8.2 Offsite Power Systems

The information in this section of the reference ABWR DCD including all subsections, tables, and figures is incorporated by reference with the following departures and supplements.

STP DEP 1.1-2 (Table 8.2-1)

STP DEP 8.2-1 (Figure 8.2-1)

STD DEP 8.3-1 (Table 8.2-1)

STD DEP Admin

Tables 8.2-2 and 8.2-3 are added as a site-specific supplement to complement the description of the STP 3 & 4 Offsite Power System.

8.2.1 Description

8.2.1.1 Scope

STD DEP 8.3-1

Applicant Scope

(4) The high voltage tie lines from the switching stations to the main power transformers, and to the reserve auxiliary transformers

(6) The reserve auxiliary transformers

ABWR Standard Plant Scope

(12) The non-segregated phase buses from the unit auxiliary transformers (UATs) *to the input terminals of the non-safety-related medium voltage (~~6.9~~* 13.8 *kV) switchgear, ~~the non-safety-related medium voltage switchgear (A4, B4, C4) and the power cables form the non-safety-related medium voltage switchgear to the safety-related switchgear~~* the power cables from the UATs to the input terminals of the plant investment protection (PIP) medium voltage (4.16 kV) switchgear and ~~stub-buses, and power cables between the stub-buses and the~~ safety-related switchgear.

(13) The non-segregated phase bus and power cables from the reserve auxiliary transformers to the input terminals of the non-safety-related and safety-related medium voltage (~~6.9 kV~~ 13.8 kV and 4.16 kV*) switchgear~~ and stub-buses, and power cables between the stub-buses and the safety-related switchgear~~.*

(14) The power cables from the combustion turbine generator to the input terminals of the *medium voltage (~~6.9~~* 13.8 *kV) switchgear, ~~including the disconnect and interconnecting bus~~* and interconnection power cables between 13.8 kV and 4.16 kV switchgear including the 13.8 kV/ 4.16 kV power transformer.

STD DEP 8.3-1

STD DEP Admin

The design scope for the ABWR ends at the low voltage terminals of the main power transformer and the low voltage terminals of the reserve auxiliary transformers. Although the remainder of the offsite power system is not in the scope of the ABWR design, the ABWR design is based on a power system which meets certain design concepts. Design bases (10CFR52 interface requirements) consistent with these concepts are included in Subsection 8.2.3. Meeting the design bases presented in Subsection 8.2.3 will ensure that the power system within the design scope for the ABWR meets all regulatory requirements. ~~Meeting the conceptual design bases presented in Section 8.2.5 will ensure that the total power system design is consistent and meets all regulatory requirements.~~

8.2.1.2 Description of Offsite Power System

STD DEP 8.3-1

Air cooled isolated phase bus duct is sized to provide its load requirements and withstand fault currents until the fault is cleared. It ~~is rated 36 kA and~~ provides for a power feed to the main power transformer and unit auxiliary transformers from the main generator. The sections of the isolated phase bus supplying the unit auxiliary transformers are rated ~~less than 36 kA~~ as appropriate to the load requirements (see Figure 8.3-1).

A generator circuit breaker is provided in the isolated phase bus duct at an intermediate location between the main generator and the main power transformer. The generator circuit breaker provided is capable of interrupting a maximum fault current of ~~275~~ 255 *kA symmetrical and ~~340~~* 320 *kA asymmetrical ~~at 5 cycles after initiation of the fault~~* in accordance with IEEE C37.013.

~~There are three unit auxiliary transformers. Each transformer has three windings and each transformer feeds one Class 1E bus directly, two non-Class 1E buses directly, and one non-Class 1E bus indirectly through a non 1E to non 1E bus tie. The medium voltage buses are in a three load group arrangement with three non-Class 1E buses and one Class 1E bus per load group. Each unit auxiliary transformer has an oil/air rating at 65°C of 37.5 MV-A for the primary winding and 18.75 MV-A for each secondary winding. The forced air/forced oil (FOA) rating is 62.5 and 31.25/31.25 MV-A respectively. The normal loading of the six secondary windings of the transformers is balanced with the heaviest loaded winding carrying a load of 17.7 MV-A. The heaviest transformer loading occurs when one of the three unit auxiliary transformers is out of service with the plant operating at full power. Under these conditions the~~

~~*heaviest loaded winding experiences a load of 21.6 MV-A, which is about two-thirds of its forcedair/forced-oil rating.*~~

There are three Unit Auxiliary Transformers (UATs), which are designated the normal preferred offsite source. UATs A and B are rated at 82.5/110 MVA (ONAN/ONAF). UATs A and B each have primary windings at the main generator voltage and two secondary windings, one at 13.8 kV and one at 4.16 kV. UAT C is rated at 22.5/30 MVA (ONAN/ONAF). UAT C has primary winding at the main generator voltage and a single secondary winding at 4.16 kV. All three UATs use automatic tap changers to improve voltage regulation on the plant medium voltage buses. The UATs are designed with significant capacity margin during normal operation because the transformers operate near their ONAN ratings.

UAT A supports 13.8 kV Power Generation (PG) buses A1 and C1 and 4.16 kV Plant Investment Protection (PIP) bus A2 and Class 1E 4.16 kV bus A3. UAT B supports PG buses B1 and D1 and PIP bus B2 and Class 1E bus B3. UAT C supports PIP bus C2 and Class 1E bus C3.

~~*One, three-winding 37.5 MV-A reserve auxiliary transformer provides power as the "Alternate Preferred" power to the "Normal Preferred" power. One of the equally rated secondary windings supplies reserve power to the nine (three through cross-ties) non-Class 1E buses and the other winding supplies reserve power to the three Class 1E buses. The combined load of the three Class 1E buses is equal to the oil/air the rating of the transformer winding serving them. This is equal to 60% of the forced-air/forced-oil (FOA) rating of the transformer winding. The transformer is truly a reserve transformer because unit startup is accomplished from the normal preferred power, which is backfed over the main power circuit to the unit auxiliary transformers. The reserve auxiliary transformer serves no startup function. The operational configurations are such that the FOA ratings of the reserve auxiliary transformer, or any unit auxiliary transformer, will not be exceeded under any operating mode (Subsection 8.2.4.5).*~~

There are two Reserve Auxiliary Transformers (RATs), either of which can be used as the alternate preferred offsite source. RATs A and B are each rated at approximately 82.5/110 MVA (ONAN/ONAF). RATs A and B each have primary windings at the switchyard voltage and two secondary windings, one at 13.8 kV and one at 4.16 kV. RATs A and B use automatic tap changers to improve voltage regulation on the plant medium voltage buses. The RATs are designed with significant capacity margin during normal operation because the transformers operate near their ONAN ratings.

RAT A is designed to be capable of supporting PG buses A1 and C1, which are normally supported by UAT A, via an intermediate 13.8 kV bus designated as CTG 2. The 4.16 kV winding of RAT A can be aligned to support any of the three PIP buses (A2, B2, and C2) and any of the three Class 1E buses (A3, B3, and C3) and has the capacity to support all three Class 1E buses. RAT A is not normally aligned to support any PG, PIP, or Class 1E bus. RAT B is designed to be capable of supporting PG buses B1 and D1, which are normally supported by UAT B, via an intermediate 13.8 kV bus designated as CTG 1. The 4.16 kV winding of RAT B can be aligned to support

any of the three PIP buses and any of the three Class 1E buses and has the capacity to support all three Class 1E buses.

The normal and alternate offsite preferred power circuits are designed with sufficient capacity and capability to limit variations of the operating voltage of the onsite power distribution system to a range appropriate to ensure: (1) normal and safe steady-state operation of all plant loads, (2) starting and acceleration of the limiting drive system with the remainder of the loads in service, and (3) reliable operation of the control and protection systems under conditions of degraded voltage [Subsection 8.3.1.1.7 (8)]. Specifically, the unit auxiliary transformers and the reserve auxiliary transformers are designed to limit the voltage variation of the onsite power distribution system to ±10% of load rated voltage during all modes of steady state operation and a voltage dip of no more ~~that~~ than *20% during motor starting.*

According to IEEE C57.19.100 the STP Units 3 & 4 site is a medium to heavy contamination environment due to its proximity to the coast and additional salt deposition from the Ultimate Heat Sinks. To prevent insulator and bushing failure on offsite power system equipment due to contamination from salt deposition, the bushings and insulators for offsite power equipment up to the switchyard will have a minimum creep distance of 44 mm/kV and a permanent coating.

STD DEP 8.3-1

STD DEP Admin

The unit and reserve *auxiliary transformers are designed and constructed to withstand the mechanical and thermal stresses produced by external short circuits. In addition, these transformers meet corresponding requirements of the latest revisions of ANSI Standard C57.12.00. See Subsection ~~8.2.3(8)~~* 8.2.3 (4) *for interface requirements on the main step-up transformers and the reserve auxiliary transformers.* ~~*See Subsection 8.2.3(10) for interface requirements on the high-voltage circuit breakers and disconnect switches.*~~

STD DEP 8.3-1

The non-segregated phase bus or power cable *that connects the unit auxiliary and reserve auxiliary transformers to ~~the 6.9 kV~~* their respective *switchgear is sized to supply its load requirements and rated to withstand fault currents until the fault is cleared.*

The following site-specific supplement provides a description of the Offsite Power System for STP 3 & 4 addressing information requested by RG 1.206 and replacing the conceptual design provided in Subsection 8.2.5 of the reference ABWR DCD.

The offsite power system includes at least two (2) preferred sources of power for the reactor protection system and engineered safety features (ESFs) during normal, abnormal, and accident conditions. It includes a minimum of two (2) independent and physically separated 345 kV circuits of the six (6) circuits available from the transmission network as required by GDC 17. Five of the six (6) offsite circuits for STP

3 and 4 are existing transmission lines that were connected to the STP 1 & 2 switchyard and have been re-routed to the STP 3 & 4 switchyard. Of the six (6) transmission lines, four identified as preferred sources of power are as follows: White Point 39, Elm Creek 27, Velasco 27, and the tieline with a series reactor between STP 3 & 4 switchyard and the STP 1 & 2 switchyard. The remaining two (2) transmission lines, Hillje 44 and Blessing 44, are used for power transmission. However, these two lines do not meet the criteria of being independent and physically separated. Hillje 44 crosses under the Elm Creek 27 line at the Hillje switchyard. Blessing 44 connects to the local 138 kV system via an autotransformer and is considered a source which can not supply adequet power and voltage under all operating scenarios. Refer to Figure 8.2-6 for 345 kV transmission configuration. The offsite power system encompasses the connections to the power grid, transmission lines (overhead and/or underground), transmission line towers, transformers, switchyard components and control systems, switchyard battery systems, MPT, and the RATs.

The offsite power system is designed to provide reliable and redundant sources of power for starting, operation, and safe shutdown of STP 3 & 4 in accordance with GDC 17. The offsite power system configuration, single line, general arrangement, and transmission network map are shown in the following figures:

Figures 8.2-1 (7 sheets)	Power Distribution Routing Diagrams
Figure 8.2-2	345 kV General Arrangement
Figure 8.2-3	345 kV Switchyard Single Line Diagram
Figure 8.2-4	345 kV Switchyard Arrangement
Figure 8.2-5	Transmission Network Map of ERCOT
Figure 8.2-6	345 kV Transmission Configuration

8.2.1.2.1 Transmission Lines

Six 345 kV transmission circuits rated from 896 MVA to 1793 MVA (Reference 8.2-3) connect the STP 3 & 4 switchyard to the Electric Reliability Council of Texas (ERCOT) grid, as shown on Figure 8.2-6. These six 345 kV circuits provide the source of AC power to the 345 kV switchyard. The 345 kV transmission circuits terminate at six points as follows: at Velasco 345 kV Substation (CenterPoint Energy); at Hillje 345 kV Switchyard (CenterPoint Energy); at Elm Creek 345 kV Switchyard (City of Public Service Board of San Antonio (CPS); at White Point 345 kV Substation (AEP Texas Central Company (TCC); at the STP 1 & 2 switchyard via a tieline with a series reactor (TCC); and at Blessing 345 kV Substation autotransformer (TCC). The Blessing 345 kV autotransformer is connected to the TCC's Blessing 138 kV Substation.

The STP 3 & 4 transmission lines utilize the existing (from STP 1 & 2) corridor and rights-of way for interconnects to the existing transmission grid. The description of the transmission system components for both existing and new structures as listed below fully describes and qualifies the use of this system within the present boundaries of the

existing corridors. Transmission service providers (TSP) in the ERCOT region are subject to regulations of the Public Utility Commission of Texas (PUCT) that control new transmission facilities or interconnections needed to provide transmission service to and from the transmission grid. (Reference 8.2-3).

Three (3) existing rights-of-way commence from the STPEGS property (for STP 1, 2, 3, & 4) toward the termination points described below and shown on Figure 8.2-5. The eastern right-of-way is 100 ft wide and contains two (2) 345 kV circuits to Velasco (on double-circuit structures). The western right-of-way is 100 ft wide and contains a 345 kV circuit to Blessing. The middle or northwestern right-of-way is 400 ft wide and contains six (6) circuits. These circuits are carried on three sets of double-circuit towers. The Elm Creek 18 and the W.A.Parish 39 line locations are on the eastern structures, the Hillje 64 and the Elm Creek 27 lines are on the middle structures. The White Point 39 and the Hillje 44 line are on the western structures. There is adequate spacing between the middle and western towers to allow complete failure of one without jeopardizing the other. For the purpose of analysis, the right-of-way has been considered as two independent rights-of-way. This right-of-way is approximately 20 miles long and terminates in four separate rights-of-way varying in width from 100 to 150 ft. The Velasco 27 line includes an underground 345 kV cable that crosses under the two double circuit overhead lines that feed Elm Creek 18, Hillje 64, and W.A.Parish 39. This underground installation eliminates the possibility of a failure of the overhead lines from impacting the Velasco 27 line. The transmission configuration map showing the proposed usage of existing rights-of-way in the region is included in Figure 8.2-5. Refer to Figure 8.2-6 for transmission configuration for both STP 1 & 2 and STP 3 & 4.

A list of all transmissions circuits from each of the four transmission service providers to the STPEGS plant site is given in Table 8.2-2. This table includes all termination points, ownership of the circuit, circuit operating voltage, and approximate circuit length in miles.

The 345 kV transmission circuits are routed on rights-of-way as described above except for the distance from the rights-of-way to the STP 3 & 4 switchyard on the STPEGS plant property. In this small section, the 345 kV structures are arranged as depicted in Figure 8.2-2. The location of transmission circuits within this small section has been analyzed and failure of a tower due to failure of an adjacent tower has been determined not to adversely impact plant offsite power supply.

The 345 kV transmission system from STP 3 & 4 to the ERCOT grid is designed so that any two of the 345 kV transmission circuits from STP 3 & 4 may be taken out of service and the full-load generation of STP 3 & 4 can still be transmitted to their respective load centers. The loss of any double-circuit structure or any two transmission circuits does not reduce the availability of the offsite supply of power to the STP 3 & 4 345 kV switchyard. The transmission grid associated with the plant is further designed so the loss of an independent right-of-way may necessitate some reduction in generation output, but does not reduce the availability of the offsite supply of power. The transmission system is designed to maintain a voltage variance of +/- 5% without STP 3 & 4 reactive support in accordance with ERCOT Protocols, Operating Guides and Procedures (Reference 8.2-6). With a +/- 5% voltage variance

on the grid, the onsite power distribution system maintains a +/- 10% voltage on the loads. The ERCOT Protocols, Operating Guides and Procedures also keep the frequency at 60 Hz except during periods of major generation loss. During periods of generation loss, frequency will drop; however, ERCOT employees automatic firm load shedding schemes which unload the grid and allow generators to recover to normal frequency.

All the transmission lines to the STPEGS plant are designed for reliability and performance. The structures for these circuits, as well as the 345 kV switchyard, are built to withstand hurricane force winds. In southeastern Texas, the ice-loading condition on transmission lines is not considered significant since it is less than the hurricane wind-loading on transmission or substation structures. The 345 kV structures have sufficient vertical spacing to minimize galloping conductor flashover. Galloping conductors have caused outages primarily of 138 kV and 69 kV vertically spaced circuits since the vertical spacing between conductors is much less than that for 345 kV circuits. Galloping conductors are considered a rare phenomenon in southeastern Texas. The Transmission Line Historical Data on Outages Due to Failures, Table 8.2-3, does not attribute any outages due to galloping conductors.

The isokeraunic level in thunderstorm days per year is moderate to moderately high for the Texas Gulf Coast area. Long-term historical data show this area to have approximately 65 thunderstorm days per year (Reference 8.2-4). The transmission line design has sufficient basic insulation level (BIL) to minimize lightning flashover from the expected number of lightning strokes (the number of lightning strokes is assumed proportional to the number of thunderstorm days per year).

The ERCOT grid and transmission system (as described in Section 8.1.1) ensures that AC offsite power is available for shutdown of STP 3 & 4 and for mitigating the consequences of postulated accidents at either unit.

8.2.1.2.2 Switchyard Description

The STP 3 & 4 345 kV switchyard is sized and configured to accommodate the output of both units. The location of this switchyard is on the STP site approximately 650 feet north of STP 3 & 4. The switchyard layout and location are shown on Figures 8.2-2, 8.2-4 and 8.2-6.

As indicated on Figure 8.2-3, a breaker and-a-half scheme is incorporated in the design of the 345 kV switchyard. The switchyard bus is a 63 kA fault duty design. Circuit breakers and disconnect switches are sized and designed in accordance with ANSI Standard C37.06 (Reference 8.2-1). All circuit breakers are equipped with dual trip coils. The 345 kV circuit breakers in the switchyard are rated according to the following criteria:

- Circuit breaker continuous current ratings are chosen such that no single contingency in the switchyard (e.g., a breaker being out for maintenance) will result in a load exceeding 100 percent of the nameplate continuous current rating of the breaker.

- Interrupting duties are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate interrupting capability.
- Momentary ratings are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate momentary rating.
- Voltage ratings are specified to be greater than the maximum expected operating voltage.

All 345 kV breakers have a minimum symmetrical interrupting capability of 63,000 amperes. The Onsite Electrical System is designed for a future maximum switchyard short circuit contribution of 37 Gva.

The design of the switchyard is consistent with a standard breaker-and-a-half scheme, and includes seven bays in the configuration. The breaker-and-a-half switchyard arrangement offers the operating flexibility to maintain the anticipated operational containment integrity and other vital functions in the event of a postulated accident(s) as described in the Failure Modes and Effects Analysis (FMEA) Subsection 8.2.2.2. Some of the specific advantages of the breaker-and-a-half switchyard arrangement are:

- Any transmission line into the switchyard can be cleared either under normal or fault conditions without affecting any other transmission line or bus.
- Either bus can be cleared under normal or fault conditions without interruption of any transmission line or the other bus.
- Any circuit breaker can be isolated for maintenance or inspection without interruption of any transmission line or bus.
- A fault in a tie breaker or failure of the breaker to trip for a line or generator fault results only in the loss of its two adjacent circuits until it can be isolated by disconnect switches.
- A fault in a bus side breaker or failure of the breaker to trip for a line or generator fault results only in the loss of the adjacent circuits and the adjacent bus until it can be isolated by disconnect switches.

Electrical protection of circuits from the STP 3 & 4 switchyard use a primary and secondary relaying scheme. The current input for the protective relaying schemes come from separate sets of circuit breaker bushing current transformers. Also, the control power for all primary and secondary relaying schemes is supplied from separate 345 kV switchyard 125 VDC systems. These schemes are used for the following:

- The scheme is used on each of the six 345 kV transmission circuits from the STPEGS 345 kV switchyard to the ERCOT grid. The potential input for the primary

and secondary transmission circuit relaying systems is supplied from fused branch circuits originating from a set of coupling capacitor potential devices connected to the associated transmission circuit.

- The switchyard buses use a primary and backup scheme. The zone of protection of each 345 kV bus includes all the 345 kV circuit breakers adjacent to the protected bus.
- Line protection for the main power transformers and reserve auxiliary transformers use primary and backup schemes.

In addition to the above described STP 3 & 4 345 kV switchyard relaying systems, each of the 345 kV circuit breakers has an associated circuit breaker failure relaying system. The primary and secondary relaying systems of the STP 3 & 4 345 kV switchyard are connected to separate trip circuits in each 345 kV circuit breaker.

For the two 125 VDC batteries located in the STPEGS 345 kV switchyard control house, each battery has its own battery charger. Each battery charger is connected to separate 480 VAC distribution panel boards also located in the control house. The 345 kV switchyard 125 VDC systems are entirely independent of the unit non-Class 1E and unit Class 1E battery systems.

The STP 3 & 4 345 kV switchyard 480 VAC and 120/240 VAC station service system consists of two 4.16 kV/480 VAC load center transformers, a 480 VAC double-ended load center, two 480 VAC distribution panel boards, a 480/120-240 VAC transformer bank and two 120/240 VAC distribution panel boards. The 4.16 kV/480 VAC load center transformers are supplied by two 4.16 kV non-Class 1E feeders, one from each unit, and each are provided with a backup power feed from the CTG.

The control cables for the switchyard breakers are routed through three parallel, independent cable trenches. The two outer trenches carry the primary relaying and control for all breakers. The center trench carries the secondary (or backup) relaying and control for all breakers. Cables are routed from each breaker to the respective trenches in such a fashion as to maintain separation between primary and secondary circuits.

8.2.1.2.3 Main Power and Reserve Auxiliary Transformers

The main power transformer (MPT) and the reserve auxiliary transformers (RATs) tie-lines run south from the new 345 kV switchyard toward STP 3 & 4.

The MPT consists of three normally energized single phase transformers with an additional installed spare. Provisions are made to permit connecting and energizing the spare transformer following a failure of one of the normally energized transformers.

The calculated rated conditions for the MPT(s) are approximately 1612 MVA with a nominal voltage of approximately 26 kV and with taps at 105%, 102.5%, 100%, 97.5%, and 95% of 362.25 kV. The MPTs are each individually rated at approximately 537.5 MVA. MPT and high voltage circuits have sufficient impedance to limit the primary side

maximum available fault current contribution from the system to that required by the main generator output circuit breaker.

The offsite transmission circuits from the transmission network through and including the main step-up power and reserve auxiliary transformers are designed and constructed to withstand the mechanical and thermal stresses from the worst case faults.

The offsite transmission circuits from the transmission network through and including the main step-up power and reserve auxiliary transformers are sized to supply their load requirements during all design operating modes of their respective Class 1E divisions and non-Class 1E load groups.

The impedances of the unit auxiliary and reserve auxiliary transformers are compatible with the interrupting capability of the plant's circuit interrupting devices.

The main step-up power and reserve auxiliary transformers are provided with separate oil collection pits and drains to safe disposal area, and are provided with fire protection deluge systems as specified in Section 9A.4.6.

Each transformer has primary and backup protective devices. DC power to the primary and backup devices is supplied from separate non-Class 1E DC sources.

8.2.1.3 Separation

STD DEP 8.3-1

STD DEP Admin

The location of the main power transformer, unit auxiliary transformers, and reserve auxiliary transformers are shown on Figure 8.2-1. The reserve auxiliary transformers ~~is~~are separated from the main power and unit auxiliary transformers by minimum distance of 15.24m. It is a requirement that the 15.24m minimum separation be maintained between the switching station and the incoming tie lines ~~(see Section 8.2.3)~~. The transformers are provided with oil collection pits and drains to a safe disposal area.

Reference is made to Figures 8.3-1 for the single line diagrams showing the method of feeding the loads. The circuits associated with the alternate offsite circuit from the reserve auxiliary transformers to the Class 1E buses are separated by walls or floors, or by at least 15.24m, from the main and unit auxiliary transformers. The circuits associated with the normal preferred offsite circuit from the unit auxiliary transformers to the Class 1E buses are separated by walls or floors, or by at least 15.24m, from the reserve auxiliary transformers. Separation of the normal preferred and alternate preferred circuits is accomplished by floors and walls over their routes through the Turbine, Control and Reactor Buildings except within the switchgear rooms where they are routed to opposite ends of the same switchgear lineups. Either reserve auxiliary transformer may be used to satisfy requirements as the alternate preferred power

supply. Separation between the two reserve auxiliary transformers is not sufficient to allow each to be considered an independent offsite power supply.

STP DEP 8.2-1

The alternate preferred feeds from the reserve auxiliary transformers are routed inside the Turbine Building. The Turbine Building switchgear feed from the reserve auxiliary transformer is routed directly to the Turbine Building switchgear rooms. The feed to the Control Building is routed in corridors outside of the Turbine Building switchgear rooms. It exits the Turbine Building and crosses the Control Building roof on the opposite side of the Control Building from the route for the normal preferred power feeds. The steam tunnel is located between the normal preferred feeds and the alternate preferred feeds across the stepped roof of the Control Building. The alternate preferred power feed turns down between the Control and Reactor Building and enters the Reactor Building on the ~~Division II~~ Division I *side of the Reactor Building. From there it continues on to the respective switchgear rooms in the Reactor Building.*

STD DEP 8.3-1

Feeder circuit breakers from the unit auxiliary and reserve auxiliary transformers to the medium voltage ~~(6.9 kV)~~ switchgear are interlocked to prevent paralleling the normal and alternate power sources.

STD DEP Admin

Instrument and control cables associated with the normal preferred power circuits are separated [i.e., by 15.24m, or by walls or floors] from the instrument and control cables associated with the alternate preferred power circuits; with exception of the circuits in the control room, the circuits at the control and instrument DC power sources, and the interlock circuitry required to prevent paralleling of the two offsite sources. However, these circuits are electrically isolated and separated to the extent practical, and are not routed together in the same raceway. The reserve auxiliary transformers' power, instrument and control cables do not share raceways with any other cables. The instrumentation and control circuits for the normal and alternate preferred power shall not rely on a single common DC power source. ~~[See Subsection 8.2.3 items (13) and (15)]~~

STD DEP 8.3-1

A combustion turbine generator (CTG) supplies standby power to the non-Class 1E buses which supply the non-Class 1E plant investment protection (PIP) loads. It is a ~~9 MW~~ 20 MW (minimum) *rated self-contained unit which is capable of operation without external auxiliary systems. Although it is located on site, it is treated as an additional offsite source in that it supplies power to multiple load groups. In addition, manually controlled breakers provide the capability of connecting the combustion turbine generator to any of the Class 1E buses if all other AC power sources are lost.*

In this way, the CTG provides a second "offsite" power source to any Class 1E bus being fed from the reserve auxiliary transformers while the associated unit auxiliary transformer is out of service.

8.2.2.1 General Design Criteria

STP DEP 1.1-2

(1) GDC 5 and RG 1.81 - Sharing of Structures, Systems and Components

~~*The ABWR is a single-unit plant design. Therefore this GDC is not applicable.*~~ STP 3 & 4 is a dual-unit station. STP 3 & 4 receive offsite power from a common 345 kV switchyard through normal and alternate preferred power transmission lines and circuits in accordance with GDC 17. The Failure Modes and Effects Analysis (FMEA) discussed in Section 8.2.2.2 concludes that there are no single failures which can prevent the offsite power system from performing its function to maintain the anticipated operational containment integrity and other vital functions in the event of a postulated accident. The ability to perform an orderly shutdown and cooldown of the other unit in the event of an accident is not significantly impaired and it is concluded that GDC 5 and RG 1.81 are met.

STD DEP 8.3-1

(2) GDC 17—Electric Power Systems

As shown in Figure 8.3-1, each of the Class 1E divisional ~~6.9~~ 4.16 kV M/C buses can receive power from multiple sources. There are separate utility feeds from the offsite transmission network (via the main power transformer, the unit auxiliary transformers, and the reserve auxiliary transformers).

8.2.2.2 Failure Modes and Effects Analysis (FMEA)

8.2.2.2.1 Introduction

This subsection provides a description of the failure modes and effects analysis (FMEA) for the "Offsite Power System" for the STP 3 & 4 units. This specific FMEA is a supplement and is provided for each of the following in accordance with RG 1.206:

- Transmission Line Towers
- Transmission Line Conductors
- 345 kV Switchyard
- Circuit Breakers
- Disconnect Switches
- Main Power Transformers (MPTs)

- Reserve Auxiliary Transformers (RATs)

Regulatory Guide 1.206 requires that an FMEA be performed on Switchyard components to assess the possibility of simultanious failure of both prefered circuits as a result of single event.

8.2.2.2.2 Analysis

Outage data on the 345 kV transmission lines of current experience is given in Table 8.2-3.

8.2.2.2.2.1 Transmission Line Tower(s) Failure Mode Evaluation

The 345 kV towers that will be constructed for STP 3 & 4 and the STP 1 & 2 transmission line towers that will be reworked for STP 3 & 4 are designed and constructed using the same type of design as the existing towers for STP 1 & 2. All towers for STP 1 & 2 are grounded with either ground rods or a counterpoise ground system. All transmission line towers are constructed and grounded using the same methods.

Failure of any one tower due to structural failure can at most disrupt and cause a loss of power distribution to only those circuits on the tower. The spacing of the towers between adjacent power circuits is designed to account for the collapse of any one tower.

Therefore, one of the preferred sources of power remains available for this failure mode in order to maintain the containment integrity and other vital functions in the event of a postulated accident(s).

8.2.2.2.2.2 Transmission Line Conductor(s) Failure Mode Evaluation

The transmission lines have conductors installed or resized with replacement conductors to the proper load carrying conductor size in order to accommodate the additional capacity as a result of STP 3 & 4.

Failure of a line conductor would cause the loss of one preferred source of power but not more than one.

Therefore, a minimum of one preferred sources of power remains available for this failure mode in order to maintain the containment integrity and other vital functions in the event of a postulated accident(s).

8.2.2.2.2.3 345 kV Switchyard Failure Mode Evaluation

As indicated in Figure 8.2-3 and 8.2-4, a breaker-and a-half scheme is incorporated in the design of the 345 kV switchyard for STP 3 & 4. The 345 kV equipment in the switchyard are all rated and positioned within the bus configuration according to the following criteria in order to maintain load flow incoming and outgoing from the units.

- Equipment continuous current ratings are chosen such that no single contingency in the switchyard (e.g., a breaker being out of for maintenance) can result in current exceeding 100 percent of the continuous current rating of the equipment.
- Interrupting duties are specified such that no faults occurring on the system exceed the equipment rating.
- Momentary ratings are specified such that no fault occurring on the system exceeds the equipment momentary rating.
- Voltage ratings are specified to be greater than the maximum expected operating voltage.

The breaker-and-a-half switchyard arrangement offers the following flexibility to control a failed condition within the switchyard:

- Any faulted transmission line into the switchyard can be isolated without affecting any other transmission line.
- Either bus can be isolated without interruption of any transmission line or other bus.
- Each battery charger is connected to a 480 VAC distribution panel board located in the STP 3 & 4 345 kV switchyard control house. The 345 kV switchyard 125 VDC systems are independent of the unit non-Class 1E and unit Class 1E battery systems.
- A primary and secondary relaying system is included on each of the six 345 kV transmission circuits from the STP 3 & 4 345 kV switchyard to the ERCOT grid. All relay schemes used for protection of the offsite power circuits and the switching station equipment include primary and backup protection features. All breakers are equipped with dual trip coils. Each protection circuit which supplies a trip signal is connected to a separate trip coil.
- Instrumentation and control circuits of the main power offsite circuit (i.e., normal preferred power circuit) are separated from the instrumentation and control circuits for the reserve power circuit (i.e., alternate preferred power circuit)
- The current input for the primary and secondary transmission circuit relaying systems is supplied from separate sets of circuit breaker bushing current transformers. The potential input for the primary and secondary transmission circuit relaying systems is supplied from fused branch circuits originating from a set of coupling capacitor potential devices connected to the associated transmission circuit. The control power for the primary and secondary transmission circuit relaying systems is supplied from separate 345 kV switchyard 125 VDC systems.
- A primary and secondary relay system is included for protection of each of the STP 3 & 4 345 kV switchyard buses. The zone of protection of each 345 kV bus protection system includes all the 345 kV circuit breakers adjacent to the protected bus. The primary relay is the instantaneous high impedance type used for bus

protection to detect both phase and ground faults. This relay is connected in conjunction with auxiliary relays and pilot wire relaying to form a differential protection, instantaneous auxiliary tripping, and transferred tripping relay system. The secondary relay system and pilot wire relaying is a duplicate of the primary relay system.

- The current input for the primary and secondary 345 kV bus relaying systems is supplied from separate sets of 345 kV circuit breaker bushing current transformers. The control power for the relay terminals of the primary and secondary 345 kV bus relaying systems located in the STP 3 & 4 345 kV switchyard control house is supplied from separate 345 kV switchyard 125 VDC systems.

- A primary and secondary relay system is included on each of the circuits connecting the MPT(s) and the RAT(s) to their respective STP 3 & 4 345 kV switchyard position. The zone of protection of each of the MPT(s) circuit connection protection system includes two associated circuit breakers at the STP 3 & 4 345 kV switchyard and the high side bushings of the MPT(s). The secondary relay system is a duplicate of the primary relay system.

- The current input for the primary and secondary MPT and the RAT circuit connection relaying systems are supplied from separate sets of 345 kV circuit breaker bushing current transformers, MPT and RAT transformer bushing current transformers. The control power for the relay terminals of the primary and secondary MPT circuit connection relaying systems located in the STP 3 & 4 345 kV switchyard control house are supplied from separate 345 kV switchyard 125 VDC systems. The control power for the relay terminals of the primary and secondary MPT and RAT circuit connection relaying systems located at the unit relay room are supplied from the respective unit non-Class 1E 125 VDC battery systems.

- Spurious relay operation within the switchyard that trips associated protection system will not impact any primary or backup system.

Therefore, a minimum of one preferred source of power remains available for this failure mode in order to maintain the containment integrity and other vital functions in the event of a postulated accident(s).

8.2.2.2.2.4 Circuit Breakers Failure Mode Evaluation

As indicated in Figures 8.2-3 and 8.2-4, a breaker-and-a-half scheme is incorporated in the design of the 345 kV switchyard for STP 3 & 4. The 345 kV equipment in the switchyard are rated and positioned within the bus configuration according to the following criteria in order to maintain load flow incoming and outgoing from the units:

- Circuit breaker continuous current ratings are chosen such that no single contingency in the switchyard (e.g., a breaker being out for maintenance) will result in a load exceeding 100 percent of the nameplate continuous current rating of the breaker.

- Interrupting duties are specified such that no fault occurring on the system, operating in steady-state conditions will exceed the breaker's nameplate interrupting capability.
- Any circuit breaker can be isolated for maintenance or inspection without interruption of any transmission line or bus.
- A fault in a tie breaker or failure of the breaker to trip for a line or generator fault results only in the loss of its two adjacent circuits until it can be isolated by disconnect switches.
- A fault in a bus side breaker or failure of the breaker to trip for a line or generator fault results only in the loss of the adjacent circuits and the adjacent bus until it can be isolated by disconnect switches.

In addition to the above described STP 3 & 4 345 kV switchyard relaying systems, each of the 345 kV circuit breakers has a primary protection rely and a backup protection relay. The primary relay is a different type or manufacture from the backup relay. This will preclude common mode failure issues with the protection relays.

The primary and secondary relaying systems of the STP 3 & 4 345 kV switchyard are connected to separate trip circuits in each 345 kV circuit breaker. The control power provided for the 345 kV switchyard primary and secondary relaying protection and breaker control circuits consists of two independent 125 VDC systems.

8.2.2.2.2.5 Disconnect Switch(s) Failure Mode Evaluation

All 345 kV disconnect switches have a momentary rating higher than the available short circuit level. The disconnect switches are implemented into the switchyard configuration to isolate main power circuits that have failed or are out for maintenance. A failure of the disconnect switch results only in the loss of its two adjacent circuits.

Therefore, a minimum of one preferred source of power remains available for this failure mode in order to maintain the containment integrity and other vital functions in the event of a postulated accident(s).

8.2.2.2.2.6 Main Power Transformers (MPTs) Failure Mode Evaluation

A primary and secondary relay system precludes any failure interruption of power to the plant as a result of a lost or damaged MPT(s).

Failure of any MPT will require a transfer of power to the standby RATs. Each RAT has a rating equal or greater to that of a UAT and the capability to supply all Engineered Safety Feature buses in a unit.

8.2.2.2.2.7 Reserve Auxiliary Transformers (RATs) Failure Mode Evaluation

The RAT(s) serve as a standby transformer to the UAT(s) associated with the respective unit and an alternate path to offsite power. Each RAT has the capacity to supply all Engineered Safety Feature (ESF) buses in a unit.

Failure of any transformer will result in a manual transfer of the sources of power for the 13.8kV plant generation buses, plant investment protection buses and ESF buses and will be initiated by the operator from the control room.

8.2.2.2.3 Conclusion

The finding of the FMEA is that there are no single failures which can prevent the "Offsite Power System" from performing its function to maintain the anticipated operational containment integrity and other vital functions in the event of a postulated accident(s).

8.2.2.3 Grid Analysis

This subsection provides an analysis in accordance with RG 1.206.

An interconnection study (Reference 8.2-3) was performed by the transmission companies for steady state short circuit and stability analysis. These steady state analyses are performed for single and double circuit contingency on the 345 kV transmission system surrounding STP. The details as stated in Subsection 8.2.1.2.1 describing the offsite power system are met in accordance with North American Electric Reliability Corporation, ERCOT, TCC, and CenterPoint Energy planning criteria. These studies further demonstrate that the loss of any double-circuit 345 kV transmission line, the loss of any two 345 kV transmission circuits, or the loss of all circuits on any single independent right-of-way do not endanger the supply of offsite power required for starting, operation, and safe shutdown of STP 3 & 4.

A short circuit analysis has been performed as part of the interconnection study. The calculated maximum short circuit level at the STP 3 & 4 switchyard is less than the equipment short circuit criteria rating.

Stability studies were undertaken to evaluate the dynamic stability performance of both the proposed expansion and the existing STP power plants during transmission disturbances. Three phase fault initiated tripping events involving existing STP 1 & 2 switchyard, STP 3 & 4 switchyard and the Hillje 345 kV switchyard transmission outlets were simulated. These cases included all the possible double circuit tower outage combinations, as well as selected pairs of independent line outages. All 345 kV transmission lines cleared the faults within 4 cycle duration. The simulation results indicate stable operation of the existing STP 1 & 2 and STP 3 & 4 for all second level transmission line contingency conditions. The stability of the grid is fully maintained when considering the loss of the largest generation source, STP 3 & 4, based on the interconnection study (Reference 8.2-3).

Based on this interconnection study (Reference 8.2-3), the preferred sources of power are maintained across the associated power grid and will remain available to maintain the anticipated operational containment integrity and other vital functions in the event of a postulated accident(s).

ERCOT uses a real time contingency analysis to determine the condition of the grid for a multitude of single contingencies. For STP 3 & 4, ERCOT will run single

contingencies for loss of largest generation and critical transmission lines like the analysis performed for STP 1 & 2 via the requirements of ERCOT's Protocols, Operating Guides and Procedures (Reference 8.2-6). During periods of instability or when analyzed switchyard voltages are lower than the allowed limit, the transmission operator will notify STP 3 & 4.

8.2.2.3.1 Grid Availability

ERCOT is composed of bulk power systems. The organization of ERCOT includes an engineering subcommittee which conducts joint studies by testing the adequacy of the bulk power system. The studies performed jointly by the members of the ERCOT Engineering Planning Subcommittee include steady-state load flow, transient stability, and loss-of-load probability (generation planning). The load flow and transient stability cases are designed to test the ERCOT bulk power planning criteria for reliability. Of primary importance in these ERCOT studies is the adequacy of the interconnection and bulk power system (primary 345 kV) to provide import capability to any system.

ERCOT relies on the TSPs to interconnect generation and loads to the ERCOT grid. For generators, an interconnection agreement is entered and provides rules and operating requirements. STP 3 & 4 interconnection agreement is expected to be similar to the STP 1 & 2 interconnection agreement. STP 1 & 2 agreement (Reference 8.2-5) requires the TSPs to support the needs of the nuclear plant for real time operation of the grid and for long term planning studies, including increased loading of the transmission system and new generation facilities.

The major load areas of the ERCOT system are interconnected by a 345 kV transmission network. The 345 kV voltage level is used for the bulk transmission system because it provides a high degree of reliability and has sufficient transport capability between the major load and generation areas.

The 345 kV transmission systems from STPEGS to the ERCOT grid are designed with sufficient BIL to endure expected lightning and switching surge voltage and expected insulator contamination. Design of transmission towers and circuit components conform to industry requirements. Studies and outage data in Table 8.2-3 demonstrate that offsite power for safe shutdown of the electrical system is highly reliable and no improvement in line outage rate is experienced.

8.2.3 Interface Requirements

The following site-specific supplements address the interface requirements for this subsection. STP 3 & 4 Offsite Power System meets the design bases assumptions, as referenced below:

(1) Reference Subsection 8.2.1.2.

(2) Reference Subsection 8.2.1.2.1.

(3) Reference Subsection 8.2.1.2.1.

(4) Reference Subsections 8.2.1.2, 8.2.1.2.1, 8.2.1.2.2 and 8.2.1.2.3.

(5) Reference Subsections 8.2.1.2.3.

(6) Reference Subsections 8.2.1.2, 8.2.1.2.1, 8.2.1.2.2 and 8.2.2.2.2.3 and Figure 8.2-1.

(7) Reference Subsections 8.2.1.2, 8.2.1.2.2 and 8.3.2.

8.2.4 COL License Information

8.2.4.1 Periodic Testing of Offsite Equipment

The following site-specific supplement addresses COL License Information Item 8.2.

Offsite power systems are designed to test periodically: (1) the operability and functional performance of the components of the offsite power systems, such as onsite power sources, relays, switches, circuit breakers, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system and the onsite power system. Procedures will be developed prior to fuel load to include periodic testing and/or verification of the following items 1-9~~8~~. These will be established to be consistent with the requirements of GDC 18 and the plant operating procedure development plan in Section 13.5 (COM 8.2-1). The procedures will provide for the following:

(1) Verify normal offsite power circuit to be energized and connected to the appropriate Class 1E distribution system division and alternate offsite power circuit to be energized at least once every 12 hours.

(2) Maintenance, calibration and functional test for instrumentation, control, and protection systems, equipment, and components associated with the normal and alternate offsite preferred circuits. Calibration of instrumentation and functional tests include tolerances for relays and meters such that minimum operable voltages for offsite power will not be exceeded, based on the design of the system. Functional test will be performed on transformers with load tap equipment including the controller. The test procedures include expected effects on the distribution system and equipment during the test. Relay testing will be performed periodically in accordance with applicable industry standards or industry accepted practice.

(3) The required Class 1E and non-Class 1E loads can be powered from their designated preferred power supply within the capacity and capability margins specified in Tier 2 for the offsite system circuits.

(4) Functional testing of undervoltage schemes that detect the loss of the offsite preferred power supply.

(5) Preferred power supplies switching

(6) Surveillances for the batteries and chargers meet accepted industry standards for their design load profiles and recharge times. Battery discharge testing will be performed periodically in accordance with applicable industry standards or industry accepted practice.

(7) Maintenance and functional test for the generator breaker.

(8) Isolated and non-segregated phase bus ducts are inspected and maintained such that they are clear of debris, fluids, and other undesirable materials. Also, terminals and insulators are inspected, cleaned and tightened, as necessary.

(9) Potential and power transformer testing, ground grid testing, arrester testing, and circuit breaker timing tests will be performed periodically in accordance with applicable industry standards or industry accepted practice.

The test and inspection intervals will be established and maintained according to the guidelines of IEEE-338, Section 6.5, as appropriate for non-Class 1E systems (i.e., Items (4) and (7) of Section 6.5.1 are not applicable), except as specifically noted above.

8.2.4.2 Procedures when a Reserve or Unit Auxiliary Transformer is Out of Service

This subsection of the ABWR DCD is replaced in its entirety with the following site-specific supplement which addresses COL License Information Item 8.3.

Technical Specifications limit plant operation whenever one of the unit auxiliary or both of the reserve auxiliary transformers is inoperable.

8.2.4.3 Offsite Power Systems Design Bases

The following site-specific supplement addresses COL License Information Item 8.4.

The interface requirements in Subsection 8.2.3 pertaining to offsite power systems have been adopted as design bases for STP 3 & 4.

8.2.4.4 Offsite Power Systems Scope Split

The following site-specific supplement addresses COL License Information Item 8.5.

The interface requirements in Subsection 8.2.3 pertaining to offsite power systems scope split have been adopted as design bases for STP 3 & 4.

8.2.4.5 Capacity of Auxiliary Transformers

This subsection of the ABWR DCD is replaced in its entirety with the following site-specific supplement which addresses COL License Information Item 8.6.

Procedure(s) that provide limits to assure that the ONAF ratings of the unit auxiliary or reserve auxiliary transformers are not exceeded under any operating mode will be

developed before fuel load consistent with the plant operating procedure development plan in Section 13.5. (COM 8.2-2)

8.2.5 Conceptual Design

The conceptual design information in this section is replaced with the following site-specific supplement.

For site-specific design of the STP 3 & 4 Offsite Power System refer to Subsections 8.2.1.2, 8.2.1.3, and 8.2.3.

8.2.6 References:

The following site-specific supplement adds new references.

8.2-3 American Electric Power Service Corporation, Center Point Energy Houston Electric, LLC, CPS Energy, and Austin Energy, Interconnection Study for New Generation in Matagorda County, Interim report for Generation 15INR008, June, 2007.

8.2-4 Weatherbase. (2007). *Historical Weather for Houston, Texas.* Retrieved August 22, 2007 from http://www.weatherbase.com/weather/

8.2-5 South Texas Project Interconnection Agreement between Reliant Energy, Incorporated; Central Power and Lighting Company; City of San Antonio, Texas; City of Austin, Texas; and STP Nuclear Operating Company, Effective date August 15, 2002.

8.2-6 ERCOT Protocols, Operating Guides and Procedures online at: http://www.ercot.com

Table 8.2-1 Additional Requirements IEEE-765	
IEEE-765 Reference	**Requirement or Explanatory Note**
7.0 Multi-Unit Considerations	~~*The ABWR is a single unit design, therefore*~~ The STP 3 and 4 plant is a dual ABWR plant, but *there is no sharing of preferred power supplies between units.*

Table 8.2-2 Tranmission Lines Providing Offsite Power To South Texas Project Electric Generating Station STP 3 & 4

Transmission Line	Ownership	Nominal Operating kV	Right-of-Way	Approximate Line Length (mi)
Elm Creek 27	CPS Energy	345 kV	NW	155
Hillje 44	CNP	345 kV	NW	20
White Point 39	AEP	345 kV	NW	133
Velasco 27	CNP	345 kV	E	45
Blessing 44	AEP	345 kV	W	15
STP 1 & 2	AEP	345 kV	E	0.5

Table 8.2-3 Transmission Line Historical Data on Outages Due to Circuit Breaker Actuations STP Unit 1 & 2

Failure Description	No. of Incidents (1980 - 2006)	
	Instantaneous	Lock-out
Airplane/Foreign Object into Circuit	1	6
Breaker Failure	1	8
Broken Insulator	8	7
Broken Conductor	0	5
Electrocution (Bird/Human)	0	2
Insulator Flashover Contamination	19	36
Lightning	56	13
Personnel Error	2	14
Relay Mis-operation	9	11
Trees / Vines into Circuits	4	10
Unknown	103	63
Weather Related	53	94

The following figure is located in Chapter 21:

- ***Figure 8.2-1 Power Distribution System Routing Diagram (Sheets 1-7)***

A site-specific supplement adds the following figures in Chapter 21:

- **Figure 8.2-2 345 kV General Arrangement**
- **Figure 8.2-3 345 kV Switchyard Single Line Diagram**
- **Figure 8.2-4 345 kV Switchyard Arrangement**
- **Figure 8.2-5 345 kV Transmission Configuration Map**
- **Figure 8.2-6 Topographic Map of 345 kV Transmission Line (Blessing SE Line)**