to maintain availability at acceptable levels. Analyses have been performed to demonstrate that electrical failures in the network would not result in unstable operation.

8.2.2.1 Availability Considerations of the Transmission Network

The offsite power sources provide sufficient capacity and capability (see Section 8.3) to start and operate safety-related equipment. This ensures that the fuel design limits and the design conditions of the reactor are not exceeded during normal operation and that the reactor core can be cooled and maintained in a safe condition in the event of postulated accidents. Because the sources to the site are normally energized, they are immediately available to the station.

The offsite power sources for the station auxiliary power system provide redundancy, as well as electrical and physical independence, so that any single failure can affect only one source of supply and cannot propagate to alternate sources. While it is highly unlikely that all transmission lines could be out-of-service simultaneously, such an event would not jeopardize safe shutdown of the station because the onsite standby diesel generators would be able to supply the necessary power to the systems required for safe shutdown (see Section 8.3).

One of the functions of MAIN is to ensure that the transmission system is reliable and adequate. Power flow and transient stability studies are conducted on a regular basis using the criteria stated in MAIN Guide No. 2.[1]

The transmission system at CECo is designed to meet all the criteria listed in the MAIN Guide No. 2.

MAIN Guide No. 2 stipulates that the generation and transmission system shall be adequate to withstand the most severe of the identified set of contingencies without resulting in an uncontrolled widespread tripping of lines and/or generators with resulting loss of load over a large area.

The ability of the CECo transmission system to withstand the loss of transmission lines connecting the Dresden switchyards to the network has been investigated through separate stability studies for each station to demonstrate adequacy of the transmission system. The electric systems in Wisconsin, Iowa, Illinois, and Indiana were all represented in lesser detail.

8.2.2.2 Stability Analysis

An analysis was made to determine the response of the external power grid to the sudden loss of both Dresden Units 2 and 3 (the worst case as compared to the loss of only one unit) and the effects on the availability of offsite power. The conclusion of this study was that the external power system would be able to supply the station requirements continuously both immediately after the loss of both units and later when generation on the power system is readjusted to make up the lost generation. The design of the offsite power system is in compliance with NRC General Design Criterion (GDC) 17.

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The auxiliary power supply from the 345-kV transmission system is protected against the effect of unplanned outages by the diversity of seven separate 345-kV circuits and two major generating units feeding into a ring bus in the switchyards at the station (see Figures 8.2-1 and 8.2-2).

As a result of an NRC request, a site-specific analysis was made to determine system voltages under various system conditions, including severely degraded conditions.

Through the analysis CECo determined the following:

A. The maximum expected load terminal voltages occur when the switchyard voltage is maximum and there are no unit loads;

B. The minimum expected continuous load terminal voltages (when not sharing an offsite power source) occur when the switchyard voltage is at a minimum and, except for those loads automatically shed due to a unit trip, the auxiliary bus loads and the Class 1E loads are maximum; and

C. The minimum expected transient load terminal voltages occur under the conditions of item B above, concurrent with the start of a large load.

Periodic studies are performed to ensure that the offsite power system voltage remains adequate to ensure the reliability of offsite power to the Dresden units.

With respect to the requirements of GDC-17, these results indicate that the possibility of losing electric power from the transmission network due to the loss of power generation from a unit is minimal.

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8.2.3 References

1. MAIN Guide Number 2, "Criteria for Simulation Testing of the Reliability and Adequacy of the MAIN Bulk Power Transmission System."

Table 8.2-1

This table intentionally deleted.

8.3 ONSITE POWER SYSTEMS

The station electrical distribution system design includes sufficient power sources and redundant buses to provide reliable electrical power during all modes of station operation and shutdown conditions.

The onsite power systems are divided into two main categories, ac and dc. The following sections provide detailed descriptions for each of the power systems and the analyses associated with them.

8.3.1 AC Power Systems

The onsite ac power system consists of two main generators, two main step-up transformers, two unit auxiliary transformers (UATs), two reserve auxiliary transformers (RATs) one 345/138-kV auto transformer, distribution buses, and three standby diesel generators (DGs). The distribution system has nominal ratings of 4160-V, 480-V, and 120/208 V.

The offsite ac power system supplies power to the onsite auxiliary power system through two RATs (one per unit). Only when being back fed from the grid, the UAT is another source of offsite power. Physical changes to the generator links are required to place the plant in an alignment to allow backfeed. Refer to Section 8.2 for more detailed information on the offsite distribution system.

The auxiliary power system provides adequate power to operate all auxiliary loads necessary for station operation. A diagram of the principal elements of the auxiliary electrical system is shown in Drawing 12E-2328, and the equipment listings are shown in Table 8.3-1. Auxiliary power is provided by the UATs connected to the unit generator isolated-phase bus and the RATs connected to the 345-kV switchyard, as shown in Figure 8.2-1. The UATs and RATs supply power to the equipment used to maintain a safe and operable plant. The auxiliary loads are split between the UAT and RAT for each unit. The auxiliary transformers step down the voltage to 4160-V to supply the auxiliary buses.

The station auxiliary buses can also be connected, by appropriate switching sequences, to the DGs which provide power in the event that the 345-kV switchyard and the unit generator are incapacitated. Thus, the DGs provide another independent source of auxiliary power to the station.

Plant layout provides physical separation of bus sections, switchgear, interconnections, feeders, power centers, motor control centers (MCCs), and other system components. Loads important to plant safety are split and diversified between switchgear sections, and circuit breakers are provided for prompt location and isolation of system faults.

All protective circuit breakers are sized according to standard electrical industry practice. That is, the maximum current interrupting capabilities of the circuit breakers exceed the available line-to-line or three-phase short-circuit current, taking into account the impedances of the generator, transformers, and other electrical system components. Certain non-safety 4kv circuit breakers have an intentional tripping time delay on short circuit interruption to allow the short circuit to delay to within the interrupting capability of the circuit breakers.

However, a 1991 NRC inspection team determined that several 250-MVA and 350-MVA circuit breakers could receive fault currents in excess of their maximum interrupting rating. The report noted that CECo performed a safety evaluation and concluded that because of redundancy and availability of emergency power sources operability of ESF loads can be maintained. The affected 250 MVA circuit breakers have been upgraded to 350 MVA with interrupting ratings higher than the calculated maximum 3-phase fault current for Buses 23, 24, 33 and 34.

The multiplicity of lines feeding the auxiliary buses, the redundancy of transformers and buses within the plant, and the divisions of critical loads between buses yield a system that has a high degree of reliability and integrity. Physical separation of buses and service components is designed to limit or localize the consequences of electrical faults or mechanical accidents occurring at any point in the system. It is therefore improbable that both electrical power sources would be lost simultaneously because each is supplied from a different source. However, the possibility of loss of normal auxiliary power is considered, and provisions for any such event have been made.

On loss of auxiliary power the reactor will scram, and the DGs will automatically start and carry the vital loads for an indefinite period. The buses are arranged so that the DGs are easily connected to the vital loads.

The loss of auxiliary power cannot prevent a reactor scram since stored pneumatic energy and reactor pressure are the driving forces for the control rods. In addition, the standby diesel generator and station battery are available for emergency operation of reactor instrumentation, isolation valves, emergency core cooling system (ECCS) pumps, and other critical systems. The station batteries (discussed in Section 8.3.2) serve as a reliable source of power for specific vital loads.

The DGs have capacity for operation of all systems required to shutdown the unit and maintain it in a safe shutdown condition. The DGs are physically independent from any normal power source, and each power source, up to the point of its connection to the auxiliary power bus, is capable of complete and timely electrical isolation from any of the other sources.

8.3.1.1 Main Generator and 18-kV System

The main generator and 18-kV systems provide electrical power to station auxiliaries via the UAT and provide electrical power for distribution to CECo and the Mid-America Interconnected Network (MAIN) transmission systems via the main transformer.

8.3.1.1.1 System Description

The main generator of each unit is connected through an isolated-phase bus to the low side of the main transformer and the high side of the UAT. The high side of the main transformer is connected to the offsite power system, and the low side of the UAT is connected to the onsite power system.

8.3.1.1.2 System Components

The major components of each unit's main generator and 18-kV system are the main generator, the isolated-phase bus, the main transformer, and the UAT.

8.3.1.1.2.1 Main Generator

The main generator converts the rotational mechanical energy of the main turbine into electrical energy. The ratings of the main generators are given in Table 8.3-1.

Syncho-check type are provided in the generator circuitry to prevent non-synchronous connection of the main generator to the grid.

8.3.1.1.2.2 Isolated-Phase Bus

The generator output leads, called the isolated-phase bus, are contained in outdoor metal-clad enclosures from the generator terminals to the transformer terminals. Forced cooling is necessary to operate the isolated-phase bus at the generator rating. The rating of the isolated-phase bus can be found in Table 8.3-1.

8.3.1.1.2.3 Main Transformer

The main transformer steps the 18-kV generated voltage up to 345-kV for distribution to the CECo and MAIN transmission systems. The main transformer windings are delta connected on the secondary (18-kV) side and grounded-wye connected on the primary (345-kV) side. The main transformer rating is given in Table 8.3-1.

8.3.1.1.2.4 Unit Auxiliary Transformer

The UAT (TR21 for Unit 2 and TR31 for Unit 3) steps the 18-kV generated voltage down to 4160-V for use by the station auxiliaries. The transformer windings are delta connected on the primary (18-kV) side, and each of the two windings on the secondary (4160-V) side are grounded-wye connected. The transformer rating is given in Table 8.3-1.

8.3.1.2 4160-V System

The 4160-V system provides ac power to the station auxiliaries that are needed for plant operation.

The electrical loads for each unit are split between two systems of three 4160-V auxiliary buses each. The engineered safety features (ESFs) equipment associated with each system can be powered by the DGs. For Unit 2, one system includes buses 21, 23, and 23-1; the other includes buses 22, 24, and 24-1. Buses 23 and 23-1 are designated as Division I and buses 24 and 24-1 are designated as Division II. Each bus has its own feeder breakers. If a short circuit occurs on one of the buses, that bus is isolated by the opening of its breaker, thus leaving the other division's buses and corresponding required equipment available for use. A similar system is provided for Unit 3.

Buses 21 and 22 provide power to the feedwater pumps and the reactor water recirculating pump motor-generator sets. Buses 23, 24, 23-1, and 24-1 supply power to all other plant services. The general design requirement is to supply duplicate services from different buses. Failure of either bus 21 or bus 22 will still facilitate station operation at reduced output. This also applies to the Unit 3 system.

Some of the components used for control, sensing, and automatic operations in the system include: GE Type IAV and ABB Type 27N and 27N-R relays for the detection of bus undervoltage; GE Type HFA, HGA, and HEA auxiliary relays for necessary multiplication of contacts to achieve simultaneous functions; GE Type CR2820 and Agastat type ETR timing relays; GE Type SB-1 or SBM control switches; and seismically qualified Westinghouse Type SA-1 relays, which are in the output breakers of the Unit 2, 3, and 2/3 DGs and provide generator differential overcurrent protection. These electrical devices are of the heavy-duty industrial type, conservatively rated and applied, and with which there have been many years of excellent operating experience. All control power comes from the 125-Vdc system supplied from the station battery.

8.3.1.2.1 System Description

Normal power is supplied to the 4160-V system from the main generator and 18-kV bus through a UAT and also from the 345-kV system through a RAT.

During normal operation, a portion of the station auxiliary load is supplied from the UAT, and the remainder of the load is supplied from the RAT. When the generator is not operating, as during startup, shutdown, or unit trip, the loads fed from the UAT are transferred to the RAT. The transfer of the 4160-V buses from the UAT to the RAT is performed manually during startup and normal shutdown. This same transfer is accomplished automatically, following a unit generator trip, provided that a fault does not exist on the bus. This transfer occurs fast enough to preclude load trip due to undervoltage. Under single transformer operation, administrative controls ensure adequate system voltages are maintained and equipment ratings and/or short-time capabilities are not exceeded.

The unit's RAT is the primary offsite source to the essential service system (ESS) buses. The RAT of the other unit provides a second offsite power source through a bus tie provided between corresponding ESS buses of the two units. Additionally, the UAT of either unit provides another source of offsite power to the ESS buses only when the unit is shutdown and the UAT is being back fed from the grid. Physical changes to the generator links are required to place the plant in an alignment to allow backfeed. There are manual crosstie connections between buses 23-1 and 33-1 and between buses 24-1 and 34-1 which may be used to supply power from one unit to the other under abnormal conditions. Bus 40 is shared between the units and is the mechanism by which standby diesel generator 2/3 supplies either bus 23-1 or 33-1. Because of the configuration of the control circuitry, under normal conditions bus 40 does not supply power to both units simultaneously. However, procedural provisions exist that allow bus 40 to feed both units simultaneously if conditions warrant such an alignment.

A partial firewall with an open accessway is installed between the 4160-V switchgear 23-1 and 24-1 to prevent fire from spreading from one switchgear area to the other for Unit 2. A similar barrier is also installed between switchgear 33-1 and 34-1 for Unit 3.

8.3.1.2.2 System Components

The major components of the 4160-V system are the UAT, the RAT, the 4160-V switchgear, and the circuit breakers. The UAT is described in Section 8.3.1.1.2.4.

8.3.1.2.2.1 Reserve Auxiliary Transformer

The RAT (TR22 for Unit 2 and TR32 for Unit 3) steps switchyard voltage (345-kV through TR 86 to 138-kV for TR22 and 345-kV for TR32) down to 4160-V for use with station auxiliary loads. The ratings of the RATs and TR86 can be found in Table 8.3-1. The primary winding and each of the two secondary windings (4160-V) for either RAT are grounded-wye connected.

TR86 is a 345kV to 138kV auto transformer with a load tap changer (LTC) on the 138kV output. When operating in its automatic mode, the automatic LTC raises and lowers voltage by operation of the tap changer via the LTC controller. The combination of a deenergized (no load) tap changer and the LTC determines the overall range of the TR86 output. The LTC on TR86 provides a range of +/- 10% of the rated voltage in 33 steps, each step being approximately 0.62%. The no load tap changer, which can only be changed when TR86 is de-energized, has five taps or positions. Each tap corresponds to a voltage difference of 2.5% in five steps for a range from –5% to +5% of nominal. Therefore, the full potential range of the transformer is approximately +/- 15% with adjustments to optimize the no load tap.

TR32 is a 345-4.280-4.280kV three winding transformer with an LTC on the 4.280kV X-winding. The LTC on TR32 will provide a range of approximately +25% to –5% of the rated voltage with 33 positions, each step being approximately 0.93% of rated voltage.

The TR32 and TR86 LTCs may be operated in manual or automatic (voltage regulating) modes. Controls for manual mode operation are available in the Main Control Room and at the transformer local control cabinet. The automatic LTC utilizes both a primary and backup controller. The backup controller prevents the primary unit from running the secondary side voltage outside of the desired upper and lower limits in the event of a primary controller failure.

Automatic operation of the LTC was evaluated in license amendment number 219/210 approved by the NRC. The evaluation determined that the potential failure modes of the LTC are not likely to cause a common mode failure of the safety related equipment powered from TR86 or TR32. A failure in which the LTC rapidly increases or decreases transformer output voltage is not likely, since both the primary and backup controllers would have to fail. A failure of the LTC to respond to changing transmission system voltage would occur slowly and can be mitigated by operator action.

8.3.1.2.2.2 4160-V Switchgear

The 4160-V switchgear provides a means of enclosing the bus work, breakers, and relays associated with the 4160-V system. The switchgear for the 4160-V buses is a metal-clad indoor type and is located in both the reactor and turbine buildings. Flow deflectors have been installed above buses 23-1 (33-1) and 24-1 (34-1) to assure that any leakage from piping which runs above the switchgear will not impinge on the switchgear. Buses 23 (33) and 24 (34) do not have piping overhead and therefore do not need similar protection.

8.3.1.2.2.3 Circuit Breakers

Circuit breakers provide a means for isolating loads and power supplies from the 4160-V buses. Typical current ratings for 4160-V circuit breakers are 1200A, 2000A, and 3000A. Circuit breakers for the 4160-V system are three pole, electrically operated, with a 125-Vdc stored energy closing mechanism. Maintenance of 4160-V breakers is performed in accordance with Dresden

Maintenance Procedures. Safety-related and nonsafety-related breakers are functionally tested on a periodic basis, and each cubicle is inspected and cleaned, if necessary. These procedures are intended to minimize breaker failure.

8.3.1.3 480-V System

Power is supplied from 4160-V buses 23, 24, 23-1, and 24-1 to 480-V buses through six separate transformers. The 480-V buses supply power to electrically operated auxiliaries. The 480-V buses are of the indoor load center type which, in addition to supplying power directly to the 480-V motor loads, also supply the transformers used in stepping down the voltage to 120/208-V or 120/240-V for lighting, instrumentation, and small plant service loads. The equipment vital to safe plant shutdown under accident conditions is supplied by 4160-V buses 23-1 and 24-1, and by 480-V buses 28 and 29. Additionally, the containment cooling service water pumps described in Section 9.2, which are used for long-term safe plant cold shutdown, are supplied with electrical power from buses 23 and 24. These buses can be backfed from buses 23-1 and 24-1 under accident conditions. A similar arrangement exists for Unit 3.

Transformers and switchgear for the 480-V buses are located in the turbine and reactor buildings. Switchgear for each load center is in self-supporting metal clad sections with continuous main buses having draw-out units that are replaceable under live bus conditions. Circuit breakers within the switchgear are either operated electrically using power from the 125-V station battery or they are operated manually.

8.3.1.3.1 System Description

The 480-V system consists of six switchgear buses for each unit. These buses supply large 480-V motors (such as fans) and 480-V MCCs for the control of small 480-V motors (such as valve motors). Each 480-V bus is fed from a 4160-V bus via a 4160-V-480-V transformer. The following list identifies the 4160-V bus associated with each 480-V bus:

A. 4160-V bus 23 (33) feeds 480-V bus 25 (35);

B. 4160-V bus 24 (34) feeds 480-V buses 20, 26, and 27 (30, 36, and 37);

C. 4160-V bus 23-1 (33-1) feeds 480-V bus 28 (38); and

D. 4160-V bus 24-1 (34-1) feeds 480-V bus 29 (39).

Buses 28 and 29 (38 and 39) are 480-V ESS buses. Bus 28 (38) is designated as Division I and Bus 29 (39) is designated as Division II. These buses can be powered by the DGs via the 4160-V ESS buses 23-1 and 24-1 (33-1 and 34-1) respectively.

Motor control centers are designated by the feeding bus number followed by a sequential number (e.g., MCC 28-1 is fed by bus 28).

Manual crossties exist between buses 25 and 26 (35 and 36), buses 25 and 27 (35 and 37), and buses 28 and 29 (38 and 39) to supply power to one of these buses in the event its normal supply is lost.

Table 8.3-1 lists the auxiliary power main equipment, their rating, loads fed from the 4.16 KV switch and gives a sample listing of the loads on various 480-V switchgear and MCC units.

8.3.1.4 120-V Systems

The main function of the 120-V system is to provide a reliable source of 120-V, 60 Hz, single-phase power for plant controls and instrumentation. This system is divided into three different subsystems:

A. 120-V reactor protection system,

B. 120-V instrument bus system, and

C. 120-V essential service system.

Drawing 12E-2325-1 provides an overview of the 120-V systems.

8.3.1.4.1 Reactor Protection System

The RPS loads for each unit are fed from one of two buses. Each 120-V RPS bus is supplied by a motor-generator set. M-G set 2A (3A) is fed from 480-V MCC 28-2 (38-3) and M-G set 2B (3B) is fed from 480-V MCC 29-2 (39-2). A reserve supply to each RPS bus exists from 480-V MCC 25-2 (35-2). This reserve supply is mechanically interlocked with the normal supply for each bus to prevent simultaneous feed from both sources. A key interlock is also provided to ensure that MCC 25-2 (35-2) cannot feed both RPS buses simultaneously. A detailed description of this system is provided in Section 7.2.

8.3.1.4.2 Instrument Bus System

The instrument bus system supplies 120-V power for various control circuits, relays, solenoids, and instruments. The normal power supply to the instrument bus is MCC 28-2 (38-2); the alternate power supply is MCC 25-2 (35-2). On loss of the normal power supply, an automatic bus transfer (ABT) switches power to MCC 25-2 (35-2) and transfers it back upon restoration of normal power (normal seeking ABT).

8.3.1.4.3 120-V Essential Service System and Uninterruptible Power Supply

The ESS bus supplies 120-V power to certain essential loads for which even a momentary interruption of power could cause deleterious effects. Some of these loads include:

A. Standby gas treatment initiation logic;

B. Feedwater level control system;

C. Rod worth minimizer;

D. Rod position indication relays;

E. Neutron monitor recorders;

F. Generator hydrogen and stator cooling control;

G. Recirculation pump speed control circuit;

H. Channel B - Primary containment isolation system logic (PCIS); and

I. Main steam line radiation monitors channels A and C.

The 120-V ESS bus is designed to remain in service even if all sources of ac power, including the DGs, should fail. Normal power to the ESS bus is supplied from a 35-kVA static (solid-state), uninterruptible power supply (UPS). The UPS has three power sources available to it: the 480-V Bus 25 (36), the 480-V Bus 29 (39), and the safety related 250-Vdc system.

The static UPS systems (see Figure 8.3-3 for a typical UPS arrangement) consists of the following equipment:

A. A rectifier to convert three-phase 480-Vac power (preferred source) to safety related 250-Vdc;

B. Auctioneering diodes to select between the rectifier output and the safety related 250-Vdc supply;

C. An inverter to convert safety related 250-Vdc to 120/240-Vac, three-wire, single-phase power;

D. A static switch of auctioneering diodes or thyristors to select between the inverter output and a 120/240-Vac, three-wire, "reserved" source;

E. A line voltage regulator for the reserve ac source;

F. Circuit breakers for each of the three power sources;

G. A circuit for holding the inverter output in synchronism with the reserve source;

H. A manual transfer switch for bypassing the static switch and selecting either the inverter or the reserve source; and

I. Related devices such as instruments, meters, alarms, relays, switches, and fuses.

A malfunction of the static UPS system will have no adverse affects on the bus because it is physically separated and electrically isolated, by the use of circuit breakers, from the Class 1E bus.

8.3.1.4.4 Computer Bus

The computer bus supplies electrical power to the process computer, the main computer, the rod worth minimizer computers, and the fire protection system computer. This bus is normally fed from 480-V switchgear 36 through a 100-kVA UPS. The alternate supply is from 480-V switchgear 25 with backup from a dedicated 250-Vdc battery should the normal and alternate sources fail.

8.3.1.5 Standby Diesel Generator System

The standby diesel generator system produces ac power at a voltage and frequency compatible with normal bus requirements. Each unit has its own DG sized to carry the ECCS power requirements on one unit or supply that power necessary for safe shutdown of the unit. Another DG is shared by Units 2 and 3. In addition, the system is of sufficient capacity to start all initial loads it is expected to drive.

The primary basis for using a standby diesel generator system is to provide an independent source of onsite electric power for the station auxiliaries. Actually, normal sources of power are very reliable and the probability of truly random coincident failures of all sources of power into the station is very low. If the failures were random, standby power would probably not be necessary. However, all the external sources of power entering the plant are carried on overhead lines with a certain vulnerability to storms of wind, lightning, and ice. The standby diesel generator system is provided to guard against the contingency of the concurrent forced outage of all normal sources of power. As a consequence, it is imperative that the diesel generator system not be influenced by the same environments that affect the normal sources of power. For these reasons, the DG air starting capability is completely self-contained and, aside from fuel and the 125-Vdc control power, no outside power source is required for it to start.

8.3.1.5.1 System Components

The physical locations, in relation to each other, of the DGs and emergency buses for the present design provides a great degree of independence. Each DG is housed in its own concrete block cell with an independent fuel supply serving each diesel engine (refer to Section 9.5.4 for a description of the DG fuel oil system). Two of the DGs are housed in reinforced concrete block cells in the turbine building, and the third DG is located in a concrete vault next to the reactor building. Equipment connecting the DGs to the auxiliary equipment consists of metal enclosed switchgear and metal enclosed bus ducts. The location of the DGs within concrete structures and provision of the metal enclosed switchgear and bus ducts assures protection against damage from tornadic winds or missiles.

The buses between the DGs and the emergency buses are routed through the turbine and reactor buildings in such a manner so as to prevent interaction between them in the event of damage to a bus section. Power cables from the emergency buses to the ECCS are also routed to preclude any possible interaction.

Each DG is rated at 2600 kW at 0.8 power factor for continuous operation. They also have a 2000-hour, 10% overload rating of 2860 kW at 0.8 power factor. The DGs supply power to the 4160-V buses, as shown in Drawing 12E-2328.

Each diesel generator system is designed to start automatically within 13 seconds and accept full load within 30 seconds of loss of all normal sources of power (see Figures 8.3-4 through 8.3-7). The engine is preheated, and starting power is self-contained (compressed air) and is not dependent on the availability of any other source of normal plant power at the moment of starting; however, 125-Vdc control power is needed for the initial excitation of the generator, as well as the startup logic and starting air system control. The rapid start capability of the DGs is consistent with the requirement for core cooling under postulated accident conditions.

If at any time during the first 40 seconds any one of the loads should drop or fail to start, the design load-torque margin of the DG would increase. If a major pump should be dropped for any reason, the diesel generator governor is designed to recover from the drop of the largest single load without exceeding predetermined voltage and frequency and while maintaining a specified margin to the overspeed trip.

Each diesel generator is also provided with manual start control and is equipped with means for being started periodically to test for readiness and for synchronizing with the auxiliary power system without interrupting the service of the plant.

DG size has been determined from station design and power requirements. The starting load requirement is a factor in sizing the generators. They are capable of starting and carrying the largest vital loads required under postulated accident conditions. The generators may be manually loaded to rated capacity at the discretion of the operator. Alarms are provided which will annunciate upon an overloaded condition.

Each DG is protected from start failure (overcranking) and by the following trip mechanisms:

A. After an Auto Start, the DG will trip on a diesel engine overspeed or high generator differential current. The diesel generator output breaker will trip on a high generator differential current.

B. After a Manual Start, the DG will trip on a diesel engine overspeed or high generator differential current in addition to any of the following engine trouble conditions: high engine temperature, low water pressure, low bearing oil pressure, or high crankcase pressure.

   After a Manual Start, the diesel generator output breaker will trip on diesel engine overspeed or high generator differential current in addition to any of the following electrical trouble conditions: underfrequency, loss of field, generator ground fault, generator overcurrent or reverse power.

A start failure or overspeed trip will stop fuel injection and shut down the diesel. The control room will receive an alarm when the diesel is tripped for any of the previously listed reasons. To restart the diesel after a trip, the actuated trip relay(s) must first be reset at the engine control panel.

For a discussion of the diesel fuel oil storage and transfer system, see Section 9.5.4. For the DG cooling water system, see Section 9.5.5. For the starting air system, see Section 9.5.6. For diesel generator lubrication, see Section 9.5.7. For the DG combustion air intake and exhaust, see Section 9.5.8.

8.3.1.5.2 System Arrangement

The interconnection between the standby diesel generator system and the ac power system is depicted on Drawing 12-2328. DG 2 provides power to the Division II ECCS equipment for Unit 2, and DG 3 provides power to the same equipment for Unit 3. DG 2/3 provides power to the Division I ECCS equipment for either Unit 2 or Unit 3. The connection of the DGs to their respective buses occurs automatically.

There are also a number of manual capabilities within the system. For example, DG 2 can power the Unit 3 main 4160-V ESS bus, if desired, by manually closing two circuit breakers. Also, the DG system can backfeed to the main unit 4160-V auxiliary buses from the 4160-V ESS buses by manually closing two circuit breakers. However, such manual operations are possible only under certain specific conditions because interlock devices are installed to protect against possible fault conditions. For example, connecting DG 2 to Unit 3 4160-V ESS bus cannot be accomplished if DG 3 is already connected to that bus. Such flexibility is an operational convenience designed and controlled such that safety is not jeopardized.

8.3.1.5.3 System Loads

The loads supplied by the diesel generator system are grouped into two main categories:

A. Loads required for accident conditions, which start automatically upon restoration of bus voltage by the diesel generator system; and

B. Loads required for safe shutdown conditions, which are started either automatically or manually.

The first and second category loads are connected to 4160-V buses 23-1 or 24-1(33-1 or 34-1) or to the associated 480-V buses 28 or 29 (38 or 39). Other loads may be connected by the station operators through normally open, manually operated breakers. This arrangement reduces connected loads to a practical minimum without eliminating the ability to select alternate loads.

During accident conditions, two diesel generators are used for redundancy. Table 8.3-2 lists the Category 1 loads which are on each diesel generator. Category 1 loads are those DG loads that automatically start when the DG is connected to the buses on an accident signal. Category 2 loads are those loads required to maintain a safe shutdown condition.

In addition to supplying the Category 2 loads listed in Table 8.3-3, the DG system is available on a manual basis to feed other loads, including essentially all of the equipment on buses 23, 24, 23-1, and 24-1 of the 4160-V system and lower voltage systems connected to the 4160-V systems. The connections of such other loads must be made with regard to overload restrictions. A similar arrangement exists for Unit 3.

All the ESF systems are designed to be loaded onto the DG buses automatically whenever accident signals are received. For example, when the design basis accident (DBA) defined as a loss of offsite power (LOOP) concurrent with a loss of coolant accident (LOCA) occurs, the DG is started upon initiation of the accident signal. Approximately 20 seconds after the DBA, the first low pressure coolant injection (LPCI) pump is started and is pumping at minimum flow, 5 seconds later the second LPCI pump is started and is pumping at minimum flow, and finally, 10 seconds after the first LPCI pump starts, the core spray pump is started and is pumping at minimum flow. Typically, the greatest loading occurs when the core spray pump is started, which is illustrated below:

Loads on DG	
Running loads when core spray pump starts	1,219.86 KVA
Starting loads when core spray pump starts	369.96 KVA
Starting power required for core spray pump	5350.39 KVA
TOTAL	6,570.25 KVA

General Motors has provided data indicating successful starting of a 1750-hp motor followed by two 600-hp motors in succession from a single DG of the same capacity as the DG being used in this plant. These motors are quite similar to the initial motor loads for this unit. It is concluded, therefore, that the loading on the Dresden DGs is within the capacity of each diesel generator with adequate margin.

The above analysis is for one DG. When an accident signal is present, two DGs, each powering the loads as summarized in Table 8.3-2, will be in operation. As can be seen by the detailed load listing in Figures 8.3-4 through 8.3-7, the automatically sequenced load will not exceed 2600-kW continuous rating of the EDG.

Diesel generator loading is evaluated and monitored by a computer based electrical load monitoring system. The load values used in the electrical load monitoring system models for determination of Diesel Generator loading are calculated based upon the expected brake Hp, KVA or KW of loads under accident conditions. The electrical load monitoring system program applies motor efficiencies and power factors in the conversion of brake horsepower to generator output required to power the loads. Actual test data were used when available. Individual load requirements in the electrical load monitoring system diesel generator models are updated as required to reflect changes in the plant.

The manual loading of the DG is not considered in the accident analysis because operator action will not be necessary until after 10 minutes: by this time the core flooding associated with a DBA is complete.

Section 6.3.3.1.4.1 describes station procedures addressing a dual unit LOOP with an accident on one unit.

8.3.1.5.4 Primary Operational Characteristics

From an operational standpoint, each DG is capable of either parallel or independent operation. Likewise, the emergency bus system is designed to operate either sectionalized or with a crosstie between Units 2 and 3. Therefore, under a situation in which all offsite power is lost, the operator has the ability to cope with all types of onsite emergencies.

Under normal operating conditions the ECCS of Unit 2 are powered from buses 23-1 and 24-1 (refer to Drawing 12E-2328). These buses receive power from 4160-V buses 23 and 24, which are fed from the UAT, and the normal offsite ac power sources via the RAT. In the event of loss of these power sources, buses 23-1 and 24-1 are automatically disconnected from buses 23 and 24 and connected to DG 2/3 and DG 2 respectively. Simultaneous with the interruption of power from 23 and 24, all nonessential loads on the buses supplied by 23-1 and 24-1 are tripped from the buses. Similarly, the major loads on the main 4160-V auxiliary buses 23 and 24 are tripped. This general sequence of events occurs in a similar manner on Unit 3.

The 480-V swing MCC 28/29-7 (38/39-7) is made up of two MCCs whose buses are connected with cables (copper link) to form one continuous bus. The purpose of this common bus is to provide a dual source of power to the LPCI and recirculation valves for operation in the LPCI mode.

The 480-V swing MCC 28/29-7 (38/39-7) is normally supplied from DG 2(3) through 4160-V bus 24-1 (34-1), Transformer 29 (39), and 480-V bus 29 (39) during a loss of offsite power with or without an accident signal. Should the DG 2(3) power source fail, the ac contactor and breaker feeding MCC 28/29-7 (38/39-7) from 480-V bus 29 (39) will open automatically and the breaker and contactor feeding MCC 28/29-7 (38/39-7) from 480-V bus 28 (38) will close automatically restoring power to the swing MCC from DG 2/3 through 4160-V bus 23-1 (33-1), Transformer 28 (38) and 480-V bus 28 (38). A time delay relay is utilized to allow sufficient time for switching between busses in the event that the DG 2/3 is required. The source breaker and ac contactor to 480-V swing MCC 28/29-7 (38/39-7) are electrically interlocked, such that DG 2(3) and DG 2/3 are isolated from each other at all times. Loss of Division II DC control power will not prevent the automatic transfer to the alternate supply.

Design changes were implemented that supplement the previously described automatic transfer logic by initiating an automatic transfer based upon voltage and frequency abnormalities when the 480-V swing MCC 28/29-7 (38/39-7) power is being supplied from DG 2(3). The transfer is accomplished through the use of the undervoltage, overvoltage, and under/overfrequency protective relays which monitor and initiate a bus transfer if voltage and frequency conditions are above or below the relay setpoints and exceed the specified relay time delays. See Table 8.3-7 for typical relay setpoints.

In the event of an accident on a unit, DG 2/3 will start and close-in on the unit experiencing the accident if no offsite power is available. This is accomplished by using the accident signal to prevent DG 2/3 from closing-in on the nonaccident unit. For example, referring to Drawing 12E-2328, if an accident should occur in Unit 2, a high drywell pressure signal (or a low-low reactor water level signal with a low reactor pressure signal), would start DG 2 and DG 2/3, would initiate core spray, and would initiate shedding of nonessential 480-Vac loads such as the drywell coolers, recirculation M-G set vent fans, south turbine pump building vent fans, and the condensate storage tank heaters. This signal would also prevent the closing of the breaker between DG 2/3 and bus 33-1.

The DG close permissive circuit contains a time delay contact to prevent a non-synchronous closure. This relay is picked up by one of the auxiliary relays in the undervoltage relay scheme and is set at 2 seconds ± 10% to allow the back electromotive force (EMF) from motors on this bus to decay. This relay assures that bus voltage decay and load shedding take place prior to closure of the DG feed breaker.

The time delay relay will have no effect on the DGs when no ESF actuation signal is present. The DG start signal is from an undervoltage auxiliary contact, and therefore the DGs will start immediately on an undervoltage signal. The time delay contact effects only the closing of the DG feed breaker, and as this relay is set for approximately 2 seconds, it will have timed out before the DG is ready to accept load, which is approximately 10 seconds after starting.

A synchronizing relay is in the manual-close circuit of each DG 4160-V output breaker to prevent inadvertent, out-of-phase closure within the system. The device is an electronic synchro-check relay connected in the manual-close circuit at a point that will not interfere with the auto-close circuit. A failure of the synchronizing relay will not block the auto-close feature. Also, the capability to close into a dead bus remains available by local control of the 4160-V breakers at the switchgear.

8.3.1.5.5 Tests and Inspections

Since the DGs are utilized as standby units, readiness is of prime importance. Readiness can best be demonstrated by periodic testing, which insofar as practical, simulates actual emergency conditions. The testing program is designed to demonstrate the ability to start the system and show its ability to run under load long enough to verify that cooling and lubrication are adequate for extended periods of operation. Full functional tests of the automatic circuitry will be conducted on a periodic basis to demonstrate proper operation.

Preoperational tests have verified and demonstrated that the DG equipment was constructed in accordance with the specifications and that the DG and related equipment function properly to perform the service intended. The loads described in Tables 8.3-2 and 8.3-3 were used to check the DG system and establish the capability of the DG to supply the rated power during an accident. This included the sequential loading of each ECCS pump following a simulation of the accident signal.

The DGs are started manually on a periodic basis to demonstrate their availability. Routine surveillances are performed to maintain the equipment.

8.3.1.6 Plant Electrical Cabling

This section describes the types of cables used both inside and outside the drywell. It also describes the cable penetrations into the drywell, cable pan routing and spacing, and overcurrent protection and derating of cables.

8.3.1.6.1 Types of Cable Being Used Outside the Drywell

8.3.1.6.1.1 Power Cables

Characteristically, the power cables are three-conductor type or large single-conductor type. The power cables have polyvinyl chloride (PVC) or neoprene jackets, which aid in resisting "squashing," burning, or flame propagation. Single-conductor, 4160-V cables have metallic shields under the jacket.

8.3.1.6.1.2 Control Cables

In general the control cables are multiconductor, although there are single-conductor control cables. Most multiconductor control cables have jackets made of PVC or neoprene. Typically, single-conductor control cables do not have jackets.

8.3.1.6.2 Types of Cable Being Used Inside the Drywell

Cross-linked polyethylene (Vulkene) insulation is used on cables in the drywell and in the electrical penetrations. This insulation has excellent radiation and moisture properties and meets all NEPIA requirements for this type of service. The temperature rating of the insulation is 90°C for normal service, 130°C for emergency conditions, and 250°C for short circuit conditions.

Whittaker-type cables are used inside the drywell in addition to those cables which have the insulation described above.

8.3.1.6.3 Cable Penetrations into Drywell

8.3.1.6.3.1 Location

Cable penetrations are located in the four geographical quadrants of the drywell. Cables for ESF systems and PCIS are divided so that one portion (Division I) is in penetrations in one quadrant, and the other portion (Division II) is in penetrations in a different quadrant.

8.3.1.6.3.2 Incore Instrumentation Penetrations

The incore instrumentation utilizes four shielded cable penetrations. Table 8.3-4 lists the penetration numbers and the instrumentation channels that the cables supply.

All four penetrations carry two intermediate range monitor (IRM) channels and two penetrations carry local power range monitor (LPRM) channels for the two average power range monitor (APRM) channels. The arrangement of the incore channels in the penetrations is such that loss of a penetration and cabling will not prevent a scram if it is required. For example, if penetration X-202N and associated cabling were lost, APRM Channels 1 and 5 would be unavailable. If a high flux condition were present, a trip on Channel 2 or 3 would result in protective action on reactor protection system Channel A. Likewise, this condition would result in a trip of Channel 4 or 6, either of which would initiate protective action on Channel B and therefore a scram. The same situation holds for the IRM channels. In addition to the separation discussed above, no power cables are run in these shielded penetrations.

8.3.1.6.3.3 Low-Voltage Power and Control Penetrations

Low-voltage and control penetrations carry both power and control cables, but the same criterion as is indicated above is used: i.e., loss of a penetration will not result in loss of scram function or ESF action. Refer to Section 3.8.2 for a mechanical description of the penetrations.

8.3.1.6.3.4 High-Voltage Power Penetrations

High-voltage penetrations are used to carry 4160-V power to equipment such as recirculation pumps in the drywell. There are no control or instrumentation cables in these penetrations, and none of these penetrations carries cables for the RPS or ESFs. Refer to Section 3.8.2 for a mechanical description of the penetrations.

8.3.1.6.3.5 Current-Carrying Ratings of Cables in Penetrations

The current-carrying capacity of cables used in drywell penetrations is conservatively limited when compared to the National Electric Code (NEC).

8.3.1.6.3.6 Pan-Routing

Division I cables are routed in Division I pans. Division II cables are routed in Division II pans. Division I and Division II cables are not permitted in the same pan section. As modifications are incorporated into the plant design, whenever practical, greater separation between Class 1E and non-Class 1E loads is provided in accordance with the philosophy stated in the Regulatory Guide 1.75. When new systems are installed they are in accordance with current standards (e.g., IEEE-384) where practical.

Division I pans and Division II pans follow different, physically separated routes through the plant. Where Division I pans and Division II pans are in close proximity, consideration is given to whether external potential sources of fire or missiles are present. If there are none, pans are permitted in close proximity. Two barriers of metal must then be present, however, to prevent a fire in a pan of one division from adversely affecting the cables in the pans of the other division. One barrier is the bottom of one pan; the other, a metal cover over the other pan. If there are two tiers of pans in very close proximity (less than 1 foot between the nearest surfaces) and if there is a Division I pan in one tier and a Division II pan in the other, an additional metal barrier is provided. Additional detail regarding pan routing is addressed in GE Design Specification 22A2501.

8.3.1.6.4 Design and Spacing of Cable Pans

Cables are carried in solid-bottom, steel, sheet metal cable pans throughout the power plant. The pans have 6-inch high metal sides, with the top edges of the sides turned inward. (Ladder-type metallic pans are used in areas in which potential non-electrical sources of fire are not present, e.g., in the drywell and in areas where cables run from the pan down to or up to equipment such as MCCs or switchgear.) Spacing of cable pans is designed to minimize the effect of a missile or fire. Specific requirements for cable pan spacing is addressed in GE Design Specification 22A2501.

8.3.1.6.5 Overcurrent Protection and Derating of Cables

8.3.1.6.5.1 Overcurrent Protection

Overcurrent protection on power circuits is provided by circuit breakers (which trip all three phases) rather than fuses (each of which trips only one phase).

The electrical power system is connected grounded-wye rather than delta. The 4160-V systems are grounded through resistors, and the feeder circuits have (corresponding) neutral-ground relaying. Faults can continue to be energized from one feeder circuit to another through noncleared phases on a delta-connected, fuse-protected system.

8.3.1.6.5.2 Derating of Current-Carrying Capacity of Cable in Pans

The current carrying capacity of cable is limited by the continuous temperature rating of the insulation. The ambient temperature, the heat generated in the conductor and the heat transfer from the conductor to ambient all affect the current carrying capacity. The quantity and type of cables in cable pans affect the heat transfer. Record is kept of the quantity and type of cable at each section of the cable pan system. Allowable ampacity is established for every cable at a given cable pan section to assure that no cable will have a continuous conductor temperature in excess of the temperature rating of the cable insulation. Cable size or the different routing paths that can be taken by the new cables are used to meet the allowable criteria.

8.3.1.7 Analysis of Station Voltages

A study and a transient analysis were conducted at the original plant design stage to confirm the ability of the DG to start and accelerate the emergency cooling pumps. The major focus of this effort was to determine the effect of the voltage dips on the running motors. Should the running motors fail to develop sufficient torque to overcome the load torques, they will decelerate toward a stall condition. If they decelerate below the breakdown-torque speed, they will draw high currents (inrush current reduced proportionately with the voltage) and compound the voltage dip problem. The manufacturer's design performance data was used for the pumps, drive motor, and diesel characteristics to conduct the transient studies. The results of these studies are reflected in the designed starting sequence and have been used in determining if the undervoltage relay setpoints are adequate from a motor-starting and voltage dip standpoint. The analysis of the undervoltage relays is described in the following paragraphs.

In addition to the first level "loss of voltage" relays which protect against a LOOP condition by initiating the sequence of events discussed in Section 8.3.1.5.4, a second level of undervoltage relays has been added to each of the 4160-V buses 23-1 (33-1) and 24-1 (34-1) to protect against a degraded voltage condition. As noted above, a degraded voltage condition causes induction motors to draw more current and results in the motor windings becoming overheated. If the degraded voltage condition persists for 7-seconds, an annunciator alerts the operator and a 5-minute timer is initiated. After 5-minutes have passed, the DG is started, the incoming line breakers are tripped, load shedding is initiated, and the DG breakers close when the existing permissives are satisfied. The 7-second time delay prevents circuit initiation due to grid disturbances and motor starting transients, whereas the 5-minute time allows the operator to attempt restoration of normal bus voltage. The 5-minute timer is bypassed on high drywell pressure/low-low reactor water level conditions.

An evaluation of system voltages determined that the critical voltage for the 4160-V buses was above the setpoint of the second level "degraded voltage," undervoltage relays. To remedy this situation, CECo raised the setpoint and implemented modifications which reduced the voltage drop to those 480-V MCCs that supply critical safety-related loads. These modifications involved the installation of larger feed cables to the 480-V MCCs that supply the DG cooling water pumps; and an automatic trip of the nonessential loads from the 480-V switchgear upon a LOCA start signal for the DG (high drywell pressure or low-low reactor water level). Analyses were performed to ensure that the new setpoints would not have deleterious effects on operation of low voltage equipment fed from the 480-V MCCs.

The second level of protection can cause the possibility of a non-synchronous closure of the DG breakers. This could happen when a high drywell pressure/low-low reactor water level signal starts the DGs and there is a subsequent degradation of offsite voltage. Non-synchronous closure is avoided by the presence of a time delay relay in the close circuitry that ensures bus voltage is sufficiently low before closing to the DG. Note that the original undervoltage scheme (first level loss of voltage) does not have this possibility of causing a non-synchronous closure, because the relays are set for a very low voltage (approximately 70% of normal). A fault on the feed to the essential service buses after an ESF signal has started the DGs is another potential for non-synchronous closure. Both undervoltage schemes are susceptible to this failure because opening the feed breaker will immediately close the DG breaker regardless of bus voltage. Note that a fault will not cause a common mode failure; whereas, a degraded voltage induced trip will.

8.3.2 DC Power Systems

Station batteries are provided as a final source of power for specific vital loads. A total of four (250-V safety related, 250-V non safety related, 125-V and 24/48-V) station battery systems are provided for each unit. One safety related 250-V "power" battery is provided to serve the larger loads, such as dc motor-driven pumps and valves. One 125-V "control" battery is provided to supply the power required for exit lighting and all dc control functions; e.g., that required for control of the 4160-V breakers, 480-V breakers, various control relays and annunciators. Two 24/48-V batteries are provided to supply the neutron monitoring system and the stack gas, radwaste discharge, off-gas and process radiation monitors.

An alternate 125-V battery is provided to allow rated discharge testing of the unit 125-V battery while both units remain at power. The alternate 125-V battery is also available, in accordance with the Technical Specifications, if the unit 125-V battery is inoperable.

The unit safety related 250-V, 125-V and non-safety related 24/48-V batteries are located in a ventilated battery room having concrete block walls. The Unit 2 alternate 125-V battery is located in the former Unit 1 high pressure coolant injection (HPCI) building east battery room. The Unit 3 alternate 125-V battery is located on the Unit 3 turbine building mezzanine floor outside the Unit 3 battery charger room.

The reliability of the dc systems has been improved by the installation of dc battery and bus voltage indication, undervoltage alarms, battery high discharge current alarms, dc ground alarms (safety related 250-V and 125-V systems only), and battery charger trouble alarms on the safety related 250-V, 125-V, and non-safety related 24/48-V systems. This assures that an adequate state of charge exists on the station batteries at all times and meets IEEE 308-1974, Regulatory Guide 1.97, and Criterion 13 of Appendix A to 10 CFR 50.

8.3.2.1 250-V System

8.3.2.1.1 Safety Related 250-V System

The safety related 250-V battery system is sized to start and carry the normal dc loads plus all dc loads required for safe shutdown on one unit, and the operational loads required to limit the consequences of a design-basis event on the other unit for a period of four hours following loss of offsite power plus a single active failure without taking credit for the battery chargers. These loads are summarized in the load tracking database. This time period is deemed adequate to safeguard the plant until normal sources of power are restored.

The three battery chargers (one per unit plus a swing charger) have a capacity suitable for restoring the battery to full charge under normal load conditions. The chargers are powered from separate ac buses. These buses are arranged so that they can be connected to multiple sources of ac power available in the plant, including the DG.

The 250-V MCCs are normally fed from their primary source (charger) and their secondary source (battery) operating in a float charger configuration. The battery charger and the battery each have sufficient capacity to supply normal bus loads. The voltage is raised periodically for equalization of the charge on the battery cells. The normal float voltage should remain between 262.8-V and 265.2-V, (2.19-V and 2.21-V per cell). The equalizing voltage must remain between 2.25-V and 2.26-V, per cell or between 270.0-V and 271.2-Vdc while the load is connected to the battery.

The ampere-hour capacity of each unit's battery is adequate to supply expected essential loads following station trip and loss of all ac power without battery terminal voltage falling below the minimal discharge level (i.e., 210-Vdc).

The Unit 2 and 3 safety related 250-V batteries are lead calcium batteries which utilize 120 cells having a nominal 8-hour rating of 1495 ampere-hours based on a minimum terminal voltage of 210-V when discharged to 1.75 volts per cell (vpc) at 77 degrees F and a fully charged specific gravity of 1.215. The cells have been sized based on a minimum electrolyte temperature of 65 degrees F utilizing the temperature correction factor for the manufacturer's rating basis electrolyte temperature of 77 degrees F. The batteries have a calculated end of discharge voltage of 1.75 vpc. The battery racks are seismically qualified and the breakers and buswork are of sufficient capacity for the new batteries.

A design margin exists for aging and load growth (it was 11% in 1988) that is reported by a load tracking database.

The battery room is classified as a mild environment. Therefore, the batteries do not specifically require environmental qualification. However, the batteries have a qualified life of 20 years after which they are required to be replaced.

The safety related 250-V system is arranged so that more than one failure is required before normal plant needs are not served. All of the loads normally connected to the safety related 250-V dc system can be supplied by either charger. Buses are arranged to allow for alternate paths to other systems throughout the plant where redundancy is employed. The aggregate system is arranged and powered so that the probability of system failure due to a loss of safety related 250-V power is very low. All of the systems either self-annunciate upon failure or are periodically tested in service to discover faults.

The safety related 250-V battery system operates ungrounded with an alarm located in the main control room and a recording ground detection device to annunciate the first ground. In addition, the ground fault resistance and time at which the ground fault occurs is recorded by the ground detection device. Thus grounds of a magnitude that could affect equipment operability, the only reasonable mode of failure, are extremely unlikely. The normal mode of battery failure is a single cell deterioration which is signaled well in advance by the routine tests which are performed regularly on the battery.

When a ground is identified, the action that is taken is determined by the ground's level. If it is a Level I ground (greater than the alarm setpoint of 125,000 ohms), then it is recorded and tracked each shift. If it is a Level II ground (between the alarm setpoint of 125,000 ohms and 40,000 ohms) or a Level III ground (40,000 ohms or less) then station procedures are implemented immediately to locate and remove the ground. If a Level III ground cannot be eliminated within 14 days, a Justification for Continued Operation (JCO) is prepared. If an intermittent ground occurs, then it is logged with the time, date, and coincident activities. Table 8.3-8 provides the voltage-resistance correlation for the response levels described above.

Each unit has two heavy-duty buses (one in the turbine building and one in the reactor building) that furnish power to the various loads (as shown in Figure 8.3-8), most of which are connected only in an emergency condition. In general, these loads are motor loads such as backup isolation valves and emergency lube oil pumps where the power source is the main battery. Removable copper links have been provided such that the power supply to the Unit 2 reactor building bus can be manually transferred from the Unit 3 battery (normal source) to the Unit 2 battery (reserve source). A similar connection exists for the Unit 3 reactor building bus. The Unit 2 Reactor Building Motor Control Center's (MCC), 2A/2B, are a split MCC (two MCC's hardwired together). The Unit 3 Reactor Building MCC's, 3A/3B, are a split MCC (two MCCs hardwired together).

8.3.2.1.2 Non Safety Related 250-V System

The non safety related 250-V battery system provides power for the non safety related 250-Vdc loads which have been relocated from the existing safety related 250-Vdc MCCS. The only loads transferred thus far are the Unit 2(3) Main Turbine Emergency Bearing Oil Pumps.

8.3.2.2 125-V System

8.3.2.2.1 Safety Related 125-V System

There are two 125-V battery systems, one per unit. The basic function of the 125-V battery is to supply electrical power to the dc distribution systems whenever the battery charger, which supplies the normal source of power, fails. The 125-V power system supplies power to control circuits, DG excitation system switchgear, and the turbine system.

Another design feature of the 125-V battery system is that each battery is sized to start and carry the normal dc loads plus all dc loads required for safe shutdown on one unit and operations required to limit the consequences of a design basis event on the other unit for a period of 4 hours following loss of offsite power plus a single active failure without taking credit for the battery chargers. These loads are summarized in the load tracking database. This time period is deemed adequate to safeguard the plant until normal sources of power are restored.

Units 2 and 3 each have two 125-V battery chargers; one of each pair is a backup. The battery chargers have a capacity suitable for restoring the battery to full charge under normal load. The chargers are powered from separate ac buses. These buses are arranged so that they can be connected to any valid source of ac power available in the plant, including the DG. The battery chargers are supplied from MCC 29-2 for the Unit 2 normal charger, MCC 28-2 for the Unit 2 backup charger, MCC 39-2 for the Unit 3 normal charger, and MCC 38-2 for Unit 3 backup charger.

The 125-V buses and distribution panels are normally fed from their primary source (charger) and their secondary source (battery) operating in a float charger configuration. Loss of either source does not interrupt power flow to the bus. The voltage is raised when required for equalization of the charge on the battery cells.

The ampere-hour capacity of each unit battery is adequate to supply expected essential loads following station trip and loss of all ac power, without the battery terminal voltage falling below the minimal discharge level (i.e., 105-Vdc).

The Unit 2 and 3 safety related 125-V main, and Unit 3 alternate, batteries are lead calcium batteries which utilize cells having a nominal 8-hour rating of 1495 ampere-hours based on a minimum terminal voltage of 105-V when discharged to 1.75 volts per cell (vpc) at 77 degrees F and a fully charged specific gravity of 1.215. The Unit 2 and 3 125 Vdc main batteries and the Unit 3 alternate battery each utilize 58 cells having a calculated end of discharge voltage of 1.81 vpc.

The Unit 2 alternate battery has a calculated 1.75 vpc end of discharge voltage and utilizes 63 cells. It has a nominal 8 hour rating of 1945 ampere hours based on a minimum terminal voltage of 105-V when discharged to 1.75 vpc at 77 degrees F with a fully charged specific gravity of 1.215.

For all four batteries the cells have been sized based on a minimum electrolyte temperature of 65 degrees F utilizing the temperature correction factor for the manufacturer's rating basis electrolyte temperature of 77 degress F.

The areas of the plant housing the 125-V dc batteries are mild environments. Therefore, the batteries do not require environmental qualification. However the batteries have a qualified life of 20 years after which they are required to be replaced.

The 125-V system is arranged so that more than one failure is required before normal plant needs are not served. All of the loads normally connected to the 125-V dc system can be supplied by either charger. Buses are arranged to allow for alternate paths to other systems throughout the plant where redundancy is employed. The aggregate system is so arranged and powered that the probability of system failure due to a loss of 125-V dc power is very low. All of the systems either self-annunciate upon failure or can be periodically tested in service to discover faults.

The 125-V battery system operates ungrounded with an alarm located in the main control room and a recording ground-detection device to annunciate the first ground. In addition, the ground fault resistance and the time at which a ground fault occurs is recorded by a ground detection device. Thus grounds of a magnitude that could effect equipment operability, the only reasonable mode of failure, are extremely unlikely. The normal mode of battery failure is a single cell deterioration which is signaled well in advance by the tests that are performed regularly on the battery.

When a ground is identified, the action that is taken is determined by the ground's level. If it is a Level I ground (indicated voltage is less than the alarm setpoint voltage that corresponds to 125,000 ohms), then it is recorded and tracked each shift. If it is a Level II ground (between the alarm setpoint of 125,000 ohms and 20,000 ohms) or a Level III ground (20,000 ohms or less), then station procedures are implemented immediately to locate and remove the ground. If a Level III ground cannot be eliminated within 14 days, then a JCO is prepared. If an intermittent ground occurs, then it is logged with the time, date, and coincident activities. Table 8.3-8 provides the voltage-resistance correlation for the action response levels described above.

Each unit has been provided with an alternate 125-V battery in order to allow the unit 125-V battery to undergo rated discharge testing while both units remain at power. The alternate battery is available to supply system loads upon a failure of the unit 125-V battery. The alternate battery is of a similar type as the unit battery, though of a different size, and has been sized to support the same loads. The alternate battery is normally disconnected from the system and is kept on a float charge.

Each 125-Vdc system provides Division I dc power to its unit and Division II dc power to the other unit. The system's battery is tested in accordance with IEEE-450-1995. However, due to crossties between units, the unit battery test requires that the alternate battery be declared operable.

The Unit 1 Charger 1C provides an equalizing charge to the alternate battery. After the equalizing charge, the Unit 1 Charger 1C is disconnected, and the battery is connected to the 125-Vdc system by momentarily paralleling with the Unit 2 battery and charger. The alternate battery is then declared operational.

Because of the physical distance between the Unit 2 alternate battery and the dc distribution panel, the associated voltage drop was considered when sizing the alternate battery. The alternate battery is larger in size (8hr, 77°F electrolyte temperature rating of 1945 amp hours) than the unit battery and uses more cells (63 versus 58).

The Unit 2 alternate battery is located in the Station Blackout Building (former Unit 1 HPCI Building) east battery room. This location was originally designed to house a battery and as such provides adequate seismic and tornado missile protection.

MCC 65-1 provides power to the heating/cooling units and exhaust fans in the alternate battery room, and smoke detection and lighting of the Station Blackout Building. A safety-related ac feed for MCC 65-1 is available from MCC 29-2 if the normal feed for MCC 65-1 is out-of-service.

The Unit 3 alternate battery is located on the turbine building mezzanine floor outside the Unit 3 battery charger room. This location provides adequate seismic protection but does not provide the required tornado missile protection. To address this concern, a risk analysis was performed to determine the probability of a tornado missile striking the alternate battery. From the analysis, it was determined that the probability of a tornado missile strike is less than 1×10^{-7} for an entire calendar year. Therefore, the current location of the alternate battery maintains the probability of the tornado missile event below a threshold level where the event is not a concern.

The station battery is an integral part of the 125-V dc system which includes the battery chargers, breakers, buses, and other auxiliaries (Drawing 12E-2322B and 12E-3322B). The 125-V distribution system is divided into three groups of buses as follows:

A. The turbine building main bus,

B. The turbine building reserve bus, and

C. The reactor building bus.

The following description for Unit 2 is typical for Unit 3.

The Unit 2 turbine building main buses 2, 2A-1, and 2A-2 are supplied by the Unit 2 battery and are the normal sources of control power to 4160-Vac switchgear 21 and 23 and 480-Vac switchgear 25, the Unit 2 main control room panels, relay panels and control room, turbine and radwaste building escape lighting. The Unit 2 main buses also supply reactor building bus 2 and the Unit 3 turbine building reserve buses 3B, 3B-1 and 3B-2. The main buses are the reserve power supply to the Unit 2 reserve buses 2B, 2B-1 and 2B-2.

The Unit 2 reactor building bus 2 is normally supplied from the Unit 2 turbine building main bus 2A-1 (as described above) and is the normal source of control power for the Unit 2 4160-Vac switchgear 23-1, 480-Vac switchgear No. 28, and reactor building escape lighting, etc. It is the reserve source of control power to Unit 2 4160 -Vac switchgear 24-1 and 480-Vac switchgear 29.

The Unit 2 turbine building reserve bus 2 is normally supplied from the Unit 3 turbine building main bus 3A and is the normal source of control power for 4160-Vac switchgear 22, 24, and 24-1 and 480-Vac switchgear 26, 27 and 29.

Note that the control power for one set of reactor building 4160-Vac and 480-Vac switchgear is completely independent (including the battery) from the control power to the other set of switchgear in the reactor building.

The unit battery is sized to carry its loads for specific time periods as indicated by the load tracking database.

8.3.2.2.2 Non Safety Related 345kV Switchyard 125-V System

The non safety related 345kV switchyard 125-V battery system provides power for the 345kV switchyard loads that have been relocated from the existing Unit 2 and Unit 3 safety related 125-V batteries.

There are two 125-V battery systems, each supplying a dedicated switchyard distribution system. The batteries and battery chargers are located in a ventilated battery room, adjacent to the 345kV switchyard relay house.

8.3.2.2.3 Non Safety Related 138kV Switchyard 125-V Control Power

Control power to the 138-kV switchyard is supplied from the Unit 1 125-V battery and has been replaced with a new battery and seismic rack. The ratings on the new battery are within the ratings of the existing equipment.

8.3.2.3 24/48-V System

The electrical supply for the source range monitor (SRM) and IRM systems, the Unit 2 dP type scram discharge volume level switches, the signal isolators and the stack gas, radwaste discharge, and off-gas radiation monitors consists of two duplicate 24/48-V three-wire, grounded neutral systems (Drawing 12E-2324-2). Each system (2A, 2B, 3A and 3B) consists of two 11-cell, 250-ampere hour (8- hour rated), lead calcium batteries in series and connected to a dc distribution panel. There are two silicon rectifier-type 25-ampere battery chargers on each system, one of which is connected to each of the 24-V batteries. The source of power for the battery chargers is the 120-Vac instrument bus. Each 24/48-V system is equipped with undervoltage and overvoltage alarms, as well as battery discharge and open bus alarms. The battery chargers are capable of completely recharging the battery while simultaneously supplying the normal continuous load. The batteries are mounted in seismically qualified racks.

8.3.2.4 Test and Inspection

The station batteries and other equipment associated with the 24/48-V, 125-V, and safety related 250-V dc systems are easily accessible for inspection and testing. Service and testing is accomplished on a routine basis in accordance with recommendations of the manufacturer. Typical inspections include visual inspections for leaks and corrosion, and checking all batteries for voltage, specific gravity, and level of electrolyte.

8.3.3 Evaluation of AC and DC Emergency Power Systems

The emergency power systems, starting with the batteries and DGs, and continuing through the control equipment to the driven equipment, are designed (and/or located) to be completely operable regardless of seismic or tornadic events. To accomplish this design, the DGs and battery racks are Class I equipment and are separated by the length of the reactor building. The cable pans and cables were routed in Class I areas of the plant and are physically separated where redundancy is involved. The switchgear for critical components is also located within Class I structures.

Redundancy and separation are employed in all critical systems and equipment essential to safe plant shutdown and/or control of the design basis accident.

An exhaustive study has been made to determine if any single component failure could negate operation of the emergency power system's redundant counterpart or of any other component which could possibly prevent meeting the onsite power requirements. No failures were found which could prevent the receipt of electrical power to the required core cooling equipment. The most degraded cases found were: the loss of one DG through failure of a diesel auto-start relay which limits the core cooling capabilities to one core spray subsystem and two LPCI subsystem pumps, and the failure of the MCCs that provide power to the LPCI admission valves, which limit the core cooling capabilities to two core spray subsystems.

Despite the degraded cases stated above the LPCI Swing MCC (28/29-7, 38/39-7) has special features which are represented in Figure 8.3-1 and are discussed in Section 8.3.1.5.4.

The safety related 250-Vdc power supply is used as a source of power for some of the containment isolation valves. Each dc-powered isolation valve is backed up by an ac-operated isolation valve. For example the HPCI steam line isolation valves; the in-board valve is ac, and the outboard valve is dc supplied from the safety related 250-V battery. Should the safety related 250-V battery fail, the ac-operated valve would still isolate the system. Manual switchover to the other safety related 250-V battery is possible and is represented in Drawing 12E-2328 of the FSAR.

The 125-V power supply is used to supply control power to the switchgear that is required during a LOCA. Both the Unit 2 and the Unit 3 125-V battery systems are shown in Drawing 12E-2322B. Control power (125-V) to all of the 4160-V and 480-V switchgear is monitored. The loss of this control power to any one bus actuates an alarm in the control room. The operator acknowledges the alarm and can take manual action to transfer DC control power for the bus to the alternate dc power supply. Feeder breakers to all dc distribution panel buses have trip alarms to alert the operator of the loss of power to any dc bus. Loss of either battery or any one bus in its entirety will interrupt control power to only one of the two redundant power systems.

For example, loss of turbine building main bus 2 or the Unit 2 battery will result in the loss of control power to Switchgear 23, 23-1, and 28 and the normal supply to DG 2/3, HPCI, and automatic depressurization system (ADS). The DG control circuit, HPCI, and ADS, will automatically switch over to their alternate power source. Buses 24, 24-1, and 29 are unaffected. The operator will be alerted and can transfer the control power feeds for buses 23, 23-1, and 28 to their alternate sources. Should the core cooling systems be required before the alternate source is switched in, the core cooling equipment would be reduced to one core spray and two LPCI's, which provide in excess of 100% DBA LOCA core cooling.

The HPCI room 125-V annunciation circuit has been modified to provide a means to monitor the status of both the main and reserve bus feeds. Should the dc feed auto-transfer, it would alert the operator if the reserve bus is deenergized.

Loss of the turbine building reserve bus 2 (or the Unit 3 battery or turbine building main bus 3) will result in the loss of control power to switchgear 24, 24-1, and 29, and to DG 2. As described above, only half of the control power is temporarily lost.

Control power failure to redundant buses and/or DGs can be affected only by the concurrent loss of the combined turbine building main bus/reactor building distribution panel and the turbine building reserve bus. Concurrent failure due to an electrical fault is prevented by keeping the bus tie breakers open during normal operation. The two turbine building buses are located within the same Class 1 structure that houses the control room and auxiliary equipment room. The same fire and missile protection afforded to control room panels is applied to the turbine building dc equipment. The physical separation of the turbine building reserve bus and the reactor building distribution panel will preclude concurrent mechanical damage to both buses.

Alternating current transfer devices meet single failure criteria as designed. The only dc transfer devices are used for control power to the DG 2/3, HPCI, and ADS, and their failures could cause loss of only those respective systems.

The emergency power system is designed so that an overload of any magnitude less than that expected from a direct phase-to-phase fault will not trip breakers or cause performance of any automatic functions. Overcurrent relays are provided which will isolate a fault on buses 23, 23-1, 24, or bus 24-1 when offsite power is available. Should the fault be on bus 23-1 or bus 24-1, these relays will also prevent the DG breakers from closing into the fault after offsite power has been isolated. Similar protection is provided for Unit 3.

Overload protection is not provided for those situations when onsite emergency power is being utilized; however, a kilowatt overload alarm is furnished with each DG which will alert the operator to a potentially hazardous situation.

It is concluded that the redundancy achieved by the dual battery systems, both the safety related 250-Vdc and the 125-Vdc, and by the DG arrangement, in addition to separation employed in all components, transfer devices, etc., assures that no single failure can prevent operation of the ESFs. The worst single failure would result in the loss of one-half of the core cooling equipment, i.e., one core spray pump and two LPCI pumps would become inoperable. One core spray pump and two LPCI pumps would remain operable to cool the core. In addition it is noted that the switchover capability in each of the battery systems permits the operator to supply battery power to a unit even if that unit's battery has failed.

The load capacity of each battery is monitored by a load tracking database and is sufficient to supply power to both units, even in the case that one unit has sustained an accident and the other unit is being shutdown.

The following dc systems from one unit are capable of feeding the other unit's systems:

A. The 125-V battery,

B. The 125-V main bus and reserve bus,

C. The 125-V battery chargers,

D. The 125-V cable feeders to switchgear, and

E. The safety related 250-V system.

The following systems or equipment are required for operation for both Units 2 and 3 and thus have redundant power supplies.

A. Cardox CO_2 system controls;

B. Standby gas treatment system (SBGTS) (two trains, each of which can be used on either unit: each unit supplies power to one of the trains);

C. MCCs to supply power for the SBGTS components.

Table 8.3-1

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING(1)

TRANSFORMER

TR2 Main Power	982/1100 MVA 55º/65º, 18-362.25 kV 1050 kVBIL, 3ϕ, 60Hz, ODAF, 55°/65° Rise
TR20	1000 kVA, 4160 — 480-V, 3ϕ, 60Hz.
TR21(31) Unit Auxiliary Power (Unit 3 data is in parenthesis)	27.6/36.8/46-MVA, 55°C; 17.1 — 4.16 — 4.16 kV 150 kVBIL, 3ϕ, 60Hz, OA/FA/FOA, 55°/65° Rise Impedance: H - X = 6.64(6.93)% (on a 11.4-MVA base) H - Y = 7.16(7.48)% (on a 16.2-MVA base) X - Y = 11.4(11.48)% (on a 11.4-MVA base) Winding Ratings: H - 27.6/36.8/46-MVA (55° rise) X - 11.4/15.2/19-MVA (55° rise) Y - 16.2/21.6/27-MVA (55° rise)
TR22 Reserve Auxiliary Power (Unit 3 data is in parenthesis)	27.6/36.8/46-MVA, 50°C; 138 — 4.16 — 4.16 kV 550 kVBIL, 3ϕ, 60Hz, CA/FA/FA, 55°/65° Rise Impedance: H - X = 6.4% (on an 11.4-MVA base) H - Y = 7.5% (on a 16.2-MVA base) X - Y = 11.6% (on an 11.4-MVA base) Winding Ratings: H - 27.6/36.8/46-MVA (55° rise) X - 11.4/15.2/19-MVA (55° rise) Y - 16.2/21.6/27-MVA (55° rise)
TR32 Reserve Auxiliary Power	37.5/50/62.5 MVA, 345-4.280-4.280 kV, 3ϕ, 60 Hz, ONAN/ONAF/ONAF, 1050/110/110kV BIL, 65°C rise Impedance: H – X = 24.02% (on a 37.5 MVA base) H - Y = 21.95% (on a 37.5 MVA base) X – Y = 43.60% (on a 37.5 MVA base) Winding Ratings: H – 37.5/50.0/62.5-MVA (65°C Rise) X – 18.75/25.0/31.25-MVA (65°C Rise) Y – 18.75/25.0/31.25-MVA (65°C Rise) X – Winding Load Tap Changer (LTC): Full Capacity, 33 Positions at approx. 0.93% rated voltage Resultant approx. +25%/-5% of rated voltage
TR25, TR26, TR27	1500/1725 kVA, 4160 — 480/277V 3-phase, 60Hz, OA/FA, 55°/65°C Rise (See Note) Nominal Impedance 11.3% @ 1500 kVA ±7.5% Tolerance (Note: PCB Replacements are only 65°C Rise except for TR35 which is still 55°/65°C
TR28 and TR29	1500/1725 kVA, 4160-480/277V 3 phase, 60Hz, OA/FA, 55°/65°C Rise Nominal Impedance 11.3% @ 1500 kVA ±7.5% Tolerance

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING(1)

TR 86	100 MVA (55°C), 345-138 kV. LTC ± 10% 3ϕ, 60 Hz, ONAN/ONAF/ONAF 55°/65°C RISE 1050 kVBIL
CIRCUIT BREAKERS	
4160 V Bus 40	
Incoming	None
Feeders	AM 4.16 — 250-MVA, 1200 A
4160 V Buses 21 and 22	
Incoming	AM 4.16 — 350-MVA, 3000 A
Feeders	AM 4.16 — 350-MVA, 1200 A
4160 V Buses 23 and 24	
Incoming	AMHG 5-350-20 — 350-MVA, 2000 A
Feeders	AMHG — 350-MVA, 1200 A
Bus Tie	AMHG — 350-MVA, 1200 A
Spares	AMHG 5-351-12 — 350-MVA, 1200 A
4160 V Buses 23-1 and 24-1	
Incoming	4 - AMH 4.76 — 250-MVA, 1200 A
Feeders	9 - AMH 4.76 — 250-MVA, 1200 A
Bus Tie	4 - AMH 4.76 — 250-MVA, 1200 A
480-V Switchgear 25, 26 and 27	
Incoming	AK - 75
Feeders	AK - 25
Bus Tie	AK - 50
480-V Switchgear 28 and 29	
Incoming	AK - 75
Feeders	AK - 25
Bus Tie	AK - 50
BUS DUCTS	
Main Generator Leads (isolated phase bus)	Isolated-phase 33,000 A
Unit and Reserve Auxiliary Transformer Secondary Feeders	Winding "X" to switchgear — non-segregated, 3000 A, 2000A Winding "Y" to switchgear — non-segregated, 4000 A
Tie Bus Between Buses 24-1 and 34-1	non-segragated, 1200A
GENERATORS	
G2	1068-MVA, 0.945 PF, 0.50 SCR, 18 kV 1800 rpm, 3ϕ, 60Hz, 60 # H_2.

Table 8.3-1

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING(1)

G3	1068-MVA, 0.945 PF, 0.52 SCR, 18 kV 1800 rpm, 3ϕ, 60Hz, 60 # H_2
DG 2 and DG 2/3	Diesel-driven, 3250 kVA, 2600 kW, 0.80 PF, 4160-V, 3ϕ, 60Hz
SBO DG2	Diesel-driven, 5437 kVA, 4350kW, 0.80 PF, 4160-V, 3ϕ, 60Hz

EQUIPMENT DATA SHEET
<u>ELECTRICAL BUS LOADS</u>

4160-V Bus 21	1 -	Reactor feed pump 2A	9000 hp
	1 -	Reactor recirculation pump M-G set 2A	7000 hp
	1 -	Reactor feed pump 2C	9000 hp(2)
4160-V Bus 22	1 -	Reactor feed pump 2B	9000 hp
	1 -	Reactor recirculation pump M-G set 2B	7000 hp
	1 -	Reactor feed pump 2C	9000 hp(2)

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING(1)

4160-V Bus 23	1 -	480-V switchgear 25	1500 kVA(3)
	2 -	Circulating water pumps	1750 hp each
	2 -	Condensate and booster pumps	1750 hp each
	1 -	Service water pump 2A	1000 hp
	2 -	Containment cooling service water pumps	500 hp each
	1 -	4160-V bus 23-1	
	1 -	Control rod drive (CRD) feed pump 2A	250 hp
	1 -	Tie to SBO Bus 61	
	1 -	Spare	
4160-V Bus 23-1	2 -	Shutdown cooling pumps	500 hp each
	1 -	Reactor building closed cooling water (RBCCW) pump	300 hp
	2 -	LPCI pumps	700 hp each
	1 -	Reactor cleanup recirculation pump 2A	600 hp
	1 -	480-V switchgear 28	1500 kVA(3)
	1 -	Core spray pump 2A	800 hp
4160-V Bus 24	1 -	CRD feed pump 2B	250 hp
	2 -	Condensate and booster pumps	1750 hp each
	1 -	4160-V bus 24-1	
	2 -	480-V switchgear 26, and 27	1500 kVA each(3)
	1 -	480-V switchgear 20	1000 kVA(3)
	2 -	Service water pumps	1000 hp each
	1 -	Circulating water pump 2C	1750 hp
	2 -	Containment cooling service water pumps	500 hp each
	1 -	Tie to SBO Bus 61	
	1 -	Spare	

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING[1]

4160-V Bus 24-1	2 -	RBCCW pumps	300 hp each
	2 -	LPCI pumps	700 hp each
	1 -	480-V switchgear 29	1500 kVA[3]
	1 -	Shutdown cooling pump 2B	500 hp
	1 -	Core spray pump 2B	800 hp
	1 -	Reactor cleanup recirculation pump 2B	600 hp
<u>ESS 480 Loads</u>			
480-V Switchgear 28 & 29, and MCCs 28-1, 28-2, 28-3, 28-7, 29-1, 29-2, 29-3, 29-4, 29-5, 29-6, 29-7, 29-8, and 29-9 (Note that MCC 39-8 and 39-9 do not exist for Unit 3)	1 -	Essential service uninterruptible power supply (input to rectifier)	100A @ 480V
	5 -	120/208- and 240-V distribution transformers	9, 10, and 15 kVA each
		Motor-operated valves	
	2 -	Standby liquid control pumps	50 hp
	7 -	Drywell cooling blowers	75 hp each
	3 -	Diesel engine starting compressors	5 hp each
	1 -	Reactor building emergency lighting	21.5 kW (U2) 18.4 kW (U3)
	2 -	Diesel oil transfer pumps	1.5 hp each
	2 -	Safety related 250-V battery chargers	65 kW each
	1 -	Standby gas treatment fan	20 hp
	2 -	Condensate transfer pumps	30 hp each
	2 -	Reactor protection system M-G sets	25 hp each
		Standby gas treatment motor-operated dampers	
	1 -	Main hydrogen seal oil pump	15 hp
	2 -	125-V battery chargers	34 kW each
	1 -	Hydrogen seal oil vacuum pump	2 hp

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING[(1)]

2 -	Diesel standby circulating lube oil pumps	1 hp each
2 -	Diesel standby turbo circulating lube oil pumps	0.75 hp each
1 -	Condensate transfer jockey pump	7.5 hp
1 -	Turbine and radwaste buildings emergency lighting	27 kW (Unit 2) 13.7 kW (Unit 3)
2 -	Diesel cooling water pumps	87 kW each
1 -	Turbine turning gear oil pump	50 hp
1 -	Turbine turning gear	60 hp
5 -	Turbine bearing lift pumps	10 hp each
1 -	Standby gas treatment air heater	30 kW
2 -	Diesel circulating water heaters	15 kW each
1 -	Drywell and torus purge exhaust fan	30 hp
4 -	LPCI/CS room sump pumps	1.5 hp each
2 -	Drywell floor drain sump pumps	5 hp each
4 -	Reactor building floor drain sump pumps	7.5 hp each
2 -	Drywell equipment drain sump pumps	3 hp each
1 -	Reactor building elevator	25 hp
1 -	Refueling platform feeder	
1 -	Fuel pool receptacle feeder	
1 -	Reactor building equipment drain tank pump	5 hp
1 -	Cleanup precoat tank mixer	0.75 hp
1 -	Cleanup precoat pump	15 hp
1 -	Cleanup filter sludge pump	2 hp
1 -	Cleanup filter aid pump	7.5 hp
1 -	Safety system jockey pump	7.5 hp
2 -	Diesel generator vent fans	30 hp each

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING(1)

2 -	LPCI/core spray pump area cooling units	5 hp each
1 -	HPCI pump area cooling unit	3 hp each
1 -	Computer room transformer (spare)	9 kVa (Unit 2 only)
2 -	Reactor building condensate return pumps	7.5 hp each
1 -	Drywell air sampling compressor motor and pump	7.5 hp
1 -	Control room standby HVAC air handling unit	50 hp(4)
1 -	Control room standby HVAC cooling/ condensing unit	150 hp(4)
2 -	Control room standby HVAC booster fans	7.5 hp each(4)
1 -	Control room standby HVAC air filter unit heater	12 kW(4)
1 -	120/208-Vac distribution panel	15 kVA
1 -	Fuel storage vault and equipment hatch jib crane	7.5 hp
1 -	Drywell equipment patch shield door	0.5 hp
3 -	Reactor building vent fans	100 hp each
1 -	Reactor cleanup demineralization auxiliary pump	100 hp
2 -	Fuel pool cooling water pumps	100 hp each
3 -	Reactor building exhaust fans	100 hp each
2 -	South turbine room ventilation Fans	75 hp each (Unit 2) 100 hp each (Unit 3)
1 -	Post-LOCA monitor and sample pump	1 hp
2 -	Torus/drywell air compressors	40 hp
2 -	Instrument bus transformer feeds	25 kVA each
8 -	Containment cooling service water (CCSW) pump cub cooler fans	3 hp each
1 -	Submersible sewage pump	1 hp

Table 8.3-1 (Continued)

AUXILIARY ELECTRICAL SYSTEM EQUIPMENT LISTING[1]

8 -	Main steam isolation valve (MSIV) unit coolers	2 hp each
1 -	HPCI auxiliary coolant pump	15 hp
1 -	HPCI oil tank heater	9 kW
9 -	Contaminated condensate tank heaters	36 kW each

Notes:

1. Listing is for Unit 2 but also applies to Unit 3 except where noted otherwise. In general the load values listed are the nameplate values or from the electrical load monitoring system load data base used in auxiliary power system calculations. See engineering to obtain the calculation of record for design values. The number of spare circuit breakers and cubicles is different between units.

2. Pump 2C which may be fed from either Bus 21 or Bus 22.

3. For a detailed list of equipment on 480-V buses, see Dresden Station Electrical Distribution Key Diagrams for respective buses.

4. The Control Room is common to Units 2 and 3. These loads are control room HVAC Train B (safety related) loads supplied from the Unit 2 motor control center 29-8. There are presently no corresponding loads on Unit 3.

Table 8.3-2

CATEGORY 1 LOADS ON EACH OF THE TWO DIESEL GENERATORS

One core spray pump

Two low pressure coolant injection pumps

Standby gas treatment equipment (1 unit only)

AC-powered valves required for emergency conditions

Emergency ac lighting, essential instrumentation and battery charger

480-Vac transformer losses

Diesel generator auxiliaries (includes ECCS pump room coolers)

Note:

1. See Figure 8.3-4 through Figure 8.3-7 for typical load profiles associated with the DGs during accident conditions.

Table 8.3-3

SHUTDOWN LOADS NECESSARY FOR MAINTENANCE OF SAFE SHUTDOWN CONDITIONS (CATEGORY 2)

Four drywell cooling blowers

Reactor building cooling water system

Service water pump

Emergency ac lighting

480-Vac transformer losses

Essential instrumentation and battery charger

Diesel auxiliaries (cooling water pump, fuel transfer pump, starting air compressors, vent fan, and lube oil circulating pump)

Control room pressurization

Note:

1. For nominal equipment ratings refer to Table 8.3-1.

Table 8.3-4

INCORE INSTRUMENTATION PENETRATIONS

Penetration Number	Instrumentation Channels Supplied
X-202N	LPRM Channel No. 5 LPRM Channel No. 1 SRM Channel No. 22 IRM Channel No. 12 IRM Channel No. 14
X-204H	LPRM Channel No. 3 SRM Channel No. 21 IRM Channel No. 11 IRM Channel No. 13
X-202J	LPRM Channel No. 4 SRM Channel No. 24 IRM Channel No. 16 IRM Channel No. 18
X-204E	LPRM Channel No. 2 LPRM Channel No. 6 SRM Channel No. 23 IRM Channel No. 15 IRM Channel No. 17

Table 8.3-5

Table Deleted

Table 8.3-6

Table Deleted

Table 8.3-7

TYPICAL PROTECTIVE RELAY SETPOINTS

	Protective Relay Type	Setpoint	Time Delay
480 V MCC	Overvoltage	131.5 V, ± 0.35 V	10.0 seconds, (±10%)
28-7/29-7	Undervoltage	110.0 V, ± 0.35 V	5.0 seconds, (±10%)
	Under/Overfrequency	57.0 Hz, (±0.008 Hz)	99 cycles, (+3, -2)
		63.0 Hz, (±0.008Hz)	99 cycles, (+3, -2)

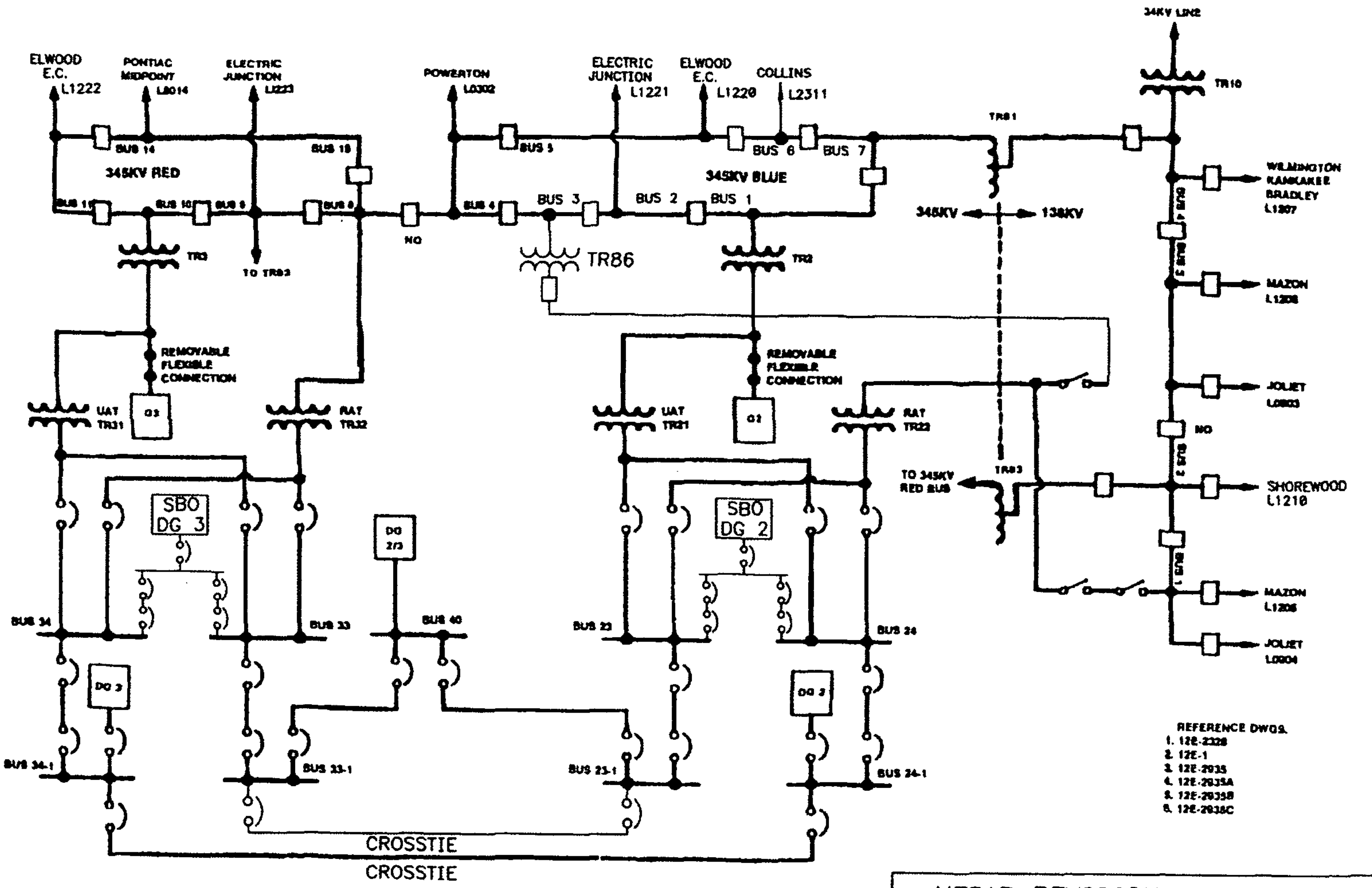
Note: Refer to Technical Specifications for 4kV Emergency Bus Undervoltage Allowable Values

Table 8.3-8

GROUND DETECTOR VOLTAGE-RESISTANCE CORRELATION FOR ACTION RESPONSE

	Voltage-Resistance Equivalents							
	Safety Related 125 Vdc System				Safety Related 250 Vdc System			
	Level II		Level III		Level II		Level III	
	Alarm Resistance Limit							
	≤ 125 KOhm	≤ 125 KOhm	≤ 20 KOhm	≤ 20 KOhm	≤ 125 KOhm	≤ 125 KOhm	≤ 40 KOhm	≤ 40 KOhm
	Ground Detector Alarm Setpoint Operation Mode							
	Level II		Level III		Level II		Level III	
Stations	**Normal**	**Button Pushed**	**Normal**	**Button Pushed**	**Normal**	**Button Pushed**	**Normal**	**Button Pushed**
Dresden 2	≤ 130 KOhm	N/A	≤ 20 KOhm	N/A	≥ 185 V	≥ 215 V	≥ 230 V	≥ 245 V
Dresden 3	≥ 70 V	≥ 90 V	≥ 115 V	≥ 120 V	≥ 185 V	≥ 215 V	≥ 230 V	≥ 245 V

NOTE: The voltage values were rounded off to the nearest 5 volts due to instrument accuracy.



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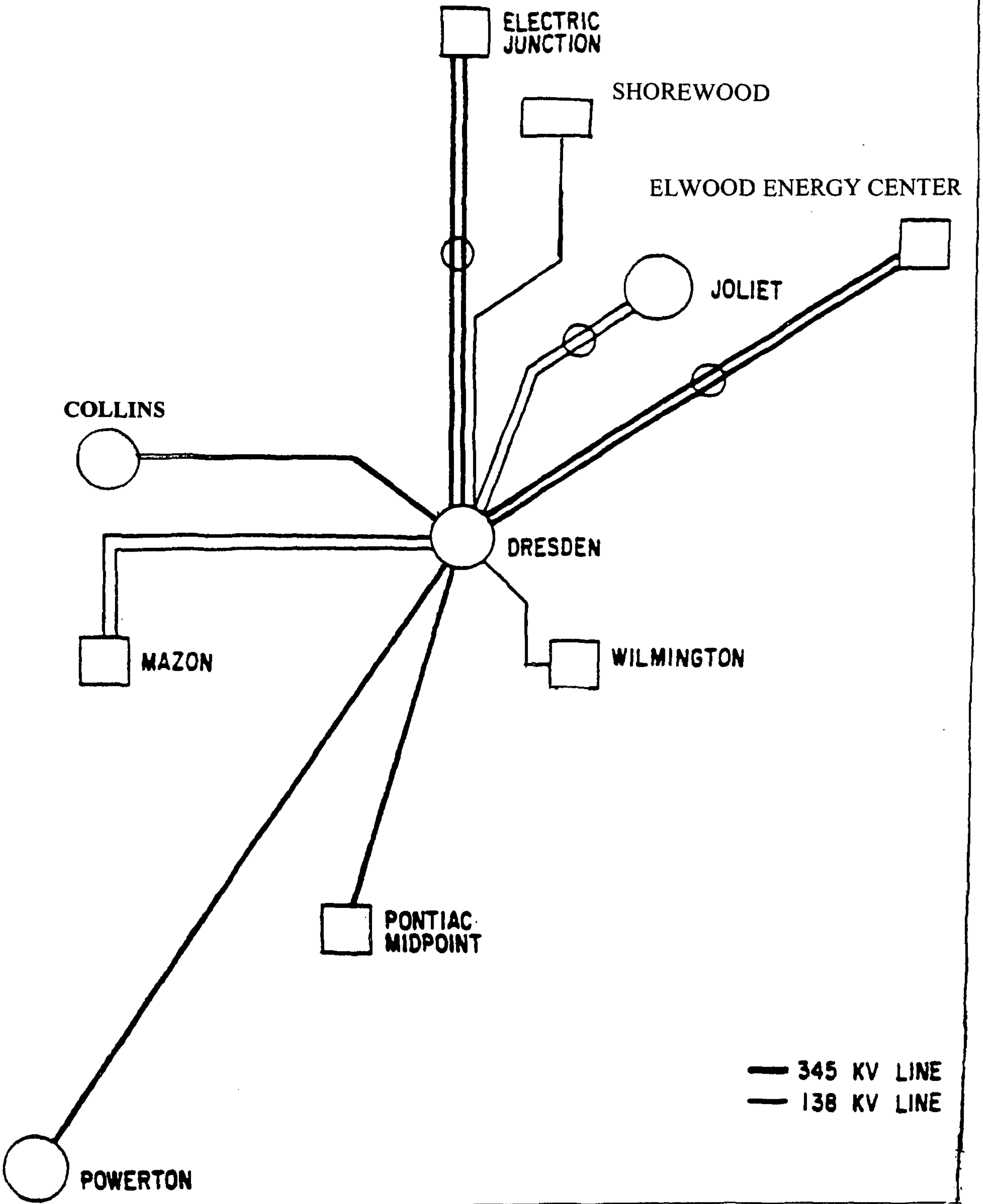
DRESDEN STATION
UNITS 2 & 3

SINGLE LINE DIAGRAM
SWITCHYARDS TO EMERGENCY POWER SYSTEM
(4kV LEVEL)

FIGURE 8.2-1



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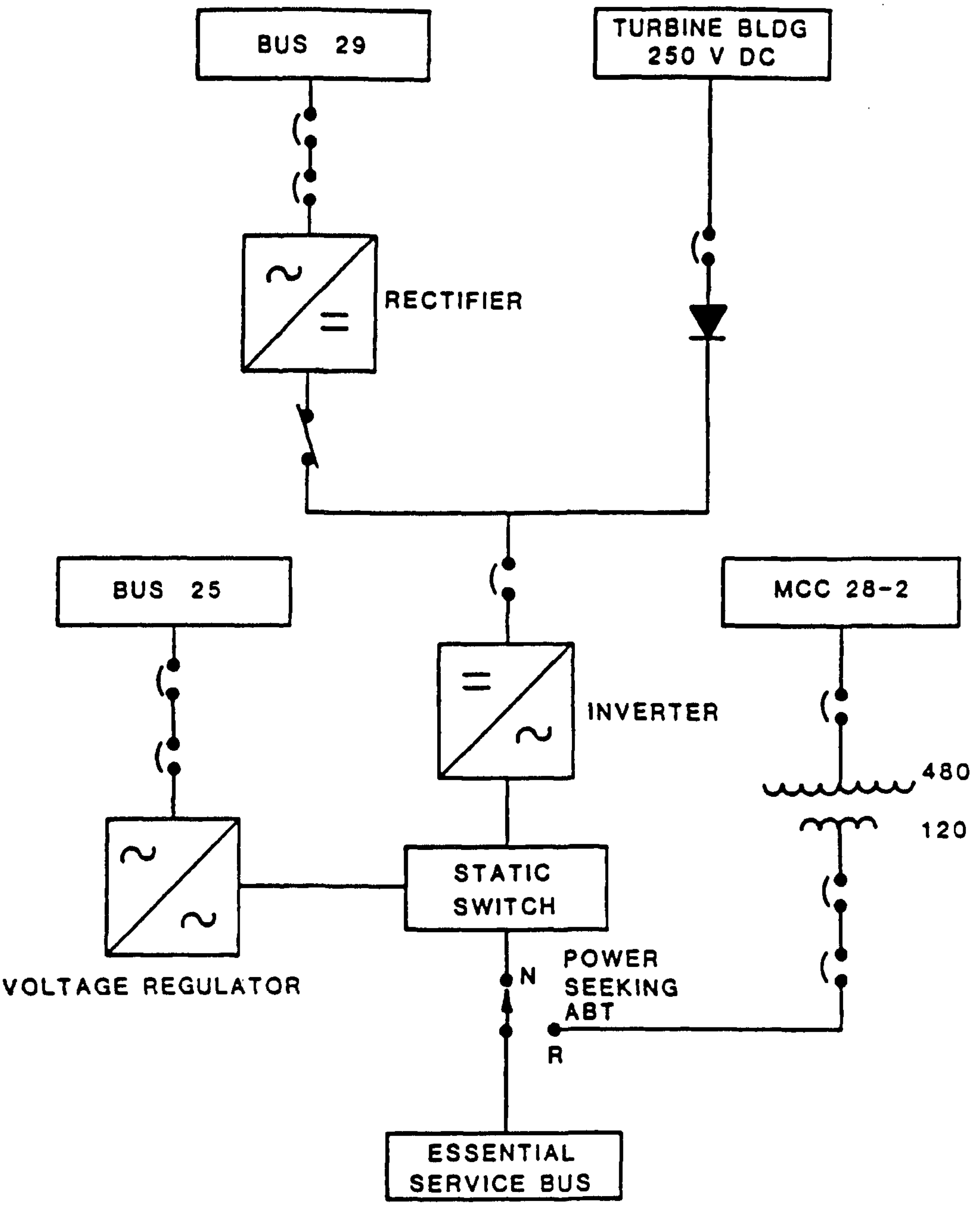
DRESDEN STATION UNITS 2 & 3

TRANSMISSION SYSTEM INTERCONNECTIONS

FIGURE 8.2-2



DRESDEN STATION
UNITS 2 & 3

UNIT 2 ESSENTIAL SERVICE BUS
UNINTERRUPTABLE POWER SUPPLY

FIGURE 8.3-3

EPN	Name	Starting KW	Running Hp	(0s)	0s	5s	10s	10+ min	10++ min	10+++ min
					▨	▨	▨	■	■	■
2-1502-C	LPCI 2C	944-19	647.00 (1)				▨			
2-1502-D	LPCI 2D	944.19	629.00 (1)					■	■	■
2-1401-B	CS 2B	1070.08	893.00 (1)						■	■
2-1501-44C	CCSW 2C	593.44	465.00					■	■	■
2-1501-44D	CCSW 2D	593.44	575.00 (2)	▨	▨	▨	▨	■	■	■
2-902-63	ESS UPS Panel	37.9	37.9 KW	▨	▨	▨	▨	■	■	■
	120/208V Dist Xfmr 29-1	6.80	9.00 KVA	▨	▨	▨	▨	■	■	■
2-1103	Standby Liquid Control Heater	25.00	25.00 KW	▨	▨	▨	▨	■	■	■
2-2301-4	HPCI Turbine Inlet Isolation Valve	38.20	7.80	▨	▨	▨	▨			■
2-1402-25B	CS Inboard Isolation Valve 2B	21.10	4.00				▨			
2-2400-2B	Post LOCA H202 Sample Pump 2B	6.10	0.90	▨	▨	▨	▨	■	■	■
2-83125-2	125V Battery Charger 2	33.66	33.66 KW	▨	▨	▨	▨	■	■	■
731613	Diesel Cooling Water Pump 2	132.1	66.28 KW	▨	▨	▨	▨	■	■	■
2-4611-B	Diesel Starting Air Compressor 2B	19.90	5	▨	▨	▨	▨	■	■	■
1206429	Diesel Oil Transfer Pump 2	8.70	1.35	▨	▨	▨	▨	■	■	■
2/3-83250-2/3	250V Battery Charger 2/3	65.62	65.62 KW	▨	▨	▨	▨	■	■	■
2-5790	Diesel Vent Fan 2	81.30	30	▨	▨	▨	▨	■	■	■
2-7902	Turbine and Radwaste Emergency Lighting	27.0	27.0KW				▨	■	■	■
2-5700-30C1	CCSW Pump Cooler C Fan 1	14.00	3.00						■	■
2-5700-30C2	CCSW Pump Cooler C Fan 2	14.00	3.00						■	■
2-5700-30D1	CCSW Pump Cooler D Fan 1	14.00	3.00						■	■
2-5700-30D2	CCSW Pump Cooler D Fan 2	14.00	3.00						■	■
2-8001-B	RPS MG Set 2B	69.40	3.9	▨	▨	▨	▨	■	■	■
2-1501-13B	LPCI Pump Flow Bypass Valve 2B	0.70	0.13		▨	▨	▨	■	■	■
2-5747	HPCI Pump 2 Area Cooling Unit	14.00	1.85	▨	▨	▨	▨	■	■	■
2-5746B	LPCI/CS Pump Area Cooling Unit 2B	19.90	4.6		▨	▨	▨	■	■	■
	Diesel Circulating Water Heater 2/3	15.00	15.00 KW	▨	▨	▨	▨	■	■	■
2/3-6699-111/113	Engine Lube Oil Circulating Pump (1.00 Hp)	6.10	0.90	▨	▨	▨	▨	■	■	■
2/3-6699-111/113	Engine Lube Oil Circulating Pump (0.75 Hp)	4.20	0.68	▨	▨	▨	▨	■	■	■
2-1402-38B	CS Pump Recirc. Isolation Valve 2B	0.70	0.13				▨			

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2 ELECTRICAL LOAD PROFILE
FIGURE 8.3-4
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EPN	Name	Starting KW	Running Hp	(0s)	0s	5s	10s	10+ min	10++ min	10+++ min
	HPCI Turbine Oil Tank Heater	9.00	9.00 KW	▒	▒	▒	▒	▓	▓	▓
2-1501-3B	Containment Cooling Heat Exchanger Discharge Valve 2B	1.00	0.33					■	■	■
2-202-5B	Recirc. Pump 2B Discharge Valve	52.40	13.00	▒	▒	▒	▒			
2-1501-22B	LPCI Inboard Isolation Valve 28	39.1	10.5	▒	▒	▒	▒			
2-1501-21A	LPCI Outboard Isolation Valve 2A	53.20	16.20	▒	▒	▒	▒			
	120/208 Distr Xbr 29-B	11.3	15.00 KVA							▓
2/3-9400-102	Control Room Standby AC	250.20	144.0							▓
2/3-9400-104	Control Room AFU Booster Fan	28.8	7.5							▓
2/3-9400-100	Control Room Standby AFU	115.80	50.00							▓
2/3-9400-101	Control Room AFU Heater	12.00	12.00 KW							▓
2/3-7505A	SBGT Inlet Damper 2/3A	8.20	1.40	▒	▒	▒	▒			
2/3-7504A	SBGT Outside Air Supply Damper 2/3A	4.00	0.61	▒	▒	▒	▒			
2/3-A-7503	SBGT Air Heater 2/3A	30.00	30.00 KW	▒	▒	▒	▒	▓	▓	▓
2/3-5707A	SBGT Discharge Damper 2/3A	16.70	4.20	▒	▒	▒	▒			
2/3-A-7506	SBGT Fan 2/3A	56.80	17.2	▒	▒	▒	▒	▓	▓	▓
	Xfmr 29 Losses	4.4	4.4KW	▒	▒	▒	▒	▓	▓	▓
		Running Loads	(KW)	414.0	939.0	1444.0	2190.0	2594.00	2402.00	2592.0

■ Indicates Manual Connection

▒ Indicates Automatic Connection

(0s) - 0 seconds after closing of DG Breaker
0s - 0 seconds after UV reset
5s - 5 seconds after UV reset
10s - 10 seconds after UV reset
10+min - All loads that automatically stop before 10 minutes are shown off and first CCSW Pump is started
10++min - The second CCSW Pump is started
10+++min - Both CCSW with its auxiliaries

(1) Runnuing horsepower is reduced at T=10+ min and is reflected in the DG total loading.

(2) Running horsepower is 465 hp with 2 CCSW pumps running and is reflected in the DG total loading.

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2 ELECTRICAL LOAD PROFILE
FIGURE 8.3-4
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EPN	Name	Starting KW	Running Hp	(0s)	0s	5s	10s	10-min	10+ min	10++ min
3-1502-C	LPCI 3C	944.19	649.00 (1)		▒	▒	▒	▓	▓	▓
3-1502-D	LPCI 3D	944.19	621.00 (1)			▒	▒	█	█	
3-1401-B	CS 3B	818.54	889.00 (1)				▒	▓	▓	▓
3-1501-44C	CCSW 3C	593.44	465.00						▓	▓
3-1501-44B	CCSW 3D	593.44	575.00 (2)							▓
3-903-63	ESS UPS Panel	50.50	50.50 KW	▒	▒	▒	▒	▓	▓	▓
	120/208V Dist Xfmr 39-1	6.80	9.00 KVA	▒	▒	▒	▒	▓	▓	▓
3-1402-25B	Core Spray Inboard Isolation Valve	20.60	3.9	▒	▒	▒	▒			
	Rx. Building Emergency Lighting	16.50	18.36 KW	▒	▒	▒	▒			
	Post LOCA H202 Sample Pump 3B	6.10	0.90	▒	▒	▒	▒	▓	▓	▓
3-1501-13B	LPCI Pump Flow Bypass Valve 3B	3.30	0.60		▒	▒	▒			
3-1501-3B	Containment Cooling Heat Exchanger Discharge Valve 3B	0.90	0.33						▓	▓
3-5746B	LPCI/CS Pump Area Cooling Unit 3B	19.90	4.60		▒	▒	▒	▓	▓	▓
3-2301-4	HPCI Turbine Inlet Isolation Valve	47.60	7.80	▒	▒	▒	▒	▓	▓	▓
3-1402-38B	Core Spray Pump Recirc. Isolation Valve	3.30	0.60				▒			
3-5747	HPCI Pump 3 Area Cooling Unit	14.00	1.85	▒	▒	▒	▒	▓	▓	▓
3-2501	ACAD Air Compressor	69.4	25.0							▓
	HPCI Oil Tank Heater	9.00	9.00 KW	▒	▒	▒	▒	▓	▓	▓
2/3-83250-2/3	250V Battery Charger 2/3	65.62	65.62 KW	▒	▒	▒	▒	▓	▓	▓
2/3-7503B	SBGT Air Heater 2/3B	30.00	30.00 KW	▒	▒	▒	▒	▓	▓	▓
2/3-7504B	SBGT Outside Air Supply Damper 2/3B	3.9	0.6	▒	▒	▒	▒			
2/3-7507B	SBGT Fan Dischage Damper 2/3B	20.0	4.3	▒	▒	▒	▒			
2/3/7506	SBGT Fan 2/3B	56.80	20	▒	▒	▒	▒			
2/3-7505B	SBGT Inlet Damper 2/3B	10.50	1.8				▒	▓	▓	▓
3-7902	Turbine Room 3 Emergency Lighting	13.68	13.68 KW							▓
3-5700-30C	CCSW Pump Cooler C Fan 2	15.70	3.00							▓
3-5700-30C	CCSW Pump Cooler C Fan 1	15.70	3.00							▓
3-5700-30D	CCSW Pump Cooler D Fan 1	15.70	3.00							▓
3-5700-30D	CCSW Pump Cooler D Fan 2	15.70	3.00	▒	▒	▒	▒	▓	▓	▓
3-83125-3	125V Battery Charger 3	33.66	33.66 KW	▒	▒	▒	▒	▓	▓	▓
3-4611B	DG Starting Air Compressor 3B	19.90	5.00	▒	▒	▒	▒	▓	▓	▓
3-3903	DG Cooling Water Pump 3	131.3	59.28 KW	▒	▒	▒	▒	▓	▓	▓
3-5203	DG Fuel Oil Transfer Pump 3	8.70	1.35	▒	▒	▒	▒	▓	▓	▓

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 3 ELECTRICAL LOAD PROFILE
FIGURE 8.3-5
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EPN	Name	Starting KW	Running HP	(0s)	0s	5s	10s	10-min	10+ min	10++ min
				▨	▨	▨	▨	▨	■	■
3-5790	DG Ventilation Fan 3	81.30	30.00	▨	▨	▨	▨	▨	■	■
3-8001-B	RPS MG Set 3B	69.40	3.9	▨	▨	▨	▨	▨		
3-1501-22A	LPCI Inboard Isolation Valve 3A	39.1	10.5	▨	▨	▨	▨	▨		
3-202-5A	Recirc. Pump 3A Discharge Valve	51.00	13.00	▨	▨	▨	▨	▨		
3-1501-21B	LPCI Outboard Isolation Valve 38	51.30	16.20	▨	▨	▨	▨	▨		
	Xfmr 39 Losses	2.5	2.5 KW	▨	▨	▨	▨	▨	■	■
		Running Loads	(KW)	392.0	919.0	1413.0	2161.0	2106.0	2562.0	2385.0

■ Indicates Manual Connection

▨ Indicates Automatic Connection

(0s) - 0 seconds after closing of DG Breaker

0s - 0 seconds after UV reset

5s - 5 seconds after UV reset

10s - 10 seconds after UV reset

10+min - CCSW pump is started with its auxilaries

10++min - CCSW Pump is running and other loads starting after 10 minutes are shown here

10+++min - Both CCSW pumps are running and other loads starting after 10 minutes are shown here

(1) Runnuing horsepower is reduced at T=10+ min and is reflected in the DG total loading.

(2) Running horsepower is 465 hp with 2 CCSW pumps running and is reflected in the DG total loading.

DRESDEN STATION
UNIS 2 AND 3
DIESEL GENERATOR 3 ELECTRICAL LOAD PROFILE
FIGURE 8.3-5
Sheet 2 of 2

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EPN	Name	Starting KW	Running HP	(0s)	0s	5s	10s	10-min	10+ min	10++ min	10+++ min
2-1502-A	LPCI 2A	944.19	633.00 (1)		░	░	░	■	■	■	■
2-1502-B	LPCI 2B	944.19	638.00 (1)			░	░				
2-1401-A	CS 2A	1070.08	877.00 (1)				░	■	■	■	■
2-1501-44A	CCSW 2A	593.44	575.00 (1)						■	■	■
2-1501-44B	CCSW 2B	593.44	465							■	■
	Aux PT Indicating Lights, Meter and Relay	0.4	0.40 KW	░	░	░	░	■	■	■	■
2/3-6600-A	Diesel Generator Starting Air Compresser 2/3A	19.90	5	░	░	░	░	■	■	■	■
	120/208 Distr Xfmr 28-1	6.80	9.00 KVA	░	░	░	░				
2-1201-7	Cleanup System Return Isolation Valve	13.20	2.60	░	░	░	░				
2-1201-1	Cleanup System Inlet Isolation Valve	39.30	5.20	░	░	░	░	■	■	■	■
2/3-5203	Diesel Transfer Pump 2/3	8.70	1.35	░	░	░	░	■	■	■	■
2/3-5790	Diesel Generator Vent Fan 2/3	81.30	30.00	░	░	░	░				
2-1402-25A	Core Spray Inboard Isolation Valve 2A	20.60	3.90				░				
2-1501-13A	LPCI Pump Flow Bypass Valve 2A	0.70	0.13	░	░	░	░	■	■	■	■
2-2252-81A	Post LOCA H2 & 02 Monitoring Sample	6.10	0.90	░	░	░	░	■	■	■	■
2-7902	Rx Building Emergency Lighting	21.5	21.54 KW				░	■	■	■	■
2-5746-A	LPCI/CS Pump Area Cooling Unit 2A	19.90	4.60		░	░	░	■	■	■	■
2-1501-3A	Containment Cooling Heat Exchanger Discharge Valve 2A	1.0	0.33						■	■	■
2-1402-38A	Core Spray Recirc. Isolation Valve 2A	0.70	0.13				░				
	120/208 Distr Xfmr 28-2	13.00	17.32 KVA	░	░	░	░	■	■	■	■
2-4321	Condensate Transfer Jockey Pump	28.80	6.75	░	░	░	░	■	■	■	■
	120/240 Distr Xtmr Inst 2A and 2B	65.00	86.60 KVA	░	░	░	░	■	■	■	■
2-5350-MSOP	Main H2 Seal Oil Pump	47.40	13.50	░	░	░	░	■	■	■	■
2-83125-2A	125V Battery Charger 2A	33.66	33.66 KW	░	░	░	░	■	■	■	■
2-5350-SOVP	H2 Seal Oil Vacuum Pump	10.30	1.80	░	░	░	░	■	■	■	■
2-4611-A	Diesel Generator Starting Air Compresser 2A	19.90	5.00	░	░	░	░	■	■	■	■
2-5758A	Main Steam Isolation Valve Unit Cooler A	10.30	2.00	░	░	░	░	■	■	■	■
2-5758B	Main Steam Isolation Valve Unit Cooler B	10.30	2.00	░	░	░	░	■	■	■	■
2-5758C	Main Steam Isolation Valve Unit Cooler C	10.30	2.00	░	░	░	░	■	■	■	■
2-5758D	Main Steam Isolation Valve Unit Cooler D	10.30	2.00	░	░	░	░	■	■	■	■
2-5758E	Main Steam Isolation Valve Unit Cooler E	10.30	2.00	░	░	░	░	■	■	■	■
2-5758F	Main Steam Isolation Valve Unit Cooler F	10.30	2.00	░	░	░	░	■	■	■	■
2-5758G	Main Steam Isolation Valve Unit Cooler G	10.30	2.00	░	░	░	░	■	■	■	■

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2/3 ELECTRICAL LOAD PROFILE, UNIT 2 LOADING
FIGURE 8.3-6
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EPN	Name	Starting KW	Running HP	(0s)	0s	5s	10s	10-min	10+ min	10++ min	10+++ min
2-5758H	Main Steam Insolation Valve Unit Cooler H	10.30	2.00	▒	▒	▒	▒	■	■	■	■
2-5700-30A	CCSW Pump Cooler A Fan 1	14.00	3.00							■	■
2-5700-30A	CCSW Pump Cooler A Fan 2	14.00	3.00							■	■
2-5700-30B	CCSW Pump Cooler B Fan 1	14.00	3.00							■	■
2-5700-30B	CCSW Pump Cooler B Fan 2	14.00	3.00							■	■
2-8001-A	RPS MG Set 2A	69.40	3.9	▒	▒	▒	▒	■	■	■	■
	120/208 Distr Xfmr FP-2	11.30	15.00 KVA	▒	▒	▒	▒	■	■	■	■
	Diesel Circulation Water Heater 2	15.00	15.00 KW	▒	▒	▒	▒	■	■	■	■
2-6657	Engine tube Oil Circulating Pump Motor (1 Hp)	6.10	0.90	▒	▒	▒	▒	■	■	■	■
2-6660	Engine Lube Oil Circulating Pump Motor (0.75 Hp)	4.20	0.68	▒	▒	▒	▒	■	■	■	■
2-5600-TGOP	Turning Gear Oil Pump	-	45.00					■	■	■	■
2-5620-A	Turbine Bearing Lift Pump 2A	-	9.00								■
2-5620-B	Turbine Bearing Lift Pump 2B	-	9.00								■
2-5620-C	Turbine Bearing Lift Pump 2C	-	9.00								■
2-5620-D	Turbine Bearing Lift Pump 2D	-	9.00								■
2-5620-E	Turbine Bearing Lift Pump 2E	-	9.00								■
2-83250-2	250V Battery Charger 2	65.62	65.62 KW	▒	▒	▒	▒	■	■	■	■
2/3-3903	Diesel Generator Cooling Water Pump 2/3	132.1	65.97KW	▒	▒	▒	▒	■	■	■	■
2-5601-TGM	Turbine Turning Gear Motor		51.00								■
2-1501-22A	LPCI Inboard Isolation Valve 2A	39.1	10.5				▒				
2-202-5A	Recirc. Pump 2A Discharge Valve	50.40	13.00				▒				
2-1501-21B	LPCI Outboard Isolation Valve 2B	53.20	16.20				▒				
	Xfmr 28 Losses	3.9	3.9 KW	▒	▒	▒	▒	■	■	■	■
■	Indicates Manual Connection	Running	(KW)	371.0	885.0	1397.0	2160.0	2150.0	2609.0	2407.0	2491.0
▒	Indicates Automatic Connection										

(0s) - 0 seconds after closing of DG Breaker
0s - 0 seconds after UV reset
5s - 5 seconds after UV reset
10s - 10 seconds after UV reset
10-min - All loads that automatically stop before 10 minutes are shown off
10+min - CCSW Pump 2A is started
10++min - CCSW Pump 2B is started with its auxiliaries
10+++min - Both CCSW pumps are running and other loads starting after 10 minutes are shown here

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2/3 ELECTRICAL LOAD PROFILE, UNIT 2 LOADING
FIGURE 8.3-6
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EPN	Name	Starting	Running	(0s)	0s	5s	10s	10-min	10+ min	10++ min	10+++ min
		KW	Hp								
3-1502-A	LPCI 3A	944.19	629.00 (1)		■	■	■	■	■	■	■
3-1502-B	LPCI 3B	944.19	642.00 (1)			■	■				
3-1401-A	CS 3A	1070.08	901.00 (1)				■	■	■	■	■
3-1501-44A	CCSW 3A	593.44	575.00 (2)						■	■	■
3-1501-44B	CCSW 3B	593.44	465.00							■	■
	Aux PT Indicating Lights, Meter and Relay	0.40	0.40 KW	■	■	■	■	■	■	■	■
	120/208 Distr Xfmr 38-1	6.80	9.00 KVA	■	■	■	■	■	■	■	■
3-1201-7	Cleanup System Return Isolation Valve	13.20	2.6	■	■	■	■				
3-1201-1	Cleanup System Inlet Isolation Valve	23.20	3.9	■	■	■	■				
2/3-5203	Diesel Transfer Pump 2/3	8.70	1.35	■	■	■	■	■	■	■	■
2/3-5790	Diesel Generator Vent Fan 2/3	81.30	30.00	■	■	■	■	■	■	■	■
3-1402-25A	Core Spray Inboard Isolation Valve 3A	21.10	4.00				■				
3-2400-A	Post LOCA H2 & 02 Monitoring Sample Pump 3A	6.10	0.90	■	■	■	■	■	■	■	■
3-4710-A	Drywell Air Compressor	26.80	3.10	■	■	■	■	■	■	■	■
3-1103	Standby Liquid Control Tank hater	25.00	25.00 KW	■	■	■	■	■	■	■	■
3-5746A	LPCI/CS Pump Area Cooling Unit 3A	19.90	4.60		■	■	■	■	■	■	■
3-1501-3A	Containment Cooling Heat Exchanger Discharge Valve 3A	0.9	0.33						■	■	■
	120/208 Distr Xfmr 38-2	13.00	17.32 KVA	■	■	■	■	■	■	■	■
3-4321	Condensate Transfer Jockey Pump	28.80	4.6	■	■	■	■	■	■	■	■
	120/240 Distr Xfmr Inst	48.70	64.95 KVA	■	■	■	■	■	■	■	■
3-5350-MSOP	Main H2 Seal Oil Pump	47.40	13.5	■	■	■	■	■	■	■	■
3-83125-3A	125V Battery Charger 3A	33.66	33.66 KW	■	■	■	■	■	■	■	■
3-5350-SOVP	H2 Seal Oil Vacuum Pump	10.30	1.80	■	■	■	■	■	■	■	■
3-4611A	Diesel Generator Starting Air Compresser 3A	19.90	5.00	■	■	■	■	■	■	■	■
3-5758A	Main Steam Isolation Valve Unit Cooler A	8.70	1.50	■	■	■	■	■	■	■	■
3-5758B	Main Steam Isolation Valve Unit Cooler B	8.70	1.50	■	■	■	■	■	■	■	■
3-5758C	Main Stem Isolation Valve Unit Cooler C	8.70	1.50	■	■	■	■	■	■	■	■
3-5758D	Main Steam Isolation Valve Unit Cooler D	8.70	1.50	■	■	■	■	■	■	■	■
3-5758E	Main Steam Isolation Valve Unit Cooler E	8.70	1.50	■	■	■	■	■	■	■	■
3-5758F	Main Steam Isolation Valve Unit Cooler F	8.70	1.50	■	■	■	■	■	■	■	■
3-83250-3	250V Battery Charger 3	65.62	65.62 KW	■	■	■	■	■	■	■	■
	125Vdc Alternate Battery Electric Heaters	15.00	15.00 KW	■	■	■	■	■	■	■	■
	120/208 Distr Xfmr FP-3	11.30	15.00 KVA	■	■	■	■	■	■	■	■

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2/3 ELECTRICAL LOAD PROFILE, UNIT 3 LOADING
FIGURE 8.3-7
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EPN	Name	Starting KW	Running Hp	(0s)	0s	5s	10s	10-min	10+ min	10++ min	10+++ min
				■	■	■	■	■	■	■	■
-	Diesel Circulation Water Heat 3	15	15.00 KW	■	■	■	■	■	■	■	■
3-6657	Engine Lube Oil Circulating Pump Motor (1 Hp)	6.1	0.9	■	■	■	■	■	■	■	■
3-6660	Engine Lube Oil Circulating Pump Motor (0,75	4.2	0.68					■	■	■	■
2-5600-TGOP	Turning Gear Oil Pump 1	-	45.00								■
3-5620-A	Turbine Bearing lift Pump 3A	-	9.00								■
3-5620 B	Turbine Bearing Lift Pump 3B	-	9.00								■
3-5620-C	Turbine Bearing Lift Pump 3C	-	9.00								■
3-5620-D	Turbine Bearing Lift Pump 3D	-	9.00								■
3-5620-E	Turbine Bearing Lift Pump 3E	-	9.00								■
2/3-3903	Diesel Generator Cooling Water Pump 2/3	132.70	65.97 KW	■	■	■	■	■	■	■	■
	120/208 Distr Xfmr 38-3	11.30	15.00 KVA	■	■	■	■	■	■	■	■
3-5700-30A	CCSW Pump Cooler A Fan 1	14.00	3.00							■	■
3-5700-30A	CCSW Pump Cooler A Fan 2	20.80	3.00							■	■
3-5700-30B	CCSW Pump Cooler B Fan 1	14.00	3.00							■	■
3-5700-30B	CCSW Pump Cooler B Fan 2	14.00	3.00							■	■
3-8001-A	RPS MG Set 3A	69.40	3.9	▨	▨	▨	▨	■	■	■	■
3-5601-TGM	Turbine Tuning Gear Motor	-	51.00								■
3-1402-38A	Core Spray Pump Recirc. Isolation Valve 3A	0.70	0.13				▨				
2/3-6600-B	Diesel Generator Starting Compressor 213E	19.90	5.00	▨	▨	▨	▨	■	■	■	■
3-1501-13A	LPCI Pump Flow Bypass Valve 3A	0.70	0.13		▨	▨	▨				■
3-1501-22A	LPCI Inboard Isolation Valve 3A	39.1	10.5				▨				■
2-202-5A	Recirc. Pump 3A Discharge Valve	51.00	13.00				▨				■
3-1501-21B	LPCI Outboard Isolation Valve 3B	15.30	16.20				▨				■
	Xfmrr 38 Losses	3.8	3.8 KW	▨	▨	▨	▨	■	■	■	■
■	Indicates Manual Connection	Running Loads	(KW)	403.0	914.0	1430.0	2189.0	2181.0	2638.0	2435.0	2518.0
▨	Indicates Automatic Connection										

(Os) - 0 seconds after closing of DG Breaker
Os - 0 seconds after UV reset
5s - 5 seconds after UV reset
10s- 10 seconds after UV reset
10-min - All loads that automatically stop befor 10 minutes are shown off
10+min - CCSW Pump 3A is started
10++ min - CCSW Pump 3B is started with its auxiliaries
10+++min - Both CCSW pumps are running and other loads starting after 10 minutes are shown here

(1) Running horsepower is reduced at T=10+ min and is reflected in the DG total loading.
(2) Running horsepower is 465 hp with 2 CCSW pumps rinning and is reflected in the DG total loading.

DRESDEN STATION
UNITS 2 AND 3
DIESEL GENERATOR 2/3 ELECTRICAL LOAD PROFILE, UNIT 3 LOADING
FIGURE 8.3-7
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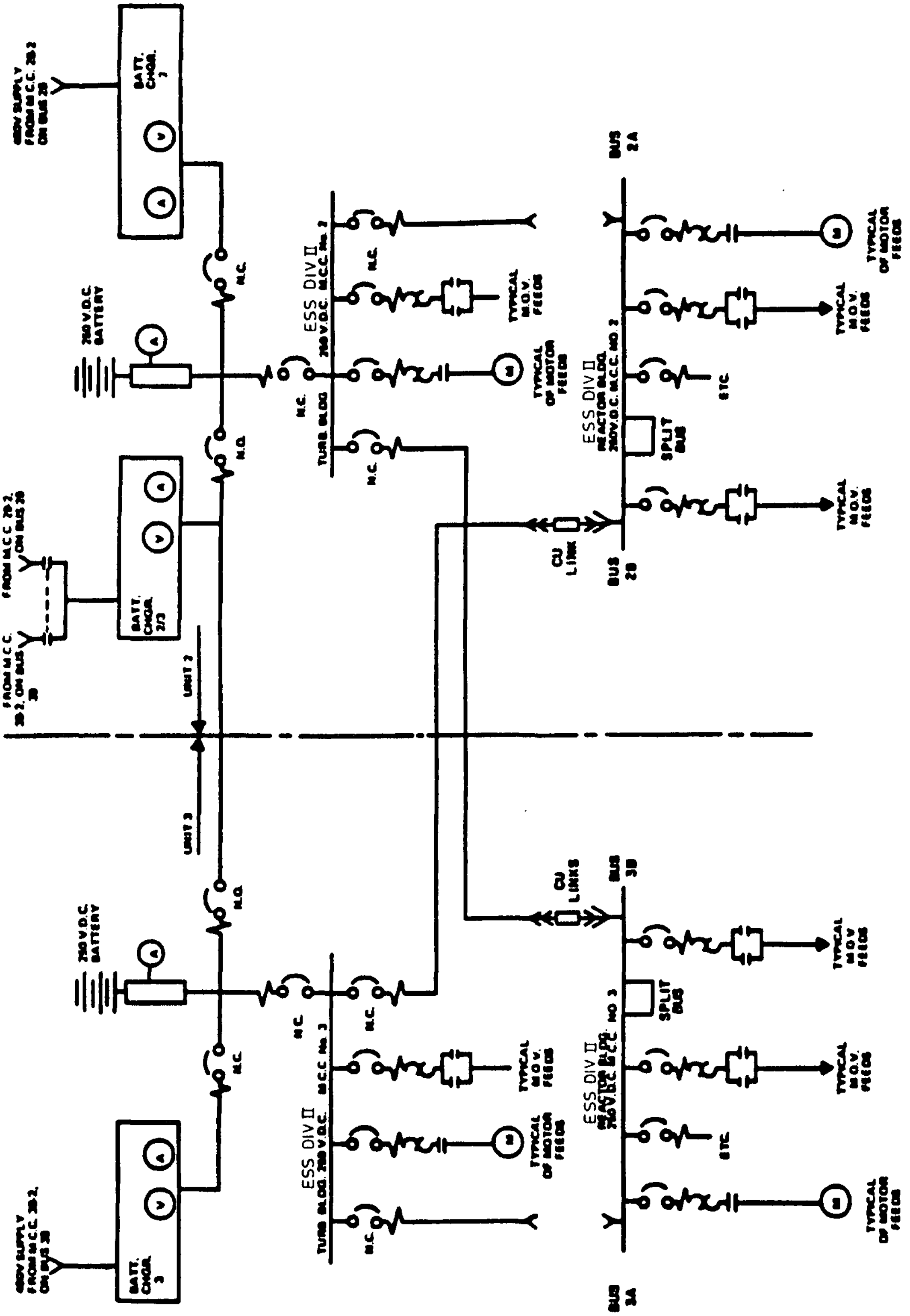

DRESDEN STATION
UNITS 2 & 3

250 V DC STATION BATTERY SYSTEM

FIGURE 8.3-8