CHAPTER 8

ELECTRIC POWER

8.1 INTRODUCTION

The electric power system provides sources of power for the unit auxiliary and service loads during normal operation of the plant, plant startup, and normal shutdown, and for the engineered safety feature (ESF) systems during normal, abnormal, and design basis accident (DBA) conditions. The electric power system consists of the offsite power system, the onsite ac power system, and the dc power system. The offsite power system includes the two power circuits provided from the Niagara Mohawk Power Corporation (NMPC) grid system to Nine Mile Point Nuclear Station - Unit 2 (Unit 2). This system provides a reliable source of power for operation of the onsite emergency ac power system under normal, abnormal, or DBA conditions and plant startup and shutdown, and serves as the backup source of power for the normal onsite ac power system.

The onsite ac power system distributes ac power to unit auxiliary and service loads and instrumentation and control system loads. This system is divided into the onsite emergency or safety-related ac power system which feeds safety-related loads, and the onsite normal or nonsafety-related ac power system which feeds all nonsafety-related loads.

The onsite emergency or safety-related ac power system includes the standby ac power system consisting of the standby diesel generators that feed the safety-related loads in case of loss of offsite power (LOOP). The onsite emergency ac power system is divided into three physically separate and electrically independent divisions, any two out of three divisions being capable of bringing the plant to safe shutdown in case of a loss-of-coolant accident (LOCA) or any other DBA. The onsite normal or nonsafety-related ac power system is normally energized from the unit generator. In case of loss of power from its normal source, the system is energized from offsite power sources.

The dc power system provides dc power to protective relaying control, instrumentation, and other dc loads. This system includes the Station batteries, battery chargers, and dc distribution system. The dc power system is divided into the emergency or safety-related dc power system which feeds safety-related dc loads, and the normal or nonsafety-related dc power system which feeds nonsafety-related dc loads. The emergency dc power system is divided into three physically separate and electrically independent divisions.

The electric power system is designed in accordance with General Design Criteria (GDC) of Appendix A, 10CFR50, regulatory guides

(RG), and applicable industry standards. This system provides adequate capacity, independence, redundancy, and testability. The safety classification of the electric power system is discussed in Section 3.2.2. All safety-related components are designed as Class 1E, QA Category I, and are located in seismic Category I structures.

8.1.1 Utility Grid

During the year 1981, NMPC owned and operated generating and transmission facilities that produced and delivered over 32 billion kWh of electrical energy, which is approximately one-fourth of the total New York Power Pool (NYPP) production. The NYPP and NMPC grid system are shown on Figure 8.1-1.

System transmission lines at the beginning of 1986 totaled 5,061 circuit miles, of which 586 miles were at 345 kV, 519 miles were at 230 kV, and 3,956 miles were at 115 kV. The transmission system interconnecting these facilities with those of other utilities and major load centers consists of single-circuit 345-kV lines and single- and double-circuit 230-kV and 115-kV lines. These lines and other lines of the interconnected utilities are arranged in conformance with reliability criteria of power pools (such as the NYPP) and reliability councils (such as the Northeast Power Coordinating Council) to ensure secure and reliable service for the customers.

A 345-kV transmission facility is being provided to connect the Unit 2 generator to the Scriba Substation. The NMPC grid system is described in Section 8.2.

8.1.2 Interconnections

The NMPC transmission system is closely integrated with those of other utilities, not only in the NYPP, but also with adjacent pools. As of January 1986, there were 32 transmission interconnections between the NYPP and neighboring pools and Canadian utilities.

System	Voltage	NMPC	Others	Total NYPP
Hydro Quebec	765 kV	0	1	1
	115 kV	0	2	2
Ontario Hydro	345 kV	0	2	2
	230 kV	1	3	4
	115 kV	1	0	1
PJM	500 kV	0	1	1
(PA, NJ, MD)	345 kV	0	6	6
	230 kV	1	2	3
	115 kV	1	4	5

System	Voltage	NMPC	Others	Total NYPP
New England	345 kV	1	1	2
	230 kV	1	0	1
	138 kV	0	1	1
	115 kV	2	1	3
Total		8	24	32

8.1.3 Offsite Power System

Offsite power is provided to permit functioning of the nuclear safety-related systems and for plant startup and shutdown. The offsite power system consists of two 115-kV circuits from two offsite power sources on separate rights of way. The two circuits are designed so that probability of simultaneous failure is minimal. The circuits terminate at the same switchyard and are connected to two separate reserve Station service transformers that feed separate and independent divisions of the onsite emergency power system. The onsite ac emergency power system is normally energized from offsite power sources. The offsite power sources also provide a backup source for the plant nonsafety-related auxiliary power distribution system. The nonsafety-related auxiliary power distribution system is normally energized from the unit generator through the normal Station service transformer. In case of loss of power from the normal Station service transformer, the system is energized from offsite power sources. Each offsite power circuit has adequate capacity and capability to supply power to the associated safety-related loads under all conditions of plant operation. The two offsite circuits are independent of each other, and this independence is maintained through the onsite power distribution system and connected loads under all conditions of plant operation, except during plant cold shutdown and refueling conditions when the 13.8-kV switchgears are momentarily paralleled for performing maintenance activities.

A separate 115-kV emergency/backup source to either 115-kV normal offsite power source is available and can be connected by aligning disconnect switches in the Scriba Station if either Scriba 345/115-kV transformer bank is out of service. The backup source has adequate capacity and capability to supply power to the associated loads. However, certain operating conditions must be met prior to removing either Scriba 345/115-kV bus from service, and use of line #2 will be administratively controlled. Operating restrictions include limiting the amount of Station load that could be connected to this line. The administrative controls include ensuring that the 115-kV transmission system is fully functional prior to using the #2 line. The operating restrictions and administrative controls shall be in accordance with Safety Evaluation 94-035.

The main generator is connected to the NMPC system at Scriba Substation via a 25/345-kV main transformer, the 345-kV switchyard, and a 345-kV transmission line.

The offsite power system is described in Section 8.2.

8.1.4 Onsite Ac Power System

The onsite ac power system consists of the emergency ac power system, the normal or nonsafety-related ac power system, and the standby ac power system. The emergency ac power system includes the plant auxiliary loads required for safe shutdown of the plant in case of a DBA and the associated power distribution system. The normal ac power system includes the plant auxiliary loads, which are required for normal operation of the plant and are not required for safe shutdown of the plant, and the associated power distribution system. The standby ac power system includes the standby diesel generators which energize the emergency power system in case of a LOOP.

The emergency ac power system is divided into three physically separate and electrically independent divisions designated Divisions I, II, and III. Any two out of these three divisions has the capacity and capability to safely shut down the reactor in case of a LOCA or any other DBA. The physical separation and electrical independence of the three divisions are maintained through the distribution system under all conditions of plant operation. The three divisions are color coded for easy identification.

The emergency ac power system is normally energized from offsite power sources via the tertiary winding of the reserve Station service transformers or auxiliary boiler transformer. In case of a LOOP, this system is energized by the standby diesel generators. The auxiliary boiler transformer can also be used to energize either of the two Class 1E Division I or II safety-related buses if required using appropriate operating procedures.

The normal or nonsafety-related ac power system normally receives power from the unit generator via the normal Station service transformer. In case of loss of power from the normal Station service transformer, the system receives power from the offsite sources via a 13.8-kV secondary winding of the reserve Station service transformers. This transfer from normal source to backup source is automatic. The emergency ac power system and normal ac power system are described in Section 8.3.1.

The standby ac power system consists of three standby diesel generators dedicated to the three divisions of the onsite emergency ac power system. The three diesel generators are independent of each other. Each diesel generator provides adequate capacity and capability to start the associated loads in the desired sequence and run them in case of LOOP. The standby ac power system is described in Section 8.3.1.

8.1.5 Dc Power System

The plant dc power system provides dc power to the plant protection, instrumentation, and control systems from Station batteries and battery chargers. The plant dc power system consists of the emergency or safety-related dc system and normal or nonsafety-related dc system. The emergency dc system is divided into three physically separate and electrically independent divisions corresponding to the three divisions of the onsite emergency ac power system. Each division feeds the dc loads associated with the corresponding division of the onsite power system. Each division has its own 125-V dc battery and primary and backup battery chargers and associated distribution systems. Each charger has 100-percent capacity. Each battery charger is capable of supplying the continuous load on the battery while recharging the battery from the designed minimum charge to the fully charged state in 24 hr. Each battery is capable of supplying the associated dc loads for 2 hr in case of loss of the ac power supply to the battery charger.

The normal or nonsafety-related dc system consists of the normal 125-V dc power system, the normal ±24-V dc power system, and the associated distribution system. The normal 125-V dc system provides dc power for normal switchgear, main transformer, reserve Station service transformers, auxiliary boiler transformer, and other nonsafety-related systems. The normal ± 24-V dc system provides dc power for the neutron monitoring system (NMS). There are three 125-V dc batteries and two 24-V dc batteries each connected to a separate bus. Each bus has a battery charger that is capable of supplying the continuous load on the battery while recharging the associated battery from the design minimum charge state to the fully charged state in 24 hr. Each battery is capable of supplying its connected load for 2 hr according to a precalculated load profile. The plant dc system is described in Section 8.3.2.

8.1.6 Uninterruptible Power Supply System

The plant uninterruptible power supply (UPS) system provides 120/208-V ac 1-phase or 3-phase power to the plant essential instrumentation and control loads and plant computer, for which a very high quality and highly-reliable power supply is required. The UPS system consists of the UPS units and the associated distribution system. Each UPS unit has a normal ac supply that normally feeds the UPS, a backup dc supply that feeds the UPS in case of loss of normal ac supply, and an alternate ac supply that will feed the UPS load, in the event of UPS inverter failure or during maintenance mode.

The plant UPS system is divided into the emergency or safety-related UPS system and normal or nonsafety-related UPS system. The emergency UPS system has four 25-kVA units; two units (one operating and one standby) are associated with Division I and the other two units (one operating and one standby) are associated with Division II of the onsite emergency ac power system. The emergency UPS units receive power from their respective divisional emergency buses. The normal UPS system has eight UPS units, three 80 kVa, two 75 kVA, two 10 kVA, and one 5 kVA. The 80-kVa, 75-kVA and 5-kVA units feed nonsafety-related instrumentation, control, and lighting loads.

The 10-kVA units supply the power for the reactor protection system (RPS) trip channels and other associated loads. The normal UPS units receive power from the onsite normal power distribution system. The plant UPS system is described in Section 8.3.1.

8.1.7 Design Criteria for Plant Auxiliary Power System

The offsite power system and the emergency onsite power system are designed to meet the requirements of applicable sections of the GDC outlined in Appendix A, 10CFR50, and regulatory guides as listed below. The methods of conformance to the GDC and regulatory guides are detailed in Sections 1.8, 3.1, 3.2, 3.10, 3.11, 8.2, and 8.3.

<u>General Design Criterion 2</u> Design bases for protection against natural phenomena.

<u>General Design Criterion 4</u> Environmental and missile design bases.

<u>General Design Criterion 5</u> Sharing of structures, systems, and components.

<u>General Design Criterion 17</u> Electric power systems.

<u>General Design Criterion 18</u> Inspection and testing of electric power systems.

<u>General Design Criterion 21</u> Protection system reliability and testability.

<u>Regulatory Guide 1.6</u> Independence between redundant standby (onsite) power sources and between their distribution systems.

<u>Regulatory Guide 1.9</u> Selection, design, and qualification of diesel generator units used as standby (onsite) electric power systems at nuclear power plants.

<u>Regulatory Guide 1.22</u> Periodic testing of protection system actuation functions.

<u>Regulatory Guide 1.29</u> Seismic design classification.

Regulatory Guide 1.30 Quality assurance requirements for the installation, inspection, and testing of instrumentation and electric equipment.

Regulatory Guide 1.32 Criteria for safety-related electric power systems for nuclear power plants.

Regulatory Guide 1.40 Qualification tests of continuous-duty motors installed inside the containment of water-cooled nuclear power plants.

Regulatory Guide 1.41 Preoperational testing of redundant onsite electric power systems to verify proper load group assignments.

Regulatory Guide 1.47 Bypassed and inoperable status indication for nuclear power plant safety systems.

Regulatory Guide 1.53 Application of the single-failure criterion to nuclear power plant protection systems.

Regulatory Guide 1.62 Manual initiation of protective actions.

Regulatory Guide 1.63 Electric penetration assemblies in containment structures for light-water-cooled nuclear power plants.

Regulatory Guide 1.73 Qualification tests of electric valve operators installed inside the containment of nuclear power plants.

Regulatory Guide 1.75 Physical independence of electric systems.

Regulatory Guide 1.81 Shared emergency and shutdown electric systems for multi-unit nuclear power plants.

Regulatory Guide 1.89 Qualification of Class 1E equipment for nuclear power plants.

Regulatory Guide 1.93 Availability of electric power sources.

Regulatory Guide 1.100 Seismic qualification of electric equipment for nuclear power plants.

Regulatory Guide 1.106 Thermal overload protection for electric motors on motor-operated valves (MOV).

Regulatory Guide 1.108 Periodic testing of diesel generators used as onsite power systems at nuclear power plants.

Regulatory Guide 1.118 Periodic testing of electric power and protection systems.

Regulatory Guide 1.128 Installation design and installation of large lead storage batteries for nuclear power plants.

Regulatory Guide 1.129 Maintenance, testing, and replacement of large lead storage batteries for nuclear power plants.

Regulatory Guide 1.131 Qualification tests of electric cables, field splices, and connections for light-water-cooled nuclear power plants.

8.2 OFFSITE POWER SYSTEM

The plant is provided with two offsite power sources from the Niagara Mohawk Power Corporation (NMPC) transmission network to the onsite ac power distribution system as required by GDC 17 of Appendix A, 10CFR50, and in a manner outlined in RG 1.32, Revision 2, dated February 1977, and IEEE-308-1974. The two offsite power sources have adequate physical and electrical separation to minimize the chance of their simultaneous failure. The physical and electrical separation is maintained throughout the switchyard, the reserve Station service transformers, the onsite distribution system, and associated loads under all conditions of plant operation, except during plant cold shutdown and refueling condition when the 13.8-kV switchgears are momentarily paralleled for performing maintenance activities. Each offsite source has adequate capacity and capability to supply power to the associated safety-related loads and other required loads during normal, accident, and emergency shutdown conditions. The plant onsite emergency power distribution system is normally energized from the offsite power sources via the reserve Station service transformers, whereas the normal onsite power distribution system is normally energized from the unit generator through the normal Station service transformer. The offsite power sources provide alternative sources for the normal onsite power system in case of loss of its normal source. The offsite power system is designed to be testable in accordance with GDC 18.

8.2.1 Description

8.2.1.1 Grid System

The NYPP and NMPC grid systems are shown on Figures 8.1-1 and 8.2-1. Unit 2 is connected to this grid system at Scriba Substation through a 345-kV transmission line. Scriba Substation is shown on Figure 8.2-1. The 345 lines connected to Scriba Substation include:

1. J. A. FitzPatrick to Scriba Substation (0.9 mile)

2. Unit 2 to Scriba Substation (0.5 mile)

3. Scriba Substation to Volney Substation (8.9 miles - 2 lines)

4. Nine Mile Point Nuclear Station - Unit 1 (Unit 1) to Scriba Substation (0.4 mile)

5. Independence - Scriba Substation (2.2 miles)

Figure 8.2-1a shows layout and right-of-way.

Figure 8.2-1b details the routing of the 115-kV circuits. Source A, designated as the Nine Mile-Scriba No. 5 circuit, exits the north side of the Scriba Station and is routed in a northerly direction to a termination structure in the Unit 2 switchyard. Source B, designated as the Nine Mile-Scriba No. 6 circuit, exits the south side of the Scriba Station and is routed in an easterly direction for approximately 1,000 ft and then northerly to a termination structure in the Unit 2 switchyard. A distance of approximately 500 ft is maintained between these circuits until they approach their respective termination structures in the Unit 2 switchyard.

A tower spacing drawing is not provided since the 115-kV circuit is not on a common right-of-way, as shown on Figure 8.2-1b.

The 115-kV Indeck - Lighthouse Hill line #2 is additionally available as an emergency/backup offsite power source for connection to either line #5 (source A) or line #6 (source B) through aligning 115-kV disconnect switches in the Scriba Station. Line #2 enters Scriba Station from the south and north sides and is connectable to either line #5 or line #6 through disconnect switches to the corresponding line breakers R50 or R60. The 115-kV line #2 is generally not routed through the owner-controlled access area (site boundary). Line #2 is located on the 345/115-kV north/south transmission line corridor and is designed and constructed to NMPC transmission line standards and supported on tubular steel poles, H-frame wood poles or wood angle structures as shown on Figures 8.2-6d through 8.2-6u.

A transmission planning analysis supports the adequacy of the Indeck - Lighthouse Hill #2, 115-kV line as a backup power source for Unit 2 offsite normal power sources during normal plant operation and accident condition. However, certain operating conditions must be met prior to removing either Scriba 345/115-kV bus from service and use of line #2 will be administratively controlled. Operating restrictions include limiting the amount of Station load that could be connected to this line. The administrative controls include ensuring that the 115-kV transmission system is fully functional prior to using the no. 2 line. The operating restrictions and administrative controls shall be in accordance with Safety Evaluation 94-035.

The 345-kV buses have adequate capacity to carry their loads under any postulated switching sequence, and are designed to withstand a maximum fault on any section with Unit 2 operating. The associated 345-kV circuit breakers are arranged in a breaker-and-a-half configuration. This provides for the isolation of any faulted line without affecting any other line. The 345-kV breakers are rated for nominal 345 kV, with a maximum voltage of 372 kV and 1,300 kV BIL. The continuous current rating is 3,000 amp; the interrupting capability at nominal system voltage is 50,000 amp. All 345-kV breakers are equipped with dual trip coils for redundant circuit protection. All protective relay schemes are redundant; each relay scheme is supplied with separate current input and operates from a separate battery, and is connected to separate trip coils of the circuit breaker. Figure 8.2-1c provides a one-line diagram of the dc power supplies which feed the circuit breaker dual trip coils and redundant relaying. Indicated also on this drawing is the source of ac power to the power supplies. The 345-kV lines meet the National Electric Safety Code heavy loading conditions, and ANSI C2-1981 requirements. The 345-kV transmission towers are tubular steel towers as shown on Figures 8.2-2 and 8.2-3.

The 115-kV lines connected to Scriba Substation include two 115-kV lines to Unit 2 from separate 345/115-kV transformers. The 115-kV circuit breakers are rated for 115-kV nominal voltage with maximum voltage of 121 kV, and 550 kV BIL. The continuous current rating is 2,000 amp and the interrupting capability at the nominal system voltage is 40,000 amp. The 115-kV lines are routed through the owner-controlled areas. They meet the National Electric Safety Code heavy loading conditions and ANSI C2-1981 guidelines. The 115-kV lines are supported on tubular steel poles, H-frame wood poles, or wood angle structures, as shown on Figures 8.2-4 through 8.2-6c.

The maintenance and surveillance procedures provided for the relays, circuit breakers, and power supplies are described in established Station procedures. These procedures provide for the following:

1. Installation Tests

    a. Breaker timing

    b. Relay inspection

    c. Control circuit verification

    d. Communication channel and equipment test

    e. Circuit breaker tests

    f. Tests under load current

    g. Current transformers and associated circuitry

    h. Voltage transformers and associated circuitry

2. Periodic Maintenance

    a. Overhaul

    b. Inspection

    c. Mechanism and linkage adjustments

    d. Interruption checks

e. Primary contact checks

f. Arcing contact checks

g. Dielectric checks

h. Cubicle checks

The intervals for these tests are conducted to maintain reliable service.

Scriba Station equipment which is monitored in the Unit 2 control room (P852) includes:

1. 345-kV circuit breaker and disconnect switch status of the following is provided via indicating lights, red (closed) and green (open):

   a. 345-kV Scriba circuit breaker (R230).

   b. 345-kV Scriba circuit breaker (R925).

   c. 345-kV transmission line disconnect switch at Scriba (SW233).

2. Voltmeter and voltmeter selector switch for each of the following:

   a. 345-kV Scriba Station north bus which is supplied by breaker (R230).

   b. 345-kV Scriba Station south bus which is supplied by breaker (R925).

   c. 345-kV Scriba Unit 2 transmission line.

Scriba Station equipment which is controlled in the Unit 2 control room includes:

1. 345-kV Scriba circuit breaker (R230) control switch.

2. 345-kV Scriba circuit breaker (R925) control switch.

3. 345-kV transmission line motor-operated disconnect switch (SW233).

In the Unit 2 control room there is also a synchroscope with separate synchronizing switches for each breaker (R230 and R925) which is used by the Operator to interconnect with Unit 2 and the grid.

8.2.1.2 Main Generator

The main generator is a hydrogen-cooled synchronous generator, direct-driven by a 15-stage tandem compound steam turbine.

The generator stator is water cooled. The main generator excitation is provided by an alternator-exciter, and a power rectifier assembly. Main generator and exciter ratings are given in Section 10.2.2.

The main generator is connected to the main generator transformer bank through forced-air-cooled, isolated-phase bus ducts that are tapped off to feed the normal Station service transformer via a separate isolated-phase bus duct. The tap-off isolated-phase bus ducts are self-cooled due to the reduced current-carrying requirement of these sections. The main generator neutral is grounded through a neutral grounding transformer.

The generator stator winding is protected against internal faults by high-speed differential relays. Stator ground fault protection is provided by a neutral ground overvoltage relay in the high impedance grounding circuit. An instantaneous overvoltage relay is also furnished in the circuit to provide ground fault protection during turbine generator warmup. The generator rotor is protected against excessive heating due to asynchronous operation by loss of field relay. Protection from excessive heating due to stator unbalance currents is provided by negative sequence current relays. The steam turbine is protected against excessive heating caused by motoring generator during periods of low- or zero-steam flow by antimotoring devices. The unit overall differential relays provide a secondary level of protection for the main generator, isolated-phase bus, the main generator step-up transformer, and the normal Station service transformer.

8.2.1.3 345-kV Switchyard and Generator Step-up Transformer

The arrangement of the 345-kV switchyard is shown on Figure 8.2-7. It is bounded on the north by the turbine building, on the east by the 115-kV switchyard for Unit 2, and on the west by Unit 1. The outgoing 345-kV line extends to the south and terminates at Scriba Substation. The 345-kV switchyard consists of the 345-kV generator step-up transformers (2MTX-XM1A, 1B, 1C, 1D), the 345-kV bus bars, 345-kV disconnect switch (2YXC-MDS1), the take-off tower, and the associated instrumentation, control, and protection systems.

The generator step-up transformer steps up the generator voltage of 25 kV to 345 kV for interconnection to the NMPC grid at Scriba Substation via a 345-kV transmission line. The generator step-up transformer consists of four shell-type, oil-immersed, single-phase units. Three of these four single-phase units are connected to form a three-phase 25-kV delta on the low voltage side, and a three-phase, 363.68-kV grounded wye on the high voltage side. The fourth unit is used as a spare. Each single-phase unit is rated for 475 MVA, oil Directed Air Forced oil air

(ODAF) cooled, 209.971/25 kV, 60 Hz. The transformers have a tap changer suitable for operation from ground level when the transformers are de-energized. Each transformer has three fan banks, each bank having three fans, and one pump for forced circulation of air and oil. The fans and the pumps are started automatically in a given sequence, depending on the oil temperature. Each transformer is provided with the following accessory equipment:

1. Resistance temperature detectors for use with remote instrumentation.

2. Sudden pressure relay panel.

3. Cover-mounted pressure relief vent with target visible from the ground.

4. Oil level indicator.

5. An oil flow indicator for each pump.

6. Top oil temperature indicator.

7. Upper and lower filter connection.

8. Drain valve.

9. Gas analyzer.

10. Winding temperature indicator.

11. Partial discharge monitor.

12. Bushing monitor.

The 345-kV bus bars are made of rigid, extruded aluminum tube rated for 3,000 amps continuous current. The phase buses are spaced 16 ft centerline to centerline. The minimum clearance of any phase bus from any grounded components is 8 ft 8 in. The minimum clearance of the phase buses from the ground is 25 ft.

The 345-kV disconnect switch is vertical break, group operated with interlocked grounding switches. The disconnect switch is rated for 3,000 amps continuous current and 1,300-kV BIL. The motor operator operates at 125 V dc.

8.2.1.4 115-kV Switchyard

Two 115-kV lines are provided from two offsite sources to serve as preferred power sources for the emergency onsite power distribution system as shown on Figure 8.2-1. One 115-kV line provided from the 345/115-kV Scriba Substation, designated Source A, is approximately 0.5 mi long routed overhead on towers. The other line provided from the 345/115-kV Scriba Substation, designated Source B, is about 0.9 mi long and routed overhead on towers. The transmission towers used for the 115-kV lines are shown on Figures 8.2-4 through 8.2-6c. Both lines terminate at the Unit 2 115-kV switchyard.

Each 115-kV line from the Scriba Substation originates from a separate 345-kV/115-kV transformer as shown on Figure 8.2-1. Each transformer is designed to supply 220 MVA of power. Redundant dc power required for protection and control of these two transformers and the 345-kV circuit breakers in the Scriba Substation is supplied from two separate batteries located in separate control houses in the Scriba Substation.

A separate emergency/backup source to either normal offsite power source is available if either Scriba 345/115-kV transformer bank is out of service. The 115-kV line #2 backup source has adequate capacity and capability to supply power to start and operate the emergency loads required for safe shutdown of the plant while supplying other connected loads. However, certain operating conditions must be met prior to removing either Scriba 345/115-kV bus from service, and use of line #2 will be administratively controlled. Operating restrictions include limiting the amount of station load that could be connected to this line. The administrative controls include ensuring that the 115-kV transmission system is fully functional prior to using the #2 line. The operating restrictions and administrative controls shall be in accordance with Safety Evaluation 94-035.

The arrangement of the 115-kV switchyard is shown on Figure 8.2-8. The 115-kV switchyard is bounded on the north by the normal switchgear building and on the east by the control building and the diesel generator building. The incoming 115-kV lines enter the switchyard on the south side and terminate on two 115-kV buses. The line from Scriba Substation Source A terminates on the 115-kV west bus, which connects the source to the reserve Station service transformer 2RTX-XSR1A via a sectionalizing bus with a motor-operated disconnect switch 2YUL-MDS1, and motor-operated circuit switcher 2YUC-MDS3. The line from Scriba Substation Source B terminates on the 115-kV east bus, which connects the reserve Station service transformer 2RTX-XSR1B via a sectionalizing bus with motor-operated disconnect switch 2YUL-MDS2, and motor-operated circuit switcher 2YUC-MDS4.

All these buses are 4-in diameter tubular aluminum. Another 5-in tubular aluminum bus, called the center bus, cross connects the east bus and the west bus via two motor-operated disconnect switches, 2YUC-MDS10 and 2YUC-MDS20. A 4-in tubular aluminum bus taps off the center bus and connects the auxiliary boiler transformer 2ABS-X1 via motor-operated circuit switcher 2YUC-MDS5. The auxiliary boiler transformer is normally energized from Source A. The clearance between the phase buses is 10 ft; the clearance from the ground is 15 ft.

Motor-operated disconnect switches 2YUL-MDS1, 2YUL-MDS2, 2YUL-MDS10, and 2YUL-MDS20 are used to disconnect the offsite power sources from the switchyard buses. These are three-pole, gang-operated, outdoor air switches with motor operators. These disconnect switches are rated for 115 kV with maximum voltage of 121 kV and 550 kV BIL. The continuous current rating is 1,200 amps at 30°C.

The motor operators operate at 125 V dc with accelerating current of 30 amps and maximum operating time of 1.5 sec. The motor operators operate through a maximum of 270 deg to open the disconnecting switches.

Circuit switchers 2YUC-MDS3, 2YUC-MDS4, and 2YUC-MDS5 are used to disconnect the reserve Station service and auxiliary boiler transformers from their respective 115-kV power sources. Each motor-operated circuit switcher consists of an interrupting contact in series with a disconnect switch. Both the interrupting contact and the disconnect switch are opened by automatic trip signal. The motor-operated disconnect switch is also opened and closed by control switches on the electrical control board in the main control room. The circuit switchers are three-pole, vertical break style, with a type CS-1A motor operator. The circuit switchers are rated for 115-kV nominal voltage with maximum voltage of 121 kV and 550 kV BIL. The continuous current rating is 1,200 amps; the symmetrical interrupting capability at normal system voltage is 3,000 amps. The motor operators are rated for 125 V dc with accelerating current of 30 amps.

The circuit switchers or the disconnect switches may see maximum fault current of 6.1 kA for 2 to 3 cycles (the time required to clear the fault by the Scriba Substation circuit breakers). The circuit switchers are rated for 40 kA for 3 sec. The disconnect switches are rated for 38 kA for 4 sec.

The circuit switchers are provided with a time delay which prevents opening of the circuit switchers until the fault has been cleared.

The two reserve Station service transformers and the auxiliary boiler transformer are located approximately 13 ft south of the normal switchgear building wall. The reserve and auxiliary boiler transformers are arranged side by side, with the auxiliary boiler transformer positioned between the two reserve Station service transformers. Fire walls are provided between the transformers, which are also protected by a deluge fire protection system. Reserve Station service transformer 2RTX-XSR1A, energized from offsite Power Source A, feeds Division I of the onsite emergency power distribution system through its 4.16-kV tertiary winding; its 13.8-kV secondary winding serves as a backup source for the plant normal power distribution system, which normally receives power from the unit generator via normal Station service transformer 2STX-XNS1 located in the 345-kV switchyard. Reserve Station service transformer 2RTX-XSR1B, energized from the offsite Power Source B, feeds Division II of the onsite emergency distribution system through its 4.16-kV tertiary winding; its 13.8-kV secondary winding serves as backup source for the plant nonsafety-related power distribution system. The auxiliary boiler transformer, normally energized from the offsite Source A, feeds the auxiliary boiler and associated loads through its 13.8-kV secondary winding; its 4.16-kV tertiary winding provides a backup source for Divisions I or II of the emergency power distribution system. The 4.16-kV tertiary windings of reserve Station service transformers 2RTX-XSR1A and 2RTX-XSR1B, and auxiliary boiler transformer 2ABS-X1, are connected to 4.16-kV switchgear 2NNS-SWG016, 2NNS-SWG017, and 2NNS-SWG018, respectively, through separate nonsegregated phase bus ducts. Separate cables, routed in separate nonsafety-related raceways, connect these switchgear to their respective Class 1E buses. The control ductbank between Scriba Station and Unit 2 consists of two ductbanks that are located in the same trench and separated by 2 ft of concrete. Each ductbank, including manholes, has control circuits associated with one alternate of the control scheme as shown on Figure 8.2-8. The control cables associated with alternates 1 and 2 are routed in separate ducts in the switchyard and are terminated in two sections of a common panel. The sections are separated by a barrier. The alternate (alternates 1 and 2) protection circuits for the two sources (A and B) are routed to the Scriba Substation via separate ducts. The alarm and position indication circuits for the two offsite sources are routed to the control room, partially in separate nonsafety-related raceways and partially in common nonsafety-related raceways. The two 345-kV/115-kV transformers located in the Scriba Substation are in diagonally opposite corners of the substation and approximately 400 ft apart. Bus sectionalizing disconnect switch 2YUC-MDS20 is normally open, maintaining separation between the two offsite sources.

Under normal operating conditions, reserve Station service transformer 2RTX-XSR1A and auxiliary boiler transformer 2ABS-X1 are energized from the 115-kV Scriba Substation Source A; reserve Station service transformer 2RTX-XSR1B is energized from the 115-kV Scriba Substation Source B; and normal Station service transformer 2STX-XNS1 is energized from the main generator. The 115-kV disconnect switches 2YUL-MDS1, 2YUL-MDS2, and 2YUC-MDS10 are closed, and disconnect switch 2YUC-MDS20 is open. Circuit switchers 2YUC-MDS3, 2YUC-MDS5, and 2YUC-MDS4 are closed.

In case of the loss of power from Scriba Substation Source A, transformers 2RTX-XSR1A and 2ABS-X1 can be energized from the Scriba Substation Source B by operating the appropriate 115-kV disconnect switches.

In case of the loss of power from Scriba Substation Source B, transformer 2RTX-XSR1B can be powered from Scriba Substation Source A by operating the appropriate 115-kV disconnect switches.

In case of loss of power to normal Station service transformer 2STX-XNS1 from the main generator, its associated normal switchgear buses are automatically transferred to the reserve transformer sources. In case one of the two reserve transformers is out of service for maintenance and, concurrently, power to the 2STX-XNS1 is lost from the main generator, then switchgear buses are also transferred to the available reserve transformer. The transfer scheme is described in Section 8.3.1.

The 115-kV circuit switchers and disconnect switches are designed to operate as described below. The opening or closing of the circuit switchers or the disconnect switches is controlled by actual permissive interlocks.

<u>115-kV Circuit Switcher 2YUC-MDS3</u> closes when there is no electrical fault on reserve Station service transformer 2RTX-XSR1A (i.e., lockout relays 86-2SPRX01 and 86-2SPRZ01 are not tripped) and the control switch for 2YUC-MDS3 on the main control panel 2CEC*PNL852 is in the CLOSE position. Circuit switcher 2YUC-MDS3 opens when an electrical fault occurs in transformer 2RTX-XSR1A, or if the control switch is placed in the OPEN position.

<u>115-kV Circuit Switcher 2YUC-MDS4</u> closes when there is no electrical fault on reserve Station service transformer 2RTX-XSR1B (i.e., lockout relays 86-2SPRY01 and 86-2SPRZ08 are not tripped) and the control switch for 2YUC-MDS4 on main control panel 2CEC*PNL852 is in the CLOSE position. Circuit switcher 2YUC-MDS4 opens when an electrical fault occurs on transformer 2RTX-XSR1B, or the control switch on the main control panel is placed in the OPEN position.

<u>115-kV Circuit Switcher 2YUC-MDS5</u> closes when there is no electrical fault on auxiliary boiler transformer 2ABS-X1 (i.e., lockout relays 86-2SPRX11 and 86-2SPRY11 are not tripped) and the control switch for 2YUC-MDS5 on main control panel 2CEC*PNL852 is in the CLOSE position. Circuit switcher 2YUC-MDS5 opens when any electrical fault occurs in transformer 2ABS-X1 or the control switch on the main control panel is placed in the OPEN position.

<u>115-kV Disconnect Switch 2YUL-MDS1</u> can be opened or closed using the control switch for 2YUL-MDS1 on main control panel 2CEC*PNL852 when any of the following conditions exist:

1. Circuit switcher 2YUC-MDS3 and disconnect switch 2YUC-MDS10 are open.

2. Circuit switchers 2YUC-MDS3 and 2YUC-MDS5 and disconnect switch 2YUC-MDS20 are open.

3. Circuit switchers 2YUC-MDS3, 2YUC-MDS5, and 2YUC-MDS4 and disconnect switch 2YUL-MDS2 are open.

115-kV Disconnect Switch 2YUL-MDS2 can be opened or closed using the control switch on the main control panel 2CEC*PNL852 when any of the following conditions are met:

1. Circuit switcher 2YUC-MDS4 and disconnect switch 2YUC-MDS20 are open.

2. Circuit switchers 2YUC-MDS4 and 2YUC-MDS5 and disconnect switch 2YUC-MDS10 are open.

3. Circuit switchers 2YUC-MDS4, 2YUC-MDS5, and 2YUC-MDS3, and disconnect switch 2YUL-MDS1 are open.

115-kV Disconnect Switch 2YUC-MDS10 can be opened or closed using the control switch on main control panel 2CEC*PNL852 when any of the following conditions exist:

1. Circuit switcher 2YUC-MDS3 and disconnect switch 2YUL-MDS1 are open.

2. Circuit switcher 2YUC-MDS5 and disconnect switch 2YUC-MDS20 are open.
3. Circuit switchers 2YUC-MDS5 and 2YUC-MDS4 and disconnect switch 2YUL-MDS2 are open.

115-kV Disconnect Switch 2YUC-MDS20 can be opened or closed using the 2YUC-MDS20 control switch on the main control panel when any of the following conditions exist:

1. Circuit switcher 2YUC-MDS4 and disconnect switch 2YUL-MDS2 are open.

2. Circuit switcher 2YUC-MDS5 and disconnect switch 2YUC-MDS10 are open.

3. Circuit switchers 2YUC-MDS5 and 2YUC-MDS3 and disconnect switch 2YUL-MDS1 are opened.

Reserve Station Service Transformers

The reserve Station service transformers step down the 115-kV offsite power to 13.8 kV and 4.16 kV for the plant normal and emergency power distribution systems, respectively. These are core-type, oil-immersed, three-winding transformers rated for 42/56/70 MVA OA/FA/FOA cooled, 115 13.8/4.16 kV, three phase, 60 Hz, with a 115-kV wye-connected (grounded) primary winding, 4.16-kV delta-connected tertiary winding, and a 13.8-kV wye-connected (grounded) secondary winding.

The criteria for sizing the reserve Station service transformers are as follows:

1. Each transformer is capable of supplying its maximum connected load during normal and abnormal plant conditions.

2. Each transformer is capable of carrying the plant at 100-percent power. This condition arises in case the normal Station service transformer is unavailable due to unit trip while one of the two reserve transformers is out of service.

3. Tertiary winding of each transformer is capable of carrying the greater of the loads on 4.16-kV emergency buses 2ENS*SWG101 (Division I) and 2ENS*SWG102 (Division III) plus the load on 4.16-kV stub bus 2NNS-SWG014 or 4.16-kV emergency buses 2ENS*SWG103 (Division II) and 2ENS*SWG102 (Division III) plus the load on 4.16-kV stub bus 2NNS-SWG015.

4. One transformer is capable of carrying the auxiliary boiler loads on the 13.8-kV winding in addition to its 4.16-kV loads stated in Item 3 above. This, however, is not a limiting case since the load under this condition is much less than that under conditions stated in Item 1 above.

The 115-kV primary wye windings of each transformer are solidly grounded. The 13.8-kV wye-connected secondary is resistance grounded. The 4.16-kV tertiary delta winding is also resistance grounded at 4.16-kV switchgear 2NNS-SWG016 and 2NNS-SWG017. The transformers have automatic load tap changing (LTC) mechanisms. The LTC mechanism is set to automatically maintain 13.8 kV at the nonsafety-related switchgear buses under varying offsite voltage and transformer secondary loading conditions. This also ensures satisfactory voltage conditions at the 4.16-kV emergency buses. The 115-kV offsite system voltage may fluctuate between 120.75 kV (105 percent) and 109.25 kV (95 percent). Manual operation or override of the automatic LTC mechanism is also controlled from the main control room. Each transformer also has a no-load tap changer on the secondary winding. Each transformer has two fan banks, each bank having seven fans for forced air cooling and two pumps for forced circulation of the insulating oil. The fans and pumps are started automatically in a given sequence depending on the oil temperature.

Each transformer is also provided with the following accessory equipment:

1. Hot spot resistance temperature detector for use with remote instrumentation.

2. Two fault pressure relays.

3. Cover-mounted pressure relief vents with target visible from the ground.

4. Oil level gauge.

5. Top oil thermometer.

6. Winding temperature relay.

7. Fittings for vacuum filling.

8. Upper and lower filter connection.

9. Drain valve.

10. Oil sampling valve.

11. Pressure test and gas sampling valve.

Auxiliary Boiler Transformer

The auxiliary boiler transformer, which steps down 115-kV offsite power to 13.8 kV and 4.16 kV for the auxiliary electric boilers and the plant emergency power distribution system, respectively, is a core-type, oil-immersed, three-winding transformer rated for 16.6/22.08/27.56 MVA, OA/FA/FA cooled, 115-13.8/4.16 kV, three phase, 60 Hz, with a 115-kV wye-connected (grounded) primary winding, 13.8-kV wye-connected (grounded) secondary winding, and 4.16-kV delta-connected tertiary winding.

The auxiliary boiler transformer is sized to supply the two electric boilers through its 13.8-kV secondary winding. The 4.16-kV tertiary winding is designed to carry the loads of either Division I or II of the emergency power distribution system. The 115-kV primary wye winding and the 13.8-kV wye-connected secondary winding are solidly grounded; the 4.16-kV delta-connected tertiary winding is resistance grounded at switchgear 2NNS-SWG018.

In case of loss of power from the auxiliary boiler transformer, the 13.8-kV auxiliary boiler bus can be energized from reserve Station service transformer 2RTX-XSR1A. When the auxiliary boiler bus is fed from the reserve Station service transformer 2RTX-XSR1A, the reserve Station service transformer secondary grounding resistor is shunted by a switch in order to have solidly grounded neutral that matches the 13.8-kV auxiliary boiler bus. Under such a condition, the normal 13.8-kV bus cannot be connected to the reserve Station service transformer 2RTX-XSR1A since the normal 13.8-kV system is resistance grounded.

The auxiliary boiler transformer has two fan banks for forced air cooling; one bank contains six fans and the other, five. The fans are automatically started in a given sequence depending on the oil temperature. The transformer has a no-load tap changing mechanism. The transformer also has the following accessory equipment:

1. Hot spot resistance temperature detector for use with remote instrumentation.

2. Two fault pressure relays.

3. Winding temperature relay.

4. Cover-mounted pressure relief vents with target visible from the ground.

5. Lightning arrestors.

6. Oil level gauge.

7. Top oil thermometer.

8. Pressure-vacuum bleeder.

9. Pressure-vacuum gauge.

10. Drain valve.

11. Oil sampling valve.

12. Pressure test and gas sampling valve.

Normal Station Service Transformer

The normal Station service transformer steps down the 25-kV output of the unit generator to 13.8 kV for the plant normal power distribution system. This is a core-type, oil-immersed, three-winding (split secondary) transformer rated for FOA cooled 100 MVA, 24.9-13.8 kV, three phase, 60 Hz, and 55°C temperature rise. The primary winding is delta-connected; the secondary consists of two wye-connected windings each rated for 50 MVA. The primary winding and each secondary winding is capable of being continuously loaded at 112 percent of its 55°C rise MVA rating without exceeding an average temperature rise of 65°C.

The normal Station service transformer is sized to carry all the plant nonsafety-related loads through the two 13.8-kV nonsafety-related switchgear buses 2NPS-SWG001 and 2NPS-SWG003. The transformer secondary consists of two windings connected to the preceding two buses. Each secondary winding is resistance grounded.

The transformer has four coolers, each consisting of an oil pump and three cooling fans. Two coolers together constitute a cooling group. One cooler group operates continuously, and the second cooler group is energized by automatic temperature control. The transformer has an automatic LTC on the primary winding. The LTC is set to automatically maintain the secondary voltage close to 13.8 kV under maximum loading condition, while limiting the voltage of the lightly loaded secondary winding to no more than 110 percent of the rated voltage during all main generator voltage variations. Manual operation of the LTC and manual override of its automatic controls are also provided at the transformer and in the main control room.

The transformer also has the following accessory equipment:

1. Three hot spot resistance temperature detectors for use with remote instrumentation.

2. Two fault pressure relays.

3. Cover-mounted pressure relief vent with target visible from ground.

4. Oil level gauge.

5. Top oil thermometer.

6. Upper and lower filter connection.

7. Fittings for vacuum filling.

8. Drain valves.

9. Oil sampling valves.

10. Pressure test and gas sampling valve.

11. Winding temperature relay.

8.2.1.5 Protection System

Transformer Protection

Each transformer has the following primary and backup protective devices so that any single failure in the protection system will not prevent a protective function from occurring:

1. Generator step-up transformers:

   a. Differential protection (Differential relay 87-2SPMX01).

   b. Backup protection for phase-to-ground faults in the high-voltage windings and leads (51N-2SPMZ01).

   c. Protection against sudden rise in pressure within the transformer due to internal faults (sudden pressure relay panel 2SPM-XM1C-SPR, 2SPM-XM1b-SPR, 2SPM-XM1C-SPR or 2SPM-XM1D-SPR).

d. The transformer protection lockout relays 86-1- and 86-2-2SPUZ01 trip when any one of the following conditions exists:

   (1) Device 51N-2SPMZ01 is energized due to main transformer bank inverse time ground overcurrent.

e. The unit protection lockout relays 86-1- and 86-2-2SPUX01 operate when differential relay 87-2SPMX01 is energized due to main transformer differential.

2. Reserve Station service transformers:

   a. Differential protection and open phase detection (differential and open phase relays 46/87-2SPRX02 and 46/87-2SPRY02).

   b. Backup protection for phase-to-ground fault on 115-kV winding (directional overcurrent relays 67N-2SPRZ02 and 67N-2SPRZ09).

   c. Backup protection for phase-to-phase fault on 115-, 4.16-, and 13.8-kV winding, leads, and buses (instantaneous/time overcurrent relays 50/51-2SPRZ02 and 50/51-2SPRZ09).

   d. Backup protection for phase-to-ground faults in the 13.8-kV winding, leads, and buses (time overcurrent relays 51N-2SPRZ05 and 51N-2SPRZ11).

   e. Backup protection for phase-to-ground faults in the 4.16-kV winding, leads, and buses (time overcurrent relay 51N-2SPRZ07 and 51N-2SPRZ13).

   f. Primary protection for phase-to-ground fault in the 13.8-kV winding and leads when the reserve Station service transformers are parallel with the normal Station service transformer through the 13.8-kV buses (directional time overcurrent relays 67N1-2NPSN01, 67N2-2NPSN01, 67N3-2NPSN14, 67N4-2NPSN14, 67N7-2NPSN01 and 67N8-2NPSN14).

   g. Primary protection for phase-to-ground faults in the 13.8-kV winding and leads when any of the reserve Station service transformers are feeding both the 13.8-kV buses (time overcurrent relays 51N-2SPRX05 and 51N-2SPRY05).

   h. Backup protection for phase-to-ground faults in the 13.8-kV winding of 2RTX-XSR1A leads and the

13.8-kV switchgear 2NPS-SWG002 when 2RTX-XSR1A is feeding 2NPS-SWG002 (51N-2SPRZ04).

i. Protection against sudden pressure rise in the transformer due to any internal fault (fault pressure relays 63X-2SPRY10, 63Y-2SPRY10, 63X-2SPRX10, and 63Y-2SPRX10).

j. Protection against any sudden pressure rise in the LTC due to any internal fault (fault pressure relays 63LX-2SPRY17, 63LX-2SPRX17, 63LY-2SPRY17, and 63LY-2SPRX17).

k. Primary protection for phase-to-ground faults on 4.16-kV winding/nonsegregated phase bus duct (instantaneous overcurrent relays 50G-2SPRX19 and 50G-2SPRY19).

l. Primary protection for phase-to-phase faults on 4.16-kV grounding transformer/leads (instantaneous/time overcurrent relays 50/51-2SPRX20 and 50/51-2SPRY20).

m. Backup protection for phase-to-phase faults on 4.16-kV windings, leads, and buses (time overcurrent relays 51-2SPRX18 and 51-2SPRY18).

n. Reserve Station service transformer 2RTX-XSR1A primary protection lockout relay 86-2SPRX01 or backup protection lockout relay 86-2SPRZ01 operates to trip and lock out 115-kV circuit switcher 2YUC-MDS3; 13.8-kV ACBs 1-1, 3-16, and 2-1; 4.16-kV ACB 16-2; and the transformer cooling system in case any of the primary or backup protective devices are energized. Similarly, reserve Station service transformer 2RTX-XSR1B, primary or backup protection lockout relays 86-2SPRY01 or 86-2SPRZ08, operate to trip and lock out 115-kV circuit switcher 2YUC-MDS4, 13.8-kV ACB 3-1 and ACB 1-16, 4.16-kV ACB 17-2, and the transformer cooling system in case any of the primary or backup protective devices are energized.

3. Auxiliary boiler transformer protection:

a. Differential protection and open phase detection (differential and open phase relay 46/87-2SPRY12).

b. Backup protection for phase-to-phase faults on 115-, 4.16-, and 13.8-kV windings and leads, and 13.8-kV bus (instantaneous/time overcurrent relays 50/51-2SPRX12).

c. Backup protection for phase-to-ground faults in the 115-kV winding (directional overcurrent relay 67N-2SPRX12).

d. Backup protection for phase-to-ground faults on 13.8-kV winding, leads, and buses (time overcurrent relay 51N-2SPRX14).

e. Backup protection for phase-to-ground faults on 4.16-kV winding, leads, and buses (time overcurrent relay 51N-2SPRX15).

f. Protection against any sudden rise in pressure within the transformer tank due to any internal fault (fault pressure relays 63X-2SPRZ10, 63Y-2SPRZ10).

g. Primary protection for phase-to-ground faults on 4.16-kV winding/nonsegregated phase bus duct (instantaneous overcurrent relay 50G-2SPRZ19).

h. Primary protection for phase-to-phase faults on 4.16-kV grounding transformer/leads

(instantaneous/time overcurrent relay 50/51-2SPRZ20).

i. Backup protection for phase-to-phase faults on 4.16-kV winding, leads, and buses (time overcurrent relay 51-2SPRZ18).

j. Primary protection lockout relay 86-2SPRY11 or backup protection lockout relay 86-2SPRX11 operate to trip and lock out 115-kV circuit switcher 2YUC-MDS5, 13.8-kV ACB 2-5, 4.16-kV ACB 18-2, and the transformer cooling system in case any of the primary or backup protective devices are energized.

4. Normal Station service transformer protection:

a. Differential protection (differential relay 87-2SPSX01).

b. Backup protection for phase-to-phase faults on 25- and 13.8-kV windings, leads, and buses (instantaneous/time overcurrent relays 50/51-2SPSZ01).

c. Backup protection for phase-to-ground faults on 13.8-kV winding, leads, and buses (time overcurrent relays 51N-2SPSZ02 and 51N-2SPSZ03).

d. Protection for phase-to-ground faults in the 13.8-kV windings and leads when the normal Station service transformer is the only source feeding 13.8-kV buses.

e. Protection for phase-to-ground faults on the 13.8-kV windings and leads when the normal Station service transformer and either or both reserve Station service transformers are paralleled through either of the 13.8-kV buses (directional overcurrent relays 67N5-2NPSN12, 51N-2NPSN12 in the X-winding and 67N6-2NPSN13, 51N-2NPSN13 in the Y-winding).

f. Protection against any sudden rise in pressure within the transformer or LTC due to internal faults.

g. When the differential relay (87-2SPSX01) is energized, it trips lockout relay 86-1-2SPUX01 and 86-2-2SPUX01, and tripping relay 94-2SPUX01.

h. When instantaneous overcurrent element 50-2SPSZ01 for backup protection of the 24.9-kV winding is energized, it trips lockout relays 86-1-2SPUY01 and 86-2-2SPUY01, and tripping relay 94-2SPUY01.

i. All other backup protection devices, when energized, trip lockout relay 86-2-2SPGZ01.

5. Transmission line protection: The 345-kV line is provided with a dual-channel direct-transfer trip scheme as shown on Figure 8.2-7. This trips the line from Scriba Substation in case of a fault at the Unit 2 end. The 115-kV incoming lines are also provided with a dual-channel direct-transfer trip scheme as shown on Figure 8.2-8. In case of a fault on any one of the 115-kV lines, the low-voltage side breakers of the associated reserve Station service transformer (offsite Source B) or the reserve Station service transformer and the auxiliary boiler transformer (offsite Source A) at Unit 2 are tripped via transfer trip scheme.

8.2.1.6 Instrumentation and Control

Remote Instrumentation and Controls

The following indications are provided in the main control room in connection with the offsite power sources:

1. 115-kV feed from Scriba Substation Source A line voltage and frequency.

2. 115-kV feed from Scriba Substation Source B voltage and frequency.

3. Reserve Station service transformer tap position.

4. Reserve Station service transformer primary phase current.

5. Auxiliary boiler transformer primary phase current.

Alarms are provided in the main control room for the following conditions:

1. Loss of 115-kV offsite power from Scriba Substation Source A.

2. LOOP from Scriba Substation Source B.

3. 115-kV switchyard MDS/switcher/transfer trip loss of control power.

4. Motor-operated disconnect switch open.

5. Reserve Station service transformer transfer trip.

6. Reserve Station service transformer lockout relay trip.

7. Reserve Station service transformer fault pressure trouble.

8. Reserve Station service transformer trouble.

9. Reserve Station service transformer protective relay power failure.

10. Auxiliary boiler transformer transfer trip.

11. Auxiliary boiler transformer lockout relay trip.

12. Auxiliary boiler transformer fault pressure trouble.

13. Auxiliary boiler transformer oil system trouble.

14. Auxiliary boiler transformer protective relay power failure.

15. Scriba transformer TB1 open phase and 46 relay trouble.

16. Scriba transformer TB2 open phase and 46 relay trouble.

17. Reserve Station service transformer open phase and 46/87 relay low load and trouble.

18. Auxiliary boiler transformer open phase and 46/87 relay low load and trouble.

Local Instrumentation and Controls

The following instrumentation and controls are provided locally in the 115-kV switchyard with the associated equipment:

1. 115-kV circuit switchers 2YUC-MDS3, 2YUC-MDS4, and 2YUC-MDS5:

   a. Open and closed positions indicating target.

   b. Switch operator manual engaging lever coupled or decoupled position indicators.

2. 115-kV motor-operated disconnect switches 2YUL-MDS1, 2YUL-MDS2, and 2YUC-MDS20: open and closed positions indicating target.

3. Reserve Station service transformers 2RTX-XSR1A and 2RTX-XSR1B:

   a. Magnetic liquid level gauge for main tank oil level.

   b. Magnetic liquid level gauge for LTC tank oil level.

   c. Top liquid temperature indicator.

   d. Winding temperature indicator relays.

   e. Liquid flow gauge to indicate forced oil flow.

   f. Indicating lights to indicate flow of oil to coolers.

   g. Indicating lights to indicate that coolers are energized.

   h. Local control switches for the following functions:
      (1) Space heater control switch.

      (2) LTC control mode selector switch (manual-off-auto).

      (3) LTC control switch (raise/off/lower).

      (4) LTC control transfer switch (local/remote).

      (5) Fan banks control mode selector switch (auto/manual).

(6) Oil pump control mode selector switch (auto/manual).

4. Auxiliary boiler transformer 2ABS-X1:

a. Magnetic liquid level gauge.

b. Liquid temperature indicator.

c. Winding temperature indicator.

d. Local control switches for the following functions:

(1) Fan banks 1 and 2 control mode selector switch (manual, off, and auto).

(2) Fan bank sequence selector switch.

(3) Space heater control switch.

5. Normal Station service transformer 2STX-XNS1:

a. Magnetic liquid level gauge for the main tank oil level.

b. Magnetic liquid level gauge for LTC tank oil level.

c. Top liquid temperature indicator.

d. Winding temperature indicator relays.

e. Liquid flow gauge to indicate forced oil flow.

f. Indicating lights to indicate flow of oil to coolers.

g. Indicating lights to indicate that coolers are energized.

h. Local control switches for the following functions:

(1) Space heater control switch.

(2) LTC control mode selector switch (manual-off-auto).

(3) LTC control transfer switch (local/remote).

(4) LTC control switch (raise/off/lower).

(5) Cooler group 1 and 2 mode selector switch (manual/auto).

8.2.1.7 Switchyard Dc Power Supply

The dc power required for protection and control of the 115-kV switchyard equipment is supplied from two different batteries associated with the plant normal 125-V dc system. Battery 2BYS-BAT1A feeds all the primary protection systems of the reserve Station service transformers 2RTX-XSR1A and 2RTX-XSR1B, and auxiliary boiler transformer 2ABS-X1 via 125-V dc switchgear 2BYS-SWG001A, the associated distribution panels, the termination cabinets, and the Power Generation Control Complex (PGCC) panels. Battery 2BYS-BAT1B feeds all the backup protection systems of the foregoing transformers via 125-V dc switchgear 2BYS-SWG001B, the associated distribution panels, the termination cabinets, and the PGCC panels.

Battery 2BYS-BAT1A also provides dc power for the 115-kV motor-operated disconnect switches and circuit switchers 2YUL-MDS1, 2YUC-MDS3, 2YUC-MDS10, and 2YUC-MDS5 via 125-V dc switchgear 2BYS-SWG001A. Battery 2BYS-BAT1B feeds motor-operated disconnect switches and circuit switchers 2YUL-MDS2, 2YUC-MDS4, and 2YUC-MDS20 via 125-V dc switchgear 2BYS-SWG001B.

The dc power for protection of the normal Station service transformer 2STX-XNS1 is provided by 125-V battery 2BYS-BAT1A and 2BYS-BAT1B. The dc power for protection and control of the 345-kV switchyard is provided from battery 2BYS-BAT1A and BAT1B. The dc power for protection and control of the generator set-up transformer is provided from battery 2BYS-BAT1B.

Each battery is capable of starting and operating all connected loads for 2 hr without the battery terminal voltage falling below 105 V should the charger become unavailable during any part of the duty cycle. Each battery has a battery charger that is capable of supplying the continuous load on the battery, excluding the UPS loads, while recharging the battery from the design minimum charge state to the fully-charged state in 24 hr with an ac supply voltage range of 90 to 110 percent. Refer to Section 8.3.2 for details of the batteries, battery chargers, and the associated distribution systems.

8.2.1.8 Inspection and Testing

Preliminary tests (Chapter 14) are performed on the offsite power system to confirm that all the components of the offsite power system are installed and connected properly, and that they are capable of performing their designed functions.

Periodic testing of the components of the offsite power system is performed to ensure continued integrity of the system. The transmission lines are inspected periodically. Functional checks of the protection and control systems, and calibration check of the protective relays, are performed periodically. The batteries are inspected, maintained, and periodically tested.

8.2.2 Analysis

The offsite power system is designed in accordance with the GDC of Appendix A, 10CFR50, and the applicable regulatory guides, to meet the requirements of capacity, independence, redundancy, and testability. The method of conformance is described in the following sections. Conformance with the Station Blackout Rule, 10CFR50.63, is described in Section 8.3.1.5.

Conformance with General Design Criterion 17

Two offsite power sources that are provided for the onsite power distribution system are drawn from two separate transformers through overhead transmission lines on separate rights-of-way. The lines are located so that the likelihood of their simultaneous failure under operating and postulated environmental conditions is minimal. A falling tower or transmission line in one of the offsite sources would not affect the other offsite power source. Two reserve Station service transformers located on opposite sides of the auxiliary boiler transformer are separated by 45 ft and by fire walls. Each transformer is provided with a separate deluge fire protection system. The fire protection system has been designed to prevent the spread of fire to the adjacent transformers. The drainage pit has been adequately sized; this is based on a complete oil spill from the largest transformer, and three transformer water spray deluge systems operating simultaneously for 10 min during a rain storm. The grade levels are such that the oil/water mixture will flow south from each transformer area and not toward the adjacent transformers. The offsite power sources are normally connected to the plant onsite emergency power system via the 115-kV switchyard and, therefore, they are readily available to the plant onsite emergency power distribution system.

Conformance with Regulatory Guide 1.32

Two offsite power sources that are provided for the Class 1E onsite distribution system are drawn from two different sources of power through overhead transmission lines on separate rights-of-way.

The offsite power sources are normally connected to the Class 1E onsite power distribution system and furnish power required for the operation of emergency systems and ESFs, and for safe shutdown of the plant in case of a DBA. The offsite power sources also feed the Station normal power distribution system in case it loses power from its normal source, the unit generator.

Each of the two offsite power sources has adequate capacity to start and operate the emergency loads required for safe shutdown of the plant while supplying other connected loads.

A separate emergency/backup source to either normal offsite power source is available if either Scriba 345/115-kV transformer bank is out of service. The 115-kV line #2 backup source has adequate capacity and capability to supply power to start and operate the emergency loads required for safe shutdown of the plant while supplying other connected loads.

The offsite power sources are normally connected to the onsite emergency power distribution system and, therefore, are readily available in case of a LOCA. In case of loss of any of the offsite sources, the associated emergency power distribution system is energized from its associated standby diesel generator (Section 8.3.1).

Degraded Voltage Condition

The 115-kV offsite sources that energize the reserve Station service transformers have a normal operating voltage range of 109.25 kV (95 percent) to 120.75 kV (105 percent). The reserve Station service transformers have automatic LTC mechanisms that operate over a range of ±10 percent in 32 steps, each 5/8 percent. The LTC is capable of maintaining 13.8 kV at the normal switchgear bus for 115-kV system voltage fluctuations of 120.75 kV (105 percent) to 109.25 kV (95 percent) and secondary load fluctuations. The 4.16-kV tertiary winding voltage fluctuates in accordance with the foregoing selected tap position, primary voltage variation, and/or 4.16-kV emergency switchgear bus load condition.

The minimum starting voltage for all Class 1E and NSSS-supplied motors is 80 percent of the motor nameplate voltage. The actual available starting voltage under degraded voltage conditions for safety-related MOVs is calculated on a case-by-case basis and used in determining if the valve can develop sufficient torque to operate under design conditions. All Class 1E motors are capable of running at the minimum voltage of 90 percent of the motor nameplate voltage.

The maximum permissible voltage drop between any 4.16-kV emergency bus and the 4.16-kV connected loads under normal running condition is 20 V, while that during motor starting is 60 V. The maximum permissible voltage drop between the 600-V emergency load center buses and their connected loads under normal operating conditions is 12 V (for the motor control centers [MCCs], this is broken up as 4 V between the load center and the MCC, and 8 V between the MCC and the motors). However, for MCC feeders having longer cable lengths, voltage drops from 600-V load centers to the MCC and from the MCC to the motor are redistributed within the framework of the total voltage drop limitation of 12 V.

The voltage profile study of the plant electrical power distribution system has been performed using the permissible voltage drops previously stated. This study confirms that the minimum voltage to ensure proper starting of all Class 1E motors at 4.16 kV, as well as 600-V buses, is 460 V at 600-V motor terminals (80 percent of the motor nameplate voltage of 575 V) during the most severe motor starting condition with 4.16-kV and 600-V buses fully loaded. The minimum voltage that will ensure proper running of all Class 1E motors at 4.16 kV, as well as 600-V buses, is 517.5 V at the 600-V motor terminals (90 percent of the motor nameplate voltage of 575 V) under full load conditions of 4.16 kV and 600-V buses.

From the original voltage profile study for the reserve Station service transformers, it is observed that the minimum 115-kV system voltage that will satisfy the preceding conditions for minimum bus voltages is 107.8 kV (93.74 percent of 115 kV) under the worst loading conditions, i.e., when the 13.8-kV buses are unloaded, and the 4.16-kV buses are loaded fully. This voltage (107.8 kV) is less than the minimum 115-kV system voltage of 109.25 kV (95 percent of 115 kV).

Under the opposite conditions, i.e., when the 13.8-kV buses are heavily loaded and the 4.16-kV buses are lightly loaded with the 115-kV system operating at the minimum (109.25 kV), voltage at the 4.16-kV load terminal will be 4.328 kV (108.2 percent of the motor nameplate voltage of 4 kV). This is within 10 percent of the motor nameplate voltage. The current voltage profile study confirms that with the 115-kV system operating between 95% and 105%, the preceding minimum voltages are met for all plant operating conditions.

With grid voltage at minimum level, voltages at the 4.16-kV and 600-V emergency buses under various bus loading conditions are above 80 percent of the nominal bus voltage of 4.16 kV and 600 V during the worst-case starting condition, and above 90 percent of the nominal bus voltage of 4.16 kV and 600 V during the steady-state condition. Voltages at the 4.16-kV and 600-V emergency load terminals are above 80 percent of the rated load voltages of 4 kV and 575 V during starting, and 90 percent of the rated load voltages of 4 kV and 575 V during normal running. The actual voltages are shown in Table 8.2-1.

From the voltage profile study for the auxiliary boiler transformer, it is observed that when the auxiliary boiler is feeding any 4.16-kV emergency bus, the minimum 115-kV system voltage that will ensure at least 80 percent of the motor nameplate voltage at the motor terminals during starting condition, and 90 percent of the motor nameplate voltage at the motor terminals during normal running condition for 4.16-kV, as well as 600-V levels, is 109.25 kV (95 percent of 115 kV), which is within the operating limits of the 115-kV system. With grid voltage at minimum level, and with auxiliary boiler transformer tertiary winding loads less than 5.5 MVA, voltages at the connected 4.16-kV and 600-V emergency buses under various bus loading conditions are above 80 percent of the nominal bus voltage of 4.16 kV and 600 V during the worst-case starting condition, and above 90 percent of the nominal bus voltages of 4.16 kV and 600 V emergency during the steady-state condition. Voltages at 4.16-kV and 600-V load terminals are above 80 percent of the rated load voltages of 4 kV and 575 V during starting, and above 90 percent of the rated load voltages of 4 kV and 575 V during normal running. The actual voltages are shown in Table 8.2-1.

It should be noted that the auxiliary boiler transformer serves only as a backup for either the Division I or II emergency bus and supplies the auxiliary boiler loads. The auxiliary boiler loads are present during plant shutdown and startup conditions. However, for the purposes of observing the worst case, the voltage profile study on the auxiliary boiler transformer assumes that one auxiliary boiler load, as well as one of the emergency bus (Division I or II) loads occur simultaneously. It should also be noted that transfer of one 4.16-kV emergency bus from the reserve Station service transformer to the auxiliary boiler transformer can occur only by manual transfer initiated by the Operator in the absence of any DBA condition.

When the 4.16-kV emergency buses (Divisions I and II) are fed from the emergency diesel generators, the minimum voltages at the 4.16-kV loads under the most severe starting condition and the normal running condition will be 3,268 V (81.7 percent of the nominal load terminal voltage of 4000 V) and 3921 V (98 percent of 4000 V), respectively; the minimum voltages at the 600-V loads under the most severe starting condition and the normal running condition will be 461 V (80.2 percent of the nominal load terminal voltage of 575 V) and 517.5 V (90 percent of 575 V), respectively.

The minimum voltage that will ensure proper operation of all Class 1E control and other loads at 120-V ac level is as follows:

a. The minimum pickup voltage for Gould/ITE starters is 88 V for sizes 0 and 1, 85.2 V for size 2, 85.2 V for size 3, and 91.2 V for size 4; for GE starters, 96 V for all sizes 1 through 3; for FASCO 120 V ac, the minimum pickup voltage is 88 V for size 0, and for 24 V ac, size 0 is 18 V.

b. The minimum voltage for all other control devices, including SOVs, varies between 90 V and 102 V, as determined by vendor documentation.

All 600-V cables feeding 600-V-120/208-V transformers and 120-V cables are sized to ensure the minimum voltages shown above for 120-V loads at the 120-V load terminals, assuming the minimum voltages (477 V, the worst voltage condition during motor starting) at the 600-V load centers.

The minimum 125-V dc voltage that will ensure proper operation of all Class 1E dc loads is as follows:

a. The minimum operating voltage for all Division I and II dc loads is 101 V (SOVs, etc.). The actual available starting voltage under degraded voltage conditions for safety-related MOVs is calculated on a case-by-case basis, and is used in determining if the valve can develop sufficient torque to operate under design conditions.

b. The minimum operating voltage for all Division III dc loads is 101 V (SOVs, etc.).

All 125-V dc cables are sized to maintain these minimum voltages at the 125-V load terminals, assuming the battery terminal voltage at the minimum of 105 V for Divisions I, II, and III, except in cases where the device (relay trip coils and closing coils) is capable of operating at levels below 101 V when the cables are sized to maintain these minimum voltages. The minimum pickup voltage for dc starters is 80 percent of coil rated voltage.

The minimum voltages at the various buses and their connected loads under different loading conditions are summarized in Table 8.2-1.

Two levels of undervoltage protection are provided at the 4.16-kV emergency buses: one to detect LOOP, and one to detect degraded voltage conditions. The LOOP relay is set to trip the offsite power supply breaker, alarm the control room, and initiate emergency diesel generator starting when the 4.16-kV bus voltage drops to 3212.86 V, which corresponds to 430.6 V at the 600-V buses. The time setting is approximately 3.0 sec.

In order to maintain 90-percent voltage at the 600-V motor terminals, it is calculated that the degraded voltage relay would have to be set at 3,847 V. This assumes that all of the 600-V connectable load is being supplied simultaneously from the load center. Setting the degraded voltage relay at 3,847 V corresponds to 531.7 V at the 600-V buses. With the maximum of 12-V permissible drop between the 600-V load center bus and any 600-V load during normal running, this corresponds to 519.7 V at the 600-V load terminals, which is 90.3 percent of the rated load voltage of 575 V.

Assuming the maximum variation of the degraded voltage relay setpoint due to accuracy, calibration, drift, environmental effects, etc., the voltage at the 600-V motor terminals may reach about 88.27 percent of the motor rated voltage during a degraded voltage condition. An analysis has been performed to show that this will not affect the qualified thermal life of the motors.

The degraded voltage relay is provided with two time delays. The first time delay is approximately 8 sec. Following this time delay, the degraded voltage condition is alarmed in the control room under normal plant operating conditions. Under accident conditions, the offsite power supply breaker will trip, and the emergency diesel generator will start following this time delay. The second time delay is set approximately 30 sec. Following this time delay, the degraded voltage condition will be alarmed in the control room, the offsite power supply breaker will trip, and the emergency diesel generator will start under normal plant operating conditions.

When the emergency buses are energized from the diesel generators, the undervoltage protection scheme prevents any load shedding during sequencing of emergency loads on the bus under an accident condition. When the emergency buses are energized from the offsite source (preferred source), the undervoltage protection scheme is functionally operational.

The undervoltage protection scheme uses coincident logic (two out of three phases) to preclude spurious trips of the offsite power sources. The relays and other devices associated with the undervoltage protection scheme are Class 1E and are located on the respective Class 1E switchgear.

The voltages at different buses under various loading conditions obtained from the voltage profile study will be verified by actual measurement (Table 14.2-90) prior to initial full-power reactor operation.

Stability Considerations

The designs and operation of the interconnected power system must be such that system and generator unit stability will be maintained on those facilities not directly involved in clearing the fault. Northeast Power Pool Coordination Council (NPCC) criteria calls for this testing to be done for permanent, three-phase, normally cleared faults and for permanent, single-phase faults with delayed clearing.

A transient stability study was conducted to demonstrate compliance with the NPCC criteria. Figure 8.2-9 shows the system configuration upon which stability cases were based. A criteria fault of any kind does not cause system instability or result in LOOP to safety-related systems.

Grid Availability

NMPC records indicate that there has been one trip of the Nine Mile-Volney No. 9 line since its original energization, occurring on May 17, 1983, at 10:41 am. Power was restored immediately, and the cause is unknown. There are no records on any other lines because these lines in and out of Scriba Station are new and have no record of operation. A study performed on the central region (including the Unit 2 transmission system) of the NMPC service area has shown 58 trips on 6,100 year-miles of 345-kV lines over a 15-yr period. This results in 0.0095 unplanned trips per mile per year. These trips include all unplanned events, including the following:

1. Lighting strikes.
2. Equipment failures.
3. System disturbances.

It should be noted that the experienced trip rate (0.0095) from all unplanned sources is less than the design value for lighting strikes of 0.0117 unplanned trips per mile per year.

TABLE 8.2-1
MINIMUM VOLTAGES AT VARIOUS EMERGENCY BUSES AND THEIR
CONNECTED LOADS UNDER DIFFERENT LOADING CONDITIONS

Item	Required Minimum Voltage (Volts)		Actual Voltage Level: Reserve Transformer → 95% (109.25 kV)		Actual Voltage Level: Auxiliary Boiler Transformer → 95% (109.25 kV)		Actual Voltage Level: Diesel Generator 100% (4.16 kV) → 94.26% (3.921 kV)		Remarks
	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	
1. 4.16 kV Bus									
SWG101, Full Power[5]	-	-	4112	-	3903	-	4160	-	
SWG101, Unit Trip w/LOCA[6]	-	-	4062	3845	3885	3707	3941	3328	
SWG101, Shutdown[7]	-	-	4115	-	3915	-	-	-	
SWG102, Full Power[5]	-	-	4116	-	Not Applicable		See FSAR Sec. 8.3.1.1.2		SWG102 can be energized only from reserve transformer or HPCS diesel generator.
SWG102, Unit Trip w/LOCA[6]	-	-	4061	3638					
SWG102, Shutdown[7]	-	-	4119	-					
SWG103, Full Power[5]	-	-	4121	-	Note (10)		4160	-	
SWG103, Unit Trip w/LOCA[6]	-	-	4103	3942			3941	3328	
SWG103, Shutdown[7]	-	-	4126	-			-	-	
2. 4.16 kV Load	3600	3200							
SWG101, Full Power[5]	-	-	4092	-	3883	-	4160	-	
SWG101, Unit Trip w/LOCA[6]	-	-	4042	3785	3865	3647	3921	3268[1]	
SWG101, Shutdown[7]	-	-	4095	-	3895	-	-	→ 3268	
SWG102, Full Power[5]	-	-	4096	-	Not Applicable		See FSAR Sec. 8.3.1.1.2		
SWG102, Unit Trip w/LOCA[6]	-	-	4041	3578					
SWG102, Shutdown[7]	-	-	4099	-					
SWG103, Full Power[5]	-	-	4101	-	Note (10)		Same as Above		
SWG103, Unit Trip w/LOCA[6]	-	-	4083	3882					
SWG103, Shutdown[7]	-	-	4106	-					
3. 600-V Load Centers US1 and US3									
Full Power[5]	-	-	578	-	545	-	615[2]	-	SWG102 does not have any load center.
Unit Trip w/LOCA[6]	-	-	570	538	542	512	529.5	477	
Shutdown[7]	-	-	578	-	547	-	→ 529.5	489	

TABLE 8.2-1 (Cont'd.)

Item	Required Minimum Voltage (Volts)		Actual Voltage Level						Remarks
			Reserve Transformer → 95% (109.25 kV)		Auxiliary Boiler Transformer → 95% (109.25 kV)		Diesel Generator 100% (4.16 kV) → 94.26% (3.921 kV)		
	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	
4. 600-V Load (Motors Connected Directly to Load Centers)	517.5	460							
Full Power[5]	-	-	566	-	533	-	603	-	
Unit Trip w/LOCA[6]	-	-	558	503	530	477	517.5	461	
Shutdown[7]	-	-	566	-	535	-	→ 517.5	472	
5. 600-V Motor Control Centers MCC101, 102, 103, 301, 302 and 303									
Full Power[5]	-	-	576	-	543	-	611[3]	-	
Unit Trip w/LOCA[6]	-	-	568	554	539	527	525.5[3]	516	
Shutdown[7]	-	-	576	-	543	-	→ 525.5	527	
MCC201									
Full Power[5]	-	-	595	-	Not Applicable		614	-	SWG102 can be energized only from reserve transformer or from HPCS diesel generator.
Unit Trip w/LOCA[6]	-	-	586	567			577	558	
Shutdown[7]	-	-	595	-			-	561	
6. 600-V Load (Motors Connected to MCC)	517.5	460							
Full Power[5]	-	-	568	-	535	-	603	-	
Unit Trip w/LOCA[6]	-	-	560	519	531	492	517.5	496	
Shutdown[7]	-	-	568	-	535	-	→ 517.5	507	
MCC201									
Full Power[5]	-	-	587	-	Not Applicable		602	-	
Unit Trip w/LOCA[6]	-	-	578	532			565	546	
Shutdown[7]	-	-	587	-			-	549	

TABLE 8.2-1 (Cont'd.)

Item	Required Minimum Voltage (Volts)		Actual Voltage Level						Remarks
			Reserve Transformer → 95% (109.25 kV)		Auxiliary Boiler Transformer → 95% (109.25 kV)		Diesel Generator 100% (4.16 kV) → 94.26% (3.921 kV)		
	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	Steady-State	Transient	
7. 120-V AC Loads									
Main plant computer	110		All 600-V cables feeding 600-120/208-V transformers and 120-V cables are sized to ensure the minimum voltages for each load terminal, assuming the minimum voltage (477-V; worst condition during motor starting condition, refer to Item 3) at the 600-V load center bus.						
Other computers	105								
Isolator	100								
MOV and SOV	96								
Starter	77								
Heater	-								
Light	-								
Motors (90% of motor nameplate voltage)	108								
8. 125-V DC Loads									
MOV and SOV	101		All 125-V dc cables are sized to maintain at least the minimum voltages at the 125-V load terminals, assuming the battery terminal voltage is 105-V for Divisions I, II and III.						

NOTES:

(1) The computer program assumes a 20-V drop from the 13.8-kV and/or 4.16-kV switchgear to the connected load during the steady-state conditions and a 60-V drop during the motor starting condition (transient).

(2) $V_2 = 4.16\text{ kV} \left(\frac{600\text{ V}}{4.056\text{ kV}}\right) = 615\text{ V}$; 4.056 kV is the tap voltage.

(3) The computer program assumes a 12-V drop from 600-V load centers to connected loads during the steady-state condition. For MCC loads, it is assumed that this voltage drop (12-V) is divided as follows: 4-V drop from the load center to the MCC, and 8-V drop from the MCC to connected loads. However, for MCC feeders with longer cable lengths, the voltage drops from 600-V load centers to the MCC and from the MCC to the motors are redistributed within the framework of the total voltage drop limitation of 12 V.

(4) The computer program assumes a starting voltage drop from the unit subs and MCCs to the connected motor loads of 6% of the rated voltage or 35 V.

(5) Full power with the 115-kV voltage at 0.95 pu.

(6) Unit trip with LOCA just subsequent to the trip signal with the 115-kV voltage at 0.95 pu.

(7) Shutdown, long-term shutdown or refueling with the 115-kV voltage at 0.95 pu.

(8) The transient condition is when the largest motor attached to the bus is started.

(9) The voltages for the unit subs and MCCs are for the worst-case unit sub or MCC.

(10) The auxiliary boiler transformer was only modeled feeding bus 2ENS*SWG101, because this is the worst loading and voltage condition.