8.2 OFFSITE POWER SYSTEM

8.2.1 DESCRIPTION

8.2.1.0 Definitions

The following are definitions of terms used in this chapter of the FSAR.

Waterford "Switchyard" --This applies to the 230 kV Switchyard consisting of two busses and bays connected in the typical breaker and a half scheme. The "Switchyard" one-line diagram, as it existed in 1985, is shown on Figure 8.1-4.

Waterford "Switching Station" --This applies to the Station located adjacent to the generator plant. The purpose of this station is to connect the plant to the Waterford Switchyard by means of two 230 kV lines. The Waterford Switching Station one-line diagram is shown on Figure 8.1-5.

Waterford "Substation" --This is a 230/34.5 kV Substation that serves customers in the area of Taft, Louisiana. It is physically adjacent to the Waterford "Switchyard" described above and is energized at 230 kV through ties to Bay 7 & 8 of the Waterford "Switchyard." These connections are shown on Figure 8.1-4. There is no one-line diagram of this "Substation" in the FSAR.

This location of the Waterford Substation is in back of, and adjacent to, the Waterford Switchyard. Therefore, its location in relationship to the nuclear unit would be the same as the switchyard since they share a common fence and the substation is relatively small (see Figure 8.2-1).

8.2.1.1 Utility Grid and Switchyard

→

Waterford 3 is connected to the utility grid by two transmission lines to the Waterford 230 kV Switchyard. The Waterford 230 kV Switchyard also has several other 230 kV transmission lines connected to it. Three of these transmission lines connect Waterford Units 1 and 2 to the Switchyard. Transmission lines cross the river on river crossing towers to tie into the Little Gypsy 230 kV Switchyard. There is a 230 kV tie to the adjacent 500 kV Switchyard. There are other transmission lines which tie to other areas of the Entergy grid.

←

The system is designed such that no transmission lines cross the 230 kV lines connecting the Waterford 3 switching station to the Waterford 3 230 kV Switchyard. In addition to the 230 kV lines connected to the switchyard, there is also a line constructed to 230 kV standards but operating at 115 kV, which passes through the 230 kV switchyard. Figure 8.1-4 shows the line going directly across the substation, being dead-ended on each side of the largest tower in the bay. Figure 8.2-4 shows the Pre-1984 as well as the existing profile. The existing profile has been implemented coincident with the tying in of Unit No. 3 and consists of bus work between the two existing towers so that a single tower failure will not knock out the entire switchyard (both busses).

The switchyard is of double bus, breaker and a half, configuration. Thus, each outgoing line is controlled by two breakers. Since the Waterford 3 lines terminate in different bays, there are at least two breakers in series between these two lines.

8.2.1.2 Transmission Lines

→(DRN E9900733; 05-838, R14)
Two transmission lines on independent structures on a common right of way connect the switchyard with the Waterford 3 switching station. Each line consists of two 1780 KCM ACSR conductors per phase, carried on 100 foot poles. Each line is designed to carry the full output of the main generator (1333.2 MVA) at 230 kV (nominal). The basic impulse insulation level (BIL) of each line is 1350 kV and the length is 0.65 miles. See Figures 8.2-1 and 2. Figure 8.2-4 shows the crossover of the Single Circuit Line to Little Gypsy, The Double Circuit Line to Little Gypsy and the Triple Circuit Line to Waterford Units 1 and 2.
←(DRN E9900733; 05-838, R14)

8.2.1.3 Switching Station

The switching station contains a structure for terminating the two transmission lines, two motor-operated disconnect switches, two circuit breakers with maintenance disconnect switches, and interconnecting bus and supporting structures.

→(DRN 03-1484, R13; 03-1496, R14)
Both generator output breakers (GOBs) S7120 and S7130 are rated at 230 kV, 4000 A continuous 80 kA interrupting capability and 900 kV BIL. Each of the maintenance disconnect switches on either side of the breakers are also rated at 230 kV and 4000 A continuous.
←(DRN 03-1484, R13; 03-1496, R14)

The switching station is furnished with redundant 480 V, single phase supply circuits for operation of the compressors and heaters. Control power for each breaker is furnished by two independent 125 V switching station batteries.

The switching station utilizes an alarm window annunciator. This annunciator is furnished with one common alarm contact for interface with an annunciator in the plant control room.

8.2.1.4 Transformer Yard

The transformer yard, located immediately to the south of the Turbine Building, contains the two main (generator) transformers, the two start-up transformers and the two unit auxiliary transformers, together with connecting buses and overhead lines.

Each transformer is furnished with a local alarm annunciator with one common alarm contact for interface with an annunciator in the plant control room.

8.2.1.4.1 Generator Transformers

Two generator transformers are provided, each rated as in Table 8.2-1. They are forced-oil, forced-air cooled units, with coolers connected to the transformers. These coolers have the capability, through valves and piping (the piping can be installed as required), to be connected so that both can serve one transformer. The rating of either transformer may be increased to 798 MVA for the same temperature rise of 65°C by this means, with the other transformer out of service.

→ (DRN E9900733; 04-535, R14)

The high voltage bushings of both transformers are connected through an overhead line, consisting of three 1272 MCM ACSR conductors per phase, to the circuit breakers in the switching station.

← (DRN 04-535, R14)

8.2.1.4.2 Start-up Transformers

Two start-up transformers are provided, each rated as in Table 8.2-1. The high voltage bushings of each transformer are connected through an overhead line, consisting of one 1027.4 KCM ACSR conductor per phase, to one of the motor-operated disconnect switches in the switching station.

←(DRN E9900733)

8.2.1.4.3 Unit Auxiliary Transformers

Two unit auxiliary transformers are provided, each rated as in Table 8.2-1. The high voltage bushings of these transformers are connected through isolated phase taps to the generator main bus.

8.2.1.4.4 Isolated Phase Bus

An isolated phase bus is used to connect the generator to the main transformer low voltage bushings. The two main transformers are connected in parallel through an isolated phase bus, which is connected in turn to the main generator bus. Isolated phase taps are used to connect the unit auxiliary transformers to the generator bus. The bus sections are rated 25 kV class, 150 kV BIL, with forced air cooling and air to water heat exchangers. Continuous and momentary current ratings are as in Table 8.2-2. The supplementary forced cooled rating for the main transformer bus is obtained by additional emergency cooling and matches the supplementary rating for the main transformer (see Subsection 8.2.1.4.1). Links are provided in all bus ducts to enable the disconnection of all transformers and the generator from the bus system.

8.2.1.4.5 Medium Voltage Bus

The eight medium voltage transformer windings (two each for the two startup and the two unit auxiliary transformers) are connected to the Plant Electric Power Distribution System switchgear through cable bus duct rated 3000 A. Cables used in the buses are shielded and are rated 5 kV, 90 C for 4.16 kV systems and 15 kV, 90 C for 6.9 kV systems. They are sized to carry the maximum available short circuit current for the time required for the circuit breaker to clear the fault. The 5 kV and 15kV buses exceed the BIL required for voltage surges.

8.2.1.5 Turbine Building Area

The main generator is located on the turbine generator pedestal. The Turbine Building contains the turbine generator auxiliary equipment and the non-safety related medium voltage switchgear.

8.2.1.5.1 Main Generator

The main generator is an outdoor, hydrogen and water cooled unit, rated as in Table 8.2-3 complete with the shaft driven brushless excitation alternator and permanent magnet generator exciter. The neutral of the wye-connected main generator is grounded through a distribution transformer and secondary resistor, rated as in Table 8.2-3. Current transformers, rated 35000:5 A, are located on each generator bushing, three on each neutral bushing and one on each line bushing, for metering, instruments, control and protection. Six potential transformers, rated 25 kV class, 150 kV BIL, 220:1 ratio, ANSI Group 2, are connected to the generator main leads, for metering, instruments, control and protection. Each of the potential transformers is drawout mounted, with primary and secondary fuses, in its own cubicle, thus preserving the isolation of the generator bus phases. The potential transformers are connected to form two three-phase groups; the primaries are connected in grounded wye and the secondaries are connected in wye with one phase (A) grounded, for three phase, three wire service.

Generator protection is discussed in Subsection 8.2.1.6.3.

8.2.1.5.2 Auxiliary Switchgear

The Turbine Building houses the auxiliary medium voltage switchgear through which offsite or preferred power from the unit auxiliary or start-up transformers is distributed to the non-safety related loads and to the safety-related (ESF) Onsite Power System.
→ (DRN E9900733)
Two 6.9 kV and two 4.16 kV buses are provided. Each bus is fully insulated and is rated 3000 A. Each of the eight medium voltage cable bus ducts (Subsection 8.2.1.4.5) is connected to a bus through a drawout, metal-clad, air magnetic circuit breaker, rated as in Table 8.2-4. Main breakers of the same construction are connected to the buses to form four metal-clad switchboards with a total of eight breakers (two per switchboard). These eight main circuit breakers are electrically operated by 125 V dc control power supplied by the appropriate battery (Subsection 8.3.2.1). Remote electrical closing and tripping, and local manual and local electrical tripping and closing, are provided for these breakers. The breakers may be withdrawn from the "operate" (or "normal") position to the "test" and "withdrawn" positions without having to leave the cubicle doors open. In the "withdrawn" position, the breaker is completely disconnected from the ac and dc systems and may be inspected and tested in safety.
← (DRN E9900733)
The eight main breakers may be manually controlled from the main control room. The main breakers are also arranged for automatic operation under control of the bus transfer scheme (Subsection 8.2.1.6.5). In the "test" position, local electrical operation is possible, but the main power circuit will not be completed when the breaker closes.

→ (DRN E9900733)
Breaker position ("operate" or "test/withdrawn") and status ("open" or "closed") are indicated at the main control room and at the switchgear. A mechanical "open-close" target is also provided at each breaker.
← (DRN E9900733)

8.2.1.6 Protection Systems

8.2.1.6.1 Switchyard

The Waterford 3 230 kV Switchyard is provided with primary and backup differential protection on the east and west buses. Each protective system has its own current transformers and relays and is therefore independent of the other. Breaker failure protection is provided for all line breakers.

8.2.1.6.2 Transmission Lines

Each of the Waterford 3 transmission lines have protective relaying schemes that use fiber optic systems to communicate. These relaying schemes extend from the bus side of the switchyard breakers to the main transformer side of the switching station breakers. Breaker failure protection is also provided.

Underfrequency and out-of-step relaying is provided to protect the generator and plant equipment from decayed frequency and an unstable system swing condition. This relaying will trip both the switching stations breakers, allowing the plant to isolate from the system. The plant auxiliary loads will continue to be connected to the unit auxiliary transformers, with their power supply being provided from the generator (see 8.2.2.2 d).

8.2.1.6.3 Generator, Main Transformer and Unit Auxiliary Transformer

The generator, the two main transformers and the two unit auxiliary transformers are interconnected without circuit breakers, so that failure of any one apparatus necessarily requires the shutdown of all five.

Two channels of protection are provided for this system, each channel having its own hand reset lockout relay. Each channel provides full protection for all equipment, so that either may be tested with the other in service, without requiring, or causing, generator shutdown. The protection is as follows:

a) First Channel:

   1) Generator Differential (87G)

   2) Generator Negative Sequence Overcurrent (with alarm) (46G)

   3) Main Transformer 3A Differential (87MTA)

   4) Main Transformer 3B Differential (87MTB)

   5) Main Transformer High Side and Switching Station Differential (87MTS)

6) Unit Auxiliary Transformer 3A Sudden Pressure (63UTA)

7) Unit Auxiliary Transformer 3B Sudden Pressure (63UTB)

8) Loss of Field (see note below) (40L)

9) Switchyard back-up relays (Generator Breaker Failure)

The above relays trip lockout relay 86G2.

→(DRN E9900733; 03-1484, R13)

(NOTE: loss of field relay trips only if either of the generator output breakers is closed and the voltage balance relay (60) is not operated.)

←(DRN E9900733; 03-1484, R13)

b) Second Channel:

1) Generator Main Transformer Differential (87GMT)

2) Main Transformer 3A Ground Detector (51/MTA)

3) Main Transformer 3B Ground Detector (51/MTB)

4) Unit Auxiliary Transformer 3A Differential (87UTA)

5) Unit Auxiliary Transformer 3B Differential (87UTB)

6) Loss of Field (See note above) (40S)

7) Generator Ground Fault (64G)

8) Reverse Power (32G)

9) Generator Motoring (time delay of approximately 1 minute maximum)

10) Thrust Bearing Failure

11) Turbine Trip

12) Turbine Bearing Oil Low-Pressure (TBMISX)

13) Switchyard back-up relays

The above relays trip lockout relay 86G1.

→(DRN 03-1484, R13)

(NOTE: Items 10 through 12 trip only if either generator output breaker is closed and reverse power relay is picked up.)

←(DRN 03-1484, R13)

Each lockout relay, 86G1 and 86G2 trips the following:

→(DRN 03-1484, R13)

1) Both generator output breakers

←(DRN 03-1484, R13)

2) Generator Field Breaker

3) Turbine

4) Unit Auxiliary Transformer Secondary Breakers (3A1-1, 3B1-1, 3A2-1, 3B2-1)

5) Main Transformer Cooling Equipment

6) Unit Auxiliary Transformers Cooling Equipment

→(DRN 03-1484, R13)

Should either generator output breaker fail to trip, the associated breaker failure will trip corresponding switchyard line breakers. (See Subsection 8.2.1.6.2)

←(DRN 03-1484, R13)

Each lockout relay is supplied with dc power from one of the two Turbine Building dc power panels; thus the two protective systems may be individually isolated for testing.

→(DRN 03-1484, R13)

The generator also has a lockout relay (distance) which is activated by the generator back-up protective relay (21G). This lockout relay trips both generator output breakers (3A and 3B).

←(DRN 03-1484, R13)

Generator overexcitation relay (95G) will trip the generator field breaker.

→(DRN 05-838, R14)

An inherent delay of at least 3 seconds between reactor trip and the onset of LOOP is considered for the safety analysis of Steam Generator Tube Rupture (SGTR). The assumed time delay is inherent in the delay between reactor trip and the subsequent actuation of the generator lock-out relays.

←(DRN 05-838, R14)

8.2.1.6.4 Startup Transformer

Each startup transformer is provided with:

a) Differential Protection (87ST)

b) Sudden Pressure (63FP/ST)

c) Ground Detector (51GST)

→(DRN 03-1484, R13)

These relays trip a lockout relay, which in turn trips the secondary (6.9 kV and 4.16 kV) breakers, the generator output (switching station) 230 kV breaker, automatically opens the motor operated transformer disconnect switch, and through the transfer trip circuit trips the associated switchyard breaker.

←(DRN 03-1484, R13)

This trip signal will be maintained until the lockout relay is reset (by hand) after the motor-operated disconnect switch supplying the transformer has been opened.

All trips are annunciated in the main control room as is loss of power to either lockout relay.

8.2.1.6.5 Plant Electric Power Distribution System

The Plant Electric Power Distribution System consists of two 6.9 kV buses (3A1 and 3B1), four 4.16 kV buses (3A2 and 3B2, 3A4 and 3B4) and several feeder circuits.

Each bus is protected against bus faults or uncleared outgoing feeder faults by three inverse time overcurrent relays, one in each phase of the incoming supply feeder. Each of these relays will trip the incoming supply feeder breaker.

→(DRN M9900709, R9; 03-1484, R13)

Bus transfer as a result of abnormal conditions is done automatically except in the case of degraded frequency or out-of-step relay trip of the generator output breakers, (See Subsection 8.2.1.6.2). The protective devices defined in Subsection 8.2.1.6.3 in conjunction with the operation of the main generator lockout relay 86G1 or 86G2 will initiate a fast dead transfer of the station auxiliaries from the Unit Auxiliary Transformers to the Startup Transformers. Figure 8.2-3 illustrates the automatic transfer from the Unit Auxiliary Transformers to the Startup Transformers upon main generator lockout relay initiation.

←(DRN M9900709, R9; 03-1484, R13)

An automatic fast dead transfer will occur if the following conditions are met: (refer to Control Wiring Diagram LOU 1564 B-424 Sh2246, 2248, 2256, 2258, 2264, 2265, 2274, and 2275, in FSAR Section 1.7).

1. For closing of startup transformer secondary breakers:

→(DRN M9900709, R9)

a) Close signal initiated by 86G1 and 86G2 and supervised by Unit Auxiliary Transformer breaker.

←(DRN M9900709, R9)

b) The trip was not caused by the overcurrent relays referred to above as detected by relay 74/HR(AUX).

c) Voltage is present at the Startup Transformer as monitored by relays

→(DRN M9900709, R9)

$$\frac{27-1,2,}{STA1,2}\ \frac{27-1,2}{STB1,2}$$

d) The Startup Transformer lockout relay $\frac{86}{STA,STB}$ is reset.

e) The phase angle between the Unit Auxiliary and startup transformer secondary voltages is no more than +65° [6.9KV], +90° [4.16K] (leading) and no less than -65° [6.9KV], -90° [4.16KV] (lagging) electrical degrees as detected by the synchronism check relays 25-1/STA1,A2 25-1/STB1,B2.

→(DRN 03-1484, R13)

f) Both generator output breakers have not been tripped prior to the operation of the 86G1 or 86G2 lockout relays.

←(DRN M9900709, R9; 03-1474, R13)

2. For tripping the unit auxiliary transformer secondary breakers:

a) See 1a above

→(DRN M9900709, R9)

Sequential signals are provided to trip and close the unit auxiliary and startup transformer secondary breakers respectively. The unit auxiliary transformer secondary breakers receive their trip signals from either lockout relay. The tripping action of the unit auxiliary breaker, via the early "b" contact, sends a closing signal to the startup transformer secondary breaker.

←(DRN M9900709, R9)

→ (DRN E9900733)
Bus transfer under normal start-up and shutdown conditions is done manually as a live overlapping synchronous transfer. Synchronism is assured by the use of a synchronism check relay. Synchronous transfer can be made in both directions. To ensure that the overlay of the supply circuits is as short as possible, the incoming breaker, on closing, trips the "running" breaker.
← (DRN E9900733)
Each outgoing feeder is protected against short circuits by an overcurrent relay in each phase, each with one time delay and one instantaneous relay. Motor feeders are equipped with a two element time delay relay in each phase. One time delay element of one phase is for alarm only on overload.

The instantaneous element of that phase and both elements of the other two phases are arranged to trip on fault conditions.

Motors on the 6.9 kV buses are also provided with an additional high-dropout instantaneous relay. This provides closer locked-rotor protection by preventing the momentary inrush current from tripping the breaker when starting the motor.

In addition, the reactor coolant pump motors are provided with differential protection.

Feeders to the 4160-480 V power center transformers are equipped with an inverse time overcurrent relay in each phase, to trip the breaker under all conditions of overload.

Each feeder is also equipped with ground fault alarm as described in Subsection 8.3.1.2.11.7.

Loss of voltage on a 6.9 kV or 4.16 kV bus for more than a few seconds will trip all motors fed from the bus. After power has been manually restored, and the undervoltage lockout relays reset, the motors may be manually reconnected.

Rating of low voltage equipment is as shown in Table 8.2-5.

8.2.1.6.6. Cathodic Protection
→ (DRN E9900733)
Cathodic protection is provided for underground metallic structures, utilizing a remote ground bed, and for the condenser water boxes using an impressed current type system.
← (DRN E9900733)

8.2.2 ANALYSIS

8.2.2.1 Switchyard and Grid

a) The requirements of General Criterion 17 - Electric Power Systems are satisfied by the following:

   1) Although the switchyard is common to both lines, each line terminates in a separate bay and can be connected to either of two separate buses. Failure of one bus or of the equipment in one bay will not result in loss of both lines.

2) A single breaker failing to trip will not result in failure of both lines because there are always at least two breakers in series between the two lines.

3) No lines or buses within the switchyard are constructed to less than 230 kV requirements.

4) The 230 kV transmission lines are normally in-service to feed the switchyard. No transmission lines cross either the 230 kV lines connecting the Waterford 3 switching station with the Waterford 3 switchyard.

→ (DRN 05-838, R14)

5) A grid stability analysis was performed in 2003 that demonstrates continued compliance with the requirements of General Criterion 17 considering the current system configuration with Waterford-3 generation at the nameplate rating of 1333.2 MVA. This analysis considered the following criteria.

(a) Loss of Waterford Unit 3 at rated real and reactive power generation does not cause grid instability.

(b) The loss of Waterford 3 does not cause unnecessary operations of generator backup relays at other South Louisiana generating units.

(c) Loss of the most critical transmission line in the vicinity of Waterford-3 through a single event does not cause grid instability.

The evaluation of transient effects resulting from loss of interconnecting lines associated with the Waterford substation and surrounding substations bounds the effects associated with loss of the largest power supply or load in the vicinity of Waterford-3 such that:

(a) The loss of the largest power supply capacity to grid in the vicinity of Waterford-3 does not cause grid instability.

(b) Loss of the largest load from the grid in the vicinity of Waterford-3 does not cause grid instability.

The grid stability study considered varying frequency levels and frequency deviations on grid stability, but the Waterford-3 accident analysis for loss of reactor coolant flow is independent of grid frequency decay rate because it considers a complete loss of offsite power to the RCPs with no credit taken for frequency decay.

←(DRN 05-838, R14)

→(DRN E9900733; 05-1767, R14-A)

Entergy Louisiana, LLC generation requirements are planned and provided in coordination with the other members of Entergy.

←(DRN E9900733; 05-1767, R14-A)

→(DRN 05-838, R14)

6) The sources provide sufficient capacity and capability to start and operate safety-related equipment to ensure that the fuel design limits and design conditions of the reactor are not exceeded during normal operation and that reactor core cooling can be initiated and maintained in the event of postulated accidents.

Since the sources are normally energized to the Waterford 3 plant site, they are available immediately for power to the station.

The offsite power sources for the station auxiliary power system provide redundancy and electrical and physical independence such that no single agent would be likely to cause a simultaneous outage of all sources during operating, accident, or adverse environmental conditions.

7) While it is improbable that all transmission lines could be out of service simultaneously, such an event would not jeopardize safe shutdown of the station because the onsite standby diesel generators would be able to supply the necessary power to systems required for safe shutdown.

→(DRN E9900733)

←(DRN E9900733; 05-838, R14)

The offsite 230 kV system has daily voltage variations between - 1.0 percent (228 kV) to +2 percent (234 kV), and normally does not exceed the design condition of plus/minus 5 percent of nominal (230 kV).

Outage data on South Louisiana 230 kV system indicates an outage rate of approximately 4 outages per year per 100 miles. The number of permanent faults per 100 miles is less than 1.0.

Most of the terrain in South Louisiana is marsh or swamp and most areas are subject to hurricane winds. Accordingly the wind load design is such that the transmission lines will not be damaged by hurricane force winds. Aeolian vibration is controlled by low conductor tension or stockbridge dampers. Extreme galloping of conductors is very rare in the area, as are icing conditions. The transmission river crossing adjacent to the Waterford 3 plant is designed to have a minimum clearance of 170 ft. at mid span.

b) The requirements of General Design Criterion 18, Inspection and Testing of Electric Power Systems, are satisfied because each bus may be tested for operability and functional performance independently of the other because of the physical and electrical separation and independence.

8.2.2.2 Transmission Lines, Switching Station, and In-Plant Equipment

a) The requirements of General Design Criterion 17 - Electric Power Systems - are satisfied by the following:

1) Two physically independent circuits are provided for offsite power. Although in the same right of way, the two lies are spaced sufficiently far apart that a falling transmission tower cannot involve the other line. (See Figure 8.2-2)

2) Both circuits are normally energized so that either is available immediately to provide sufficient power to assure that fuel design and reactor coolant pressure design limits are not exceeded, assuming loss of all onsite power.

→

3) The transformers associated with the Offsite Power System are provided with dry pipe deluge systems for fire protection and are spaced sufficiently far apart that catastrophic failure of one (of the six) cannot readily damage any of the others, with one exception. The exception is that, as the two generator transformers are paralleled on both HV and LV sides, they comprise in effect a single unit and are placed close together. A three hour rated fire wall is therefore used to separate these two transformers rather than distance alone.

←

4) The two transmission lines are electrically separated by at least two circuit breakers in series, at both the switchyard and the switching station. Two breakers would have to fail to trip in order for a fault in one line to involve the other.

→

Similarly, interconnection of the two 6.9 kV buses 3A1 and 3B1 (and of the two 4.16 kV buses 3A2 and 3B2) through the two unit auxiliary transformers is also made through two circuit breakers in series, and the above analysis applies here also.

←

5) Failure of either main transformer, either unit auxiliary transformer or the main generator results in transfer of the 6.9 kV and 4.16 kV non-safety-related buses to the start-up transformers. Any of the above failed equipment may be disconnected and the remaining equipment restored to service within a relatively short time, without in any way reducing the ability of the Offsite Power System to supply the safety-related loads in the meantime.

6) Failure of either of the 6.9 kV non-safety-related buses (or of the supplies

to them) results in reactor trip. Safe shutdown capability is not affected in any way. Failure of either 4.16 kV non-safety-related bus results in loss of offsite power to the affected safety-related bus, and causes the related diesel generator to start. The other safety-related bus continues to receive offsite power without interruption.

7) The auxiliary transformer impedances have been chosen such that standard switchgear ratings of 500 MVA and 350 MVA (nominal) at 6.9 kV and 4.16 kV respectively may be used.

b) The requirements of General Design Criterion 18, Inspection and Testing of Electric Power Systems, are satisfied by the following:

1) Each transmission line may be tested for operability and functional performance independently of the other. The lines are physically and electrically independent.

2) Transfer of power from the start-up transformers to the unit auxiliary transformers (and vice versa) may be made manually at any time the unit is on line. Transfer from the unit auxiliary transformers to the start-up transformers will be automatic on loss of the generator or unit auxiliary transformer(s).

c) The requirements of Sections 5.2.1(5) and 5.2.3 of IEEE Standard 308-1971, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations" - are met for the reasons given above in (a) and (b).

→ (DRN E9900733)

d) When the plant is in normal operation, and the auxiliary load is being supplied by the generator through the unit auxiliary transformers, loss of the two transmission lines should not require a reactor shutdown, because surplus steam can be bypassed to the condenser by the Steam Bypass System and the reactor output can be reduced by the Reactor Power Cutback System to match the auxiliary load, without requiring a turbine trip. (See the applicable Technical Specification limiting condition for Operations for a discussion of the allowed duration for an event of this type.)

← (DRN E9900733)

e) The requirements of General Design Criteria 1, 2, 3, 4, 13, 21, 22, 33, 34, 35, 38, 41 and 44 are met as discussed in Section 3.1.

TABLE 8.2-1 Revision 14 (12/05)

POWER TRANSFORMER RATINGS

		Main Generator Transformers	Start-up Transformers	Unit Auxiliary Transformers
1 - Name of units:				
→(DRN 04-1116, R14; 04-1832, R14)				
2 - No. of units:		2(3A & 3B)	2(3A & 3B)	2(3A & 3B)
3 - No. of windings each unit:		2	3	3
4 - Cooling class:		FOA	QA/FOA/FOA	QA/FA
5 - H winding rating:	MVA	684(3A) 672(3B)	33.6/44.8/56	39/52
at temp rise above 40 C of:	C	65	65	55
6 - HV winding rating & con-nection	kV	230 Y	230 Y	25∆
7 - X winding rating:	MVA	684(3A) 672(3B)	21.6/28.8/36	24/32
at temp rise above 40 C of:	C	65	65	55
←(DRN 04-1116, R14; 04-1832, R14)				
8 - X winding rating & con-nection:	kV	25∆	7.2∆	6.9∆
9 - Y winding rating:	MVA	-	12/16/20	15/20
at temp rise above 40 C of:	C	-	65	55
10 - Y winding rating & con-nection:	kV	-	4.36∆	4.16∆
→ (DRN 04-1832, R14)				
11 - Supplementary rating:	%	(see text)	none	112%
at temp rise above 40°C of:	C 65		-	65
← (DRN 04-1832, R14)				
12 - BIL - H winding	kV	750	750	150
- X and Y windings	kV	150	95	95
- H bushings	kV	900	900	150
- X and Y bushing	kV	150	95	95
- H wdg & bshg-neutral	kV	150	150	-
→ (DRN 03-2, R12-B; 04-1832, R14)				
13 - Impedances: H-X	%	7.23(3A)	4.67(3A)	6.2(3A)
← (DRN 03-2, R12-B; 04-1832, R14)				
		7.47(3B)	4.66(3B)	6.15(3B)
H-y	%	-	7.35(3A) 7.51(3B)	7.86(3A) 7.89(3B)
X-Y	%	-	11.46(3A) 11.74(3B)	13.33(3A) 13.5(3B)
On base of	MVA	600	12	15

TABLE 8.2-2

ISOLATED PHASE BUS RATINGS

	Bus Section	Main Generator	Main Transformer	Unit Auxiliary Transformer
1 -	Continuous current rating (1)			
	a - with normal cooling:(3)	kA 33	15	4
	b - with self cooling:	kA 17.75	10	4
	c - with emergency cooling	kA N/A	20	N/A
2 -	Momentary current rating(2)	kA 445	480	660

Note:

1) Continuous current ratings are rms symmetrical

2) Momentary current ratings are rms asymmetrical

3) Bus is normally forced-cooled, except for unit auxiliary transformer (and potential transformer taps) which are self cooled.

4) Temperature rises above 40 C ambient are limited to 65 C for the bus and 40 C for the housing.

TABLE 8.2-3 Revision 14 (12/05)

MAIN GENERATOR RATINGS

1 - Rated voltage and frequency:		kV/H_z	25/60
2 - Rated output at 60 lb./in.^{2} H_2 pressure:		MVA/PF	1333.2/0.9
3 - Rated output at 45 lb./in.^{2} H_2 pressure		MVA/PF	1199.8/0.915
4 - Rated speed		rpm	1800
→(DRN 04-5, R14)			
5 - Impedance on 1333.2 MVA and 25 kV bases:			
Synchronous at rated voltage (X_{dv}):		%	167.9
Transient at rated voltage (X'_{dv}):		%	28.51
Subtransient at rated voltage (X''_{dv}):		%	21.13
Zero sequence	(Xo):	%	16.52
Negative sequence	(X_2)	%	21.08
←(DRN 04-5, R14)			
6 - Short circuit ratio			0.50
7 - Surge protection -	3 diverters each:	kV	24
→(DRN E9900733)			
	3 capacitors each:	μF	0.125
←(DRN E9900733)			
8 - Neutral grounding - transformer rating:		kVA	167
for loading time of:		hr	12
voltage ratio(1)		V/V	25000:120/240
resistor rating		ohm/kW	0.158/121
9 - Exciter rating -	main 3 60 HZ	kW/V	3700/450
	pilot 3 420 Hz	kW/V	36/125

Note:

(1) Transformer connected for 240 V and secondary resistor rated 240 V
See p.5

TABLE 8.2-4

SWITCHGEAR RATINGS

1 - Bus number:			3A1	3A2 & 3A4	3B1	3B2 & 3B4
2 - Rated voltage class:		kV	7.2	5	7.2	5
3 - Rated capability (symmetrical)		MVA	500	350	500	350
4 - Rated maximum voltage:		kV	8.25	4.76	8.25	4.76
5 - Operating voltage;		kV	6.9	4.16	6.9	4.16
6 - Max interrupting current at rated max voltage:		kA	33	41	33	41
7 - Max interrupting current at operating voltage:		kA	39.5	46.9	39.5	46.9
8 - Maximum bracing current:		kA	66	78	66	78
9 - Interrupting time:		Cycles	5	5	5	5
10 - Rated continuous current	- main	A	2500(1)	3000	2500(1)	3000
	- feeder	A	1200	1200	1200	1200
11 - Closing time	- main	Cycles	7	7	7	7
	- feeder	Cycles	5	5	5	5

Note:

(1) Rating is 3000A with forced - air cooling

TABLE 8.2-5 (Sheet 1 of 2) Revision 11 (05/01)

RATINGS OF LOW VOLTAGE EQUIPMENT

A. 480 V POWER CENTERS AND TRANSFORMERS

Transformers		3A411 & 3B411** 3A21 & 3B21 3A32 & 3B32	3A22 & 3B22
Output	kVA	2500/3333	1000
Type		AA/FA	sealed, gas-filled
Temperature rise	C	150/150	150
HV winding:			
rated voltage	kV	4.16	4.16
connection	-	delta	delta
BIL rating	kV	45	60
LV winding:			
rated voltage	V	480	480
connection	-	wye	wye
BIL rating	kV	10	30
Taps, no load full capacity*			
above rated voltage	No, %	2, 2 1/2	2, 2 1/2
below rated voltage	No, %	2, 2 1/2	2, 2 1/2
Impedance	%	(on 2500 kVA) 3A21 9.09 3B21 9.07 3A32 10.69 3B32 10.61 (on 1000 kVA) 3A411 7.71 3B411 7.88	(on 1000 kVA) 3A22 6.25 3B22 6.14

Circuit Breakers

→ (DRN E9900733)

		3A(B)411	3A(B)21	3A(B)32	
Service Voltage	V	480	480	480	480
Control Voltage,dc	V	125	125	125	125
Frame Size	A	1600	1600****	600	1600
Interrupting Rating, rms sym, current:					
with inst trip	kA	50	50	30	50
with no inst trip	kA	50	50	30	50

B. MOTOR CONTROL CENTERS

Circuit Breakers		All Motor Control Centers				
Voltage rating	V	600	600	600	600	600
Frame Size	A	100	100	150	225***	100
Interrupting rating, rms sym @480 V	kA	14	25	65/42	22	14

← (DRN E9900733)

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*Taps are in HV winding on all transformers.

**Transformers 3A411 and 3B411 are rated 1000/1333 kVA and 60 KV BIL HV.

***Specified values may be exceeded for main transformer normal and alternate cooling circuit breakers.

→ (DRN E9900733)

****Compartment 4B(3A21), 4B(3B21), and 4C(3B21) frame size is 4000A.

← (DRN E9900733)

TABLE 8.2-5 (Sheet 2 of 2)

<u>Magnetic Motor Controller</u>						
Voltage rating	V	600				
Control Circuit Voltage, ac	V	120				
Control Transformer:		Single Phase				
Voltage ratio	V/V	480:120				
Output rating	VA	100 minimum				
<u>Buses</u>						
Short circuit current, rms symmetrical	kA	42	22			
Current capacity:						
main	A	1000	600			
vertical	A	300	300			
vertical (3A215, 3B215)	A	600				
<u>Reactors</u>						
Continuous Current	A	800	600	800	600	600
Reactance	ohm	0.025	0.025	0.018	0.018	0.010

C. <u>125 V DC LOAD CENTERS</u>		<u>3A-DC-S,3A1-DC-S 3B-DC-S,3B1-DC-S</u>	<u>3AB-DC-S</u>
Circuit Breakers:			
Voltage rating	V	250	250
Frame size	A	400 & 150	800, 400, & 100
Poles		2	2
Minimum interrupting rating @ 250 V dc	kA	20	30
Buses:			
Short circuit current	kA	20	50
Continuous rating	A	400	1200