SECTION 5

Transmission System Engineering

5.1 Introduction

Section 5 discusses the transmission interconnection between the proposed Eastshore Energy Center (Eastshore) and the existing electrical grid and the anticipated impacts that operation of Eastshore will have on the flow of electrical power in the local and regional transmission systems. To better understand the impacts of the proposed power plant on the regional transmission system and power flows, the analysis presented in Section 5.2 will focus on (a) the existing electrical transmission system in the immediate area of Eastshore, (b) the proposed electrical interconnection between Eastshore and the electrical grid, and (c) the proposed interconnecting transmission line route. The discussion will also examine the impacts of the electrical interconnection on the existing electrical transmission grid. Alternatives to the proposed interconnection and line alignments are discussed in Section 5.3. Section 5.4 describes the anticipated system impacts of the proposed interconnection to the PG&E transmission systems. A detailed review of the proposed power generation plant on the local and regional network can be found in the attached System Impact Study (SIS) Report provided in Appendix 5A.

Additional discussions provided in Section 5.5 focus on potential nuisances (e.g., electrical, magnetic, audible noise, and corona effects), and safety associated with the proposed interconnection line. A description of applicable laws, ordinances, regulations, and standards (LORS) is provided in Section 5.6. Finally, a list of references applicable to the discussions can be found in Section 5.7.

The site for Eastshore was selected, in part, for its proximity to the anticipated load, existing transmission corridors, and the potential interconnection substation. PG&E has several transmission and distribution lines and one major substation near the proposed power plant. It owns and maintains the Grant-Eastshore (double-circuit) 115-kV transmission line, which passes approximately 4,200 feet west of the site, and the San Mateo-Eastshore (double-circuit) 230-kV transmission line, which is located approximately 1.5 miles south of the proposed power plant site. Figure 5.1-1 (all figures are at the end of this section) shows the proposed Eastshore site in relation to the relevant transmission resources in the immediate area.

Eastshore will be connected directly to PG&E's Eastshore Substation through a radial 115-kV interconnection transmission line, which will be designed, built, and operated by PG&E along its existing 12-kV distribution lines, located on the east side of Clawiter Road. The exact routing of this interconnection transmission line will be determined during PG&E's route survey and detailed design. An alternative route, which was investigated by Eastshore Energy, LLC, and PG&E, would have paralleled the Union Pacific Railroad Company (UPRR) tracks, which run in a southerly direction from the Eastshore site and intercepts the existing 230-kV lines on the south side of Highway 92. However, this route was determined to be infeasible by PG&E because of physical constraints, close proximity to and potential encroachment of the transmission line into the UPRR ROW, and limited space for an overhead or underground 115-kV line.

The initial examination of the local transmission system concentrated on anticipated Eastshore power flows, the capacity and location of existing transmission lines, the availability of substation capacities, and the physical distances involved with the anticipated electrical interconnection. The selection of the 115-kV transmission interconnection was made based on PG&E's recommendation to deliver power into its 115-kV bus at the Eastshore Substation to reduce the loading of the two existing 230-kV-115-kV network transformers. Thus, the power delivered to the 115-kV bus would flow directly into the local 115-kV distribution network instead of being transformed from the 230-kV bus power across the already fully loaded transformers.

The feasibility analysis for delivering the 115-kV power to the Eastshore Substation focused on two key alternatives, namely to tap to the existing PG&E 115-kV/Grant-Eastshore 115-kV transmission line to build a radial line between the project site and the Eastshore Substation. Tapping the 115-kV line was determined to be infeasible because of the limited capacity of the existing Grant-Eastshore 115-kV circuits, which would require extensive re-conductoring of the line(s) and potentially affect the reliability of the transmission system in the area. In the final analysis, the choice was made to construct a radial line between the proposed plant substation and PG&E's Eastshore Substation. This is the alternative selected by PG&E in the Eastshore facility study.

The proposed radial line was evaluated with two alternative routes, one following the existing PG&E 12-kV distribution lines along Clawiter Road, and the other paralleling the UPPR ROW. The former, favored by PG&E, would use the existing distribution line ROW and would require relocating approximately 3,900 feet of 12-kV overhead conductors on the new steel or wood poles that would also carry the 115-kV conductors. This would result in re-installing the 12-kV lines on 10 to 12 new poles that would be interposed between the existing wood poles. The 12-kV lines would be installed under the new 115-kV lines (underbuilt configuration). The extent of the relocation and underbuilding of the 12-kV lines will be determined during the detailed design phase that will be undertaken by PG&E as part of the interconnection facilities development. Figure 5.1-1 shows these features of the electrical system as superimposed on an aerial photograph to compare the proposed components (plant site, interconnection corridor, and substation locations) with geographic features and recent commercial development of the area.

Primary consideration in the analysis was given to the ability of the existing transmission lines to carry the anticipated Eastshore output. Additional aspects considered included environmental effects of building and maintaining the new interconnecting transmission line, ROW modification(s) and acquisition, engineering requirements, and costs. Alternative interconnection options were identified after analyses of these data, and review of the PG&E system maps and one-line diagrams for their respective service areas. From these alternatives, the proposed transmission line alignment, interconnection configuration, and construction techniques were selected.

5.2 Transmission Interconnection Engineering

Conceptual engineering of the proposed 115-kV transmission line was performed by PG&E based on the results of the interconnection feasibility studies performed by Eastshore Energy, LLC, and subsequently by PG&E. This section discusses the existing transmission facilities near the proposed Eastshore site and the basis of the selection of the proposed 115-kV transmission line.

5.2.1 Existing Transmission Facilities

The proposed power plant site is located on Clawiter Road near the intersection with Depot Road and near the UPRR ROW. The two nearest transmission lines are the Grant-Eastshore 115-kV transmission line located approximately 0.8 miles west of the Eastshore site and the Eastshore-San Mateo-Pittsburg (double-circuit) 230-kV transmission line, which runs approximately 1.5 miles south of the proposed Eastshore site. As previously stated, the Grant-Eastshore 115-kV transmission line was not selected because of capacity constraints. The Eastshore-San Mateo-Pittsburg 230-kV transmission line was not selected because it does not meet a basic project objective to deliver electricity at 115 kV.

The SIS performed by PG&E for Eastshore examined the local and regional loads, the ratings of the existing 115-kV and 230-kV transmission systems, and the ability of the existing transmission grid to safely and reliably transmit the anticipated nominal capability (115 MW net) of Eastshore. These factors were reviewed during the system analyses. The results of the system impact studies, coupled with the physical location of the transmission resources to the Eastshore site, aided in the selection of the proposed interconnection and selected alternatives.

5.2.2 Proposed Transmission Interconnection Line

The proposed 115-kV interconnection line will start at the dead-end structure inside the plant switchyard on the northeast corner of the power plant. The transmission line will then proceed directly across Clawiter Road and turn south to parallel the existing 12-kV distribution wood-pole line in a southerly direction for about 2,700 feet to the corner of Clawiter Road and Breakwater Court intersection. From that point, the transmission line will head east for approximately 700 feet and then cross Highway 92 just south of the Clawiter Road overpass. The total length of this segment of the 115-kV interconnection line between the Eastshore site and the south end of the Highway 92 crossing is approximately 3,600 feet. The 115-kV transmission line will be installed on steel or wood poles, which will be interposed between the existing distribution poles used by the 12-kV distribution lines. The existing distribution line consists of two 12-kV circuits installed on wood poles, which are spaced with an average span of 130 feet, whereas the 115-kV transmission line would have a ruling span of about 350 to 400 feet. Some of the transmission line poles will also support the 12-kV circuits in an underbuilt configuration permitting elimination of a number of distribution poles along the transmission line corridor. The disposition of the existing riser poles, pole-mounted transformers, and capacitor banks will be finalized during PG&E's detailed design phase for the transmission line.

After the 115-kV transmission line crosses Highway 92, it will continue south for another 2,200 feet to the 115-kV bus inside of Eastshore Substation. Approximately 600 feet runoff additional line might be necessary in the Eastshore Substation.

It is anticipated that the new 115-kV line from the Eastshore switchyard to a point south of Highway 92 will use almost the entire 12-kV distribution ROW. Additional transmission line corridor will also be added, as required, for the 115-kV line to provide clearances and address operational and maintenance criteria required by GO-95. In addition the new transmission line will conform to the recent EMF Guidelines for Electrical Facilities prepared in response to CPUC Decision 06-01-042.

5.2.3 Power Plant Switchyard

The Eastshore 115-kV switchyard consists of two 60 percent step-up transformers (GSUs) and associated 115-kV gas-insulated circuit breakers, disconnect switches, and interconnecting bus structures. The proposed double-transformer bank configuration will be used inside of the plant switchyard to provide a higher level of reliability and ease of maintenance. An electrical single-line diagram of the proposed Eastshore switchyard is shown on Figure 5.2-1. The switchyard general arrangement layout is shown on Figure 5.2-2.

The switchyard and all associated equipment will be designed for 3,000 amperes (A) continuous current and a 63 kilo ampere interrupting capacity (kAIC). As shown on Figure 5.2-1, each cluster of seven generator sets will be provided with an independent tie to the respective GSU inside the plant switchyard. These 15-kV feeders will be installed in underground conduits and will connect to the low side of the GSUs. The high-side bus, consisting of rigid aluminum bus structures, or strain bus, will be connected to the new 115-kV transmission line through 35-foot dead-end structures on the southeast end of the switchyard.

Two redundant 13.8-kV auxiliary power transformers will be connected individually to the respective 15-kV metal-clad switchgear. This switchgear will collect power from a cluster of seven generator sets and distribute it to the respective GSUs. The auxiliary power transformers will provide power to all auxiliary loads within the Eastshore facility. Startup and standby power would be supplied from the grid through the GSU, which will backfeed 13.8-kV power into the power plant 15-kV switchgear and to the respective auxiliary transformers. Alternately, startup and standby power might be provided by a separate 480V services, which is currently provided to the Eastshore site by PG&E. In emergencies (black start), an emergency service, diesel-fired 225- kW generator will deliver 480V power sufficient for running the auxiliaries needed to start one Wartsila 20V34SG engine or generator set, which, when running, will provide the power required for startup of the remaining facility.

Auxiliary controls and protective relay systems for the 115-kV plant switchyard will be in a controlled enclosure on the west side of the plant switchyard.

5.2.4 Overhead Transmission Line Characteristics

The proposed interconnecting transmission circuits will be designed to carry 115 kV in a single-circuit configuration, supported by steel or wood pole structures placed at appropriate intervals. The recommended conductor type is 715.5 kcmil AL, as proposed by PG&E in the facility study. The selection of the type of poles for the 115-kV transmission line will be determined by the exact route and use of the existing distribution line ROW. It is anticipated that the majority of the existing wood poles will be left in place, and others will be replaced with steel poles or taller and heavier (Class H1) wood poles to accommodate the transmission and distribution lines. The dead-end poles, heavy-angle poles and tangent-type poles will be steel or wood poles.

The proposed 115-kV transmission line will exit the Eastshore switchyard in a slack span configuration from the dead-end structures, approximately 35 feet tall in the northeast corner of the Eastshore site (Figure 5.1-1). The exit span will be approximately 150 feet in length and will connect the pull-off structures to a new heavy-angle pole structure, which will be located on the east side of Clawiter Road across the plant switchyard. From that degree-angle pole, the 115-kV transmission line will travel in the southerly direction following the existing 12-kV distribution line with an average span of 350 to 400 feet. Depending on the final routing of the 115-kV transmission line, some of the transmission line poles may be interposed between the existing distribution line poles, or replace the existing wood poles to minimize the congestion and to provide proper support for both lines. Heavy-angle structures will be placed at several locations along the entire 1.1 miles of the 115-kV transmission lines to accommodate changes in direction of the line. The remaining new pole structures will be tangent-type design and will be spaced based on engineering criteria. Figure 5.2-3 is a conceptual design of a typical single-circuit steel-pole or wood-pole structure proposed for the interconnection. Figure 5.2.4 shows the similar poles with 12-kV underbuilt distribution line. A “family” of structures based on this design will be developed to address the physical parameters of the route and the optimum use of the available ROW. The new pole structures will be approximately 90 feet tall, except for the two 95-foot steel-pole structures, which will be placed on each side of Highway 92 to provide additional clearance over the freeway, spanning approximately 120 feet. The detail design for this overhead crossing will comply with rules and regulations established by GO-95 and the California Department of Transportation (Caltrans).

5.3 Transmission Interconnection Alternatives

Eastshore Energy, LLC, and PG&E have examined three different routing options for the 115-kV interconnection transmission line, resulting in the following comparative analysis:

Alternative Route 1: The 115-kV transmission line would use the existing PG&E’s distribution line ROW to the maximum extent possible, with several spots requiring additional easement from private landowners. This route would result in replacement of some of the existing 12-kV distribution lines that run in the east side of Clawiter Road and across Highway 92. The 115-kV transmission line would then follow an independent route on the west side of Highway 92 crossing several blocks of commercial and industrial development areas just north of the Eastshore Substation.

This route would result in a temporary disruption to the distribution lines, and would require temporary connections and re-routing of some of the local distribution lines. This option would also be costly and cause schedule delays. However, it would significantly improve the condition and reliability of the existing 12-kV distribution lines.

Alternative Route 2: The 115-kV transmission line would follow the UPRR ROW for approximately 4000 feet, and then parallel the existing PG&E's 230-kV corridor approximately 1850 feet west to the Eastshore Substation. A portion of the 115-kV transmission line along the UPRR ROW would be underground and the rest of the line would be overhead. The design of the underground line would include trenches, pull boxes, and cables in conduit. The overhead portion of the line would be installed on steel or wood poles and appropriate support structures, without any co-location with existing overhead lines.

This option would result in higher cost than Alternative Route 1 because of the underground 115-kV installation over a significant distance and would result in potential schedule delay due to requirements for "interference" studies and with the high likelihood that UPPR would not grant ROW access.

Alternative Route 3: The 115-kV transmission line would tap into the existing 115-kV Grant-Eastshore transmission line, which runs approximately one mile west of the project site. The proposed 115-kV transmission tap line would follow Route 1, then turn west along Enterprise Avenue and connect to the existing 115-kV Grant-Eastshore line approximately 0.4 mile west of Clawiter Road. However, this option was rejected by PG&E during the facility study because of the complexity of the tap connections and the need to reconductor up to 10 mile of various segments of the existing 115-kV circuits beyond the tap points. The cost of such re-conductoring would be extremely high and the interruption in the operation of this line would have been unacceptable to PG&E and CAISO.

5.4 Transmission Interconnection System Impact Studies

Because it is located in a heavy load area, Eastshore is unique in that it will enhance the reliability and availability of the 115-kV network in the area. The SIS performed by PG&E for Eastshore has concluded that the addition of Eastshore would cause no normal Category B or Category C events. The study also determined that the transmission system's transient performance, relative to California ISO reliability guidelines, would not be adversely affected by Eastshore. The SIS did not find any overstressed circuit breakers inside the Eastshore Substation, or other affected transmission substations in the area. A copy of the draft study is provided in Appendix 5A. Based on this study, there are no grid impacts that require remediation.

5.5 Transmission Interconnection Safety and Nuisances

This section discusses safety and nuisance issues associated with the proposed electrical interconnection of Eastshore with the electrical grid. Construction and operation of the proposed overhead transmission line will be undertaken in a manner that ensures the safety of the public, as well as maintenance and ROW crews, while supplying power with minimal electrical interference.

5.5.1 Electrical Clearances

The proposed 115-kV interconnection line will be installed overhead 1.1 miles in length, and will be constructed with bare overhead conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The overhead transmission line will be built, owned, and operated by PG&E as part of its 115-kV network in the area.

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to safe operation of the line. The safety clearance required around the conductors is determined by normal operating voltages, conductor temperatures, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in GO-95 and the National Electric Safety Code (NESC). Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for the following:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features, such as roadways, railroads, driveways, parking lots, navigable waterways, airports
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The proposed Eastshore transmission interconnection will be designed to meet all national, state, and local code clearance requirements.

5.5.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories—corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware due to very high electric field strength at the surface of the metal during certain conditions. Corona could result in radio and television reception interference, audible noise, light, and production of ozone. Corona is a function of the voltage of the line, the diameter of the conductor (or bundle of conductors), and the condition of the conductor and hardware. Field effects are the voltages and currents that could be induced in nearby conducting objects. The proposed transmission line 60 hertz (Hz) electric and magnetic fields cause these effects.

Operating power lines, like the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hertz (Hz), meaning that the intensity and orientation of the field changes 60 times per second.

The 60 Hz power line fields are considered to be extremely low frequency. Other common frequencies are AM radio, which operates up to 1,600,000 Hz (1,600 kHz); television, 890,000,000 Hz (890 MHz); cellular telephones, 900,000,000 Hz (900 MHz); microwave ovens, 2,450,000,000 Hz (2.4 GHz); and X-rays, about 1 billion (10^{18}) Hz. Higher frequency fields have shorter wavelengths and greater energy in the field. Microwave wavelengths are a few inches long and have enough energy to cause heating in conducting objects. High frequencies, such as x-rays, have enough energy to cause ionization (breaking of atomic or molecular bonds). At the 60 Hz frequency associated with electric power transmission, the electric and magnetic fields have a wavelength of 3,100 miles and have very low energy that does not cause heating or ionization. The 60 Hz fields do not radiate, unlike radio frequency fields.

5.5.2.1 Electric Fields

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field. The electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains practically steady and is not affected by the common daily and seasonal fluctuations in use of electricity by customers.

Table 5.5-1 presents calculated strength of electric field in two different sections of the new transmission line – one in the section that is expected to parallel or overbuild the 12-kV distribution lines, and the other section where the 115-kV lines are not affected by the 12-kV distribution lines. Figure 5.5.1(a) shows the electric field strength as a function of distance from the centerline of the poles for the segment of the transmission line that is built over the 12-kV distribution lines. Figure 5.5.1(b) shows the electric field strength in the section of the transmission line that is not encumbered by the 12-kV distribution lines.

TABLE 5.5-1
Electric Field –Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Electric Field (kV/m) Figure 5.5.1(a) [1]	115 kV (w/o 12 kV) Electric Field (kV/m) Figure 5.5.1(b)[2]
-50	0.2172	0.0435
-45	0.2217	0.0479
-40	0.2245	0.0523
-35	0.2254	0.0562
-30	0.2240	0.0590
-25	0.2199	0.0599
-20	0.2126	0.0578
-15	0.2019	0.0518
-10	0.1882	0.0408
-5	0.1745	0.0265
0	0.1700	0.0629
5	0.1817	0.0214

TABLE 5.5-1
Electric Field –Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Electric Field (kV/m) Figure 5.5.1(a) [1]	115 kV (w/o 12 kV) Electric Field (kV/m) Figure 5.5.1(b)[2]
10	0.2021	0.0421
15	0.2219	0.0440
20	0.2377	0.0517
25	0.2490	0.0568
30	0.2561	0.0595
35	0.2595	0.0603
40	0.2595	0.0596
45	0.2568	0.0579
50	0.2500	0.0556

Notes:

[1] 115-kV transmission line profile with 12 kV underbuilt circuits, as shown on Figure 5.2.4.

(a) The voltage and current ratings of the 115 kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

(b) The voltage and current ratings of the 12-kV distribution circuits are as follows:
Voltage (Phase-Phase): 12,000 V
Phase Current/conductor: 700A
Phase Configuration-Ckt 1: A-B-C (right-left)
Phase Configuration-Ckt 2: A-B-C (left-right)

[2]115-kV transmission line profile without 12-kV underbuilt circuits, as shown on Figure 5.2.3.
The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

5.5.2.2 Magnetic Fields

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss (mG). The amperes and, therefore, the magnetic field around a transmission line, fluctuate daily and seasonally as the use of electricity varies.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether or not long-term exposure to EMF is harmful. In the absence of conclusive or evocative evidence, some states, California in particular, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use low-cost techniques to reduce the levels of EMF.

EMF field strengths were calculated using the Transmission Line Parameters and Transmission Line Calculator program developed by the Safe Engineering Services & Technologies, LTD (SESTLC). SESTLC calculates the electric fields (EF) expressed as kilovolts per meter (kV/m) and the magnetic fields (EMF) expressed in milligauss.

The various inputs for the calculations include voltage, current load (amps), current angle (i.e., phasing), conductor type and spacing, number of subconductors, subconductor bundle symmetry, spatial coordinates of the conductors and shield wire, various labeling parameters, and other specifics. The field level is calculated perpendicular to the line and at mid-span where the overhead line sags closest to the ground (calculation point). The mid-span location, therefore, provides the maximum value for the field. The EF and EMF values were calculated at the level of three feet (or 1 meter) above flat terrain.

While the State of California does not set a statutory limit for electric and magnetic field levels, the California Public Utilities Commission (CPUC), which regulates electric transmission lines, mandates EMF reduction as a practicable design criterion for new and upgraded electrical facilities. As a result of this mandate, the regulated electric utilities have developed their own design guidelines to reduce EMF at each new facility. In Spring 2006, a utility workshop culminated in the development of standardized design guidelines. The California Energy Commission (CEC), which regulates transmission lines to the point of connection, requires independent power producers (IPP) to follow the existing guidelines used by local electric utilities or transmission system owners.

The magnetic field strength for the Eastshore 115-kV transmission line was calculated for two different sections of the new transmission line – one in the section that is expected to parallel or overbuild the 12-kV distribution lines, and the other section where the 115-kV lines are not affected by the 12-kV distribution lines. Table 5.5-2 lists the tabulated results of this analysis. Figure 5.5.2(a) shows the electromagnetic field strength as a function of distance from the centerline of the poles for the segment of the transmission line which is built over the 12-kV distribution lines. Figure 5.5.2(b) shows the electromagnetic field strength in the section of the transmission line that is not encumbered by the 12-kV distribution lines.

TABLE 5.5-2
Electromagnetic Field –Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Magnetic Field (mG) Figure 5.5.2(a)	115 kV (w/o 12 kV) Magnetic Field (mG) Figure 5.5.2(b)
-50	3.5	4.7
-45	4.1	5.9
-40	4.9	7.3
-35	5.8	8.9
-30	6.8	10.8
-25	7.9	12.7
-20	9.3	14.6

TABLE 5.5-2
Electromagnetic Field –Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Magnetic Field (mG) Figure 5.5.2(a)	115 kV (w/o 12 kV) Magnetic Field (mG) Figure 5.5.2(b)
-15	11.2	16.3
-10	13.6	17.9
-5	16.5	19.0
0	19.5	19.5
5	21.9	19.5
10	23.0	18.9
15	22.8	17.8
20	21.2	16.3
25	18.8	14.5
30	16.1	12.5
35	13.3	10.6
40	10.7	8.7
45	8.4	6.9
50	6.4	5.4

Notes:

The EMF values shown above are based on the calculation performed based on the following transmission line parameters:

(a) 115-kV transmission line profile with 12-kV underbuilt circuits, as shown on Figure 5.2.4.

(b) The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Voltage (Phase-Ground): 66,474V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

In keeping with the goal of EMF reduction, the interconnection of Eastshore will be designed and constructed using the principles outlined in the PG&E publication, "EMF Design Guidelines for Electrical Facilities." These guidelines explicitly incorporate the directives of the CPUC by developing design procedures compliant with Decision 93-11-013 and General Orders 95, 128, and 131-D. That is, when the transmission line structures, conductors, and ROWs are designed and routed according to the PG&E guidelines, the transmission line is consistent with the CPUC mandate.

From page 37 of the PG&E guidelines, the following are primary techniques for reducing EMF along the line:

1. Increase the pole height for overhead design
2. Use compact pole-head configuration
3. Minimize the current on the line
4. Optimize the configuration of the phases (A, B, C)

Upon completion of the detailed design of the proposed 115-kV transmission line by PG&E, the anticipated EMF levels will be calculated for the Eastshore interconnection as preliminarily designed. The CEC requires actual measurements of pre-interconnection background EMF to compare with measurements of post-interconnection EMF levels. If required, the pre- and post-interconnection verification measurements will be made consistent with IEEE guidelines and will provide sample readings of EMF at the edge of ROW. Additional measurements will be made by request for locations of particular concern.

5.5.2.3 Audible Noise

The audible noise for the Eastshore 115-kV transmission line was calculated for two different sections of the new transmission line – one in the section that is expected to parallel or overbuild the 12-kV distribution lines, and the other section where the 115-kV lines are not affected by the 12-kV distribution lines. Table 5.5-3 presents the tabulated results of this analysis. Figure 5.5.2.3(a) shows the audible noise (dBA) as a function of distance from the centerline of the poles for the segment of the transmission line that is built over the 12-kV distribution lines. Figure 5.5.2.3(b) shows the audible noise (dBA) in the section of the transmission line that is not encumbered by the 12-kV distribution lines.

TABLE 5.5-3
Audible Noise–Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Audible Noise (dBA) Figure 5.5.2.5(a)[1]	115 kV (w/o 12 kV) Audible Noise (dBA) Figure 5.5.2.5(b)[2]
-50	12.59	12.31
-45	12.75	12.45
-40	12.90	12.62
-35	13.04	12.75
-30	13.17	12.87
-25	13.29	12.98
-20	13.38	13.08
-15	13.46	13.15
-10	13.52	13.20
-5	13.55	13.24
0	13.57	13.25
5	13.56	13.24
10	13.52	13.20
15	13.46	13.14
20	13.38	13.07
25	13.29	12.97
30	13.17	12.86
35	13.04	12.73
40	12.90	12.60
45	12.75	12.45
50	12.60	12.29

TABLE 5.5-3
Audible Noise–Calculated Data

Distance from Right-of-Way Centerline (feet)	115 kV-12 kV (Underbuilt) Audible Noise (dBA) Figure 5.5.2.5(a)[1]	115 kV (w/o 12 kV) Audible Noise (dBA) Figure 5.5.2.5(b)[2]

Notes:

[1] 115-kV transmission line profile with 12-kV underbuilt circuits, as shown on Figure 5.2.4.

(a) The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

(b) The voltage and current ratings of the 12-kV distribution circuits are as follows:
Voltage (Phase-Phase): 12,0Voltage (Phase-Ground): 6,936V
Phase Current/conductor: 400A
Phase Configuration-Ckt 1: A-B-C (right-left)
Phase Configuration-Ckt 2: A-B-C (left-right)

[2] 115-kV transmission line profile without 12-kV underbuilt circuits, as shown on Figure 5.2.3.
The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

Audible noise was estimated using Electromagnetic Environmental Impact Analysis of Overhead AC Transmission Lines (SESEnviro) program developed by SESTLC. Also using a SESEnviro mathematical model, audible noise was calculated at a 5-foot microphone height above flat terrain with information concerning rain, snow, and fog rates for daytime and nighttime hours as input. Audible noise is expressed as A-weighted in decibels (dBA), the scale which approximates the response of the human ear.

Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage. The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Irregularities, such as nicks and scrapes on the conductor surface, or sharp edges on suspension hardware, concentrate the electric field at these locations and increase corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities. Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above.

It is important that any discussion of EMF and audible noise include the assumptions used to calculate these values and to remember that EMF and audible noise near the power lines vary with regard to line design, line loading, distance from the line, and other factors. Both the electric field and audible noise depend on line voltage, which remains nearly constant for a transmission line during normal operation. A worst-case voltage of 121 kV (115 kV + 5%) was used in the calculations for the proposed 115-kV transmission line.

The magnetic field is proportional to line loading (amperes), which varies as power plant generation is changed by the system operators to meet increases or decreases in electrical demand.

The following assumptions, commonly used by utility companies were adopted for this study.

- The line was considered loaded at 75 percent of forecasted load
- Magnetic field strength was calculated at 3 feet aboveground
- Resultant magnetic fields were used
- All line loadings were considered as balanced
- Dominant power flow directions were used

These calculations were based on the preliminary conceptual design of the interconnection facilities. Estimates for these values could change based on the final design.

5.5.2.4 Induced Current and Voltages

A conducting object, such as a vehicle or person in an electric field, will have induced voltages and currents. The strength of the induced current will depend on the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. Examples of measured induced currents in a 1 kV/m electric field are about 0.016 mA for a person, about 0.41 mA for a large school bus, and about 0.63 mA for a large trailer truck.

When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock could occur as the current flows to ground. Shocks are classified as below perception, above perception, secondary, and primary. The mean perception level is 1.0 mA for a 180-pound man and 0.7 mA for a 120-pound woman. Secondary shocks cause no direct physiological harm, but could annoy a person and cause involuntary muscle contraction. The lower average secondary shock level for an average-sized man is about 2 mA.

Primary shocks can be harmful. Their lower level is described as the current at which 99.5 percent of subjects can still voluntarily "let go" of the shocking electrode. For the 180-pound man this is 9 mA; for the 120-pound woman, 6 mA; and for children, 5 mA. The NESC specifies 5 mA as the maximum allowable short-circuit current-to-ground from vehicles, trucks, and equipment near transmission lines.

The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the ROW are grounded, and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations sufficiently low to prevent vehicle short-circuit currents from exceeding 5 mA.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or aboveground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock similar to that previously described for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those that are oriented parallel to the transmission line.

The proposed 115-kV interconnection line will be constructed in conformance with California Public Utilities Commission (CPUC) GO-95 and Title 8 CCR 2700 requirements. Therefore, hazardous shocks are unlikely to occur as a result of project construction, operation, or maintenance.

5.5.2.5 Communications (Radio or Television) Interference

The communication interference (radio or television) for the Eastshore 115-kV transmission line was calculated for two different environmental conditions applied to the new transmission line – one condition is the heavy rain condition and the other is the fair weather. Because the radio or television interference (RI) cannot be modeled for the lower voltage systems, such as 12-kV distribution lines, the RI/TV values are calculated only for the 115 kV portion of the transmission lines. Table 5.5-5 shows the results of this analysis. Figure 5.5.2.5(a) shows the RI/TV levels (dB) as a function of distance from the centerline of the poles for the heavy-rain condition, and Figure 5.5.2.5(b) shows the RI/TV levels (dB) for the fair weather condition.

TABLE 5.5-5
Radio or Television Interference –Calculated Data

Distance from Right-of-Way Centerline (feet)	115kV– Heavy Rain Radio or Television Interference (dB) Figure 5.5.2(a)[1]	115kV – Fair Weather Radio or Television Interference (dB) Figure 5.5.2(b)[2]
-50	40.9	19.3
-45	41.4	19.8
-40	41.8	20.3
-35	42.3	20.7
-30	42.7	21.1
-25	43.0	21.5
-20	43.3	21.8
-15	43.6	22.0
-10	43.8	22.2
-5	43.9	22.3
0	43.9	22.4
5	43.9	22.4
10	43.8	22.2
15	43.6	22.0
20	43.4	21.8
25	43.1	21.5
30	42.7	21.1
35	42.3	20.7
40	41.9	20.3
45	41.4	19.8
50	40.9	19.3

TABLE 5.5-5
Radio or Television Interference –Calculated Data

Distance from Right-of-Way Centerline (feet)	115kV– Heavy Rain Radio or Television Interference (dB) Figure 5.5.2(a)[1]	115kV – Fair Weather Radio or Television Interference (dB) Figure 5.5.2(b)[2]

Notes:

[1] 115-kV transmission line profile with 12-kV underbuilt circuits, as shown on Figure 5.2.4.

(a) The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

(b) The voltage and current ratings of the 12-kV distribution circuits are as follows:
Voltage (Phase-Phase): 12,0Voltage (Phase-Ground): 6,936V
Phase Current/conductor: 400A
Phase Configuration-Ckt 1: A-B-C (right-left)
Phase Configuration-Ckt 2: A-B-C (left-right)

[2] 115-kV transmission line profile without 12-kV underbuilt circuits, as shown on Figure 5.2.3.
The voltage and current ratings of the 115-kV transmission line are as follows:
Voltage (Phase-Phase): 115,000 V
Phase Current/conductor: 600A
Phase Configuration: A-B-C (top to bottom)

The calculated quasi-peak radio noise at 1000 kHz is 41 to 44 dB (relative to 1 microvolt/ meter) during heavy rain conditions and 19 to 23 dB during fair weather. The amount of AM radio interference caused by the transmission line depends on the relative signal strength of the radio signal and other sources of ambient radio noise.

The North American Regional Broadcasting Agreement recognizes a 54 dB signal level as the outer boundary of an AM radio station's primary service territory. The Federal Communications Commission (FCC) recommends the following minimum signals as necessary to reliably serve a primary service area: Business City Area 80 to 94 dB, Residential City Area 66 to 80 dB, and Rural Area 40 to 54 dB. The requirements for higher signal strengths in city areas takes into consideration the higher level of ambient noise levels typically found in the city as compared with a rural location.

Good radio reception is typically based on a signal strength 26 dB greater than ambient noise. This 26 dB signal-to-noise ratio is applied to the fair weather ambient noise level. A commonly accepted level of transmission radio noise is 40 to 45 dB at the edge of ROW for fair weather conditions. A 40 dB noise level and 26 dB signal-to-noise ratio would imply signal strength of 66 dB, which agrees with recommended signal strength as listed above for residential city area.

FM radio is immune to corona type radio noise and, therefore, is not considered in evaluation of transmission radio interference. Television audio is also an FM signal that is not affected by transmission line radio noise. Television video is an AM signal that is subject to interference from transmission lines. However, the frequency spectrum for fair weather corona noise follows an inverse law. The transmission noise attenuates at a rate of 20 dB per frequency decade. In addition to attenuation for frequency, an adjustment is made for the different bandwidth of the television signal versus AM radio. When the frequency and bandwidth adjustments are made, the net correction is 10 dB. The expected noise at television frequencies is 10 dB less than for AM radio.

In conclusion, the expected peak fair weather radio noise from the 115-kV lines is anticipated to be 24 dB and 19 dB edge of ROW. The line is located in metropolitan area that would be expected to have high levels of ambient radio noise. In contrast, the low radio noise of the 115-kV lines is not expected to be a problem to AM radio or television reception beyond the transmission line corridor.

5.5.3 Aviation Safety

Federal Aviation Administration (FAA) Regulations, Title 14 of the Code of Federal Regulations (CFR), Part 77, establishes standards for determining obstructions in navigable airspace in the vicinity of airports that are available for public use and are listed in the airport directory of the current airman's information manual. These regulations set forth requirements for notification of proposed obstruction that extend above the earth's surface. FAA notification is required for any potential obstruction structure erected over 200 feet in height above ground level. Notification is required if the obstruction is greater than specified heights and falls within any restricted airspace in the approach to airports. For airports with runways longer than 3,200 feet, the restricted space extends 20,000 feet (3.3 nautical miles) from the runway with no obstruction greater than a 100:1 ratio of the distance from the runway. For airports with runways measuring 3,200 feet or less, the restricted space extends 10,000 feet (1.7 nautical miles) with a 50:1 ratio of the distance from the runway. For heliports, the restricted space extends 5,000 feet (0.8 nautical miles) with a 25:1 ratio.

The nearest public airport to the 115-kV interconnection line is the Hayward Executive Airport, which is approximately 1.5 miles to the north. Despite the relative closeness to this airport, the orientation and flight approach to its runway (north-to-northeast orientation) would place this 115-kV overhead line (with maximum height of 90 feet except for two 95-foot structures at the SR 92 overcrossing) away from the area of potential collision hazards to the aircrafts and will pose no deterrent to aviation safety as defined in the FAA regulations. Additionally, the proposed 115-kV transmission line would closely follow the existing PG&E's 12-kV overhead distribution lines and will be in the general vicinity of the existing 115-kV lattice steel transmission line (115-kV Grant-Eastshore Line), which also do not pose aviation hazards.

A heliport (on St. Rose Hospital) is approximately 2 miles to the southeast of the proposed 115-kV interconnection line. At this distance the 115-kV interconnection line would not pose aviation hazard to the helicopters.

5.5.4 Fire Hazards

The proposed 115-kV interconnection line will be designed, constructed, and maintained in accordance with GO-95, which establishes clearances from other constructed and natural structures, and tree-trimming requirements to mitigate fire hazards. Because the proposed 115-kV line will be located in the industrial or manufacturing area, it is not anticipated that its ROW will have any trees or brush. In the event that trees are encountered along the transmission corridor, those trees will be trimmed or removed to ensure mitigation of these hazards. However, it is unlikely that any vegetation management will be required because the entire proposed route is over areas that have existing transmission and distribution lines. PG&E will maintain the interconnection corridor and immediate area in accordance with accepted industry practices that will include identification and abatement of any fire hazards to ensure safe operation of the line.

5.6 Applicable Laws, Ordinances, Regulations, and Standards

This section provides a list of LORS that apply to the engineering, design, installation, and operation of the proposed 115-kV transmission line and associated interconnection facilities. The following compilation of LORS is provide in accordance with the CEC's Rules of Practice and Procedure & Power Plant Site Certification Regulations.

5.6.1 Design and Construction

Table 5.6-1 lists the applicable LORS for the design and construction of the proposed transmission line and substations.

TABLE 5.6-1
Design and Construction LORS

LORS	Applicability	AFC Reference
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction"	California Public Utility Commission (CPUC) rule covers required clearances, grounding techniques, maintenance, and inspection requirements.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3
Title 8 California Code of Regulations (CCR), Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation, and equipment to provide practical safety and freedom from danger.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3
General Order 128 (GO-128), CPUC, "Rules for Construction of Underground Electric Supply and Communications Systems"	Establishes requirements and minimum standards to be used for the station AC power and communications circuits.	Section 5.2.2.1
General Order 52 (GO-52), CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities to provide or mitigate inductive interference.	Section 5.2.2.2 Section 5.5.2.1 Section 5.5.2.2 Section 5.5.2.3.3 Section 5.5.2.4
ANSI/IEEE 693 "IEEE Recommended Practices for Seismic Design of Substations"	Provides recommended design and construction practices.	Section 5.2.2.1 Section 5.2.2.2
IEEE 1119 "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Provides recommended clearance practices to protect persons outside the facility from electric shock.	Section 5.2.2 Section 5.5.1
IEEE 998 "Direct Lightning Stroke Shielding of Substations"	Provides recommendations to protect electrical system from direct lightning strokes.	Section 5.2.2.1 Section 5.2.2.2
IEEE 980 "Containment of Oil Spills for Substations"	Provides recommendations to prevent release of fluids into the environment.	Section 5.2.2.1 Section 5.2.2.2
Suggestive Practices for Raptor Protection on Power lines, April 1996	Provides guidelines to avoid or reduce raptor collision and electrocution.	Section 5.2.2.3

5.6.2 Electric and Magnetic Fields

The applicable LORS pertaining to electric and magnetic field (EMF) interference are shown in Table 5.6-2.

TABLE 5.6-2
Electric and Magnetic Field LORS

LORS	Applicability	AFC Reference
Decision 93-11-013 of the CPUC	CPUC position on EMF reduction.	Section 5.5.2 Section 5.5.2.3.3
General Order 131-D (GO-131), CPUC, Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California	CPUC construction-application requirements, including requirements related to EMF reduction.	Section 5.2.2 Section 5.5.1 Section 5.5.2
EMF Design Guidelines for Electrical Facilities, Southern California Edison Company, EMF Research and Education, 6090 Irwindale Avenue, Irwindale, California 91702, 626-812-7545, September 2004	Large local electric utility's guidelines for EMF reduction through structure design, conductor configuration, circuit-phasing, and load balancing. (In keeping with CPUC D.93-11-013 and GO-131.)	Section 5.2.2 Section 5.5.2
EMF Design Guidelines for Electrical Facilities, Pacific Gas and Electric Company	EMF Design Guidelines adopted in conformance with CPUC Decision 06-01-042 specifying design measures to be considered for reducing EMF	Section 5.2.2 Section 5.5.2
ANSI/IEEE 644-1994 "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard procedure for measuring EMF from an electric line that is in service.	Section 5.5.2

5.6.3 Hazardous Shock

Table 5.6-3 lists the LORS regarding hazardous shock protection for the project.

TABLE 5.6-3
Hazardous Shock LORS

LORS	Applicability	AFC Reference
Title 8 CCR Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical equipment to provide practical safety and freedom from danger.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3 Section 5.5.1
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Section 5.2.2.1 Section 5.2.2.2 Section 5.5.1
National Electrical Safety Code (NESC), ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C.	Covers grounding methods for electrical supply and communications facilities.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3 Section 5.5.2.1 Section 5.5.2.2

5.6.4 Communication Interference

The applicable LORS pertaining to communication interference are shown in Table 5.6-4.

TABLE 5.6-4
Communications Interference LORS

LORS	Applicability	AFC Reference
Title 47 CFR Section 15.25, “Operating Requirements, Incidental Radiation”	Prohibits operations of any device emitting incidental radiation that causes interference to communications. The regulation also requires mitigation for any device that causes interference.	Section 5.2.2 Section 5.5.2.1 Section 5.5.2.2 Section 5.5.2.3.3 Section 5.5.2.4
General Order 52 (GO-52), CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines and specifically applies to the prevention or mitigation of inductive interference.	Section 5.2.2 Section 5.2.2.1 Section 5.5.2.2 Section 5.5.2.4
CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC’s RI-TVI mitigation requirements, developed and adopted by the CEC in past siting cases.	Section 5.2.2.1 Section 5.2.2.2 Section 5.5.2.2

5.6.5 Aviation Safety

Table 5.6-5 lists the aviation safety LORS that may apply to the proposed construction and operation of Eastshore.

TABLE 5.6-5
Aviation Safety LORS

LORS	Applicability	AFC Reference
Title 14 CFR Part 77 “Objects Affecting Navigable Airspace”	Describes the criteria used to determine whether a “Notice of Proposed Construction or Alteration” (NPCA, FAA Form 7460-1) is required for potential obstruction hazards.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3 Section 5.5.3
FAA Advisory Circular No. 70/7460-1G, “Obstruction Marking and Lighting”	Describes the FAA standards for marking and lighting of obstructions as identified by Federal Aviation Regulations Part 77.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3 Section 5.5.3
Public Utilities Code (PUC), Sections 21656-21660	Discusses the permit requirements for construction of possible obstructions near aircraft landing areas, in navigable airspace, and near airport boundaries.	Section 5.2.2.1 Section 5.2.2.2 Section 5.2.2.3 Section 5.5.3

5.6.6 Fire Hazard

Table 5.6-6 lists the LORS governing fire hazard protection for the Eastshore project.

TABLE 5.6-6
Fire Hazard LORS

LORS	Applicability	AFC Reference
Title 14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards, and specifies when and where standards apply.	Section 5.2.2.2 Section 5.5.4
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Section 5.2.2.1 Section 5.2.2.2 Section 5.5.4
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction" Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).	Section 5.2.2 Section 5.5.4

5.6.7 Jurisdiction

Table 5.6-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, and enforce the previously referenced LORS. Table 5.6-7 also identifies the associated responsibilities of these agencies as they relate to the construction and operation of Eastshore.

TABLE 5.6-7
Jurisdiction

Agency or Jurisdiction	Responsibility
CEC	Jurisdiction over new transmission lines associated with thermal power plants that are 50 megawatts (MW) or more (PRC 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the interconnection point to the utility grid (PRC 25107).
CEC	Jurisdiction over modifications of existing facilities that increase peak operating voltage or peak kilowatt capacity 25 percent (PRC 25123).
CPUC	Regulates construction and operation of overhead transmission lines (General Order No. 95 and 131-D) (those not regulated by the CEC).
CPUC	Regulates construction and operation of power and communications lines for the prevention of inductive interference (General Order No. 52).
FAA	Establishes regulations for marking and lighting of obstructions in navigable airspace. (AC No. 70/7460-1G).
CAISO	Provides final interconnection approval.

TABLE 5.6-7
Jurisdiction

Agency or Jurisdiction	Responsibility
City of Hayward	Establishes and enforces zoning regulations for specific land uses; issues variances in accordance with zoning ordinances. Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (NFPA 70). Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection.

5.7 References

California Public Service Commission, General Order 52-Construction and Operation of Power and Communication Lines.

__________. General Order 95-Rules for Overhead Electric Line Construction.

__________. General Order 128-Rules for Construction of Underground Electric Supply and Communications Systems.

__________. General Order 131D-Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities.

__________. Decision 93-11-013.

Corona and Field Effects of AC Overhead Transmission Lines, Information for Decision Makers, IEEE Power Engineering Society, July 1985.

Electrical and Biological Effects of Transmission Lines, A Review, U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, June 1989.

EMF Design Guidelines for New Electrical Facilities: Transmission, Substation, and Distribution, PG&E

National Electrical Safety Code, ANSI C2.

Overhead Conductor Manual, Southwire.

PG&E Interconnection Handbook.

Power flow cases used for the Feasibility Study as supplied by PG&E

Power flow cases used for the LGIP "System Impact Study" provided by PG&E.

Power Flow Cases obtained from WECC.

PG&E and Federal Energy Regulatory Commission (FERC) Form 715.

Transmission Line Reference Book, 115-138-kV Compact Line Design, Electric Power Research Institute, Palo Alto, California, 1978.

Transmission Line Reference Book, 345-kV and Above, Electric Power Research Institute, Palo Alto, California, 1975.

United States of America. 47CFR15.25—Operating Requirements, Incidental Radiation.

__________. 15CFR77—Objects Affecting Navigable Airspace.

__________. 14CFR1250—1258-Fire Prevention Standards for Electric Utilities.

FIGURE 5.1-1
ALTERNATIVE TRANSMISSION LINE ROUTES

EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA

CH2MHILL

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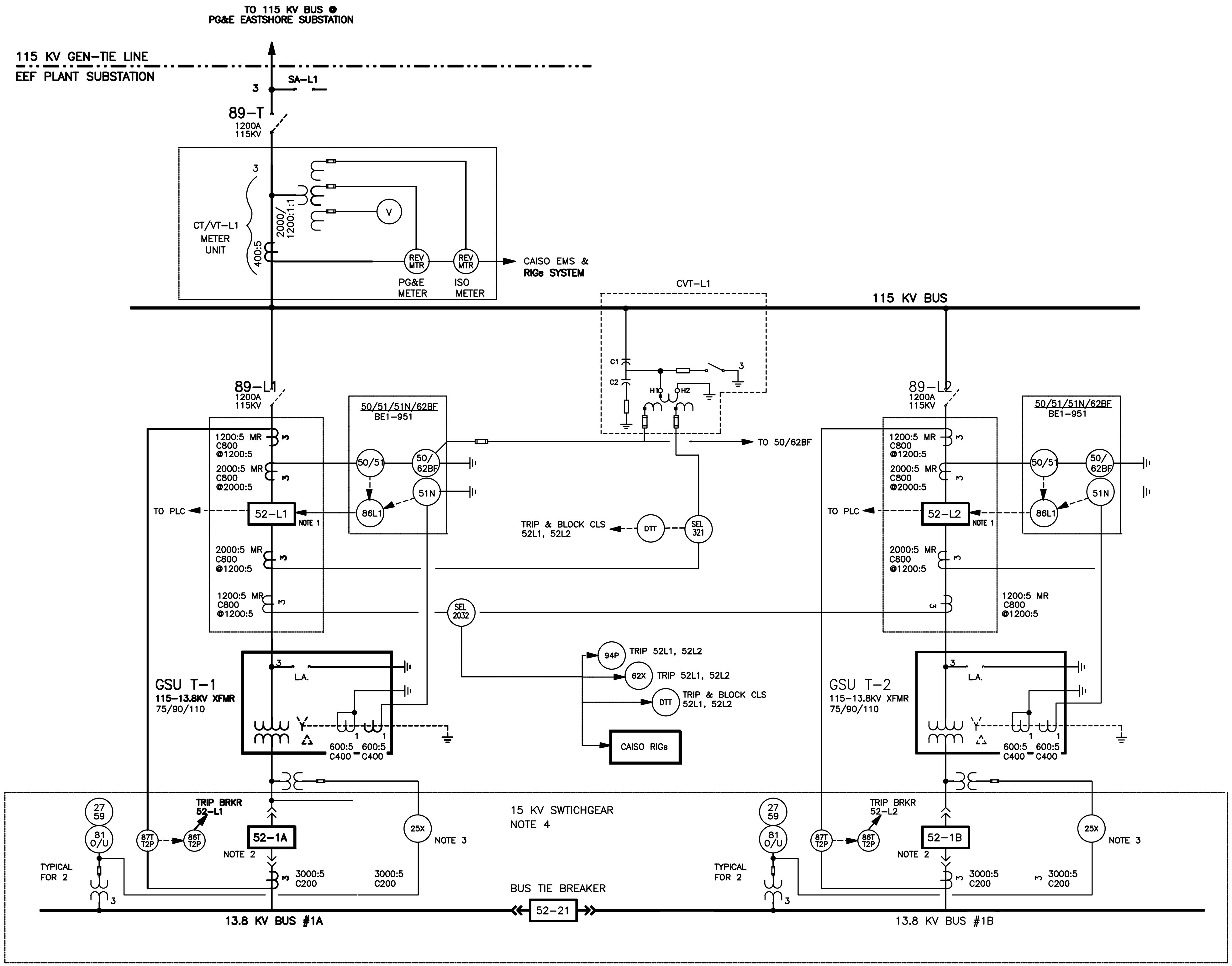


NOTES

1– CLOSE ALLOWED ONLY WHEN LOW SIDE TRANSFORMER BREAKER OPEN (INTERLOCKED).

2– CLOSE ALLOWED ONLY WHEN HIGH SIDE TRANSFORMER BREAKER CLOSED (INTERLOCKED). 25X RELAY TO PROVIDE DEAD BUS HOT LINE SUPERVISION TO CLOSE CIRCUIT.

3– CLOSE ON GENERATOR BREAKERS SUPERVISED BY 25G SYNCHRONIZER AND 25GX SYNC CHECK RELAYS. 25GX SET TO SYNC AND CLOSE FOR HOT BUS HOT LINE CONDITION ONLY.

4– FOR 15 KV SWITCHGEAR SINGLE-LINE DIAGRAMS SEE WARTSILA DWGS EE-01 (SHEETS 1 THRU 4).

PG&E REQUIRED RELAYS (UTILITY GRADE)

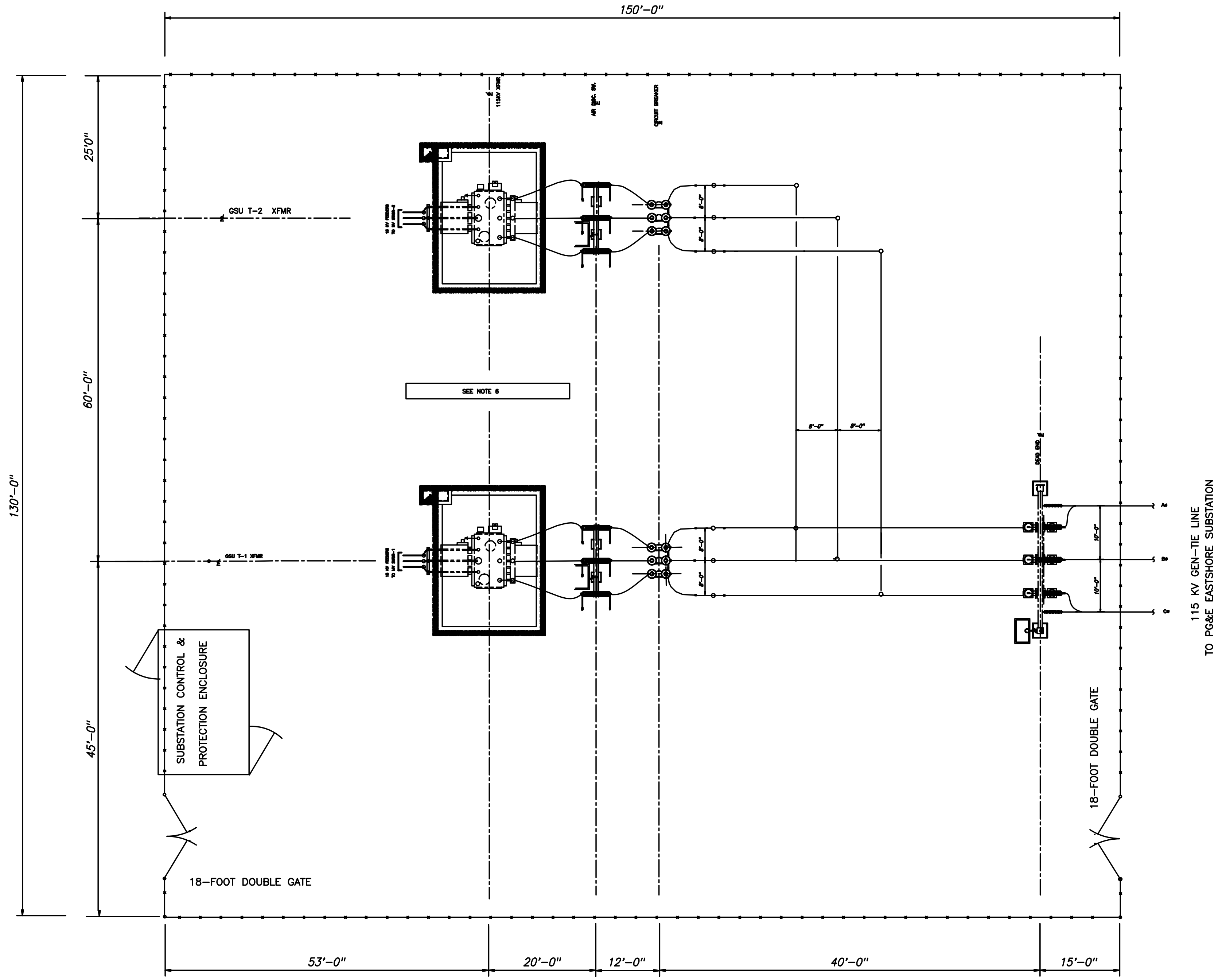
15 – SPEED MATCHING DEVICE
21 – PHASE DISTANCE (3PH) (PREFERRED, OR ALTERNATE 51V)
»» 25 – SYNCHRONIZER (1PH) (SEE SECT. 5.8)
25X – SYNC. CHECK (1PH) (SEE SECT. 5.8)
50/51T – TRANSFORMER PHASE OVERCURRENT (3PH + 1NST)
51TN – TRANSFORMER GROUND OVERCURRENT (1PH)
51V – VOLTAGE CONTROLLED OVERCURRENT (3PH) (ALTERNATE 21)
»» 59 – OVER VOLTAGE TRIP V ≥ 115%: TIME ≤ 0.1 SEC (1PH OR 3PH)
27 – UNDER VOLTAGE TRIP V ≤80.0%: TIME ≤ 0.5 SEC (3PH) OPTIONAL
62X.Y.Z – BREAKER FAILURE INITIATE AUXILIARY RELAYS
81-U – UNDER FREQUENCY (SEE SECTION 5.7) OPTIONAL
81-O – OVER FREQUENCY (SEE SECTION 5.7) OPTIONAL
86 – LOCKOUT
87T – TRANSFORMER DIFFERENTIAL (3PH)
90V – AUTOMATIC VOLTAGE REGULATOR
PSS – POWER SYSTEM STABILIZER (SEE SEC. 4.5)
{ DISCRETE DEVICE NOT INCORPORATED INTO MULTIFUNCTION RELAY.

52 – CIRCUIT BREAKER
L – LINE
T – TRANSFORMER
G – GENERATOR
Rn – NEUTRAL RESISTOR
SA – SURGE ARRESTER
WH – WATT HOUR METER
*** – INTERLOCK OR SYNCH CHECK TO PREVENT CLOSE OF BREAKER IF TRANSMISSION LINE IS DE-ENERGIZED (DEAD)
*** – 15/25 REQUIRED, BUT TESTING NOT WITNESSED BY PSCO
✱ – OPTIONAL FOR TRANSMISSION CONNECTED GENERATION
NOTE – TO PROVIDE REDUNDANCY, NOT ALL REQUIRED RELAYING MAY BE INCLUDED IN ONE MULTI-FUNCTION RELAY.

Drawing by: WestPower

FIGURE 5.2-1(E1)
115 kV SWITCHYARD SINGLE LINE DIAGRAM
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL



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NOTES:

1. THE GENERATOR FEEDERS SHALL BE INSTALLED AND CONNECTED TO THE SECONDARY BUSINGS OF GSUs VIA UNDEGROUND CONDUIT BANKS.
2. THE EXACT COORDIANTES FOR THE DEAD–END STRUCTURE SHALL BE PROVIDED UPON COMPLETION OF THE SITE SURVEY.
3. THE LOCATION OF THE DROP–DOWN POLE SHALL BE CONFIRMED BY PG&E.
4. MAXIMUM HORIZONTAL PULL ANGLE FOR THE SUBSTATION DEAD END STRUCTURE SHALL BE 15 DEGREES AT 1500 LBS PULL TENSION PER PHASE CONDUCTOR.
5. 15 KV MV SWTCHGEAR SHALL BE LOCATED INSIDE OF IN THE GENERATOR BUIDLING.
6. ALTERNATIVELY, A 8–HOUR FIRE WALL CAN BE INSTALLED TO REDUCE THE DISTANCE BETWEEN THE GSUs.

Drawing by: WestPower

FIGURE 5.2-2(E10)
115 kV SWITCHYARD
GENERAL LAYOUT - PRELIMINARY
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL

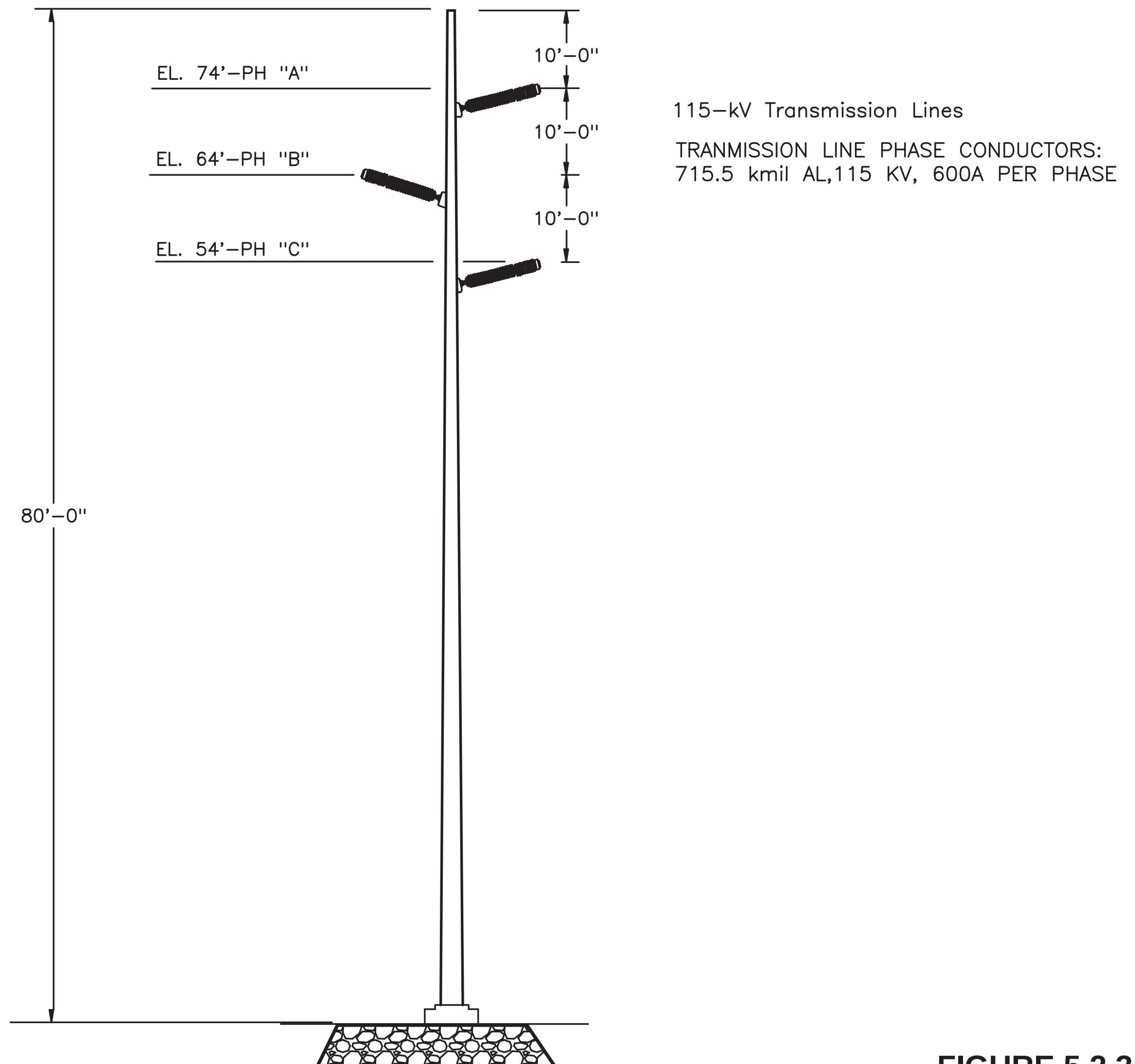

FIGURE 5.2.3
REPRESENTATIVE SINGLE-CIRCUIT
115 kV TANGENT STRUCTURE
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL

ES072006008BAO_Fig 5.2.3_RepSingleCircuit_115-kv.ai_090606_ll

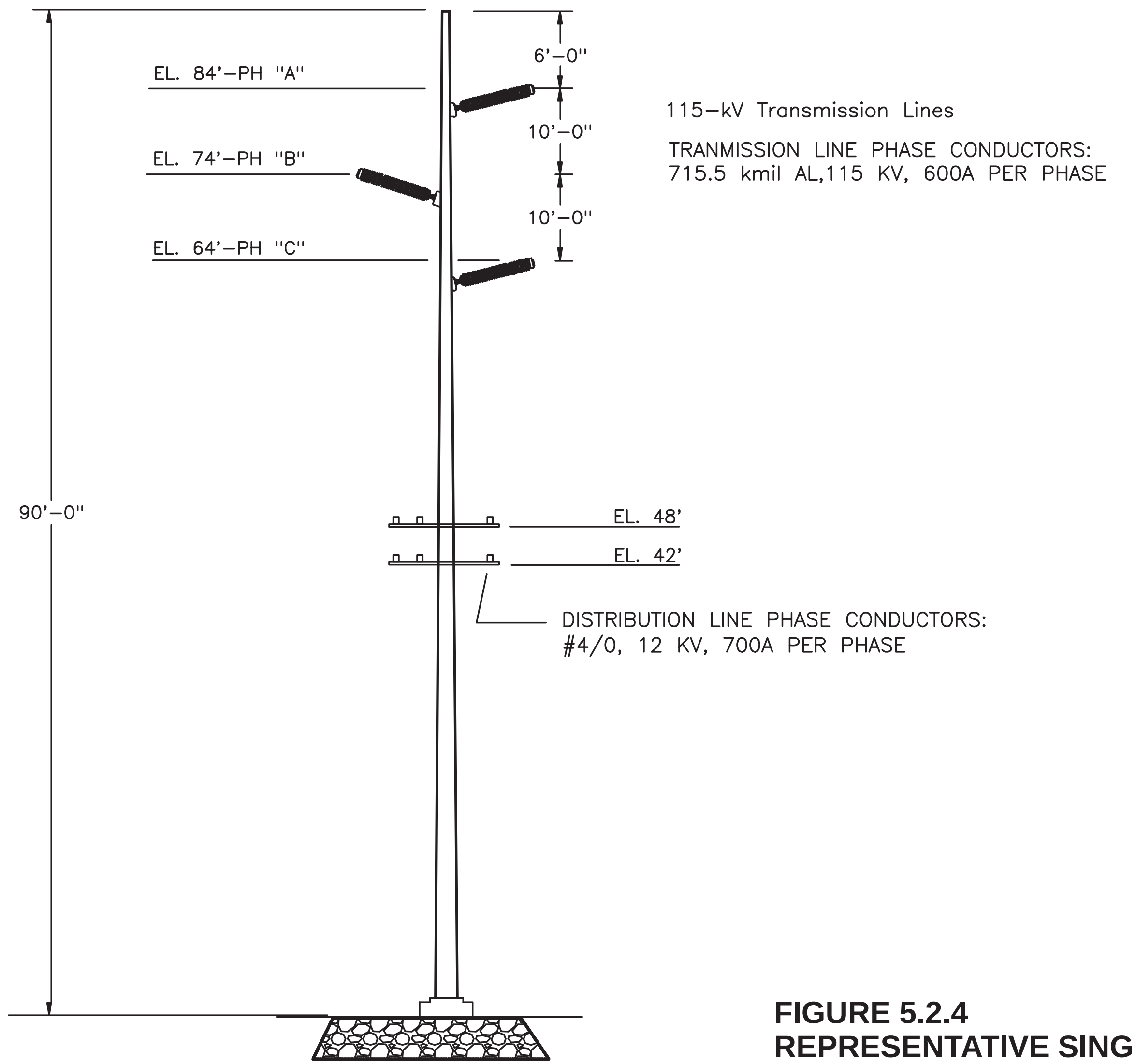

FIGURE 5.2.4
REPRESENTATIVE SINGLE-CIRCUIT 115 kV TANGENT STRUCTURE WITH 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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ES072006008BAO_Fig 5.2.4_RepSingleCircuit_12-kv_underbuilt.ai_090606_ll

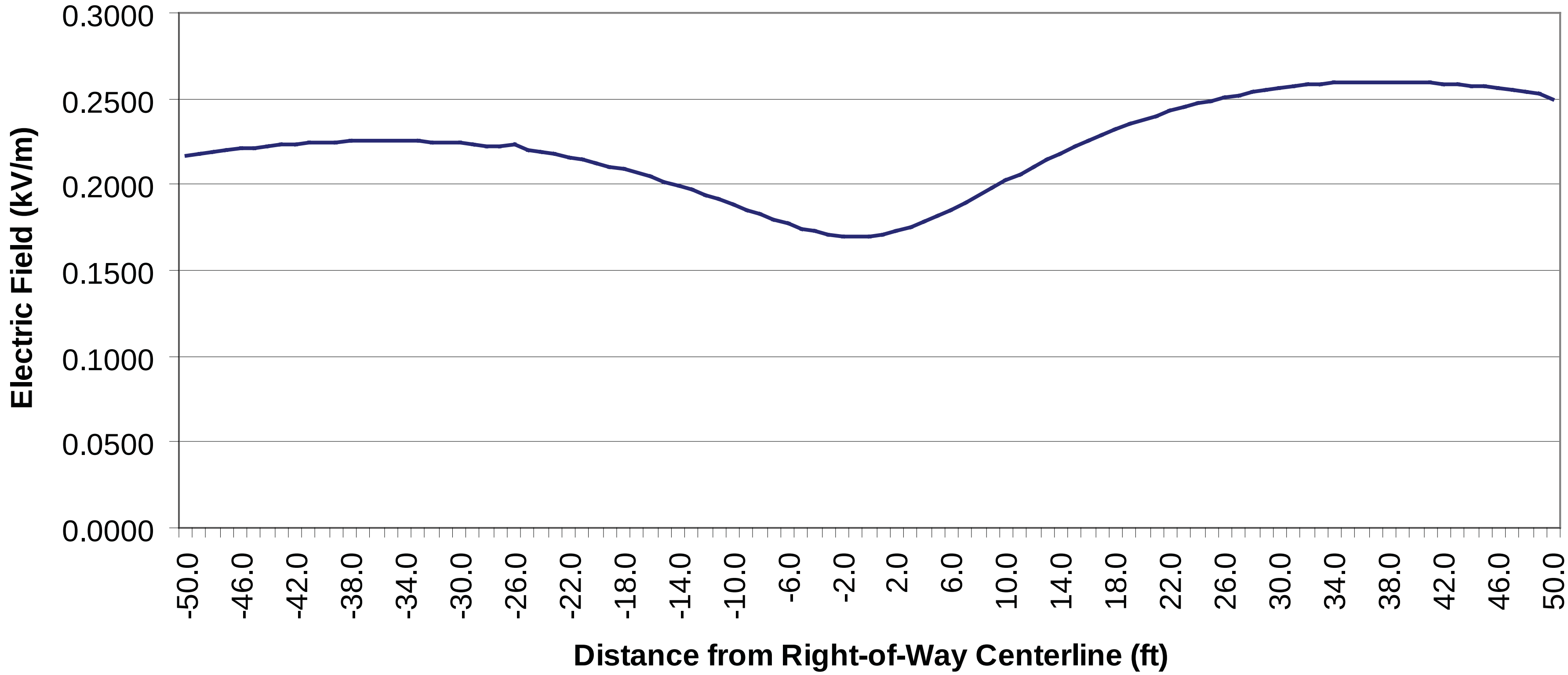

FIGURE 5.5.1A
ELECTRIC FIELD (kV/M)
115 kV TRANSMISSION LINE WITH 12 kV UNDERBUILT

EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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ES072006008BAO_Fig 5.5.1A_ElectricField.ai_090606_ll

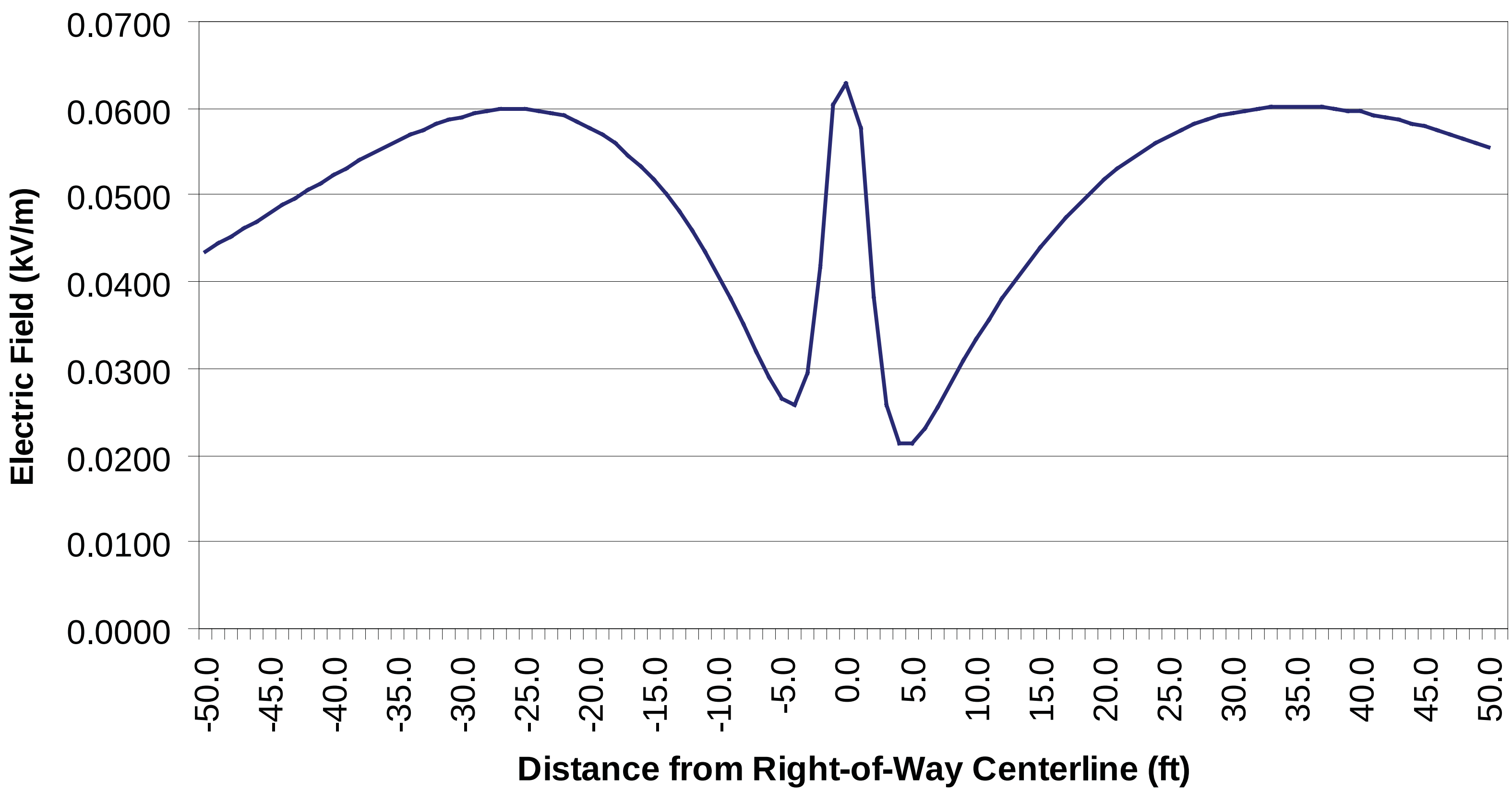

FIGURE 5.5.1B
ELECTRIC FIELD (kV/M)
115 kV TRANSMISSION LINE
WITHOUT 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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ES072006008BAO_Fig 5.5.1B_ElectricField_wo12kV.ai_090606_ll

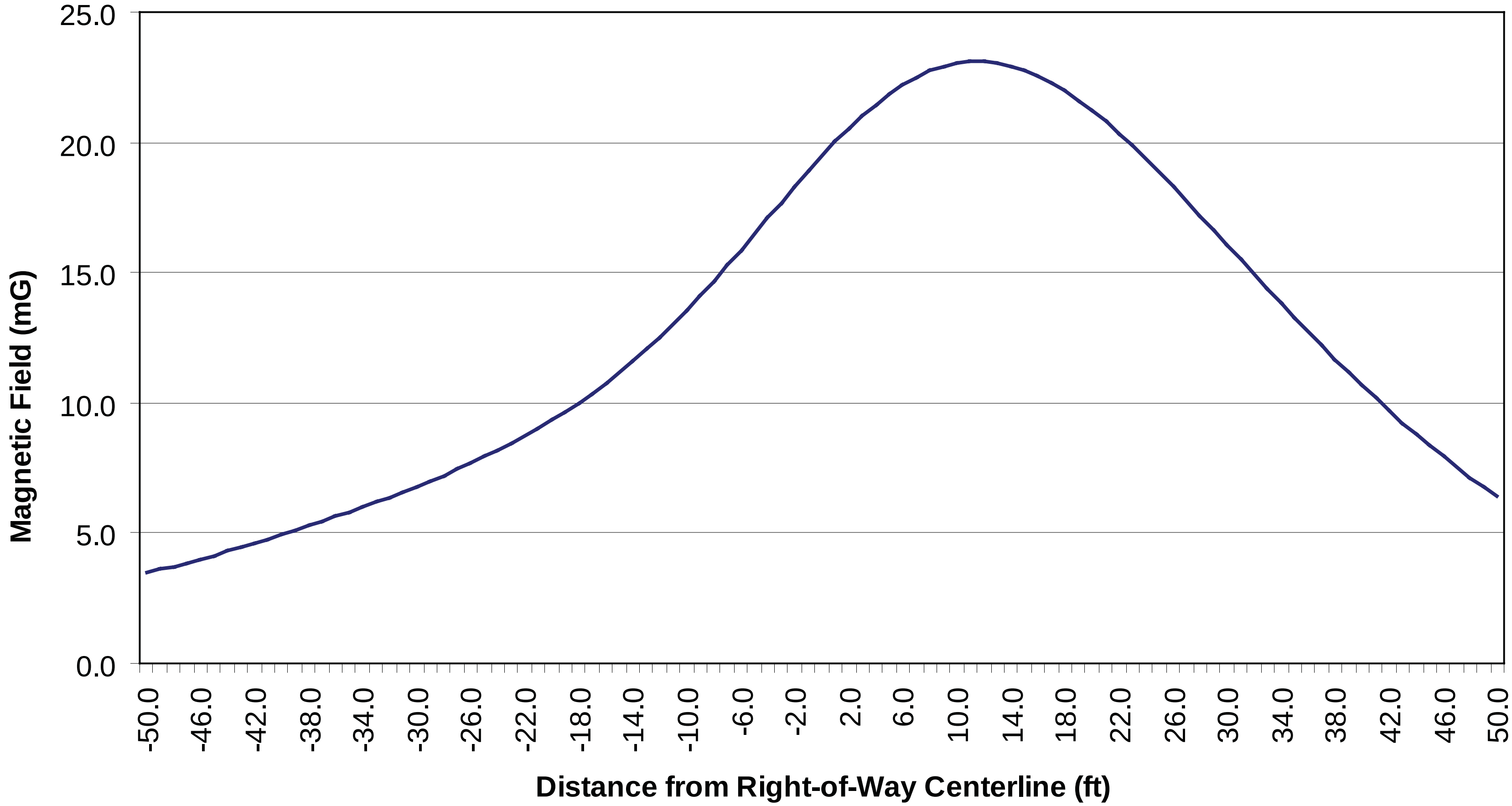

FIGURE 5.5.2A
MAGNETIC FIELD (mG)
115 kV TRANSMISSION LINE
WITH 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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ES072006008BAO_Fig 5.5.2A_MagneticField.ai_090606_ll

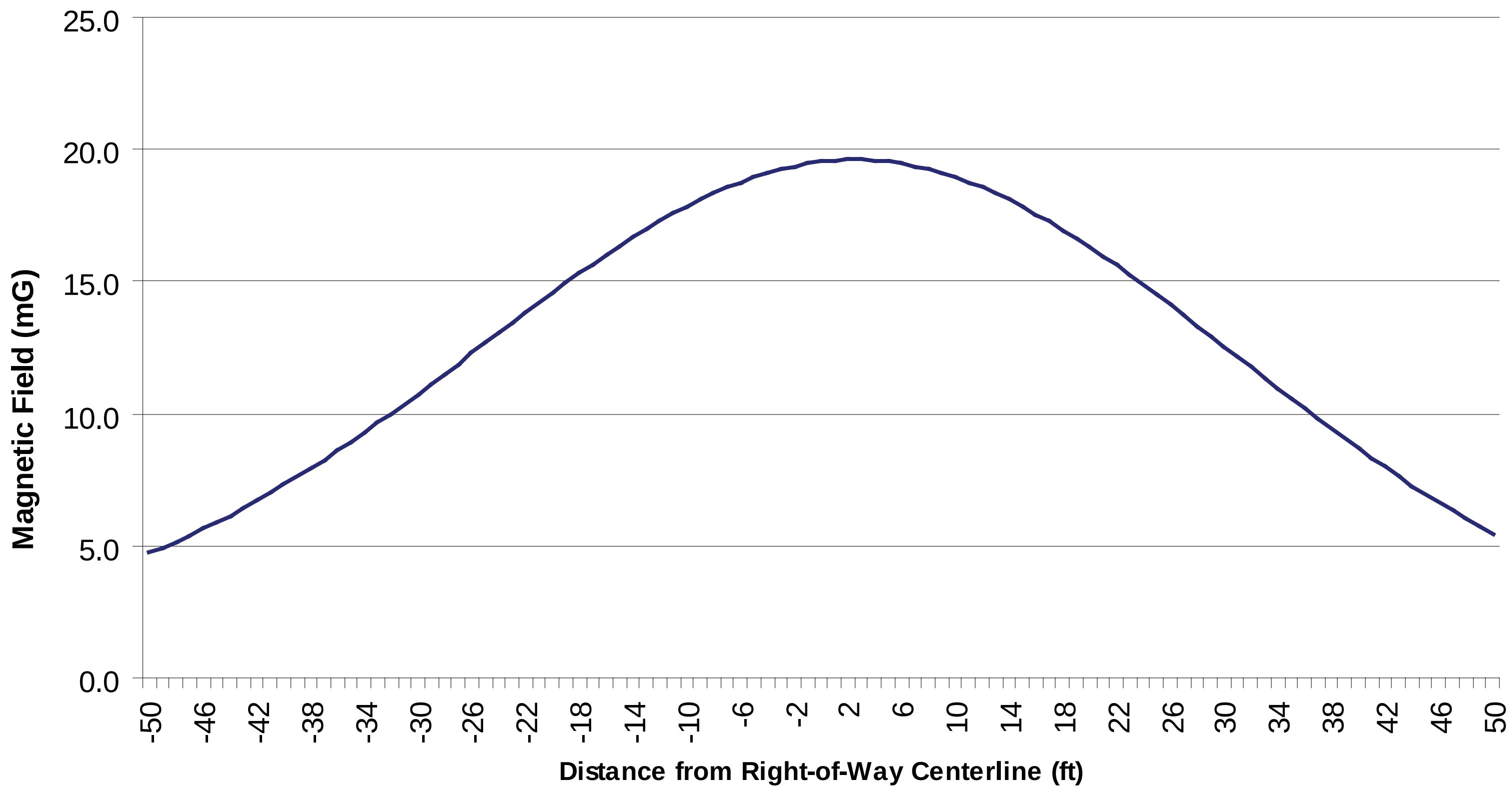

FIGURE 5.5.2B
MAGNETIC FIELD (mG)
115 kV TRANSMISSION LINE
WITHOUT 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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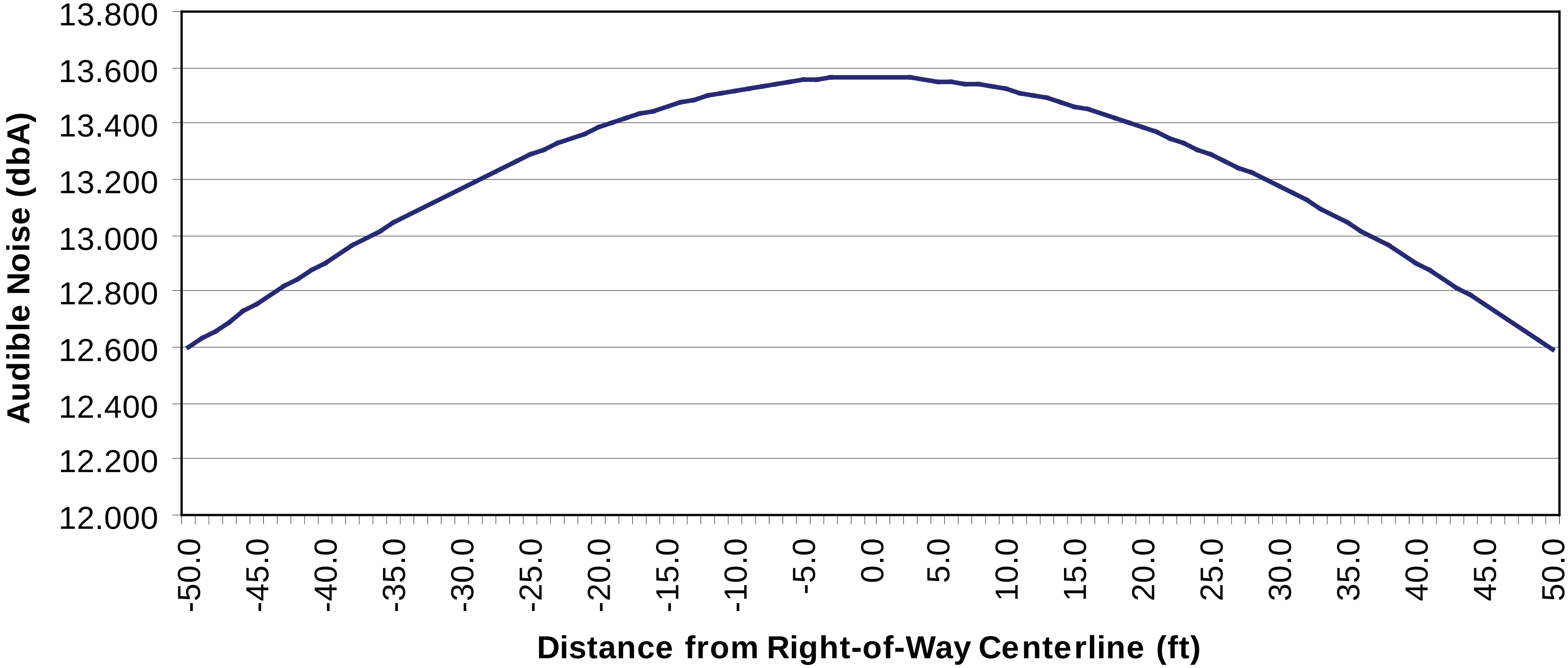

FIGURE 5.5.2.3A
AUDIBLE NOISE (dBA)
115 kV TRANSMISSION LINE
WITH 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

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ES072006008BAO_Fig 5.5.2.3A_AudibleNoise.ai_090606_ll

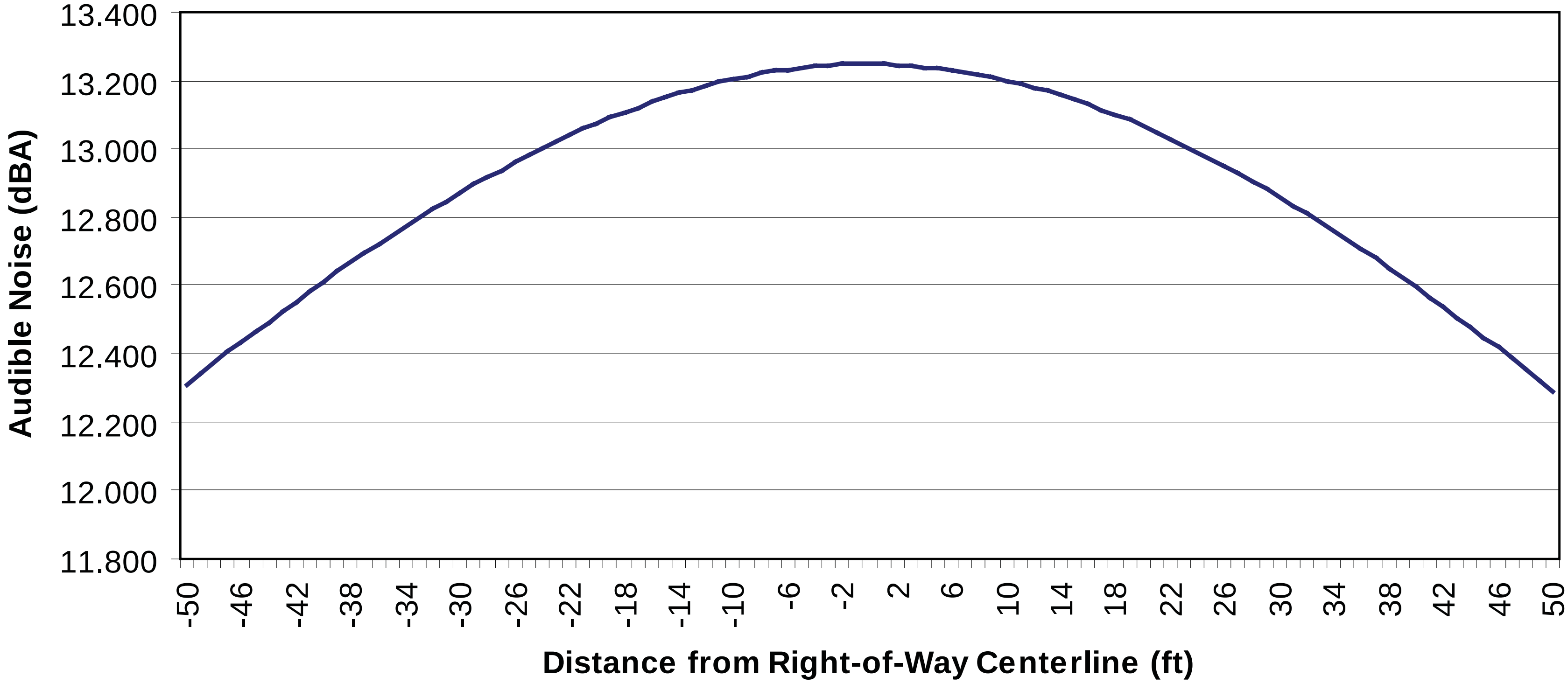

FIGURE 5.5.2.3B
AUDIBLE NOISE (dBA)
115 kV TRANSMISSION LINE
WITHOUT 12 kV UNDERBUILT
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL

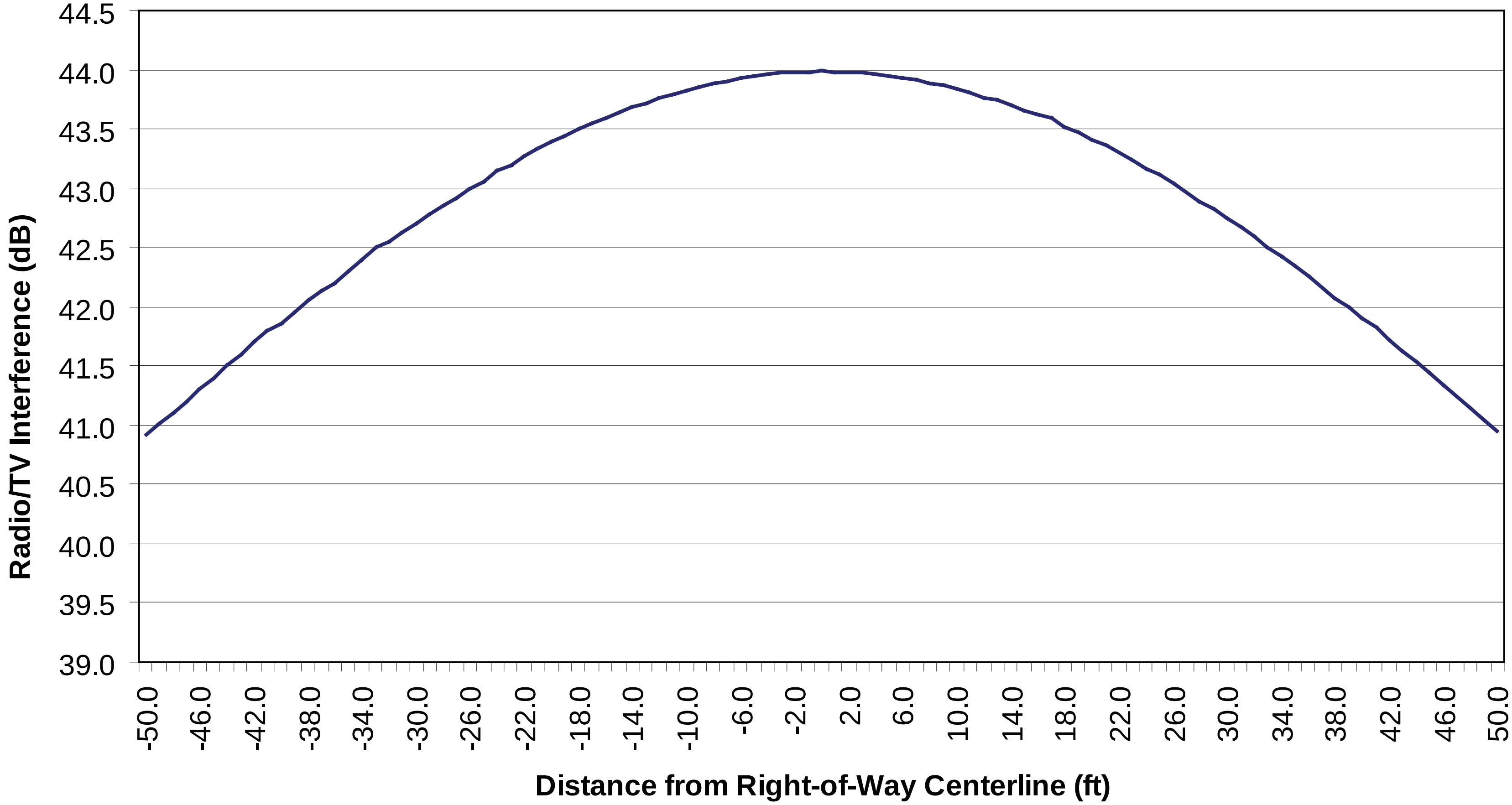

FIGURE 5.5.2.5A
RADIO/TV INTERFERENCE (dB)
115 kV TRANSMISSION LINE
HEAVY-RAIN CONDITION
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL

ES072006008BAO_Fig 5.5.2.5A_RTV_interference.ai_090606_ll

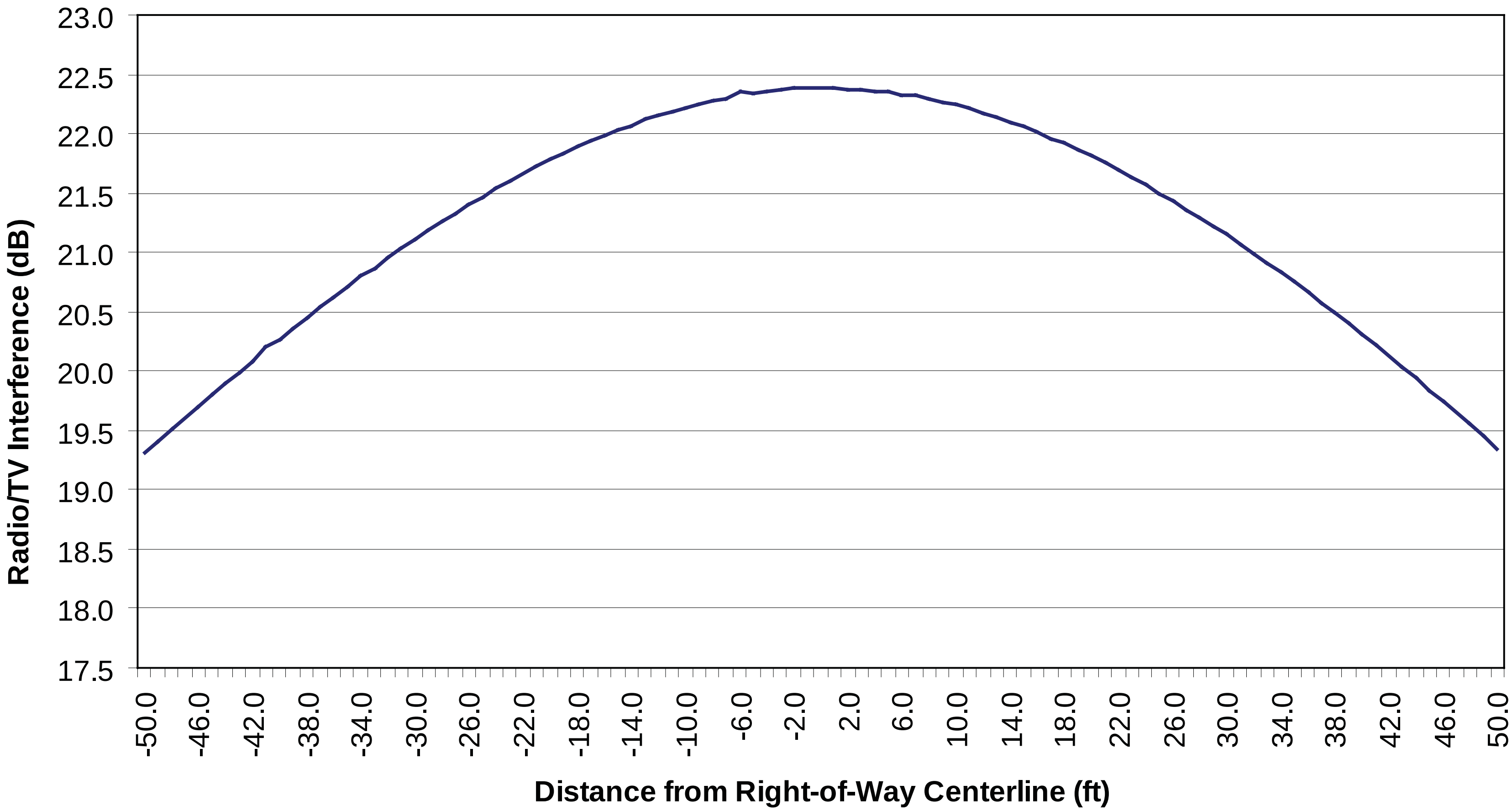

FIGURE 5.5.2.5B
RADIO/TV INTERFERENCE (dB)
115 kV TRANSMISSION LINE
FAIR WEATHER
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA
ALAMEDA COUNTY

CH2MHILL

ES072006008BAO_Fig 5.5.2.5B_RTV_interference_fairweather.ai_090606_ll