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8.1 Summary

The plant electrical power system is designed to provide a diversity of dependable power sources which are physically isolated so that any one failure affecting one source of supply will not propagate to alternate sources. The plant auxiliary electrical power systems are designed to provide electrical and physical independence and adequate power supplies for startup, operation, shutdown, and for other plant requirements which are important to safety.

In the event of a loss or degradation of all off-site power sources, auxiliary power will be supplied from diesel generators located on the site. These power sources are physically independent from any normal power system. Each power source, up to the point of its connection to the auxiliary power bus, is capable of complete and rapid electrical isolation from any other sources. Loads important to plant safety are split and diversified between switchgear sections and means are provided for rapid location and isolation of system faults. Plant batteries are provided as a reliable source of control power for specific engineered safeguards and other functions required when AC power is not available.

8.2 Transmission System

8.2.1 Network Interconnections

Output of the Monticello Nuclear Generating Plant is delivered to a 345/230/115/13.8 KV switchyard located on the plant site. Drawing NH-178635, Section 15, shows the one line diagram for the Monticello plant and its connections to the transmission system.

The 345 KV portion of the switchyard has positions for connecting the generator output, three transmission lines, a 345-230-13.8 KV autotransformer a 345-13.8 KV transformer, a 345-34.5 KV transformer, and a 345-115-13.8 KV autotransformer. The 345 KV bus and circuit breaker arrangement is a breaker-and-one-half system. One 345 KV transmission line is routed to connect into the 345 KV loop around the Twin Cities Metropolitan Area at the Elm Creek Substation. The second line connects to the 345 KV transmission system at Sherburne County Substation. The third line connects to the 345 KV Quarry Substation.

The 230 KV portion of the switchyard is provided to establish an interconnection with the transmission system of the Great River Energy. An autotransformer connects the 345 KV and 230 KV busses.

The 115 KV portion of the switchyard is connected to the 345 KV bus through an autotransformer. The 115 KV bus is arranged in a ring bus configuration. In addition to the autotransformer connection to the 115 KV bus, there are three transmission line connections and a connection to a plant auxiliary transformer. One of the three transmission lines connects into the 115 KV transmission system at Lake Pulaski Substation and at Dickinson Substation, another at Hassan Substation, and the third 115 KV line connects to the Liberty substation.

The 13.8 KV portion of the switchyard is provided to establish reliable power sources to various plant equipment. These include the plant auxiliary reserve transformer (1AR); discharge structure transformers (X7, X8); cooling tower fan transformers (X50, X60, X70, X80); transformer XP91 which powers the hydrogen water chemistry cryogenic system panel and an alternate feed (through transformer 6) to the training center.

The six (345 KV and 115 KV) transmission line connections to the switchyard are all connected into the Xcel Energy interconnected transmission grid. Their points of connection to the grid are arranged by routes and intra-right-of-way spacing to minimize multiple line outages while performing the requirement of delivering power to locations which best satisfy system growth needs. The 345 KV and 115 KV lines, as well as the lines to which they interconnect, are designed and built to exceed the requirements of the National Electric Safety Code for heavy loading districts, Grade B construction (Reference 41). Lightning performance design of the transmission lines is based on less than one outage per 100 miles per year.

The six Xcel Energy transmission lines leave the Monticello substation through four separate rights-of-way: Sherburne County line corridor; Liberty line corridor; Quarry corridor; and a common corridor for the Elm Creek, Dickinson-Lake Pulaski, and Hassan lines. These rights-of-way are considered independent as they are greater than 1/4 mile apart at a distance of 1 mile from the plant.

Three transformers are provided to supply the plant with offsite power from the substation. All three sources can independently provide adequate power for the plant's safety-related loads. These transformers and their interconnections to the substation are as follows:

The primary station auxiliary transformer, 2R, is fed from 345 KV Bus No. 1 via 345 KV to 34.5 KV transformer 2RS, and underground cabling from the substation to the area northwest of the turbine building where 2R transformer is located. 2R transformer is of adequate size to provide the plant's full auxiliary load requirements.

The reserve transformer, 1R, is fed from the 115 KV substation via an overhead line from the substation to the area northwest of the turbine building where 1R transformer is located. 1R transformer is of adequate size to provide the plant's full auxiliary load requirements.

The reserve auxiliary transformer, 1AR, is located southwest of the reactor building and may be fed from two separate 13.8 KV sources in the substation. One method of supplying 1AR transformer is from the tertiary winding of #10 transformer, the auto-transformer which interconnects the 345 KV and 115 KV systems. Power is routed from the tertiary winding of 10 transformer to 1AR via circuit breaker 1N2 and underground cabling from the substation to 1AR transformer. The alternate method of feeding 1AR is from the 345 KV substation via 345 KV to 13.8 KV transformer 1ARS, circuit breaker 1N6, and underground cabling from the substation to 1AR. Circuit breakers 1N2 and 1N6 are interlocked to prevent having both breakers simultaneously in the closed position. 1AR transformer is sized to provide only the plant's essential 4160 Vac buses and connected loads.

8.3 Auxiliary Power System

8.3.1 Design Basis

The auxiliary power system is designed to provide adequate power to operate all the plant auxiliary loads necessary for plant operation.

The auxiliary power system power sources, distribution equipment, power and control cabling and loads are arranged so that failure of a single component in the auxiliary power system will not reduce plant safety or impair the operation of essential plant functions. Loads important to plant safety are split and diversified among system components.

Plant design and circuit layout has produced physical separation of redundant power sources, distribution equipment, power and control cabling, instrumentation and control devices, and associated utilization devices. The electrical cable installations are based upon strict engineering and construction guidelines.

8.3.2 Description

The auxiliary power system consists of power sources, distribution equipment, instrumentation and control and utilization devices.

Provisions for loss of power have been made in the design. The multiplicity of sources feeding the auxiliary buses, the redundancy of transformers and buses within the plant, and the division of critical loads between buses yields a system that has a high degree of reliability. Also, the physical separation of buses and service components are designed to limit or localize the consequences of electrical faults or mechanical accidents occurring at any point in the system.

Cables and components of redundant circuits are physically separated by means of concrete walls, floors or space, and barriers to assure maximum independence of redundant channels. Cables of 4160 Vac and 13.8KV circuits are principally installed in conduit. Protection for 4160 Vac circuits is provided by magnetic air circuit breakers. Protection for 13.8KV circuits is provided by vacuum circuit breakers.

Cables of 480 Vac power circuits and 125 Vdc control circuits are installed in punched metal type trays and conduits. The current carrying capacity of all cables is conservatively calculated to preclude the possibility of thermal overloading. 480 Vac power circuits are protected by circuit breakers, and 480 Vac motor starters are protected by fused disconnect switches or circuit breakers. Motor starter contactors are provided with thermal overload devices.

Low level signal cables which are noise sensitive are carried in separate fully enclosed trays or conduits separate from power cables to limit noise interference to the maximum extent possible.

The switchgear for the 4160 Vac and 13.8KV bus is metal-clad indoor type. Circuit breakers are three-pole and are electrically operated from a 125 Vdc plant battery, except those at the discharge structure which are operated from a control power transformer. All 4160 Vac and 13.8KV breakers have stored energy closing mechanisms. Stored-energy breakers assure high-speed closing of breaker contacts. Four 4160 Vac buses and two 13.8KV buses are located in the turbine building and supply the base plant loads. Two buses located in the discharge structure supply the cooling tower pumps.

Load center unit substations located in the plant are supplied to transform power from 4160 Vac to 480 Vac and provide protection and control for 480 Vac feeder circuits. These units consist of an incoming bus section (4160 Vac), transformer and low voltage section (480 Vac) with metal-enclosed drawout power circuit breakers. Compartmentalization of major components in the low voltage section isolates faults, if they should occur, and provides safety for operating personnel.

Transformers and switchgear for the plant 480 Vac loads are located in the turbine building and the adjacent electrical equipment room. The switchgear for the 480 Vac cooling tower fans is located in small buildings adjacent to the cooling towers. The transformers which supply this switchgear are located outdoors adjacent to their buildings and transforms power from 13.8 KV to 480 Vac.

Switchgear for each 480 Vac load center is in self-supporting, metal-enclosed sections with continuous main buses having horizontal drawout circuit breaker units which are replaceable under live bus conditions. The plant load center circuit breakers are electrically operated from the 125 Vdc plant battery. The cooling tower fan load centers are electrically operated from a control power transformer.

There are two independent safety-related buses for the plant each with its associated engineering safeguards equipment that can be connected to its diesel generator.

The standby diesel generators provide AC power to essential loads on the safety related 4160 Vac buses in the event of a loss or degradation of all off-site power sources. Normally open bus tie circuit breakers permit supplying either 4160 Vac bus from the other. Administrative procedures and operating instructions prohibit cross connecting safety-related buses during reactor operation except for abnormal or emergency situations. When cross connected, Technical Specification Limiting Conditions for Operation are invoked for the affected systems (References 29 and 30). Cross-tieing essential load centers during plant outages when secondary containment and the EFT system are required to be operable is permissible when performed in accordance with plant procedures.

On loss of auxiliary power the reactor will scram, and if auxiliary power is not restored immediately, the diesel generators, which have automatically started, will carry the vital loads. The auxiliary system buses are so arranged that the vital shutdown loads are easily transferred to the diesel generators. Section 8.4 more completely describes this action.

8.3.3 Performance Analysis

Auxiliary power is supplied by the primary station auxiliary transformer, 2R, during normal power operation. Provisions are made for an automatic, fast transfer of the auxiliary load from the primary station auxiliary transformer, 2R, to the reserve transformer, 1R. In the event the 1R reserve transformer is unable to accept load, the essential buses are automatically transferred to the reserve auxiliary transformer, 1AR. These transformers supply power to the equipment used to maintain a safe plant. It is highly improbable that all three electrical power sources would be lost simultaneously because each is supplied from a different source in the substation. Nevertheless, the loss of all auxiliary power is assumed for design purposes.

A diagram of the principal elements of the auxiliary electrical system is shown in Section 15 Drawing NF-36175, and the equipment listings are shown in Table 8.3-1.

The Monticello switchyard is designed and constructed to utility standards developed over the years to maintain the continuity of service requirements of our loads. All feasible measures to assure this requirement are incorporated into the installation.

The switchyard is not designed specifically to meet the single failure criterion. However, blackout and brownout events have caused reviews and studies to take place with the result that a continuing upgrading is taking place to improve system integrity.

Control and power requirements for the switchyard circuit breakers are supplied from battery sources located in the 345/115 and 230 KV control houses. Cable leads from distribution cabinets are carried below ground to the circuit breakers. All of the high voltage switchyard circuit breakers have dual trip coils with trip functions divided to minimize the effect of equipment malfunction.

It is our historic experience that battery failure is one of the least likely events that could occur in the switchyard. This performance is attributed to preventive maintenance and proven design.

The switchyard circuit breakers supplying the redundant off-site source transformers will normally be closed. If a battery or DC failure did occur, the transformers would continue to be supplied since the circuit breakers would remain closed. It would take additional contingencies beyond switchyard DC failure conditions to interrupt the electrical supply from the redundant off-site sources to the safety-related loads.

Normally the switchyard off-site transformer power source switching is done only under direct authorization of the reactor operator. Instructions received from the System Dispatcher are approved by the Shift Supervisor before the instructions are carried out. Only under conditions of extreme system emergency can the System Dispatcher, located in the System Control Center in downtown Minneapolis, perform the switching of switchyard circuit breakers to isolate these off-site source transformers without prior approval.

Auxiliary power is provided by either the primary station auxiliary power transformer, 2R, connected to the 345 KV Bus No. 1 through the 2RS transformer, or the reserve transformer, 1R, connected to the 115 KV ring bus, as shown in Drawings NH-178635 and NF-36175, Section 15. Each of the two transformers has the capacity to carry the full plant load. These two auxiliary transformers step down the voltage to 4160 Vac to supply the 4160 Vac auxiliary buses and with separate windings, step down the voltage to 13.8KV to supply the 13.8KV auxiliary buses. The 1AR reserve auxiliary transformer can provide 4160 Vac power to buses 15 and 16 from the 345 KV substation (via the 1ARS transformer) or from the No.10 transformer. Two transformers (X7 and X8) located at the Discharge Structure Substation, step down the voltage from 13.8 KV to 4160 Vac. These transformers supply 4160 Vac to the cooling tower pumps. Four additional transformers (X50, X60, X70 and X80) step down the voltage from 13.8 KV to 480 Vac to supply the cooling tower fans.

In the event that the 115 KV and the 345 KV switchyards were incapacitated, the diesel generators provide another independent source of auxiliary power. Each diesel generator has the capacity for operation of systems required to shut down the unit and maintain it in a safe shutdown condition.

The plant auxiliary buses are in six separate sections. Buses 11 and 12 provide power to the condensate pumps, the feedwater pumps and the reactor recirculating pumps. Buses 13, 14, 15 and 16 supply power to all other plant services. The general design requirement is to supply duplicate services from different buses. Failure of any one bus will still permit the plant to operate at reduced output.

The cooling tower substation, located in the Discharge Structure, has two 4160 Vac buses, #17 and #18, which supply power to the cooling tower pumps. These buses are supplied by transformers X7 and X8.

Power is supplied from the 4160 Vac buses 13, 14, 15, and 16 to the plant 480 Vac buses through seven separate transformers (X10, X20, X30, X40, X90, X107 and X108). The 480 Vac buses supply power to the smaller electrically operated auxiliaries. The 480 Vac buses are of the indoor load center type, which, in addition to supplying power directly to certain 480 Vac motor loads, also feed a number of 480 Vac motor control centers located around the plant and which supply miscellaneous motors, lighting, instrumentation and small plant service loads of 100 hp or less. Power is supplied to two 480 Vac load centers located at the cooling tower through four separate 13.8 KV to 480 Vac transformers (X50, X60, X70 and X80). There are two transformers for each 480 Vac cooling tower load center (LC105 and LC106), with one supplied by the 1ARS transformer and the other by the #6 transformer.

Transformers and load centers for the plant 480 Vac loads are located in the turbine building and the adjacent electrical equipment room.

8.3.4 Inspection and Testing

Inspection and testing at vendor factories and during construction were conducted to demonstrate the following:

a. All components operate within their design ratings;

b. The proper mounting of all components;

c. That all metering and protective devices are properly calibrated and function correctly;

d. That all connections are properly made and that the circuits are continuous.

Operational testing of the normal and standby power systems was conducted under conditions which simulate the loss of off-site power conditions. This testing demonstrated the following:

a. All essential loads can be operated in the proper sequence for each design accident condition with normal power for essential loads available.

b. The relaying and control system can detect a loss-of-external power and, with the buses dead, start and load the standby power sources.

c. The standby power sources can provide sufficient power for an adequate time interval.

The auxiliary electrical power system is tested at regular intervals during the life of the plant to demonstrate the capability of the system to provide sufficient power to the essential loads. Special testing of the capabilities of the 1AR transformer was performed during the 1991 refueling outage in response to concerns identified during the 1990 EDSFI inspection (References 25 and 26).

8.3.5 LPCI Swing Bus Supply

8.3.5.1 Design Basis

No single failure should be allowed which could render the swing bus and one safeguards division inoperable at the same time.

The bus transfer scheme will meet the applicable portions of IEEE 279 (Reference 42) for the single failure concern, testability and quality of components.

8.3.5.2 Description

The LPCI swing bus, MCC 133B and 143B, supplies the LPCI injection valves. In order to conform to current LOCA analyses, no failure can be allowed to make the swing bus and one safeguards division inoperable at the same time. If this did occur, the only source of low pressure injection would be one Core Spray pump. According to USAR Table 14.7-11, the MNGP LOCA analyses require two core spray pumps to insure adequate core cooling in certain single failure scenarios. Therefore, the electrical supply to the swing bus must be able to switch from a failed division to the other division.

The swing bus consists of two motor control centers (MCC), 133B and 143B, which are directly connected together. The bus supplies the following loads:

MO-2012	LPCI Injection Valve Motor, Division I
MO-2013	LPCI Injection Valve Motor, Division II
MO-2014	LPCI Injection Valve Motor, Division I
MO-2015	LPCI Injection Valve Motor, Division II
MO-2-43A and B	Recirc Pump Suction Valve Motors
MO-2-53A and B	Recirc Pump Discharge Valve Motors
MO-4085A and B	RHR Discharge Intertie Line Isolation Valve Motors

The bus is normally supplied from Division I Load Center 103 through two breakers, ACB 52-307 and ACB 52-3300 (See Figure 8.3-2). An alternate power supply from Division II Load Center 104 is available through normally closed breaker ACB 52-407 and normally open breaker ACB 52-4300. An automatic transfer is provided for any of the following conditions:

Loss of Voltage
Loss of Voltage and Division I EDG Output Breaker Closed
Degraded Voltage and Division I EDG Output Breaker Closed
Over Voltage and Division I EDG Output Breaker Closed
Over/Under of Frequency and Division I EDG Output Breaker Closed

If one of the above conditions trips ACB 52-3300 and the following conditions are met:

the auxiliary contacts on ACB 52-3300 indicate the breaker is open,

the auxiliary contacts on ACB 52-407 indicate the breaker is closed,

at least one of the two under-voltage relays, 27-43A or 27-43B, sense that an under-voltage condition exists at MCC 143B; and

ACB 52-3300 did not trip on overcurrent

then ACB 52-4300 will receive a CLOSE signal.

The transfer only occurs from Division I to Division II.

The control power for the Division I breakers is supplied by the 125 Vdc Division I battery. Division II is similarly supplied by the 125 Vdc Division II Battery. There is one exception to this. Breaker ACB 52-3300 receives 125 Vdc control power from the 250 Vdc Division I battery center tap. This assures that a Division I 125 Vdc battery failure will not fail the swing bus transfer in addition to Division I equipment.

Alarms monitor the status of the control power supply to ACB 52-3300 and 52-4300 as well as the position of ACB 52-3300.

Additional information pertaining to the design considerations for the LPCI swing bus supply can be found in correspondence between NSP and the NRC dated: July 14, 1989 (Reference 44), September 8, 1989 (Reference 43), October 6, 1989 (Reference 45), and November 13, 1989 (Reference 46).

8.3.5.3 Testing

The swing bus is tested each refueling outage to verify the following conditions:

1. Upon loss of off-site power, the bus transfer does occur when Division I 480 Vac to the swing bus fails to be restored in approximately 12 seconds. This test is accomplished by: 1) interrupting the Division I 480 Vac source to the swing bus ahead of the loss of power relays, 2) recording the delay time and 3) verifying that the transfer occurs.

2. Upon loss of off-site power, the bus transfer does not occur when the Division I EDG is available and restores 480 Vac to the swing bus in less than 12 seconds.

Table 8.3-1 Electrical Equipment Listing

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Transformers

X01	- #1 - Main	800 MVA - 3ϕ - 60 Hz	22/345 KV
X02	- #2R - Primary Aux	40.5/54 MVA - 3ϕ - 60 Hz	34.5/13.8/4.16 KV
X03	- #1R - Reserve	40.5/54 MVA - 3ϕ - 60 Hz	115/13.8/4.16 KV
X04	- #1AR - Reserve	7500 KVA - 3ϕ - 60 Hz	13800/4160 Vac
X10	- LC-101	1500/2000 KVA -3ϕ - 60 Hz	4160/480 Vac
X20	- LC-102	1500/2000 KVA - 3ϕ - 60 Hz	4160/480 Vac
X30 & X40	- LC 103, -104	1500 KVA[1] -3ϕ - 60 Hz	4160/480 Vac
X50,X60, X70 & X80	- LC-105, -106	1500/1725 KVA-3ϕ - 60 Hz	13800/480 Vac
X107 & X108	- LC-107, -108	1500/1932 KVA - 3ϕ - 60 Hz	4160/480 Vac
X90	- LC-109	1500 KVA - 3ϕ - 60 Hz	4160/480 Vac
X7 and X8	- Buses 17 & 18	5000 KVA - 3ϕ - 60 Hz	13800/4160 Vac
2RS	- Feed to 2R	50 MVA - 3ϕ - 60 Hz	345/34.5 KV
1ARS	- Feed to 1AR	15/20/25/28 MVA - 3ϕ - 60 Hz	345/13.8 KV
#6	- Tertiary Feed to X7, X8, X50, X60, X70 & X80	180/240/300/336 MVA - 3ϕ - 60 Hz	345/230/13.8 KV
#10	- Tertiary Feed to 1AR	180/240/300/336 MVA - 3ϕ - 60 Hz	345/115/13.8 KV

Circuit Breakers and Fuses

Buses 11 & 12	13.8KVac	Incoming - 2000 Amp Feeders - 2000 Amp
Buses 13 & 14	4160 Vac	Incoming - 2000 Amp Frame Feeders - 1200 Amp Frames
Buses 15 & 16	4160 Vac	Feeders - 1200 Amp Frames
Buses 17 & 18	4160 Vac	Incoming -Disconnect Fuse on 13.8 KV Side of XFMR Bus Tie - 1200 Amp Frame Feeders - 1200 Amp Frames
LC -101, -102	480 Vac	Incoming - 3000 Amp Frame Bus Tie - 1600 Amp Frame[2] Feeders - 600 Amp Frames
LC -103, -104	480 Vac	Incoming - 3000 Amp Frame Bus Tie - 1600 AMP Frame Feeders - 1600 AMP Frames
LC -105, -106	480 Vac	Incoming Disconnect Fuse on 13.8 KV Side of XFMR Incoming - 3000 Amp Frame Feeders - 600 Amp Frames

1. Rating reflects the maximum 1E rating of the transformer
2. The bus tie breaker for Load Centers 101 and 102 is physically located in LC-102

Table 8.3-1 Electrical Equipment Listing

(Page 2 of 3)

LC -107, -108	480 Vac	Incoming - 3200 Amp Frame Bus Tie - 1600 Amp Frame Feeders - 800 Amp Frames
LC -109	480 Vac	Incoming - 3000 Amp Frame Bus Tie - 1600 Amp Frame Feeders - 600 & 800 Amp Frames

Bus Duct

Main Generator Isophase Bus	19,834 Amp
Unit & Reserve Secondary Feeders	1,500 Amps (13.8KV Bus Duct) 2,500 Amps (4KV Bus Duct)

Electrical Bus Loads

Bus #11	13,800 Vac	1 - Reactor Feed Pump	8000 HP
		1 - Recirc. Pump MG Set	4000 HP
		1 - Condensate Pump	2400 HP
Bus #12	13,800 Vac	1 - Reactor Feed Pump	8000 HP
		1 - Recirc. Pump MG Set	4000 HP
		1 - Condensate Pump	2400 HP
Bus #13	4160 Vac	1 - Circulating Water Pump	1250 HP
		1 - 480 Vac LC-107	1725 KVA
		1 - 480 Vac LC-101	2000 KVA
		1 - Feeder Bus #15	
		1 - 480 Vac LC-109	1500 KVA
Bus #14	4160 Vac	1 - Circulating Water Pump	1250 HP
		1 - 480 Vac LC-108	1725 KVA
		1 - 480 Vac LC-102	2000 KVA
		1 - Spare	
		1 - Feeder Bus #16	
Bus #15	4160 Vac	1 - Core Spray Pump	800 HP
		2 - RHR Pumps	600 HP[3]
		2 - RHR Service Water Pumps	700 HP
		1 - CRD Pump	250 HP
		1 - 480 Vac LC-103	1500 KVA
		1 - Turbine Auxiliary Oil Pump	250 HP
		1 - Bus Tie	
Bus #16	4160 Vac	1 - Core Spray Pump	800 HP
		2 - RHR Pumps	600 HP[3]
		2 - RHR Service Water Pumps	700 HP
		1 - CRD Pump	250 HP
		1 - 480 Vac LC-104	1500 KVA
		1 - Bus Tie	

3. Monticello's RHR Pump Motor inventory includes both 600 and 700 HP motors that may be used on any of the four RHR pumps.

Table 8.3-1 Electrical Equipment Listing

(Page 2 of 3)

Bus #17	4160 Vac	1 - Cooling Tower Pump 1 - Bus Tie	2500 HP
Bus #18	4160 Vac	1 - Cooling Tower Pump	2500 HP

8.4 Plant Standby Diesel Generator Systems

8.4.1 Safeguards Emergency Diesel Generator (EDG) Systems

8.4.1.1 Design Basis

Two independent EDGs provide redundant standby power sources. Each EDG is capable of providing sufficient power to safely shut down the reactor upon the loss of all outside power simultaneous with the design basis accident. The following design criteria were specified for each EDG:

a. Equipment shall conform to applicable standards of the NEMA, ASA, DEMA, ASME, NBFW, NFPA, ASTM, IEEE, USASI and state and local regulations.

b. The EDG sets shall be complete package units with all auxiliaries necessary to make them self-sufficient power sources capable of automatic start at any time and capable of continued operation at rated full load voltage and frequency until either manually or automatically stopped.

c. The EDGs shall have the ability to pick up loads as described in Table 8.4-2.

d. The EDGs shall be located in Class I structures.

e. The engine shall conform to the “Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines” of the Diesel Engine Manufacturers Association (Reference 47).

f. Each generator shall be capable of being synchronized for parallel operation with the normal plant AC power buses for periodic load test runs. The generators shall not be required to automatically synchronize with each other or with the plant bus.

g. Each EDG shall have local fuel tanks (day tank and base tank) fed from a common diesel oil storage tank. The local tanks shall have sufficient capacity for a minimum of eight hours of full power operation of their respective unit. The diesel oil storage tank shall provide sufficient fuel to the EDGs for at least one week of full load operation of one unit.

h. Auxiliary motors and controls required for starting each diesel generator shall operate from separate plant batteries. Other auxiliaries required to ensure continuous operation shall be supplied from the essential buses or control power transformers associated with the diesel generator.

i. The engines shall be capable of being started or stopped by manual operation from local control stations near the engines as well as from remote stations in the control room. The engines shall be capable of being connected to the essential buses from the control room, but not locally at the engines. The engines shall start automatically upon the loss or potential loss of station power, low-low water level in the reactor, or high drywell pressure.

8.4.1.2 <u>Description</u>

The EDG units are a standard design with engine, generator, electrical controls and auxiliaries all mounted on a common base. Output is rated at 2500 KW (3125 KVA @ 0.8 PF), 4160 Vac, three phase, 60 Hz. Protective relays are provided to prevent loading the generator until the diesel engine has accelerated to operating speed. Voltage and speed regulators are provided as well as overload alarms. Overloads or ground faults do not cause automatic trip out of the generator circuit breakers. Operators will adjust loads if the overload alarm indicates a need. The diesel generators are rated for 10% overload for 2000 hours out of each year or 22% overload for 30 minutes of each year based on ≤ 90°F engine intake air temperature. Above 90°F air temperature, the diesel overload rating is derated per manufacture curves. Protective relays initiate tripping of the generator circuit breakers for differential overcurrent, phase fault, reverse power, engine overspeed, loss of generator field or bus lockout. The overspeed trip device is the only mechanical device which will automatically trip the diesel engine.

The generators are Y connected with the neutral of each grounded through special transformers with ground current monitors provided. Voltmeters, ammeters, and wattmeters are provided to permit monitoring the loading of each unit. Equipment is provided for manually synchronizing the generators with the incoming AC power lines for operational and test purposes. Automatic synchronization is not provided. Each EDG unit is so loaded and of such capacity that, even if only one unit operates, safe shutdown of the reactor is assured, even under design basis accident conditions.

Each EDG is designed to start automatically, and within 10 seconds begin to accept load. Safety related ECCS pump motors are started at five second intervals. Pump motor start times must be within their rated stall times to ensure no protective relays actuate. Initial EDG acceptance testing demonstrated that during the loading sequence, the frequency and voltage were less than about 90% of nominal and about 70% of nominal, respectively. Frequency and voltage could be restored to within 2% and 10% of nominal, respectively, within 60% of the interval between pump motor starts with the final pump motor reaching rated speed within the overall time required by ECCS analysis.

Power to start each diesel engine is derived from two independent air starting systems. Each consists of a pair of compressed air driven motors, an air dryer, strainer, air line lubricator, and related storage tanks. This provides 100% redundancy for each unit's air starting system. Starting at nominal pressure (200 psig), each of these systems has adequate capacity to start five times without recharging. As described below, the automatic start logic for the diesels supplies two start attempts from each bank staggered such that there are a total of three start attempts on the engine. If the engine does not start as a result of the automatic start logic, manual operator action is required and the engine has not met its emergency operability requirement. To meet these operability requirements, the engine air start system must have the capacity to provide for two start attempts per bank without manual operator action. An alarm is provided at 165 psig to ensure this operability requirement is met. Therefore, the installed system meets the safety system operability requirements. With the engine in the standby mode of operation, the starting system will automatically proceed through a starting sequence to attempt to ensure starting upon an automatic initiation signal. The sequence includes separate starting attempts using the selected bank of air start motors, both banks of air start motors, and the non-selected bank of air start motors. If this sequence is unsuccessful, the start logic locks out. The third start attempt does not necessarily occur within enough time for the engine to be ready to accept load within 10 seconds of a demand requirement. This third start attempt is considered a redundant feature to improve overall emergency power system reliability, not a requirement to meet reactor ECCS design criteria.

Evaluation has shown it is acceptable to isolate one air start system at a time or cross connect the air banks for maintenance without affecting operability of the diesel generator. This is controlled by plant procedures.

Mounted on the same base as the engine, generator, and controls is a small fuel tank, known as the base tank, and two fuel transfer pumps. Both pumps are supplied power from the output of the generator. Each unit also has a separate fuel supply in a day tank. The day tank/base tank combination has at least an 8 hour fuel supply for the engine at full load. The day tanks are in turn supplied from a larger tank that contains sufficient fuel capacity for one week's operation of one unit at full power (Reference 76). Fuel is transferred from the underground diesel oil storage tank to the local day tanks with the diesel oil transfer pumps.

The specific Emergency Diesel Generator (EDG) fuel oil volumes contained in the diesel oil storage tank (equivalent to duration-based requirements) are calculated using Section 5.4 of American National Standards Institute (ANSI) N 195 - 1976, "Fuel Oil Systems for Standby Diesel-Generators," and are based on applying the conservative assumption that the EDG is operated continuously at rated capacity. This fuel oil calculation methodology is one of the two approved methods specified in Regulatory Guide (RG) 1.137, Revision 1, "Fuel-Oil Systems for Standby Diesel Generators," Regulatory Position C.1.c.

The ability of the EDGs to start rapidly upon demand is consistent with the requirement for core cooling under postulated accident conditions.

The EDGs are each capable of starting and carrying the largest safe shutdown loads required under postulated accident conditions. After the automatic start sequence is complete, the generator may be manually loaded to its rated capacity at the discretion of the operator. Alarms are provided which will annunciate an overloaded condition; however, the generator load will not trip when the generator becomes overloaded. Operator action will correct the overload condition.

Diesel disabling conditions are annunciated in the control room at the respective "diesel generator maintenance lockout" alarms. This provides the control room with a positive indication of a disabling condition on the diesel.

The EDGs are housed in reinforced concrete cells at ground level (Elev. 931 feet) adjacent to the turbine building. Equipment connecting the EDGs to the auxiliary equipment consists of metal-clad switchgear and cable in rigid steel conduit. All cable terminals are completely enclosed. The location of the EDGs within concrete structures, provision of the metal-clad switchgear, and cable protection assures protection against damage from tornadic winds or missiles.

The EDG room ventilation system consists of a supply fan, and a set of supply, exhaust and recirculation air dampers for each EDG room. The EDG supply fans may be started either manually with a local control switch or automatically on EDG start-up. Room temperature is controlled by the supply, exhaust and recirculation dampers modulating to maintain the setpoint of the local temperature controller. The actuators for the room dampers are air operated and supply air comes from a branch off of the Instrument and Service Air System. A modification was completed to ensure that failure of the Instrument and Service Air System to the damper actuators will result in the supply and exhaust air dampers failing open and the recirculation air dampers failing in the closed position. This failure mode will assure adequate cooling of the EDGs should they be required to operate during this time. With the current damper failure mode, loss of instrument air during the winter months could result in a drop in air temperature in the EDG room. Procedures which require periodic checks of room temperatures would detect an unusual change in room temperature. Operators are directed to take action to prevent room temperature drop should a problem be detected. In addition, continuous circulation of warmed lube oil through the engine during standby condition will assure the engine remains warm if room temperature drops. Once running, the engine will operate at the lowest expected temperature. Heat for the diesel generator rooms is provided by local unit heaters as required. Ambient temperature around the EDG units will be maintained above 60oF. Automatic sprinkler systems are provided for the diesel cubicles.

Principal emergency loads are shown on Table 8.4-2.

8.4.1.3 Performance Analysis

The EDG system one line diagram is shown in Figure 8.4-1. Starting of the EDGs is initiated by a degradation or loss of voltage on an essential 4160 Vac bus. Automatic starting is also initiated by low-low reactor water level or high drywell pressure.

Although an automatic start of the EDGs has been initiated, there may have been no loss of voltage on the safety related 4 KV buses, or an automatic transfer to another source may have been effected, in which case the running generators are held in reserve during the emergency period. Manual control is then employed for additional load switching.

If the essential buses are still de-energized when the diesels have accelerated, automatic relaying will remove unnecessary loads and disconnect the essential buses from the normal auxiliary system prior to energizing the essential buses from the EDGs. If a loss-of-coolant accident condition is indicated, Core Spray and RHR Systems are started. These pumps are started in sequence in order to prevent stalling of the diesel engine.

Table 8.4-2 “Standby Emergency Diesel Generator System-Emergency Loads” includes automatic safe shutdown loads used to determine the operating kilowatt loading for the design limitation case: DBA-LOCA including Loss of Offsite AC Power. EDG loadings for two time periods are included in the table. The initial load period considers the equipment that is automatically loaded or operating when the EDG starts due to an essential bus transfer to the diesels with an ECCS initiation. This includes those loads that may operate initially to re-align systems from their normal line-ups for ECCS initiation. The second time period represents the steady state loading that occurs following the short term loading discussed above and prior to load changes due to operator actions, with the exception of one load as noted in Table 8.4-2 that is added by operator action.

A rated KW is given for each load included in the table. For motor loads, the rated KW is calculated from the rated HP using an efficiency of 90% for the large ECCS motors and 80% for all others.

The loading of each EDG unit is below its 2500 KW continuous rating for the DBA-LOCA including Loss of Offsite AC Power. After the automatic actions have been completed, the operator may add other loads within the capacity of the generators. Each EDG unit has a 2750 KW (2000 hour/year) and a 3050 KW (30 minute/year) rating that provides margin for intermittent and short time loads. Since these additional loads are under the direct control of the operator, unnecessary loads can be removed if the EDG limits are exceeded. For long term cooling, a maximum of 1 RHR Service Water pump on either EDG may be manually started after securing 1 RHR pump on the affected EDG. This loading change has a net effect of adding an additional 83 KW to the total load shown for the steady loading of each EDG. Loading remains below the 2500 KW continuous rating. In conformance with the proposed 70 AEC design criteria (see evaluation in Appendix E), even if the largest single load during an emergency operation would adversely affect an EDG unit to the extent of tripping the unit (under the single component failure criterion requirements), the other EDG unit would be available to maintain the core and containment cooling requirements.

Control circuit redundancy or backup features prevent single failures of instrumentation or controls, including automatic relaying, for the standby EDGs, from affecting more than one of the two EDG units. Most of the devices provided for the control and loading of each of the EDGs are physically separated and independent from the corresponding devices provided for the other unit. Where there are devices with functions common to both EDG units, backup features are provided to ensure that failures of those common devices do not prevent functioning of either or both of the EDG units.

Both EDGs are automatically started upon the occurrence of degradation or loss of the source supplying the essential buses, and for situations which may require operation of the reactor emergency cooling systems. The specific devices which initiate starting are as follows:

a. Degraded voltage on either of the essential 4160 Vac buses which persists longer than 9 seconds.

b. Loss of voltage on either of the essential 4160 Vac buses.

c. Reactor water low-low level or drywell high pressure.

Starting of the diesels occurs whether or not automatic transfer to either of the two offsite sources was accomplished. Once started, the EDG engines continue to run until shutdown manually or tripped due to an overspeed condition.

Each of the two EDGs has two independent starting systems, both of which are actuated by any of the automatic start signals listed above. Control power for one of the starting systems for each unit is supplied from one of the 125 Vdc station batteries. Control power to the other starting system is supplied from the other 125 Vdc station battery. Each control power source is separately fused.

The breaker connecting each EDG to its related essential bus is automatically closed as soon as the unit has reached rated speed and voltage, provided the bus is not already energized from one of the other sources.

To avoid overloading the EDGs and to limit voltage drop while motor loads are reaccelerated, the signal which initiates closing of the breakers also actuates a load shedding circuit which trips all 4160 Vac feeder breakers connected to the bus except those supplying the essential 480 Vac load center transformers, and trips all non-essential motors and motor control centers from the essential 480 Vac buses except the electric fire pump (P-110). Upon closing of the EDG breakers the essential 480 Vac buses and apparatus supplied from them are immediately re-energized.

If, prior to or subsequent to the transfer to the EDGs, the essential 4160 Vac motors for emergency core cooling are required to operate, further load shedding is initiated and load sequencing circuits are put into operation. These circuits are described in detail later herein.

Transfer of the essential buses to either of the emergency power sources, the reserve auxiliary transformer (1AR) or the EDGs, will occur due to loss of voltage. Transfer of the essential buses to the EDGs will occur due to degraded voltage conditions on the essential buses. The essential bus transfer schemes ensure that a malfunction of any single component will only prevent the automatic re-energization of one division’s essential bus by its associated EDG or the 1AR transformer.

Transfer of the essential buses to the 1AR transformer will normally occur on loss of voltage (nominally 2625 Vac for five seconds). If the 1AR no-load voltage is unacceptable for an additional five seconds, or if the essential buses are being supplied from the 1AR transformer when the loss of voltage condition occurs, a transfer to the EDGs will take place. Transfer of the essential buses to the EDG will normally occur on degraded voltage (nominally 3920 Vac for 9 seconds) conditions.

The automatic opening of all 4160 Vac source breakers to the essential bus permits transfer to the associated EDG. The transfer relays in this scheme will strip the 4160 Vac essential bus of all loads except the associated 480 VAC load center and will also strip that load center of all non-essential MCCs. Concurrently these relays initiate a 15-cycle delayed closure of the EDG supply breaker. Additional logic also assures that the EDG breaker is not closed until the diesel generator is ready to accept load.

The 1AR transformer and the EDGs are limited in capacity and are primarily intended to supply safeguard loads. Certain other loads may be supplied if the situation permits. To prevent overloading these limited capacity sources, and to avoid excessive voltage drop during motor acceleration periods, load shedding and load application sequencing circuits are provided as previously mentioned. The following discusses in detail the features of these systems.

For the situation where the full capacity reserve transformer (1R) and the primary station auxiliary transformer (2R) are not available and loads are to be transferred to the 1AR transformer or to the EDGs, but which is not accompanied by a need for emergency core cooling, source capacity is available to supply a number of auxiliaries, the operation of which is desirable but not necessary from a safeguard standpoint. Such auxiliaries include the service water pumps, reactor building closed cooling water pumps, control rod drive pumps, fuel pool cooling water pumps, drywell cooling units, instrument and service air compressors and off-gas stack dilution fans. The RHR Service Water pumps are manually started when required.

Shedding of non-safeguard loads, other than those 480 Vac loads identified in the preceding paragraph, is accomplished by the transfer relays associated with the 1AR transformer or the EDGs. A group of relays for this purpose is provided for each of the two sources and for each of the two buses. These relays directly trip the breakers supplying the loads which are not required and then, via a 15 cycle time delay relay, initiate closing of the appropriate source breaker.

For situations where an ECCS initiation signal is present, relays for each division of Core Spray System logic will shed loads from their respective 4.16 KV and 480 Vac buses. This load shed will seal-in if both RHR pumps on the bus are running. This seal-in will remain until the ECCS initiation signal is terminated along with the shutdown of at least one RHR pump or the normal power source is restored to the essential bus. The load shed trip and lockout signals to the RHR Service Water pumps may be bypassed by the reactor operator using a keylock switch in the Main Control Room to enable manual starting of these pumps.

Also initiated by the same logic is the automatic sequencing of the starting of the safeguard loads. Separate initiating circuits are provided for each of the automatically started safeguard loads on each of the essential buses. These automatically started loads comprise the two Core Spray pumps and the four RHR pumps. The RHR Service Water pumps are always manually started and are therefore not included in the sequencing circuits. The logic is as follows: If the voltage exists on the essential bus or if any of the source breakers to the bus is closed, the reactor low-low level (coincident with either low reactor pressure or a time delay of 15 minutes (nominal)) or drywell high pressure signal starts a timer in each circuit. After the required time delay, timer contacts close resulting in the start of the associated pump motor.

The timers for each of the safeguard loads are set to provide delays as follows:

Time	#15 Essential Bus (A5)	#16 Essential Bus (A6)
5 sec.	RHR Pump A	RHR Pump B
10 sec.	RHR Pump C	RHR Pump D
15 sec.	Core Spray Pump A	Core Spray Pump B

The largest single increment of loading is 800 HP. In the case of the EDGs, this increment of load causes the voltage to drop initially to about 70% of rated. With 1AR transformer as the source, the voltage should not drop below 90% of rated voltage.

Protective relaying of the EDGs is provided only for electrical faults which, if not cleared, would eventually render the EDG unit unavailable as a power source and possibly result in major damage requiring extensive repairs. Separate protective relaying is provided for each EDG unit.

Although failure of an EDG at the moment it is required is not a very likely event, it must be recognized as a possibility. Care has been taken to arrange the loads on each EDG so that loss of either will not preclude the safe shutdown of the reactor in the event of a loss of a EDG concurrently with the loss of coolant accident. As described in Section 14, one Core Spray and one RHR System are sufficient to provide post-accident cooling for any type of loss-of-coolant accident analyzed for which AC power is necessary. Power for battery charging of all essential station batteries can be provided from either essential bus. It is concluded that the reactor can be safely shut down even if one of the EDGs fails to start when called for since the second EDG has sufficient capacity for safe shutdown.

Automatic 480 Vac Transfer - Reliability of operation of engineered safeguards is enhanced by the direct connection (the LPCI swing bus) of MCC 133B to MCC 143B, supplying LPCI injection valves. Failure of the normal Division I source, will result in an automatic transfer of the LPCI Swing Bus to the Division II source. Additionally, degraded power from the Division I EDG to the LPCI swing bus will result in an automatic transfer to the Division II source. The LPCI swing bus design meets the single failure criterion. This arrangement is designed such that no single failure could inadvertently tie the two EDGs together. Therefore, the independence of the emergency power services is not compromised.

The RHR System is designed to inject water into the intact recirculation loop in the event that a recirculation line break initiates a loss of coolant accident. Power to the RHR injection valves and recirculation valves required to operate during the loss-of-coolant accident is supplied from the referenced 480 Vac motor control centers.

The system as designed assures the availability of one Core Spray loop and two RHR pumps (LPCI system) in the event that one of the EDGs fails to start for the design basis accident. Water from the two RHR pumps may not be available under this condition unless automatic transfer is accomplished thus making power available to the selected recirculation loop valves. The Core Spray valves are independent of the transferable MCC supplying power to the RHR valves for optimum reliability.

Also, should a core spray line break initiate a loss of coolant accident and one EDG fails to start, the system design assures the availability of two RHR pumps for injection into the selected recirculation loop. Assurance of availability of LPCI under all conditions of the above is not possible without automatic transfer.

8.4.1.4 Inspection and Testing

Since the EDGs 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 test the ability to start the system as well as to run under load for a period of time long enough to bring all components of the system into equilibrium conditions to assure that cooling and lubrication are adequate for extended periods of operation. Full functional tests of the automatic circuitry are conducted on a periodic basis to demonstrate proper operation.

The preoperational testing program included tests to verify that EDG unit performance, upon loss of the largest single load during emergency operation, will not adversely affect either of the EDGs. The Diesel Generator manufacturer has advised that, based on experience with this model, tripping of the largest load on each diesel, an additional 800 HP Core Spray pump, would result in a maximum rise in voltage to about 113% of nominal and a rise in speed to about 102% of nominal. Recovery time is about 1.4 seconds for voltage and 3 seconds for speed. These tests involved loading the diesels as outlined in Table 8.4-2 and tripping off the loaded core spray pump and measuring the voltage and frequency disturbances as well as the recovery time.

8.4.2 Non Safeguards Diesel Generator

8.4.2.1 Design Basis

Diesel Generator 13 provides a standby power source for the equipment powered from plant 480 Vac Load Centers 107 and 108, which are normally supplied from non-essential buses 13 or 14. This diesel generator is to ensure the Safety Parameter Display System (SPDS) has power and cooling so that it can remain available after a loss of off-site power. Other loads within the diesel generator ratings may also be powered. This power supply is non-safety related and is physically separated from any class 1E or safety related power supplies. However, during an event that is beyond the design basis, emergency procedures are in place to connect the 13 diesel generator to Class 1E loads.

8.4.2.2 Description

The non-safeguards diesel generator set is a standard Caterpillar 3516 engine with an SR 4 generator and auxiliaries in a common enclosure. This is a complete, self-sufficient power source capable of automatic start at any time and continued operation at rated full load until manually stopped. Output is rated at 1600 KW (2000 KVA @ 0.8 PF), 480 Vac, three phase, 60 Hz. The non-safeguards diesel generator set has a standby rating of 1750 KW for 200 hours per year.

The generator may be synchronized with the normal plant AC power buses for parallel operation, such as for periodic load test runs. Automatic synchronization is not provided.

Engine and generator parameters and alarms are available at the local control panels and on the plant process computer system for display in the main control room.

Power to start the diesel is derived from two redundant 24 Vdc electric starting systems. Each consists of a 24 Volt battery and an electric starter. Transfer to the backup start system is accomplished manually.

The Diesel Generator 13 has a local fuel oil tank of sufficient capacity for a minimum of 12 hours of full load operation.

8.4.2.3 Performance Analysis

Automatic starting of the non-safeguards diesel generator is initiated by a loss of voltage on Load Center 107 sustained for 10 seconds. If load center 107 is still deenergized when Diesel Generator 13 reaches nominal voltage and frequency (about 10 seconds after start), automatic relaying will disconnect the bus from its normal sources and close the diesel generator breaker thus feeding the bus. After approximately 10 more seconds, if load center 108 is without voltage, it will also be automatically disconnected from its normal source and powered by Diesel Generator 13.

Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)

(Page 1 of 6)

Description	Equipment Number	Rated HP	Rated KW	Loss of Coolant Accident and Loss of Off-Site Power				Load when EDG output frequency is at 61.2 Hz (Note 3:)		Notes
				Short Term KW Load (Note 1:)		Steady State KW Load (Note 2:)				
EDG Number				11	12	11	12	11	12	
Core Spray Pump 11	P-208A	800	663	663	--	663	--	703	--	Note 4:
Core Spray Pump 12	P-208B	800	663	--	663	--	663	--	703	Note 4:
RHR Pump 11	P-202A	600	497	497	--	497	--	527	--	Notes 4:, 9:, 10:
RHR Pump 13	P-202C	600	497	497	--	497	--	527	--	Notes 4:, 9:, 10:
RHR Pump 12	P-202B	600	497	--	497	--	497	--	527	Notes 4:, 9:, 10:
RHR Pump 14	P-202D	600	497	--	497	--	497	--	527	Notes 4:, 9:, 10:
RHR-SW Pump 11	P-109A	700	580	--	--	--	--	--	--	Note 9:
RHR-SW Pump 13	P-109C	700	580	--	--	--	--	--	--	Note 9:
RHR-SW Pump 12	P-109B	700	580	--	--	--	--	--	--	Note 9:
RHR-SW Pump 14	P-109D	700	580	--	--	--	--	--	--	Note 9:
SGTS Fans	V-EF-17A	15	14	14	--	14	--	14.8	--	
SGTS Fans	V-EF-17B	15	14	--	14	--	14	--	14.8	
SGTS Equipment and Heaters	E-34A-1	--	22	22	--	22	--	23.3	--	
SGTS Equipment and Heaters	E-34B-1	--	22	--	22	--	22	--	23.3	
OG Stack Dilution Fan	V-EF-18A	20	18.7	18.7	--	18.7	--	19.8	--	
OG Stack Dilution Fan	V-EF-18B	20	18.7	--	18.7	--	18.7	--	19.8	
CS Injection Valve	MO-1753	8	7.5	7.5	--	--	--	--	--	
CS Injection Valve	MO-1754	8	7.5	--	7.5	--	--	--	--	
RHR Injection Valve	MO-2012 or MO-2013	13	12.1	12.1	12.1	--	--	--	--	
RHR Injection Valve	MO-2014 or MO-2015	7.8	7.27	7.27	7.27	--	--	--	--	
RHR to Recirc Intertie	MO-4086	0.7	0.65	0.65	--	--	--	--	--	

Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)
(Page 2 of 6)

Description	Equipment Number	Rated HP	Rated KW	Loss of Coolant Accident and Loss of Off-Site Power: Short Term KW Load (Note 1:		Loss of Coolant Accident and Loss of Off-Site Power: Steady State KW Load (Note 2:)		Load when EDG output frequency is at 61.2 Hz (Note 3:)		Notes
EDG Number				11	12	11	12	11	12	
RHR Heat Exchanger Bypass Valve	MO-2002	7.2	6.71	6.71	--	--	--	--	--	
RHR Heat Exchanger Bypass Valve	MO-2003	7.2	6.71	--	6.71	--	--	--	--	
Recirc Pump Discharge Valve	MO2-53A or MO2-53B	19.2	17.9	17.9	17.9	--	--	--	--	
RWCU Isolation Valve	MO-2397	1.02	0.95	0.9	--	--	--	--	--	
RWCU Return Isolation Valve	MO-2399	2	1.9	--	1.9	--	--	--	--	
RCIC Isolation Valve	MO-2075	1	0.9	0.9	--	--	--	--	--	
HPCI Isolation Valve	MO-2034	3.9	3.64	--	3.64	--	--	--	--	
MSL Drain Isolation Valve	MO-2373	0.33	0.308	--	0.308	--	--	--	--	
250 Vdc Battery Chargers	D52	--	35	30	--	30	--	30	--	Notes 8:, 12:, 13:
250 Vdc Battery Chargers	D53	--	35	30	--	30	--	30	--	Notes 8:, 12:, 13:
250 Vdc Battery Chargers	D70	--	35	--	22	--	22	--	22	Notes 8:, 12:, 13:
250 Vdc Battery Chargers	D80	--	35	--	22	--	22	--	22	Notes 8:, 12:, 13:
125 Vdc Battery Charger	D10	--	13	14	--	14	--	14	--	Note 13:
125 Vdc Battery Charger	D20	--	13	--	14	--	14	--	14	Note 13:
Emergency SW Pump 11	P-111A	20	18.7	18.7	--	18.7	--	19.8	--	
Emergency SW Pump 12	P-111B	20	18.7	--	18.7	--	18.7	--	19.8	
Emergency SW Pump 13	P-111C	15	14.0	14.0	--	14.0	--	14.8	--	
Emergency SW Pump 14	P-111D	15	14.0	--	14.0	--	14.0	--	14.8	
EDG 11 Room Supply Fan	V-SF-10	40	37.3	37.3	--	37.3	--	39.5	--	
EDG 12 Room Supply Fan	V-SF-9	40	37.3	--	37.3	--	37.3	--	39.5	
RHR Area Cooling	V-AC-5	5	4.7	4.7	--	4.7	--	4.9	--	
RHR Area Cooling	V-AC-4	5	4.7	--	4.7	--	4.7	--	4.9	

Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)
(Page 3 of 6)

Description	Equipment Number	Rated HP	Rated KW	Loss of Coolant Accident and Loss of Off-Site Power				Load when EDG output frequency is at 61.2 Hz (Note 3:)		Notes
				Short Term KW Load (Note 1:)		Steady State KW Load (Note 2:)				
EDG Number				11	12	11	12	11	12	
CRD Area Cooling	V-AC-7A	5	4.7	4.7	--	4.7	--	4.9	--	
CRD Area Cooling	V-AC-7B	5	4.7	--	4.7	--	4.7	--	4.9	
HPCI Area Cooling	V-AC-8A	5	4.7	4.7	--	4.7	--	4.9	--	
HPCI Area Cooling	V-AC-8B	5	4.7	--	4.7	--	4.7	--	4.9	
RCIC Area Cooling	V-AC-6	2	1.9	--	1.9	--	1.9	--	2.0	
AC Unit Heater	V-EAC-14A	--	36	36	--	36	--	38.2	--	Note 5:
AC Unit Heater	V-EAC-14B	--	36	--	36	--	36	--	38.2	Note 5:
AC Unit Compressor	V-EAC-14A	40	37.3	37.3	--	37.3	--	39.5	--	Note 5:
AC Unit Compressor	V-EAC-14B	40	37.3	--	37.3	--	37.3	--	39.5	Note 5:
Return Air Fan	V-ERF-14A	3	2.8	2.8	--	2.8	--	3	--	
Return Air Fan	V-ERF-14B	3	2.8	--	2.8	--	2.8	--	3	
AC Blower	V-EAC-14A	10	9.3	9.3	--	9.3	--	9.9	--	
AC Blower	V-EAC-14B	10	9.3	--	9.3	--	9.3	--	9.9	
EFT Heater	V-FE-11	--	5	5	--	5	--	5.3	--	
EFT Heater	V-FE-12	--	5	--	5	--	5	--	5.3	
EFT Fan	V-ERF-11	5	4.7	4.7	--	4.7	--	4.9	--	
EFT Fan	V-ERF-12	5	4.7	--	4.7	--	4.7	--	4.9	
Battery Room Exhaust Fan	V-EF-40A	1	0.9	0.9	--	0.9	--	1.0	--	
Battery Room Exhaust Fan	V-EF-40B	1	0.9	--	0.9	--	0.9	--	1.0	
Battery Room Heater	V-UH-125	--	7.5	--	7.5	--	7.5	--	7.5	Note 5:
EFT Power Panel	P-81	--	89.1	--	89.1	--	89.1	--	89.1	Note 5:
Lighting Panel	L05	--	41.8	41.8	--	41.8	--	41.8	--	

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Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)
(Page 4 of 6)

Description	Equipment Number	Rated HP	Rated KW	Loss of Coolant Accident and Loss of Off-Site Power: Short Term KW Load (Note 1:)		Loss of Coolant Accident and Loss of Off-Site Power: Steady State KW Load (Note 2:)		Load when EDG output frequency is at 61.2 Hz		Notes
EDG Number				11	12	11	12	11	12	
Lighting Panel	L02	--	59.4	--	59.4	--	59.4	--	59.4	
PASS / H_2O_2 Analyzer	P73A	--	22.00	22.00	--	22.00	--	22.00	--	Notes 5:, 11:
PASS / H_2O_2 Analyzer	P73B	--	11.44	--	11.44	--	11.44	--	11.44	Note 5:
Instrument AC Panel	Y20	--	25	25	25	25	25	25	25	
EFT Power Panel	B34P	--	5	5	--	5	--	5	--	
EFT Power Panel	B44P	--	5	--	5	--	5	--	5	
EPR Oil System	P-140A/B	5	4.7	--	4.7	--	4.7	--	4.9	
EDG #11 Air Compressors	K-8A and K-8B	7.5	6.99	6.99	6.99	--	--	--	--	Note 5:
EDG #12 Air Compressors	K-9A and K-9B	7.5	6.99	6.99	6.99	--	--	--	--	Note 5:
Rx Bldg Flr Drain Sump Pump	P25A	5	4.7	4.7	--	4.7	--	4.9	--	Note 5:
Rx Bldg Flr Drain Sump Pump	P25B	5	4.7	--	4.7	--	4.7	--	4.9	Note 5:
ECCS Area Sump Pump A	P88A	1.3	1.21	1.21	--	1.21	--	1.28	--	
ECCS Area Sump Pump B	P88B	1.3	1.21	1.21	--	1.21	--	1.28	--	
ECCS Area Sump Pump C	P88C	1.3	1.21	--	1.21	--	1.21	--	1.28	
ECCS Area Sump Pump D	P88D	1.3	1.21	--	1.21	--	1.21	--	1.28	
RHR Aux Compressor B	K10B	1.5	1.40	--	1.40	--	1.40	--	1.48	Note 5:
Turning Gear Oil Pump	P-62	30	28.0	--	28.0	--	28.0	--	29.7	
Turbine Turning Gear Motor	TGM	60	56.0	--	11	--	11	--	11	Note 6:
Miscellaneous			30	30	30	30	30	30	30	Note 7:

Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)
(Page 5 of 6)

Description	Equipment Number	Rated HP	Rated KW	Loss of Coolant Accident and Loss of Off-Site Power: Short Term KW Load (Note 1:)		Loss of Coolant Accident and Loss of Off-Site Power: Steady State KW Load (Note 2:)		Load when EDG output frequency is at 61.2 Hz		Notes
EDG Number				11	12	11	12	11	12	
11 EDG Diesel Oil Pump A	P-160A	1	0.9	0.9	--	0.9	--	0.9	--	Note 14:
11 EDG Diesel Oil Pump C	P-160C	1	0.9	0.9	--	0.9	--	0.9	--	Note 14:
12 EDG Diesel Oil Pump B or D	P-160B or P-160D	1	0.9	--	0.9	--	0.9	--	0.9	Note 14:
HPV Battery Charger	D83	--	3.0	3.0	--	3.0	--	3.0	--	
Total Load per EDG (KW)				2169	2304	2102	2233	2216	2349	Note 9:

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NOTE 1: **This column lists the equipment that is automatically loaded or operating when the diesel generator starts due to an essential bus transfer to the diesels with an ECCS initiation. This includes those loads (in KW) that may operate initially to re-align systems from their normal line-ups for ECCS initiation.**

NOTE 2: **This column represents the steady state loading (in KW) that occurs following the short term loading discussed in Note 1: and prior to load changes due to operator actions. Load changes due to operator action are controlled based on emergency diesel generator ratings.**

NOTE 3: **This column represents the adjusted loading in the event that the diesels are supplying power at a frequency up to 2% above the nominal 60 Hz output frequency.**

NOTE 4: **RHR and Core Spray pumps are started sequentially.**

NOTE 5: **These loads are short duration or intermittent loads and may not necessarily operate continuously or at rated output.**

NOTE 6: **The turbine turning gear motor starts on main turbine coastdown. The turning gear however does not engage automatically. A load factor of 20% is applied to the unloaded motor.**

NOTE 7: **A miscellaneous load is added to account for transformer losses and un-tabulated control and indication circuits.**

Table 8.4-2 Standby Emergency Diesel Generator System Emergency Loads (Per EDG Set)
(Page 6 of 6)

NOTE 8: **The 250 Vdc Battery Chargers are limited to 25 KW for the Division I chargers and to 21 KW for the Division II chargers. The 250 Vdc Battery Chargers actually consist of two 125 Vdc chargers each of which service half of the 250 Vdc batteries.**

NOTE 9: **For suppression pool cooling, a maximum of 1 RHR Service Water Pump on either EDG may be manually initiated after securing 1 RHR Pump on the affected EDG. This loading change has a net effect of adding an additional 83 KW to the Total Load shown for the steady state loading of each EDG.**

NOTE 10: **Monticello's inventory includes 600 and 700 HP motors that may be used on any of the four RHR pumps. Since the KW demand for a motor is determined from the pump load, the KW load used in the table is based on a 600 HP load.**

NOTE 11: **RHR Aux Compressor K10A is included in the load listed for Panel P73A.**

NOTE 12: **Loads for Uninterruptible AC Distribution Panels Y70 and Y80 are included in the 250 Vdc battery charger loads.**

NOTE 13: **Swing chargers for the battery systems (e.g., D40, D54, and D90) are not included in this table because they are considered to be backup chargers for the normal system chargers.**

NOTE 14: **These loads are expected to run continuously during diesel operation. It is necessary for diesel operation beyond 8 hrs. Diesel Oil System occasionally supplies the Diesel Fire Pump Day Tank (T-100) and infrequently supplies the Heating Boiler needs (T-84). Both 11 EDG oil pumps are included to reflect these infrequent features. Loading for the 12 EDG, reflects either P-160B or P-160D.**

8.5 DC Power Supply Systems

Two independent divisions each of 250, 125 and 24 Vdc batteries are provided. The 250 Vdc "Power" batteries serve the larger loads such as DC motor driven pumps, valves, etc. The 125 Vdc "control" batteries provide control power for the in-plant 13.8kVac Breakers, 4160 Vac breakers, 480 Vac Load Center breakers, Auxiliary control power for the 1R & 2R transformers, and various control relays, annunciators, etc. 125 Vdc also powers some emergency lighting. The 24 Vdc batteries provide power for the nuclear instrumentation system. All of the above batteries are mounted in racks designed to resist maximum earthquake accelerations of 0.12 g (maximum ground acceleration).

A single non-essential 250 Vdc battery is provided to serve the non-class 1E UPS system, the main turbine emergency seal oil and emergency bearing oil pumps, and the reactor feedwater DC lube oil pumps P-171A and P-171B.

8.5.1 Essential 250 Vdc System

8.5.1.1 Design Basis

The 250 Vdc batteries are sized to provide adequate voltage at the terminals of connected loads for the duration of a 4 hour Station Blackout (SBO) event. The demands placed on the battery by a SBO event envelope the demands which would be placed on the batteries by any Design Basis Event.

The battery chargers are sized to charge the batteries while supplying the normal continuous DC loads. The division I chargers are powered from essential MCC 134 and the division II chargers from essential MCC 144.

8.5.1.2 Description

The scheme and distribution panel schedule for the Division I - 250 Vdc system are shown on Section 15 Drawings NE-36640-4-2 and NE-36640-4. The scheme and distribution panel schedule for the Division II - 250 Vdc system are shown on Section 15 Drawings NE-93523-3 and NE-93523-4. A center tap on each battery provides 125 Vdc for MCC control power and for other loads.

Both essential 250 Vdc batteries consist of 120 shock absorbent transparent polycarbonate cells of the lead - calcium type. The manufacturer's ampere ratings for these batteries are based on 1 minute and 1, 4 and 8 hour discharge rates which result in an ending terminal voltage of 210 volts (equivalent to 1.75 volts per cell).

The chargers are full wave, filtered type with silicon controlled rectifiers used as the power-control elements. The chargers are convection cooled and rated for continuous operation in a 40° C ambient environment. The housings are free standing, NEMA Type I, and are ventilated. The chargers are suitable for float charging a lead-acid battery at 2.25 Volts per cell and are capable of supplying an equalizing charge at 2.33 Volts per cell. The chargers operate from a 480 Vac, 3-phase, 60 Hz supply. Charger output voltage is maintained within +/- 1/2% from 0-100% of charger rated load with a supply voltage variation of 10% and a frequency variation of 5%. The chargers are in compliance with all applicable NEC, NEMA, and UL Standards.

The two essential 250 Vdc batteries and related apparatus are located in independently ventilated battery rooms.

A detailed description of the 250 Vdc system, including associated alarms and operator actions, was provided to the NRC (References 35 and 73) in response to Generic Letter 91-06, "Adequacy of DC Power Supplies" (Reference 74). The NRC acknowledged receipt of the response to Generic Letter 91-06 and considers the issues closed for Monticello (Reference 48).

Battery chargers D52, D54, D70, and D90 have the ability to be re-powered from an alternate AC source via a permanently mounted local inlet receptacle and an alternate AC source input breaker installed on the charger breaker panel.

8.5.1.3 Performance Analysis

Any normal operational load connected to either division of the essential 250 Vdc system can be supplied by two chargers from that division. A third standby charger is available from each division and can be used should one of the other chargers fail.

The system operates ungrounded with ground fault detectors provided. With this type of arrangement, two grounds are required (one in a positive line and one in a negative line) before any of the system protective devices could operate. Occurrence of a ground of either polarity causes a ground current indication and, if of sufficient magnitude, will alarm. This provides an opportunity for trouble shooting before a second ground occurs.

Under and over-voltage relays provide alarms if voltage on the bus increases or decreases below preset values. A high voltage shutdown of the chargers with an alarm is provided.

8.5.1.4 Loss of 250 Vdc Battery

The Division I - 250 Vdc battery system serves the Division I uninterruptible AC power supply (UPS), RCIC motor operated valves, RCIC turbine pumps and several other non-critical loads. See Section 15 Drawing NE-36640-4.

Since all of the Division I - 250 Vdc loads are either backed up by redundant Division II components or are not required for safe shutdown, loss of the Division I - 250 Vdc system would not prevent safe shutdown.

The Division II - 250 Vdc battery system (Drawing NE-93523-4, Section 15) supplies power for the HPCI motor operated valves, HPCI turbine oil pumps, the Division II control room HVAC DC control circuits and uninterruptible AC power supply (UPS). Loss of the Division II - 250 Vdc battery would prevent operation of the HPCI system. In the event of a small break LOCA concurrent with a loss of the Division II - 250 Vdc system, the Auto Depressurization System (ADS) could be used to depressurize the reactor to allow the low pressure ECCS systems to operate. ADS is redundant in function to the HPCI system and does not require 250 Vdc for operation. All of the 250 Vdc motor operated isolation valves have redundant AC operated counter-parts.

Therefore, although undesirable, loss of the Division II 250 Vdc system would not prevent safe shutdown.

It should be noted that both 250 Vdc divisions are required to cope with a Station Blackout (SBO) event. During a SBO event, a loss of either 250 Vdc battery system might degrade safe shutdown capability. However, due to the extremely low probability of occurrence of a SBO and the high reliability of battery systems, design criteria for SBO mitigation, does not include requirements for functional redundancy.

8.5.2 125 Vdc System

8.5.2.1 Design Basis

Each battery system is sized to supply miscellaneous loads for periods suitable to its needs and still possess adequate capacity to operate switchgear for a 4-hour period.

Each 125 Vdc battery is sized to provide adequate voltage at the terminals of connected loads for the duration of a 4 hour SBO event and is capable of meeting power requirements during a Design Basis Event.

Each 125 Vdc battery charger is sized to charge the battery while supplying normal continuous 125 Vdc loads. The chargers are powered from separate AC motor control centers.

8.5.2.2 Description

A single line diagram and panel schedule for the 125 Vdc system is shown on Section 15 Drawings NE-36640-2 and NE-36640-3. Two battery systems are provided, each of which feeds separate DC buses. Three chargers energized from different essential AC power sources are provided for the two batteries; one for each system, and one as a common spare. Failure of any one charger will not prevent charging of either battery system. The redundancy of the two separate 125 Vdc systems is enhanced by locating each battery and related apparatus in separate rooms. The common standby charger is located in a room separate from the other two chargers and can be connected manually to either battery bus by operating breakers and switches locally at the chargers and battery panels.

The two battery buses can be connected to each other only by manually operating two disconnect switches in series; one switch is located at each battery bus. When two independent divisions of 125 Vdc power are required, the two battery buses are not operated in a cross-connected configuration.

Control power for each of the two 4160 Vac essential buses and for each of the two 480 Vac essential load centers is supplied from the related divisional battery.

Each 125 Vdc battery consists of 58 shock absorbent clear plastic cells of the lead-calcium alloy plate type. The manufacturer's rating for both of the 125 Vdc batteries is 95 Amperes at a 4 hour discharge rate and 458 Amperes for a 1 minute discharge rate. These discharge rates are based on an ending terminal voltage of 1.81 Volts per cell at 77°F.

The battery chargers are 3 phase, full wave, silicon controlled rectifier, constant voltage, and current limiting chargers meeting NEC, NEMA and ASA standards. Enclosures are NEMA Type I, convection cooled for operation up to 40°C ambient temperature. Chargers maintain 1/2% float and equalizing charge voltage regulation from 0-100% capacity with +/- 10% line voltage variation at 60 Hz +/- 5%. The nominal output current limit setting is 80 Amps.

Each 125 Vdc charger is capable of carrying the normal 125 Vdc load and at the same time supplying additional charging current to keep the batteries in a fully charged condition.

The loads provided by the 125 Vdc systems are shown on Drawing NE-36640-3, Section 15.

A detailed description of the 125 Vdc system, including associated alarms and operator actions, was provided to the NRC in response (References 35 and 73) to Generic Letter 91-06, “Adequacy of DC Power Supplies” (Reference 74). The NRC acknowledged receipt of the response to Generic Letter 91-06 and considers the issues closed for Monticello (Reference 48).

Battery chargers D10 and D20 have the ability to be re-powered from an alternate AC source via a permanently mounted local inlet receptacle and an alternate AC source input breaker installed on the charger breaker panel.

8.5.2.3 Performance Analysis

The 125 Vdc battery system operates ungrounded with a ground-detection alarm set to annunciate the first ground which has sufficiently low resistance to ground to pick-up the ground detection relay. Multiple grounds, which are the only reasonable mode of failure, are extremely unlikely. Single ground faults will not blow fuses. Overcurrent protective devices are applied such that failure of a non-safety related load will not result in the loss of safety related equipment that does not itself fail in a safe condition.

Alarms are also provided for battery charger supply undervoltage and 125 Vdc bus high/low voltage conditions. The chargers have a high-voltage shutdown feature. 01553835

8.5.2.4 Loss of 125 Vdc Battery

The safeguard systems supported by 125 Vdc power are redundant systems; each of which are supplied from separate 125 Vdc buses. Because of this redundancy, it is concluded that loss of a battery or its bus would not prevent safe shutdown of the plant.

Both 125 Vdc divisions are required to cope with a SBO event. During a SBO event, a loss of either 125 Vdc battery system might degrade safe shutdown capability. However, due to the extremely low probability of occurrence of a SBO and the high reliability of battery systems, SBO design criteria for SBO mitigation, does not include requirements for functional redundancy.

8.5.3 24 Vdc Battery System

8.5.3.1 Design Basis

The 24 Vdc battery system supplies power for all 24 Vdc requirements through the use of two independent systems. Each system has two 24 Vdc batteries, two 24 Vdc battery chargers, and a distribution panel arranged into a +/- 24 Vdc system.

The battery chargers for the two divisions are energized from different AC sources, which may be supplied by any source of essential AC power available.

8.5.3.2 Description

A single line diagram of the 24 Vdc power system is shown on Drawing NE-36640-6, Section 15. Drawing NE-36640-6 also provides a listing of 24 Vdc loads. Each system is insulated from ground at all points except at the remote control room where the system is grounded. During normal operation the load requirements and system losses are supplied from the battery chargers. Upon failure of the supply of power from the charger, the loads are supplied from the batteries until power from the charger is restored or the battery capacity exhausted.

Each 24 Vdc battery is of the lead calcium type consisting of 12 cells with 3 cells per jar. The manufacturer's rating for each of the 24 Vdc batteries is 20.8 Amperes at a 4 hour discharge rate. This discharge rate is based on a final average terminal voltage of 1.75 Volts per cell at 77 degrees F.

8.5.4 Non-Essential 250 Vdc Power Supply System

8.5.4.1 Design Basis

The Non-Essential 250 Vdc battery system supplies its loads with an output, for the first 90 minutes, of not less than 235 Vdc to maintain adequate voltage to motor loads.

The 250 Vdc battery (#17) is sized to supply its loads as shown in Table 8.5-3.

The rectifier portion of the UPS is sized to charge the battery while supplying the normal UPS loads. The UPS is powered from Load Center 108. Load Center 108 is normally powered from Bus No. 14 with a secondary source from Load Center 107 which is backed up by No. 13 Diesel Generator set.

8.5.4.2 Description

The No. 17 - 250 Vdc battery consists of 124 transparent polycarbonate cells of the lead-calcium type. The tested capacity of the battery is 483 amps for 90 minutes to a final average of 1.895 volts per cell.

The battery is located in its own ventilated room in the East Electrical Equipment Room. The distribution scheme for the No. 17 - 250 Vdc Distribution Panel is shown on Figure 8.5-4.

8.5.4.3 Performance Analysis

The system operates ungrounded with a ground fault detector provided as a part of the UPS. With an arrangement of this type, two grounds are required (one in a positive line and one in a negative line) before any of the system protective devices operate. Occurrence of one ground of either polarity causes a ground current alarm which would then provide an opportunity for trouble shooting before the second ground might occur. Under and over-voltage relays provide alarms if voltage on the bus increases above or decreases below pre-set values.

8.5.4.4 Loss of 250 Vdc Battery

The No. 17 - 250 Vdc battery system supplies power for the emergency oil pumps of the main turbine generator, reactor feedwater pump DC lube oil pumps P-171A and P-171B and also the non-essential Y91 UPS. Each of these is a non-critical load. Therefore, although undesirable, loss of the No. 17 battery system would not be of serious safety consequence.

8.5.5 Battery Inspection and Testing

The station batteries and other equipment associated with the battery systems are easily accessible for inspection and testing. Service and testing are performed on a routine basis. Typical inspections include visual inspections for leaks and corrosion, and checking all batteries for voltage, float current, specific gravity, and level of electrolyte.

Testing associated with the battery systems includes a battery service test and a battery performance discharge test. The battery service test is a special test of the battery's capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The discharge rate and test length correspond to the design duty cycle requirements as specified in 8.5.1.1 and 8.5.2.1. The battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

A modified performance discharge test is acceptable to satisfy the battery service test and the battery performance discharge test. Initial conditions for the modified performance discharge test should be identical to those specified for a performance discharge test as specified in IEEE-450-1995 (Reference 79).

The acceptance criteria for the performance discharge test are consistent with IEEE-450-1995. This reference recommends that the battery be replaced if its capacity is below 80% of the manufacturer's rating if the battery is sized using a 1.25 aging factor. If a lesser aging factor was used, battery replacement will be required before 80% capacity is reached to ensure that the load can be served. The 125VDC and 250VDC batteries are sized to meet the assumed duty cycle loads when the battery design capacity reaches the 90% limit.

At time of installation, a full load discharge test was made to prove battery capacity is adequate for the design basis accident. The Battery Monitoring and Maintenance Program provides for battery restoration and maintenance, based on the recommendations of IEEE-450-1995.

Table 8.5-3 #17 - 250 Vdc Battery Loads

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Y91 UPS Inverter	125 KVA	468 Amp/30 min 187 Amp/1.0 hr
Turbine-Generator Emergency Bearing	25 HP	280 Amp/1 min
Oil Pump		95.5 Amp/60 min
Main Generator Emergency Seal Oil Pump	5 HP	44 Amp/1 min 21 Amp/60 min
11 Reactor Feedwater Pump DC Lube Oil Pump P-171A	3 HP	27.5 Amps/1 min 14 Amps/10 min
12 Reactor Feedwater Pump DC Lube Oil Pump P-171B	3 HP	27.5 Amps/1 min 14 Amps/10 min

8.6 Reactor Protection System Power Supplies

8.6.1 Design Basis

Two motor generator sets provide AC power for operation of the Reactor Protection System. These sets are powered from 480 Vac buses and are used to supply power to the scram logic channels as well as neutron and radiation monitoring systems. These sets are termed interruptible power supplies since loss of AC power to them causes a delayed loss of output as the inertial energy of the flywheel is converted to power for the connected loads.

These systems are designed to provide a continued output of 120 Vac power that is free of transients and is extremely reliable. Switching transients and momentary losses of input power will not cause substantial changes in output voltage or frequency.

8.6.2 Description

Interruptible Power Supplies

The normal power supply will consist of two motor generator sets, each consisting of a three-phase induction motor driving a 120 Vac single-phase generator with flywheel. The flywheel provides energy to maintain generator output during momentary system faults or transients which do not otherwise impair reactor operation. One side of each generator output circuit will be grounded. The generator has a brushless exciter with an SCR voltage regulator. Voltage regulation is maintained within ±2%. The voltage level is adjustable approximately ±10%. Each motor is fed from a separate 480 Vac bus. A power supply from an essential source is not required for these units because the fail-safe design of the plant protection system results in a scram prior to essential bus transfer to the diesel generators.

An alternate power source is provided to permit servicing of either motor generator set. Manual circuit breakers with a mechanical interlock prevent paralleling a motor generator set and the alternate source while transferring the load between them.

The loads for these power supplies are indicated in Drawing NE-36771-4, Section 15. The principal loads on the system are magnetic contactors, AC type solenoid operated air valves, and electronic equipment for radiation and neutron monitoring.

Electrical Protection Assemblies provide overvoltage, undervoltage, and under-frequency protection to components served by these power supplies (Reference 24).

8.6.2.1 General

The flywheel MG sets are provided to supply continuing AC power availability and to provide transient-free power. The use of flywheels sustains energy delivery for short periods of time when input energy is not available. The use of MG sets provide complete isolation from normal transients since there is no opportunity for inductive coupling as there would be with regulating transformers.

8.6.2.2 Loss of Output

Interruptible Power Supply Buses

As with the other components of the reactor protection systems, a component failure can be tolerated without loss of protection and without causing a scram. This situation is also true with the interruptible AC power supplies. Loss of output of one of the power supplies will result in the loss of functions of all units connected to this bus leaving them in a tripped condition. Thus, if any one of the functions on the second protection bus should trip, a scram would result. This would occur regardless of whether the trip was spurious or warranted. Loss of voltage on either of the buses is annunciated in the control room by tripping of all auto scram parameters, providing opportunity for repair without shutting the reactor down.

Electrical Protection Assemblies monitor the electric power in each of the three sources of power (RPS M-G sets A and B, and the alternate source) to the RPS. Each assembly consists of two identical and redundant packages. Each package includes a circuit breaker and a monitoring module. When abnormal electric power is detected by either module, the respective circuit breaker will trip and disconnect the RPS from the abnormal power source.

Each monitoring module will trip its associated breaker on overvoltage, undervoltage or under frequency. With the protective packages installed, abnormal output type failures (random or seismically caused) in either of the two RPS M-G sets (or the alternate supply) results in a trip of either one or both of the two Class 1E protective packages. This tripping interrupts the power to the affected RPS channel, thus producing a scram signal on that channel. A time delay is incorporated in the circuit to prevent spurious actuation. Up to a four-second time delay before circuit breaker tripping will not result in damage to components of the RPS or prevent the RPS from performing its safety functions.

8.6.3 Inspection and Tests

The above equipment is in service during normal plant operation. However, all the equipment is inspected periodically to check for signs of malfunctioning. Sufficient alarms are provided to inform the operator of any abnormal operating condition.

8.7 Instrumentation and Control AC Power Supply Systems

8.7.1 Interruptible AC System

The interruptible portion of the instrumentation and control AC power system provides AC power to plant AC instrument loads. A single line diagram is shown in Figure 8.7-1.

Distribution panel Y20 is supplied from the plant auxiliary system. An automatic transfer to an alternate source within the plant auxiliary system occurs if the original source fails. This panel supplies both critical and noncritical instrument AC and control loads.

8.7.2 Uninterruptible AC System

8.7.2.1 Class 1E System

The system is composed of (2) Class IE inverters to provide a Division I and a Division II 120 Vac uninterruptible power source. The Division I inverter (Y71) is supplied by Division I 250 Vdc distribution panel D31 with an alternate AC source to the static switch from essential MCC 134 through a stepdown transformer. The Division II inverter (Y81) is supplied by Division II 250 Vdc distribution panel D100 with an alternate AC source to the static switch from essential MCC 144 through a stepdown transformer. Y71 supplies Class 1E distribution panel Y70 and Non-IE distribution panel Y10. Y81 supplies Class IE distribution panel Y80 and Non-IE distribution panel Y30. A single line diagram is shown on Figure 8.7-1.

During normal conditions, DC is supplied to the inverters by the Division I and Division II 250 Vdc battery chargers with their respective batteries as a backup. On loss of DC input, various inverter malfunctions, or overloads, the static switch will transfer to the alternate AC source. An external manual bypass switch may be used to connect the load directly to the alternate source to allow maintenance on the inverters.

As required by Generic Letter 91-11, which documents the NRC’s resolution of Generic Issues 48 and 49, plant procedures establish time limitations and surveillance requirements for vital instrument buses and associated inverters. (References 29 and 30).

8.7.2.2 Non-Class 1E System

The system is composed of a single module UPS to provide an uninterruptible power source primarily to the VAX computer systems. The UPS (Y91) is supplied AC by Load Center 108 with an alternate 480 Vac source from Load Center 107. The 250 Vdc backup is provided to UPS Y91 by No. 17 250 Vdc battery through distribution panel D71. UPS Y91 supplies a 3-phase 480 Vac distribution panel Y94 and also 120/208 Vac distribution panels Y90, Y96, PDS1 and PDS2 through 480 - 120/208 Vac transformers. A single line diagram of the system is shown on Figure 8.7-2.

During normal conditions, 480 Vac power is supplied to the rectifier/inverter unit by Load Center 108. On loss of 480 Vac input, the No. 17 battery will supply the power required by the inverter to the loads and on a UPS failure the static switch will transfer the load to the alternate source, LC 107.

8.8 Electrical Design Considerations

8.8.1 Division Separation

The design and installation of cables and raceways for the reactor protection and engineered safeguard systems provides protection and separation of wiring for redundant channels adequate to achieve an independence of function which is compatible with the degree of system and equipment redundancy involved.

The specific cables and raceways in the category for which separation is provided include those for circuits involved in the control, protection, and supply of power to the reactor protection and engineered safeguards systems. Circuits related to these systems, but for which separation is not necessarily provided, include cables and raceways for instrumentation and alarms which have information significance only, and which do not involve automatic control functions of any kind. Furthermore, separation is not necessarily provided for power circuits where the particular system is fail-safe on loss of power.

For those circuits which are in the category requiring separation, control wiring from the sensors to the logic devices and to the final controlled element, and power wiring from the source, through the controller to the load apparatus, are routed so that the redundant channels are physically separated by space or by barriers. Cables for the reactor protection system are routed in a completely enclosed metallic raceway system composed of rigid steel conduit, steel boxes, and fittings, steel gutters or covered steel trays. This raceway system contains no circuits other than for the protection system, and provides complete separation of redundant channels. Cables for engineered safeguard circuits are routed in trays and/or conduits which provide adequate separation of redundant channels. Control apparatus, distribution equipment, and power sources are also separated. The diesel generators, essential 4160 Vac and 480 Vac switchgear, 480 Vac MCC's, and the station batteries are in separate areas isolated by concrete floors or walls. Control room panels containing devices for redundant channels are provided with steel barriers separating the channels or redundant systems are separated by 3 feet or more. Local panels provide equivalent separation.

The plant arrangement is such that in the turbine-generator building, which houses the essential 4160 Vac switchgear, 480 Vac load centers, and 480 Vac MCCs with the exception of MCCs 134 and 144, the apparatus and connecting raceways associated with each redundant channel are located on different levels separated by a reinforced concrete floor. The two diesel-generators are located in separate rooms abutting the turbine-generator building.

Connections from the diesel-generators, and related equipment, to the apparatus or raceways in the turbine-generator building are in rigid steel conduits which are also separated from the redundant channel by the concrete floor. Where the raceways approach the cable spreading room, the trays of opposite channels, of necessity, approach each other more closely and separation here is provided by walls and barriers.

MCCs 134 and 144 are located on different floors of the EFT building and are separated by a concrete floor.

Inside the cable spreading room separation is provided by horizontal or vertical spacing of the raceways and/or by the use of metallic barriers.

In the reactor building where raceways approach the cable spreading room a concrete block wall separates trays of the opposite division. In the balance of the reactor building, separation is provided by space, barriers, structures, or combinations thereof.

Except for the reactor protection system which has its own raceway system, the safeguard cables are not separated from non-safeguard cables. Separation is only provided between cables in one channel from their redundant counterparts in the other channel. To facilitate identification of safeguard channels the redundant systems are classified as Divisions I and II. Apparatus related to these divisions are generally identified A and B or odd and even respectively. The odd-even designation applies particularly to the power sources, switchgear, and distribution apparatus related to the redundant power systems. Raceways are also numbered odd-even. Generally the odd raceways are routed to the areas occupied by the odd, Division I or A equipment, and the even raceways to the even, Division II or B equipment. The separation of the odd and even raceways in most cases, is equal to or better than the minimum described previously.

In congested areas such as the cable spreading room some odd and even trays are of necessity much closer than the minimum allowance by the criteria. Where this occurs these trays are used only for non-safeguard cables. The safeguard cables are only routed in trays where adequate separation exists.

Although most Division I safeguard cables are routed in odd numbered raceways and Division II cables in even raceways, there are occasions where this is not true. There are also possible situations where Division I and II cables occupy the same raceway. This would occur rarely and would only involve cables of unrelated systems and not the redundant counterparts related to the same protective function.

8.8.2 <u>Original Separation Criteria For The Primary Containment Isolation System (PCIS) and the Engineered Safeguards Systems</u>

The original separation requirements for the PCIS and Engineered Safeguards Systems are shown below. Separation requirements for missile and fire hazards are stated in terms of distance. The separation standard allows for closer spacing where suitable fire and missile barriers exist.

a. Mechanical Damage (Missile Zone)

These are zones of potential missile damage in the vicinity of large rotating apparatus or high pressure piping. In these zones raceways are separated by at least 20 feet or by a 6 inch thick reinforced concrete wall or floor. An exception to this requirement is inside the drywell where limited space, in some cases, prevents attainment of the minimum. Where this occurs care is taken to locate the redundant raceways so that a single missile will not damage both channels.

b. Fire Hazard Zone

Type I. These are areas where oil or other combustibles are present in large quantities which could support a damaging fire. The routing of raceways through these zones is avoided wherever practicable. Where it is necessary to route raceways through such areas only those for one division of the engineered safeguard cables are located therein. No cables are routed through the turbine oil storage room.

Type II. These are areas where the only source of fire is of an electrical nature and combustible materials consist primarily of electrical insulation. In these areas trays of the opposite division are separated by at least 3 feet horizontally or 5 feet vertically for stacked trays. When a 3 foot horizontal separation is not attainable fire resistant barriers are provided between the two trays. Where trays are stacked and meet the 5 foot separation requirement, the top tray is also provided with a solid steel bottom and the bottom tray with a solid steel cover. When trays of opposite divisions cross the separation may be reduced to 18 inches provided the tray top and bottom covers extend 5 feet or more each side of the crossing.

c. Cable Spreading Room

This is the room below the main control room and contains cable trays, conduits, gutters, and boxes used to route cables passing through the room, and cables routed to the control room boards above. The cable spreading room also houses a number of control or relay panels and instrument AC distribution panels. The criteria for tray separation of 3 foot horizontally, 5 foot vertically, 18 inches at crossings with tray bottoms and tops covered as previously described, is applied here also. Where trays of opposite division approach more closely than 3 foot horizontally, a fire resistant barrier between the trays is provided. Cables leaving trays of opposite divisions and which approach each other more closely than 3 foot are both run in separate steel conduits or enclosed gutters.

d. Control Room Panels

No single control room panel (or local panel or instrument rack) includes wiring for both Division I and II unless the following separation requirements are met.

If two panels containing circuits of different divisions are less than 3 feet apart, a fire barrier shall be between the two panels. Panel ends closed in steel end plates are acceptable as long as the divisional terminal boards and wireways are one inch from the plate. Floor to panel barriers are provided between adjacent panels having closed ends.

A panel may contain wiring and components of two engineered safeguards systems redundant to each other provided that the panel is subdivided by means of a fire barrier. No cable terminal blocks or other components should be located less than one inch from such a barrier. Penetration of separation barriers within a subdivided panel is permitted provided that such penetrations are sealed or otherwise rated so that an electrical fire could not reasonably propagate from one section to the other and destroy the protective function.

In cases where circuits and components such as manual switches, indicating lights, and annunciators are not vital to the automatic operation of redundant safety systems, these circuits and components may be grouped together on the same control room panel.

8.8.3 <u>Functional Separation</u>

In addition to providing channel separation as described above, the raceway system provides separation by function as follows:

1. Medium Voltage Power

13.8KV and 4160 Vac power cables are routed in conduits or trays separate from those for cables of other functions.

2. Low Voltage Power and Control

   This classification includes cables with insulation rated at 600 Vac used for power and control circuits operated at 480 Vac and 120 Vac and at 125 Vdc and 250 Vdc. Power and control cables are not separated from each other. Raceways consist of ladder type trays and rigid steel conduit.

3. Signal and Instrumentation

   Cables of this category are used in circuits which operate at very low energy levels and which may be noise sensitive but which are not noise producers. Raceways are selected to minimize noise pickup and consist of solid bottom steel trays with solid covers or rigid steel conduit. The instrumentation cables are not routed in the same raceways as power and control cables.

8.8.4 Equipment Identification and Configuration Management

Equipment, including locally mounted devices, which are part of engineered safeguard systems, is prominently marked with name plates or equivalent means which uniquely identify them as required by the plant labeling and equipment numbering programs.

Conduits, cable trays, boxes, and cables except those that are part of lighting, receptacle, communication and computer systems are assigned and marked with a unique identification number. This number is generally used on appropriate drawings, schedules, listings, and construction records and controls. Cables are marked at their ends. The raceway and cable numbering system incorporates an odd-even significance to aid the designer in providing the proper separation of cables in redundant safeguard systems.

Strict administrative controls combined with the proper usage of the design drawings, schedules, and listings and the identification marking of equipment, raceways, and cables facilitate safety during plant operation and maintenance. Following are described and discussed the principal design documents which provide the information necessary to the implementation of the administrative controls.

a. Conduit and Tray Drawings - These drawings identify and show the physical location of electrical raceways, equipment and devices to which electrical connections are made.

b. Schematic (Elementary) Diagrams - These drawings, in addition to defining circuit function, identify cases where mandatory separation of safeguard cables is required and usually, by means of the odd-even scheme number, indicate the safeguards division of the system to which each cable is related.

Circuit Schedule

This schedule includes for each cable, the cable number, scheme number, cable type, and a detailed routing through raceways from origin to destination.

Raceway Schedule

This schedule includes for each raceway, the raceway number, type, size, percent fill, and a listing of cables routed therein.

Connection Diagrams

These drawings show external connections to major apparatus and most local devices. The cable numbers, wire numbers, and terminals are shown on these drawings.

Cable Listing - Scheme Number Sequence

The cable schedule may be sorted and grouped in scheme number sequence. Reference to this document and the related schematic (elementary) diagram permits the identification of cables associated with a particular system. Further, this listing may be used to identify safeguard cables and their safeguard division.

8.8.5 Electrical Penetrations

There are various containment (drywell and wetwell) electrical penetration assemblies. Most are located at nearly the same elevation and in four groups around the drywell periphery approximately 90° apart. Four assemblies are used solely for the CRD position cables, four for neutron monitoring cables, two for 4160 Vac power to the recirculation pumps, one for miscellaneous thermocouples and other low level signal circuits, one for low level signal circuits, and three for miscellaneous power and control. Apparatus or devices inside the drywell, the wiring to which requires separation, include a number of neutron monitoring cables associated with the RPS, several valve position switches which serve as scram sensors for the RPS, safeguard cables related to the RCIC, RHR and Core Spray Systems.

Although one group of penetration assemblies is separated from the others on the exterior of the drywell by concrete walls, no barriers exist inside the drywell. Separation is provided by virtue of the spacing of groups which are about 40 feet apart.

The neutron monitoring cables are divided into four channels. Each channel is routed through a separate penetration assembly. Three of these assemblies contain only neutron monitoring cables. The fourth also contains four shielded cables used for vibration detector signals of extremely low energy level. The four assemblies are arranged in pairs, each pair on diametrically opposite sides of the drywell. The cables to and from each of these penetrations, being in the RPS are installed in completely enclosed raceway systems as previously described.

The scram sensor cables are also in four channels which are routed through two diametrically opposite penetration assemblies. Each assembly contains two groups of conductors which are used only for the RPS circuits. Each group is separated from the other group and from other conductors in the penetration assembly by complete enclosure in metallic conduit inside and outside the penetration assembly. The other conductors in these two penetration assemblies are used for miscellaneous power and control applications, including some of the two-channel safeguard services. Redundant channels utilize the diametrically opposite penetration assemblies.

8.8.6 Raceways

Raceways of several types are used throughout the plant for the routing of power, control, and instrument cables. Cable tray is used for routing the main concentrations of cables around the plant. Cable trays are steel and are manufactured and tested in accordance with NEMA Cable Tray Standards VE-1 (Reference 49). The trays are designed to withstand a 100 lb/ft loading with deflection not exceeding 0.25 inch for an 8 foot span. Tray supports are spaced 8 foot or closer and are predominantly constructed of unistrut channels, inserts and fittings. Trays for power and control generally are of the ladder type. Covers are provided where cables may be subject to mechanical damage or in areas where uncovered trays might tend to collect debris. Trays for instrumentation are solid bottom, and provided with covers to reduce electrical noise pickup. Solid bottom trays with covers are also used for power and control cables in congested areas where the minimum spacing for open trays cannot be obtained. Where trays in a run are stacked, the vertical spacing is generally 1 foot or greater. Except for the safeguard trays previously discussed, the minimum horizontal separation is determined by accessibility requirements during and after construction.

Galvanized rigid steel conduit is used for cables of all types routed from trays to apparatus and local devices, and for other exposed runs. Rigid steel conduit is also used for many embedded and underground runs. Thin wall conduit is used only for lighting and communications circuits. Short runs of flexible, liquid-tight conduit are used where vibration may be encountered or to facilitate removal of the connected device. Fittings and boxes are made of steel. Some of the 4 inch and larger runs embedded in concrete are made with plastic conduit. Some underground runs are directly buried in the earth and are protected by a heavy wood plank. Galvanized steel gutter is used in some applications.

Where practical, conduit fill is held within the percentage recommended by the National Electrical Code (NEC). Tray fill is tracked and controlled to limit excessive concentrations of heat producing cables and excessive sidewall pressure exerted on individual cables by other cables.

8.8.7 Cables

Cables are qualified for their specific applications. Examples of cable types used for various services are as follows:

13.8KV Power Cable	15 KV rated shielded and jacketed power cable with copper conductor.
4160 Vac Power Cable	5 KV rated shielded and jacketed power cable with copper conductor.
600 Vac (or less) Power Cable	Ozone resistant butyl rubber insulation, neoprene jacket, size as required, No.10 AWG minimum. Some power cables inside the drywell use cross-linked polyethylene insulation. Cables with EPR insulation, hypalon jacket are also used. Feeder cables to MCC 115 and MCC 124 are qualified for the specific underground installation involved

Control Cable	Mostly multi-conductor No. 14 AWG with 20 mils PE insulation and 10 mils PVC jacket on the singles, and PVC jacket overall. Some No.12 AWG and No.10 AWG control cables are used. Single conductor control cable where used is No.10 AWG minimum size. Control cables inside the drywell and in some other applications use cross-linked polyethylene insulation with a neoprene jacket.
Special Cable	A great number of special cables for particular applications are used. Following are some of the more common types:

1. Cables for miscellaneous instrumentation and computer usage are PE insulated, No. 16 AWG, braid or tape shield, PVC jacketed. Thermocouple extension leads are similar.
2. Neutron monitor cables are coaxial, triple shielded, or shielded pairs, PE insulation, shields, PVC jacket overall.
3. CRD position cables inside the drywell are multi-conductor No. 20 AWG, cross-linked polyethylene, neoprene jacket.
4. Special multi-conductor control applications, particularly where used with separable connectors are No. 16 to No. 20 AWG, PE or XLPE insulated sometimes shielded, PVC jacket overall.

In selecting conductor sizes, proper consideration is given to the ambient temperature and to the types of raceways through which the cable is routed. In most areas of the plant the design ambient is taken as 40°C (104°F). Higher local temperatures in certain areas are factored in as required. Inside the drywell the design ambient temperature is 66°C (150°F).

For power cables in conduits and trays, the cable manufacturer's recommendations, relevant ICEA (formerly IPCEA) standards or relevant industry standards are used as a guide in selecting the proper derating factor. The ICEA standards take some credit for a degree of diversity in the loading of the cables and the fact that there are a number of control cables and idle power cables which do not produce heat.

Cable overloads are prevented by the proper selection, application and setting of protective relays, circuit breakers, series trip elements motor overload heaters, and fuses. Cables are protected against damage from short circuits by selecting a conductor which will carry the available fault current for the length of time required for the protective device to clear the fault, without exceeding the manufacturer's maximum short circuit temperature rating for the conductor insulation. Cable damage protection exceptions have been identified and accepted in electrical coordination calculations. In all cases, post fault event recovery actions, will ensure cables are tested and acceptable prior to re-use. 60400000022

8.8.8 Special Considerations

a. The non-safeguard cable installations do not compromise those provided for the protective functions. The RPS cables are in their own raceway system and are not exposed to cables of other systems. Although safeguard cables and non-safeguard cables may be routed through the same raceways, the channel separation provided for the safeguard cables prevents accidents from involving more than one of the redundant channels. The previously described conservative raceway loading, cable derating, and protection against electrical faults, in conjunction with the associated circuits analysis, eliminates the possibility of the safeguard cables described in reference 6 from being involved with faults in the non-vital circuits.

b. In conjunction with the computer processed raceway and circuit schedules, appropriate raceways and cables in the plant are assigned a number. Raceway and cable numbers include an odd-even designation, which generally corresponds to the system with which they are related. Each raceway is marked with its identification number. The cable number is attached to each end of each cable. During the design phase and during construction the computer processed circuit and raceway schedules are the primary means for controlling the installation of RPS and safeguard cables so that the required channel separation is achieved. Elementary diagrams or schematic diagrams for circuits which require separation carry a notation that mandatory separation of the redundant functions is to be provided. To facilitate the routing separation, where possible, advantage is taken of the raceway numbering system for odd-even cables.

c. Control over the installation of cables to ensure that the design requirements are met is provided by the Quality Assurance Program. RPS and safeguard cables are included in this program. Because safeguard cables are not necessarily separated from non-safeguard cables, raceways containing reactor protection, safeguards, or associated non-safeguards cables are included under the Quality Assurance Program. The Quality Assurance Program assures that the cable installations have been made properly and that they comply with the design with respect to cable type, identification, routing and connections, and that the raceways are of the correct types and are properly installed, and identified.

8.9 Environmental Qualification of Safety-Related Electrical Equipment

8.9.1 General

The Equipment Qualification Branch of the Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission (NRC), required all licensees of operating reactors to submit a re-evaluation of the qualification of safety-related electrical equipment which may be exposed to a harsh environment. This requirement was implemented primarily by the issuance, on January 14, 1980, of IE Bulletin No. 79-01B (Reference 1) with subsequent clarifying supplements in February (Reference 59), September (Reference 60) and October, 1980 (Reference 61).

The bulletin required that a master list of safety-related systems and equipment be generated, all accident service conditions be defined, and the equipment be evaluated in accordance with guidelines in the Bulletin.

Northern States Power Company provided a number of responses to IE Bulletin 79-01B (References 2, 4, 5, 14 and 62). On June 3, 1981, the NRC issued a Safety Evaluation Report (SER) (Reference 3) which summarized their assessment of the early submittals and requested additional information. Additional information was provided for NRC Staff review and the NRC concluded (Reference 15) that previously identified unqualified equipment was now considered qualified and that the plant could continue to operate safely while the remaining deficiencies were being resolved.

On January 21, 1983, the NRC published in the Federal Register the final rule on environmental qualification of electric equipment important to safety for nuclear power plants that became effective on February 22, 1983. This rule, Section 50.49 of 10CFR50, specifies the requirements for environmental qualification of electrical equipment important to safety located in a harsh environment. In accordance with this rule, equipment for Monticello may be qualified to the criteria specified in either the DOR guidelines or NUREG-0588, except for replacement equipment. Replacement equipment installed subsequent to February 22, 1983, must be qualified in accordance with the provisions of 10CFR50.49, using the guidance of Regulatory Guide 1.89 (Rev. 1), unless there are sound reasons to the contrary.

The approach described by NSP for addressing and resolving the identified deficiencies included replacing equipment, performing additional analyses, utilizing additional qualification documentation beyond that reviewed earlier by the NRC, obtaining additional qualification documentation and determining that some equipment is outside the scope of 10CFR50.49, and therefore not required to be environmentally qualified (e.g., located in a mild environment). A listing of equipment which is located in a harsh environment and is necessary to mitigate the consequences of the Design Basis Accidents (DBAs) that are identified in the USAR (including high energy line breaks, and flooding resulting from these events) is contained in a Master Equipment List. This equipment was identified through a review of the accident analyses provided in the FSAR, a review of plant abnormal procedures, a review of safety system flow diagrams and the Q-List, and a review of the installed equipment locations with respect to postulated harsh environmental zones.

The method used for identification of electrical equipment within the scope of paragraph (b)(2) of 10CFR50.49, non safety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions, is summarized below:

1. A list was generated of safety-related electric equipment (as defined in paragraph (b)(1) of 10CFR50.49) that is required to remain functional during or following Loss of Coolant Accidents (LOCA) or High Energy Line Break (HELB) accidents and the flooding resulting from these events. The equipment was identified through a review of the accident analysis provided in the FSAR, a review of plant abnormal procedures, a review of safety system flow diagrams and the Q-List, and a review of the installed equipment locations with respect to postulated harsh environmental zones.

2. The wiring diagrams of safety related electrical equipment as defined in paragraph (b)(1) of 10CFR50.49 were reviewed to identify any auxiliary devices, electrically connected directly into the control or power circuitry, whose failure due to postulated environmental conditions could prevent the required operation of the safety-related equipment.

3. Auxiliary equipment with electrical components which are necessary for the required operation of the safety-related equipment was identified in the review described in Item 1 above.

4. Non safety-related electrical circuits indirectly associated with the electrical equipment defined in paragraph (b)(1) of 10CFR50.49 by common power supply or physical proximity were considered by a review of the plant electrical design including the use of properly coordinated protective relays, circuit breakers, and fuses for electrical circuit fault protection.

The final NRC SER is contained in Reference 19.

The Master Equipment List and qualification documentation are maintained in the Equipment Central File, which is maintained at the site. New equipment within the scope of 10CFR50.49 is procured to meet appropriate qualification requirements.

Equipment qualification is a living requirement that requires implementation into the activities of plant operation. The Master Equipment List will change over the course of time due to system modifications; replacement equipment; or additional 10CFR50.49 paragraphs, (b)(1) safety-related equipment, (b)(2) non safety-related electrical equipment, and (b)(3) post accident monitoring equipment, identified through procedure changes, LER Reviews, etc. The Central File records summarize the qualification status and identifies any maintenance activities that are required to preserve the qualified status of the equipment.

The EQ Central File contains:

- Master Equipment List
- Environmental Specifications by Plant Location
- Equipment Qualification Files

An analysis of the environmental qualification of plant equipment was provided to the NRC in Enclosure 17 of Reference 84. This analysis included a description of the parameters that form the design basis of the EQ program such as total integrated dose, temperature and pressure profiles, flooding levels, and the effects of thermal aging on qualified life. This response was updated by Reference 85. By letter dated (December 9, 2013) (Reference 80), the NRC staff found operation at 2004 MWt acceptable with respect to the EQ of electrical equipment. The effects of operation at 2004 MWt on the environmental conditions inside and outside containment have been appropriately considered and the qualification of electrical equipment will continue to meet the relevant requirements of 10 CFR 50.49.

8.10 Adequacy of Station Electrical Distribution System Voltages

NRC Generic Letter 79-36 “Adequacy of Station Electrical Distribution System Voltages” (Reference 7) required all addressees to analytically determine if offsite power systems and station electrical distribution systems were of sufficient capacity and capability to automatically start and operate in the event of an anticipated transient or accident. This letter also stated that protection of safety loads from under-voltage conditions must be designed to provide the required protection without causing voltages in excess of maximum voltage ratings of safety loads and without causing spurious separations of safety buses from off-site power.

Guidelines for determining if the load voltage is adequate to start and continuously operate the safety loads were included. In addition, a test was required to verify the analytical results.

In response to the Generic Letter and questions from the NRC staff, Northern States Power (NSP) provided information and analysis in January, June and November, 1981, and May, 1982 submittals (References 9, 10, 11 and 12).

On August 15, 1983, the NRC issued a Confirmatory Action letter (Reference 65) to summarize actions NSP had committed to perform in evaluating an August 1, 1983 trip of the normal power supply to the 4160 Vac essential bus No. 16. On August 31, 1983, the NRC transmitted a request for additional information pertaining to the 1981-82 NSP submittals (Reference 66). In response to these NRC letters, NSP submitted new analyses of the then current station electrical distribution system via letters dated December 30, 1983 (Reference 17), September 25, 1984 (Reference 21) and October 25, 1984 (Reference 63). These analyses identified maximum and minimum acceptable system voltages. The results from verification testing were submitted to the NRC via letter dated July 27, 1984 (Reference 22). NRC acceptance is documented in letters dated November 27, 1984 (Reference 23), and March 20, 1985 (Reference 64).

A number of electrical design improvements have been implemented since 1984. Monticello’s AC Load Study program controls and maintains the databases and computer models used to evaluate and record electrical load study cases and calculations that are performed. This program is utilized to assure that the distribution system voltage ranges meet the underlying electrical system design bases for plant conditions. The following loading conditions are analyzed to ensure that the electrical system design bases are maintained:

A. Full plant load

B. ECCS/LOCA plant load

C. Minimum plant load

The AC Load Study program has established the following electrical system design bases for determining acceptable distribution system voltages:

1. 120 Vac Instrument AC System Voltages:

Maximum - 132 Vac, Minimum - 108 Vac (+/- 10% of rated 120 Vac)

2. 480 Vac System Voltages:

Maximum - 506 Vac, Minimum - 426 Vac (+/- 10% voltage at the terminals of 460 Vac motors. Minimum voltage accounts for an additional 2.5% cable voltage drop from the MCCs to the load terminals.) Note: There are three exceptions to this statement. Due to circuit voltage drop concerns, the motors for P-111B, 12 EDG/ESW Pump, V-EF-18B B OG Stack Dilution Fan, and V-EF-17B, B Standby Gas Treatment Exhaust Fan, have been replaced with new motors designed and tested to operate at a continuous voltage down to 400 VAC or 87% of nameplate. 01506116

3. 4160 Vac System Voltage:

Maximum - 4400 Vac at the 4 KV motor terminals (110% of rated 4000 Vac). Minimum - 3975 Vac (The degraded voltage relay setpoint was established based on 3915 Vac, with a bandwidth of +/- 18 Vac. This determined the degraded voltage relay setpoint range of 3897 to 3933 Vac. The reset setpoint for the degraded voltage relay was established at 42 Vac greater than its dropout setpoint. If the degraded voltage relay is actuated following a motor start, system voltage will recover above 3933 + 42 = 3975 Vac within 9 (+/- 1) seconds. When the voltage recovers it will reset the degraded voltage relays such that a bus transfer will not occur. A separate analysis verifies that the bases for degraded voltage relay setpoint remains valid under the current configuration and loading conditions).

Plant procedures incorporate these limits.

The 345 KV and 115 KV system voltage limits are identified in Monticello plant procedures. These limits take into consideration limiting plant design base loading conditions as well as the underlying electrical system design bases. Monticello operations monitor the 345 and 115 KV system voltages to assure that appropriate off-site power sources are available.

NSPM provided a summary of the Midwest Independent System Operator system impact studies performed at the predicted electrical output consistent with operation at 2004 MWt as Enclosure 14 to Reference 84. These studies included stability, short circuit, and deliverability analyses. The study demonstrated that operation at 2004 MWt will not have a significant effect on the reliability or operating characteristics of MNGP or on the offsite system. An augmented response was provided as part of Item 1 to Reference 83. The NRC accepted the results of this study by an SER dated December 9, 2013 (Reference 80).

8.11 Power Operated Valves

8.11.1 Motor Operated Valves

IE Bulletin 85-03 "Motor-Operated Valve Common Mode Failures During Plant Transients due to Improper Switch Settings" and its supplement (Reference 50) were issued to ensure that switch settings on certain safety-related motor-operated valves (MOVs) were selected, set and maintained correctly to accommodate the maximum differential pressures expected during both normal and abnormal events within the design basis.

In June of 1989, IEB 85-03 was superceded by Generic Letter 89-10 "Safety-Related Motor Operated Valve Testing and Surveillance" (Reference 51) which recommended that a program be established to ensure that all safety-related MOVs are selected, set and maintained appropriately. Several supplements to Generic Letter 89-10 (Reference 52) have been issued to clarify program scope, schedule, and recommendations. In April 1995, the NRC conducted a closeout inspection to verify the completeness of NSP's commitments made in response to Generic Letter 89-10 (Reference 67). Enhancements to the MOV program were made to complete timely closure of the inspection findings and of the generic letter.

In September 1996, the NRC issued Generic Letter 96-05 "Periodic Verification of Design-Basis Capability of Safety related Motor-Operated Valves" (Reference 68) which superceded GL 89-10 and its supplements. Monticello's response to Generic Letter 96-05 stated that the actions requested by this generic letter would be completed for the motor operated valves within the existing Generic Letter 89-10 MOV Program scope (Reference 69).

The impact on Generic Letter 89-10 was reviewed as a part of Extended Power Uprate (EPU) to 2004 MWt (Reference 82). Monticello also provided a supplemental response that identified actions required to maintain compliance with Generic Letters 89-10 and 96-05 as a part of Item 24 in Reference 83 which was accepted by the NRC in Reference 80.

8.11.2 Generic Letter 95-07, Pressure Locking and Thermal Binding of Safety Related Power-Operated Valves

Generic Letter 95-07 (dated August 17, 1995) (Reference 53) was issued by the NRC requesting licensees to provide information concerning (1) the evaluation of operational configurations of safety-related, power-operated gate valves for susceptibility to pressure locking and thermal binding; and (2) analyses, and needed corrective actions, to ensure that safety-related power-operated gate valves that are susceptible to pressure locking or thermal binding are capable of performing the required safety function. By letters dated October 16, 1995, February 12, 1996 and July 17, 1996 (References 54, 55 and 56) Monticello responded to the Generic Letter.

All Motor Operated Valves (MOVs), Air Operated Valves (AOVs), and Hydraulically Operated Valves (HOVs) were reviewed to determine applicability of this issue.

For those valves which were identified to be potentially susceptible, an evaluation was performed to ensure each valve can perform its intended safety function. The NRC has determined that Monticello's evaluation and resulting corrective actions adequately addressed Generic Letter 95-07 (Reference 72). There was also no additional impact on Generic Letter 95-07 as a result of EPU to 2004 MWt (References 83 and 84).

8.11.3 ASME OMN-1 Code Case

The NRC has concluded that the version of Code Case OMN-1-1 in the 2009 Edition of the ASME OM Code, with the conditions specified in RG 1.192, provides an acceptable level of quality and safety for testing all MOVs in the Monticello MOV Program (Reference 78). The scope of MOVs in which Monticello has elected to apply the code case is identified in IST-Plan 5th Interval.

Those valves that are within the scope of the ASME OMN-1-1 code case are no longer governed by the Motor Operated Valve Joint Owners' Group (JOG) program (MPR-2524A) as the OMN-1-1 code case provides the requisite guidance to ensure long term reliability of active safety-related MOVs. Those valves that are not within the scope of OMN-1-1 will remain governed by the MOV JOG program.

8.12 Station Blackout (SBO)

On July 21, 1991, the Code of Federal Regulations was revised to include a new Section 50.63, entitled "Loss of All Alternating Current Power", otherwise known as the Station Blackout Rule. The Station Blackout (SBO) Rule required that the Monticello Nuclear Generating Plant (MNGP) be able to withstand and recover from a SBO of specified duration. NRC Regulatory Guide 1.155 "Station Blackout" (Reference 57) and NUMARC 87-00 "Guidelines and Technical Basis for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors" (Reference 58) provided largely identical guidance on satisfactory means of addressing this issue.

Monticello demonstrates compliance with the SBO Rule through the analyses performed that follow guidelines of Regulatory Guide 1.155. In keeping with Regulatory Guide 1.155, the analysis used the methodology of NUMARC 87-00, except where superseded by Regulatory Guide 1.155. The results of the analyses were provided to the NRC in References 31 and 32. MNGP chose to use an AC-independent methodology for coping with a SBO. The analyses determined that, using an Emergency Diesel Generator Target Reliability of 95%, Monticello fits the category of a plant that must cope with a SBO of 4 hour duration.

The NRC reviewed Monticello's plans for coping with SBO and issued a letter and Safety Evaluation Report (SER) to document that they were acceptable subject to satisfactory resolution of several recommendations contained in the SER (Reference 33). MNGP reviewed the recommendations of the SER and committed to a number of actions to ensure satisfactory resolution of outstanding NRC concerns (Reference 34). The acceptance criteria for the drywell heatup analysis during a SBO event are the temperature limitations of the equipment in the drywell that is required to be operable and the design temperature of the primary containment shell. Documentation of these actions is maintained in plant files. The NRC Supplemental Safety Evaluation Report (Reference 39) documents NRC acceptance of MNGP's actions to address the SER recommendations.

SBO mitigation is accomplished per the MNGP SBO coping analysis. The analysis credits the automatic initiation and subsequent trips of the HPCI system to maintain reactor pressure vessel level. The Division II 250 VDC Battery is postulated to be available for HPCI operation during the 4 hour coping duration. During a Station Blackout low pressure injection systems will not be available until power restoration is complete. The available Low Low Set SRVs will maintain RPV pressure within design limits.

The SBO containment response was evaluated at Extended Power Uprate (EPU) conditions to 2004 MWt using the SHEX computer code and the guidance provided by NUMARC 87-00 and Regulatory Guide 1.155. The input to the SBO analysis included the following assumptions:

- Initial reactor power is 2004 MWt.
- Decay heat is EOC (24 month) GE 14 fuel
- The HPCI system is the only credited injection source.
- An MSIV closure signal is generated at t = 0.
- No credit is taken for decay heat removal via the turbine bypass valves after the MSIVs close.
- Recirculation pump seal leakage is 18 gpm per pump.
- The primary HPCI suction source is the CST in accordance with the Monticello Emergency Operating Procedures (EOPs).
- Automatic and manual CST-torus HPCI suction transfers are included in the model.

Reference 81 contains additional detail on SBO event modeling and sequence. The model evaluates two cases, both of which involve automatic initiation of the HPCI system. The first case assumes HPCI initiation on low low reactor level and the 2nd case on high drywell pressure.

Areas containing equipment necessary to cope with an SBO event were evaluated for the effect of loss-of-ventilation due to an SBO. The evaluation shows that equipment operability is bounded due to conservatism in the design and qualification bases. The battery capacity remains adequate to support HPCI operation. Adequate compressed gas capacity exists to support the SRV actuations.

The required condensate inventory for decay heat removal calculated using the method of NUMARC 87-00 Section 7.2.1 is 44,329 gallons. This value is within the available CST inventory. The available Condensate Storage Tank (CST) inventory provides adequate water volume to remove decay heat and maintain reactor vessel level above the top of active fuel. Peak containment pressure and temperature remain within design values. The required NPSH margin for the HPCI pumps was determined to be adequate, and the NPSH evaluation shows that adequate NPSH is available during an SBO event without requiring credit for containment overpressure. See USAR section 5.2.3.3.

The EPU SBO evaluation demonstrates that Monticello meets the requirements of 10 CFR 50.63. The SBO evaluation is documented by Reference 81 and summarized in Reference 82. Reference 80 contains the associated NRC SER.

8.13 References

1. NRC IE Bulletin No. 79-01B, “Environmental Qualification of Class 1E Equipment”, January 14, 1980.

2. NSP (D E Gilberts) letter to the NRC (J G Keppler), “Response to IE Bulletin 79-01B”, October 31, 1980.

3. NRC (T A Ippolito) letter to NSP (L O Mayer), Environmental Qualification of Safety Related Electrical Equipment, dated June 3, 1981.

4. NSP (L O Mayer) letter to the NRC, “Response to IE Bulletin 79-01B Safety Evaluation Report - Revised Submittal”, dated November 16, 1981.

5. NSP (L O Mayer) letter to the NRC, “Response to IE Bulletin 79-01B, Supplement 3 - Qualification of TMI Action Plan Equipment”, dated, December 29, 1981.

6. General Electric report, NEDO-22087, “Northern States Power Company; Fire Protection and Safe Shutdown Systems Analysis Report Monticello Nuclear Generating Plant”, June 1982.

7. NRC (W Gammill) letter to all power reactor licensees (except Humboldt Bay), “Adequacy of Station Electric Distribution System Voltage”, dated August 8, 1979.

8. Deleted.

9. NSP (L O Mayer) letter to the NRC, “Analysis of Adequacy of Station Electric Distribution System Voltages”, dated January 30, 1981.

10. NSP (L O Mayer) letter to the NRC, “Additional Information Regarding Adequacy of Station Electric Distribution System Voltages”, dated June 25, 1981.

11. NSP (L O Mayer) letter to the NRC, “Additional Information Related to Adequacy of Station Electric Distribution System Voltages”, dated November 2, 1981.

12. NSP (L O Mayer) letter to the NRC, “Completion of Evaluation and Modifications Related to Adequacy of Station Electrical Distribution System Voltage”, dated May 20, 1982.

13. Deleted.

14. NSP (D M Musolf) letter to the NRC, “Response to IE Bulletin 79-01B Supplement No. 3 - Qualification of TMI ACTION Plan Equipment”, dated February 28, 1983.

15. NRC (D B Vassallo), letter to NSP (D M Musolf), “Safety Evaluation for Environmental Qualification of Safety-Related Electrical Equipment”, dated January 4, 1983.

16. Deleted.

17. NSP (D M Musolf) letter to the NRC, “Re-analysis of Adequacy of Station Electric Distribution System Voltages”, dated December 30, 1983. (Revised by NSP Letters dated September 25, 1984 and October 25, 1984).

18. Deleted.

19. NRC (D B Vassallo) letter to NSP, (D M Musolf) “Safety Evaluation Addressing the Environmental Qualification of Electrical Equipment Important to Safety”, dated December 13, 1984.

20. Deleted.

21. NSP (D M Musolf) letter to the NRC “Response to Request for Additional Information of the Re-analysis for the Adequacy of Station Electrical Distribution System Voltages”, dated September 25, 1984.

22. NSP (D M Musolf) letter to the NRC, “License Amendment Request - Degraded Voltage Protection Logic”, dated July 27, 1984. (Additional information provided by NSP letter dated October 25, 1984).

23. NRC (V L Rooney) letter to NSP (D M Musolf) “Safety Evaluation Supporting Amendment No. 31 to DPR-22”, dated November 27, 1984. (Revised by NRC NRR letter dated March 20, 1985).

24. NRC (V L Rooney) letter to NSP (D M Musolf), “Safety Evaluation Supporting Amendment 23 to Facility Operating License DPR-22”, dated April 3, 1984.

25. NRC (T O Martin) letter to NSP (L R Eliason) “Inspection Report 263/90018, Electric Distribution System Functional Inspection (EDSFI)”, dated December 14, 1990.

26. NSP (L R Eliason) letter to the NRC, “Response to NRC Inspection Report No. 50-263/90018 (EDSFI) concerning a Notice of Violation and Unresolved Items on the Electrical Distribution System”, dated January 11, 1991.

27. Deleted.

28. Deleted.

29. NRC (J G Partlow) Generic Letter 91-11, “Resolution of Generic Issues 48, ‘LCOs for Class 1E Vital Instrument Buses’, and 49, ‘Interlocks and LCOs for Class 1E Tie Breakers’ Pursuant to 10CFR 50.54(f)”, dated July 18, 1991.

30. NSP (T M Parker) letter to the NRC, “Revised Response to Generic Letter 91-11, Resolution of Generic Issues 48, ‘LCOs for Class 1E Vital Instrument Buses’, and 49, ‘Interlocks and LCOs for Class 1E Tie Breakers’ Pursuant to 10CFR 50.54(f)”, dated February 6, 1992.

31. NSP (D M Musolf) letter to the NRC, “Loss of Alternating Current Power Information Required by 10CFR Part 50, Section 50.63(c)(1)”, dated April 17, 1989.

32. NSP (T M Parker) letter to the NRC, “Loss of Alternating Current Power Information Required by 10CFR Part 50, Section 50.63(c)(1)”, dated October 17, 1989.

33. NRC (A Masciantonio) letter to NSP (T M Parker) “Station Blackout Rule (TAC No. 68569)”, dated August 22, 1991.

34. NSP (T M Parker) letter to the NRC, “Response to Recommendations Contained in Monticello Station Blackout Evaluation, dated August 22, 1991”, dated November 22, 1991.

35. NSP (T M Parker) letter to the NRC, “Response to Generic Letter 91-06 - Adequacy of DC Power Supplies”, dated October 28, 1991.

36. Deleted.

37. Deleted.

38. Deleted.

39. NRC (W O Long) letter to NSP (T M Parker), “Supplemental Safety Evaluation - Station Blackout Rule (10CFR50.63) (TAC68569)”, dated August 5, 1992.

40. Deleted.

41. National Electric Safety Code for Heavy Loading Districts, Grade B Construction.

42. American National Standard, ANSI/IEEE Standard 279 - 1971, “Criteria for Protection Systems for Nuclear Generating Stations”.

43. NRC (W O Long) letter to NSP (T M Parker), “Evaluation of Proposed Modifications to LPCI Swing Bus (TAC No. 71092)”, dated September 8, 1989.

44. NSP (T M Parker) letter to the NRC, “Description and Evaluation of the Modifications to the 480V Bus Supplying the LPCI Injection Valves, Revision 1”, dated July 14, 1989.

45. NSP (T M Parker) letter to the NRC, “Low Pressure Coolant Injection System Swing Bus Single Failure”, dated October 6, 1989.

46. NSP (T M Parker) letter to the NRC, “Modification Review Identified Potential for Degraded ECCS Capability”, dated November 13, 1989.

47. Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines.

48. NRC (A Masciantonio) letter to NSP (T M Parker), “Adequacy of DC Power Supplies (TAC No. M81483, M81484 and M81464)”, dated January 9, 1992.

49. NEMA Cable Tray Standards VE-1 - 1996, “Metal Cable Tray Systems”.

50. NRC Bulletin, NRCB 85-03, Supplement 1, “Motor Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings”, April 27, 1988.

51. NRC (J G Partlow) Generic Letter 89-10, "Safety Related Motor Operated Valve Testing and Surveillance", dated June 28, 1989.

52. NRC (J G Partlow) Generic Letter 89-10, "Safety Related Motor Operated Valve Testing and Surveillance", Supplements 1-7.

53. NRC (D M Crutchfield) Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety Related Power-Operated Valves", dated August 17, 1995.

54. NSP (W J Hill) letter to the NRC, "Response to Generic Letter 95-07: Pressure Locking and Thermal Binding of Safety Related Power Operated Gate Valves", dated October 16, 1995.

55. NSP (W J Hill) letter to the NRC, "Response to Request for Additional Information Concerning Generic Letter 95-07: Pressure Locking and Thermal Binding of Safety Related Power Operated Gate Valves (TAC M93487)", dated July 17, 1996.

56. NSP (W J Hill) letter to the NRC, "180 day Response to Generic Letter 95-07: Pressure Locking and Thermal Binding of Safety Related Power Operated Gate Valves (TAC M93487)", dated February 12, 1996.

57. NRC Regulatory Guide 1.155, "Station Blackout", August 1988.

58. NUMARC Report 87-00, "Guidelines and Technical Basis for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors", November 1987.

59. NRC (J G Keppler) letter to NSP (D E Gilberts), "Supplemental Information to IE Bulletin No. 79-01B", dated February 29, 1980.

60. NRC (J G Keppler) letter to NSP (D E Gilberts), "Supplement 2 to IE Bulletin No. 79-01B", dated September 30, 1980.

61. NRC (J G Keppler) letter to NSP (D E Gilberts), "Supplement 3 to IE Bulletin No. 79-01B", dated October 24, 1980.

62. NSP (L O Mayer) letter to the NRC, "Response to IE Bulletin 79-01B Safety Evaluation Report", dated September 28, 1981.

63. NSP (D M Musolf) letter to the NRC, "Additional Information Related to Modifications to Degraded Voltage Protection Logic and Diesel Generator Start Logic", dated October 25, 1984.

64. NRC (V L Rooney) letter to NSP (D M Musolf), "Revised Safety Evaluation Supporting License Amendment No. 31", dated March 20, 1985.

65. NRC (J G Keppler) letter to NSP (C E Larson), confirmatory letter concerning Monticello plans to address August 1, 1983 trip of normal supply to 4160Vac Essential Bus 16, dated August 15, 1983.

66. NRC (J G Keppler) letter to NSP (C E Larson), “Meeting Held August 26, 1983 and August 29, 1983 Phone Conversation Regarding August 15, 1983 Confirmatory Letter”, dated August 31, 1983.

67. NRC (J M Jacobson) letter to NSP (E Watzel), “Closeout Inspection of Generic Letter 89-10 - NRC Inspection Report No. 50-263/95003 (DRS)”, dated May 11, 1995.

68. NRC (T T Martin) Generic Letter 96-05, “Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves”, dated September 18, 1996.

69. NSP (W J Hill) letter to the NRC, “180 Day Response to NRC Generic Letter 96-05 - Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves”, dated March 13, 1997.

70. Deleted.

71. Deleted.

72. NRC (Carl F Lyon) letter to NSP (R O Anderson), Response to Generic Letter 95-07 - Pressure Locking and Thermal Binding of Safety-Related Power Operated Gate Valves (TAC No M93487), dated April 12, 1999.

73. NSP (T M Parker) letter to the NRC, “Supplemental Response to Generic Letter 91-06 - Adequacy of DC Power Supplies”, dated April 29, 1992.

74. NRC (J G Partlow) Generic Letter 91-06, “Resolution of Generic Issue A-30 - Adequacy of Safety Related DC Power Supplies”, dated April 29, 1991.

75. Deleted.

76. NRC (s Miranda) to NMC (J S Forbes), “Monticello Nuclear Generating Plant - Issuance of Amendment to Revise Technical Specifications and Surveillance Requirements Relating to Standby Diesel Generators (TAC No. MB3042)”, dated August 27, 2002.

77. NRC (T A Beltz) to NSP (K D Fili), “Monticello Nuclear Generating Plant - Issuance of Amendment to Adopt Technical Specifications Task Force (TSTF) Traveler TSTF-501, Revision 1, “Relocate Stored Fuel Oil and Lube Oil Volume Values to Licensee Control” (TAC No. ME9601)”, dated January 28, 2014.

78. NRC (I Frankl) to NSP (M A Schimmel), "Monticello Nuclear Generating Plant - Relief from the Requirements of the American Society of Mechanical Engineers Code for Operation and Maintenance of Nuclear Power Plants for the Fifth 10-Year Inservice Testing Program Interval, dated September 26, 2012.

79. IEEE Standard 450-1995, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications", dated January 24, 1995.

80. NRC (T A Beltz) letter to NSPM (K D Fili), "Monticello Nuclear Generating Plant - Issuance of Amendment No. 176 to Renewed Facility Operating License Regarding Extended Power Uprate (TAC NO. MD9990)," dated December 9, 2013.

81. GE Hitachi EPU Project Task Report GE-NE-0000-0073-2176-TR-R0, Revision 0, "Task T0903: Station Blackout," March 2008 (Monticello calculation number 11-184).

82. GE Hitachi Report NEDC-33322P, Revision 3, "Safety Analysis Report for Monticello Constant Pressure Power Uprate," October 2008.

83. NSPM letter L-MT-12-114 (M A Schimmel) to NRC, "Monticello Extended Power Uprate (EPU): Supplement for Gap Analysis Updates (TAC MD9990)," dated January 21, 2013.

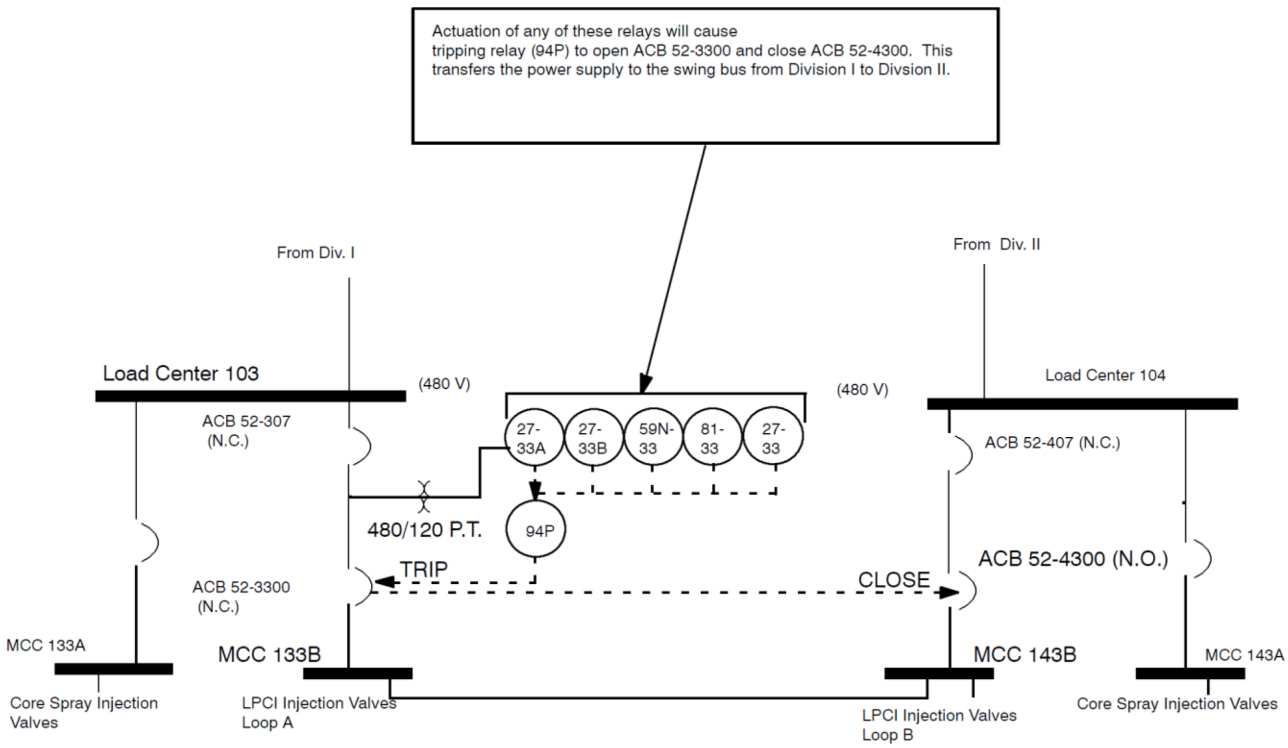
84. NSPM letter L-MT-08-052 (T J O'Connor) to NRC, "License Amendment Request: Extended Power Uprate (TCA MD9990)," dated November 5, 2008.

85. NSPM letter L-MT-13-034 (M A Schimmel) to NRC, "Monticello Extended Power Uprate (EPU): Response to Request for Additional Information - Electrical Engineering Branch (TAC MD9990)," dated April 10, 2013.

FIGURES

Figure 8.3-2 LPCI Swing Bus Degraded Power Transfer Scheme

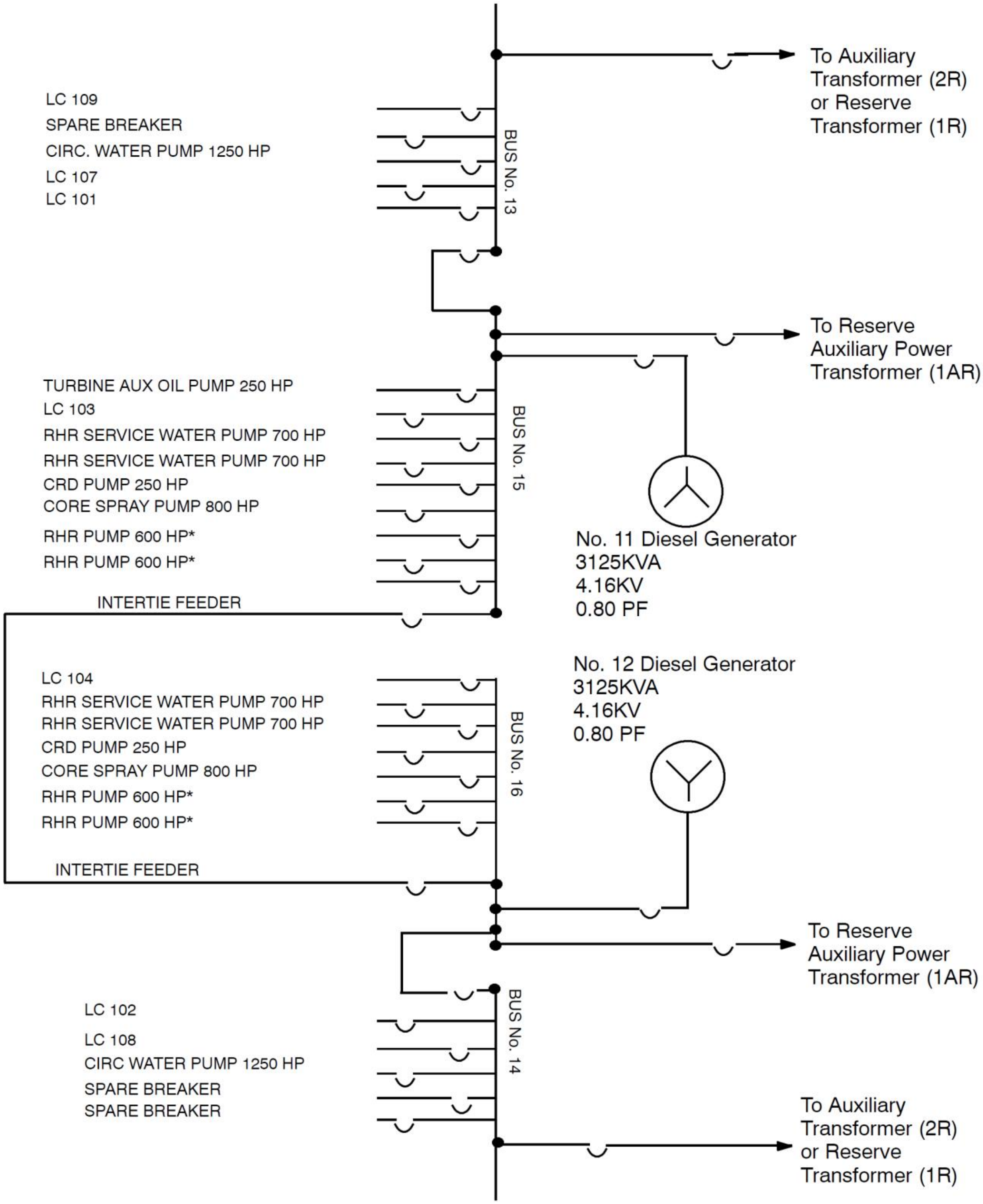
LPCI Swing Bus Degraded Power Transfer Scheme



Relay Designations

27-33A : Loss of Voltage with #11 EDG Output Breaker Closed
27-33B : Degraded Voltage with #11 EDG Output Breaker Closed
59N-33 : Over Voltage with #11 EDG Output Breaker Closed
81-33 : Out of Frequency with #11 EDG Output Breaker Closed
27-33 : Loss of Normal Voltage
94P : Tripping Relay

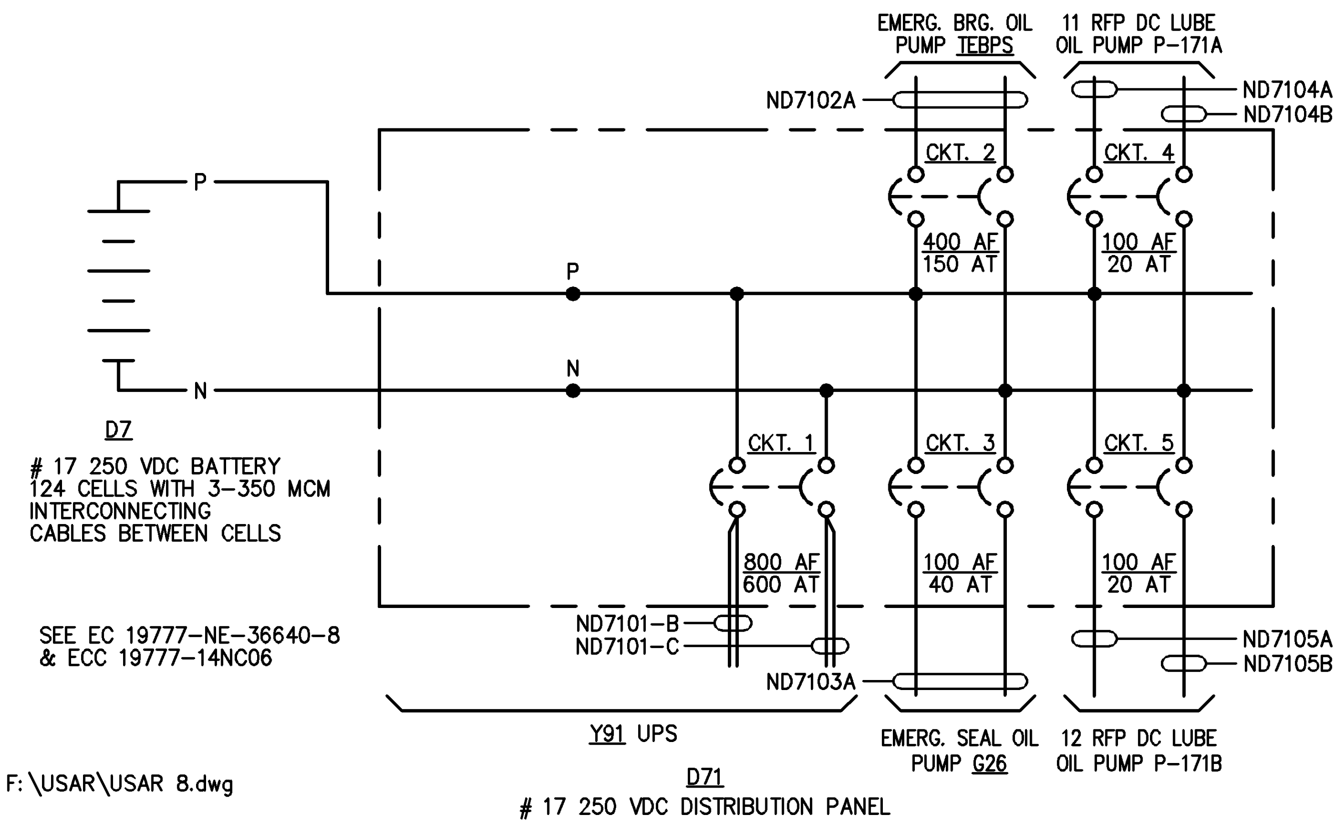
Figure 8.4-1 Diesel Generation System One Line Diagram



*NOTE: MONTICELLO'S INVENTORY INCLUDES BOTH 600 AND 700 HP MOTORS THAT MAY BE USED ON ANY OF THE FOUR RHR PUMPS.

Figure 8.5-4 #17-250 Vdc Distribution Panel (D71)

# 17 250 VDC DISTRIBUTION PANEL D-71						
SCHEME NO.	CKT NO.	BREAKER AF	BREAKER AT	DESCRIPTION	LOC	WIRE SIZE
D7101	1	800	700	Y91 UPS 125 KVA	Y91	4-1C-500
D7102	2	400	150	EMERG. BEARING OIL PUMP 25 HP	TEBPS	2-1C-4/0
D7103	3	100	40	EMERG. SEAL OIL PUMP 5 HP	G26	1-3C-2
D7104	4	100	20	11 RFP DC LUBE OIL PUMP 3HP	P171A	2-1/C-6
D7105	5	100	20	12 RFP DC LUBE OIL PUMP 3HP	P171B	2-1/C-6



60400000060

Figure 8.7-1 Instrument AC and Uninterruptible AC Distribution System Single Line Diagram

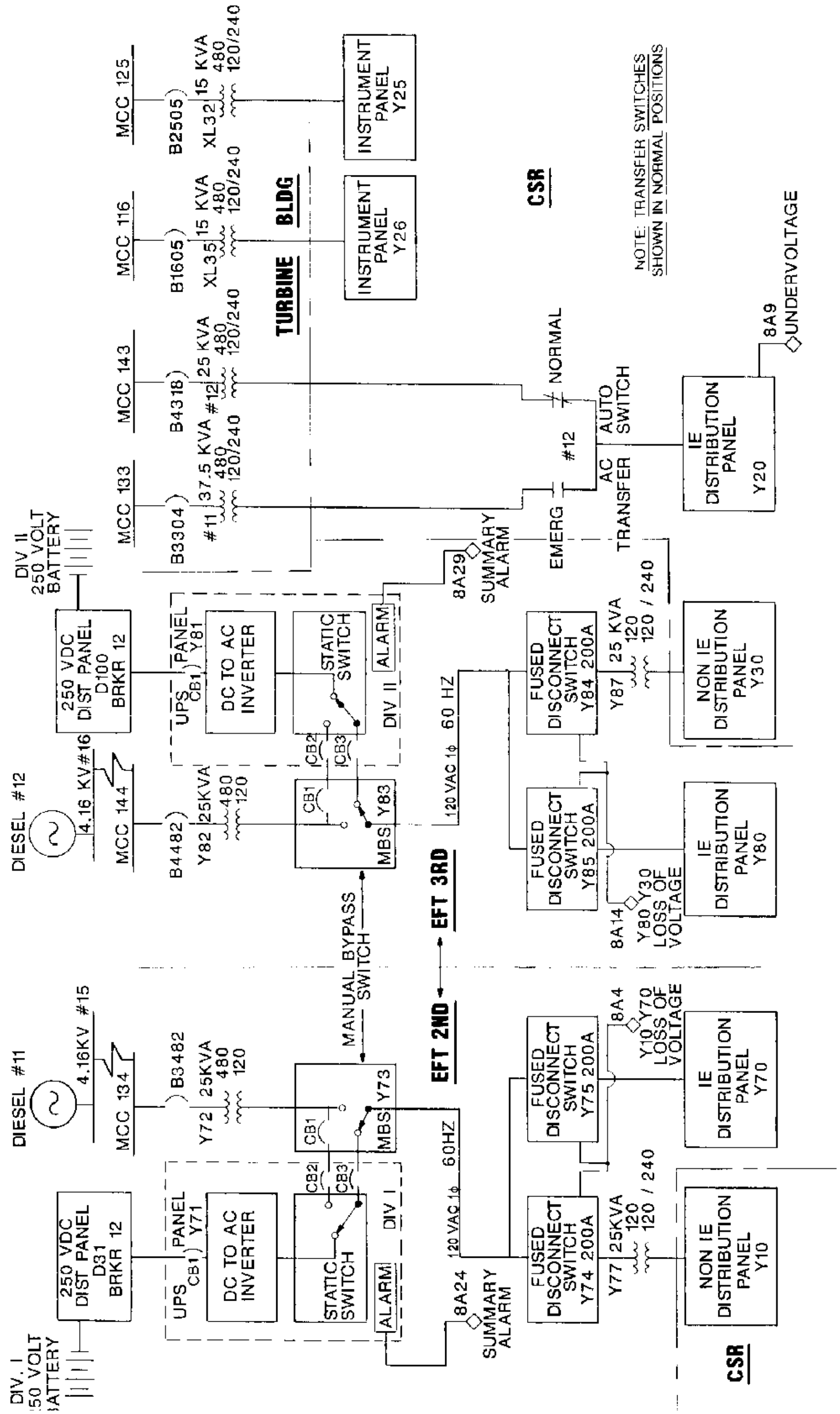


Figure 8.7-2 Y91 Uninterruptible AC Distribution System Single Line Diagram