5.18 TRANSMISSION LINE SAFETY AND NUISANCE

This section of the report provides an evaluation of electrical effects associated with operation of the high-voltage electric power facilities proposed for the El Segundo 230 kV project. These electrical effects include corona and field effects. Electric and magnetic fields (EMF) are generally described and levels are calculated for the project. EMF is a term used to describe electric and magnetic fields that are created by electric voltage (electric field) and electric current (magnetic field). Power frequency EMF is a natural consequence of electrical circuits, and can be either directly measured with proper instruments or calculated using appropriate information. The potential effects of EMF are discussed along with other considerations such as cardiac pacemakers and computer interference. In addition, topics such as induced currents, fuel ignition, and corona effects (audible noise, radio noise, and television interference) are discussed.

5.18.1 Affected Environment

Electricity generated by the El Segundo Power Redevelopment Project will be delivered to the Southern California Edison (SCE) substation located on the El Segundo Generating Station property. From SCE's El Segundo 230 kV substation, electricity will be transmitted to users by the existing transmission and distribution network.

Three new generator step-up transformers will be connected to the existing 230 kV plant switchyard via overhead lines supported from steel structures. Internal overhead lines will extend from the new generator step-up transformers to the on-site plant switchyard. The overhead lines will follow the same path as the existing overhead lines associated with the Units 1 and 2.

The ESGS site is located at 301 Vista Del Mar, situated approximately 2.5 miles southwest of the Los Angeles International Airport and west of the San Diego Freeway on the eastern shore of Santa Monica Bay. The site is bordered by Vista Del Mar to the east, 45th Street in the City of Manhattan Beach on the south, San Monica Bay on the west, and Chevron Refinery on the north. The ESGS site is approximately 32.8 acres in size and has been in operation as an electric generating station since May 1955.

Two overhead lines (three phases per overhead line) exit the switching station and cross Vista Del Mar. These lines were identified as the El Segundo - El Nido and the El Segundo - Chevmain 230 kV circuits. Each phase of each overhead line consists of two sub-conductors. Each conductor is a 1033-kcmil ACSR "Curlew," an aluminum conductor with steel reinforcement. ACSR conductors combine low electrical resistance of alloy aluminum strands with the high strength of the steel strands. All structure types are designed to provide at least 30 feet of conductor-to-ground clearance at mid-span. Overhead line structures will be located in the same corridor as the existing lattice steel structures. Lattice structures may be removed and replaced with the single shaft, tubular steel poles as required.

5.18.2 Electric and Magnetic Field Issues

5.18.2.1 Electric Fields

Overview. The potential or voltage (electrical pressure) on an object causes electric fields. Any object with an electric charge on it has a voltage (potential) at its surface, caused by the accumulation of more electrons on that surface as compared with another object or surface. The voltage effect is not limited to the surface of the object but exists in the space surrounding the object in diminishing intensity. Electric fields can exert a force on other electric charges at a distance. The change in voltage over distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). This unit is a measure of the difference in electrical potential or voltage that exists between two points one meter apart. The electric field becomes stronger near a charged object and decreases with distance away from the object.

Electric fields are a very common phenomenon. Static electric fields can result from friction generated when taking off a sweater or walking across a carpet. Body voltages have been measured as high as 16,000 volts due to walking on a carpet (Chakravarti, 1976). The earth creates a natural static field in fair weather that is due to the 300,000 to 400,000 volt potential difference between the ionosphere and the surface of the earth (Veimeister, 1972). At ground level the mean value of the earth's electric field is approximately 120 V/m. This means that a 6-foot tall person would have a static potential of about 220 volts between the top and bottom of their body.

The normal fair weather static electric field of the earth varies from month to month, reaching a maximum of about 20 percent above normal in January, when the earth is closest to the sun, and falling to about 20 percent below normal by July, when the earth is farthest from the sun. Much stronger static electric potentials can exist underneath storm clouds, where the electric potential with respect to earth can reach 10 to 100 million volts (Veimeister, 1972). Natural static electric fields under clouds and in dust storms can reach 3 to 10 kV/m (CRC, 1981).

All household appliances and other devices that operate on electricity create electric fields. However, these fields are different from the earth's static or direct current (DC) field. Fields produced by electrical appliances that use alternating current (AC) reverse direction at a frequency of 60 cycles per second (60 Hertz, or Hz). In many other countries, this frequency is 50 Hz. The electric field in this case is caused by the changing electric voltage in the appliance. The magnitude of the electric field decreases rapidly with distance from the device. The field caused by point source (compact, small-dimension) household appliances generally attenuates more rapidly with distance than line source fields (such as from power lines). Appliances need not be in operation to create an electric field. Just plugging an appliance into an electrical outlet creates an electric field around it. Typical values of electric field measured one-foot away from some common appliances are shown in Table 5.18-1 (Carstensen, 1985; Enertech, Consultants 1985).

TABLE 5.18-1

TYPICAL ELECTRIC FIELD VALUES FOR APPLIANCES (AT 12 INCHES)

Appliance	Electric Field- kV/m
Electric Blanket	0.25 *
Broiler	0.13
Stereo	0.09
Refrigerator	0.06
Iron	0.06
Hand Mixer	0.05
Phonograph	0.04
Coffee Pot	0.03

* Note: 1 to 10 kV/m next to blanket wires.

Overhead electric transmission lines and distribution lines also create 60 Hz electric fields. The strength of the electric field is primarily a function of line voltage, height of the conductors above ground, the arrangement of the electrical wires, and distance away from the line. Unlike magnetic fields, electric fields can easily be shielded (or weakened) by the presence of conducting objects. For example, a typical house shields about 90 - 95 percent of electric fields from the outside sources (Carnegie Mellon, University, 1995). Other objects, such as trees, shrubs, walls, and fences, will also provide electric field shielding. Underground transmission lines do not produce electric fields, since the earth shields the electric field.

Transmission Lines. Electric power transmission lines create 60 Hz electric fields. These fields result from the voltage of the transmission line phase conductors with respect to the ground. Electric field strengths from a transmission line decrease with distance away from the outermost conductor, typically at a rate of approximately one divided by the distance squared ($1/d^2$). As an example, in an unperturbed field, if the electric field strength is 10 kV/m at a distance of one meter away, it will be approximately 2.5 kV/m at 2 meters away, and 0.625 kV/m at 4 meters away. In contrast, the electric field strength from a single conductor typically decreases at a rate of approximately one divided by the distance (1/d). As an example, an electric field strength of 10 kV/m at 1 meter away would decrease to approximately 5 kV/m at 2 meters away, and 2.5 kV/m at 4 meters away. Electric field strengths for a transmission line remain nearly constant over time because the voltage of the line is kept within bounds of about ±5 percent of its rated voltage. Transmission line electric fields are affected by the presence of grounded and conductive objects. Trees and buildings, for example, can significantly reduce ground level electric fields by shielding the area nearby (Deno, 1987).

Methodology. For existing transmission lines, electric field measurements can be performed to characterize the electric field as a function of distance away from the line. Measurements are conducted at 1 meter (3.28 feet) above ground level and parallel to the line at varying distances, in accordance with IEEE Standards for field measurements of transmission lines (IEEE 1994). Measurement of the electric field can also be performed in a similar manner for other types of electrical facilities (substations, switchyards, transformers, etc.).

In cases where a transmission line cannot be accessed or is proposed to be constructed, electric field values can be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program to create a model of the transmission line. The software then calculates the power frequency electric field at locations of interest. Results obtained with computer models have been compared with measurement data for operating power lines and calculation accuracy has been evaluated. Typically, the computer model will calculate electric field values to within +/- 5 percent of actual field measurements.

Measurements. Electric field measurements were performed along the perimeter of the El Segundo switching station on Vista Del Mar to characterize existing electric fields near the station. These measurements included readings underneath of the El Segundo - Chevmain and El Segundo - El Nido 230 kV overhead transmission line circuits, which exit the station and cross Vista Del Mar. In addition, two electric field lateral profile measurements were made across Vista Del Mar, one to characterize the electric fields from an internal station line and a second to characterize the electric fields near the El Segundo - Chevmain and El Segundo - El Nido 230 kV overhead transmission lines further east on Vista Del Mar. Measurements were conducted at 1 meter (3.28 feet) above ground level in accordance with IEEE Standards for field measurements of transmission lines (IEEE, 1994). Measurements were conducted on Thursday, December 7, 2000 with the El Segundo generating station operating at 320 MW.

Electric field measurements were conducted along the outside perimeter of the El Segundo generating station substation along Vista Del Mar. These measurements were made to characterize existing electric field levels at the closest public access to the station. Figure 5.18-1 presents a diagram of the station with locations where the electric field measurements were conducted. Measurements were made along the perimeter of the station, along Vista

Del Mar, and underneath of the El Segundo – Chevmain and El Segundo – El Nido 230 kV overhead transmission line circuits (Profile 'A'). Figure 5.18-2 presents a graph of measured electric field along the perimeter of the station. As shown, the electric field varies from about 100 V/m (0.100 kV/m) to a maximum of about 4,400 V/m (4.4 kV/m) underneath of the El Segundo – Chevmain overhead 230 kV transmission line as it crosses Vista Del Mar.

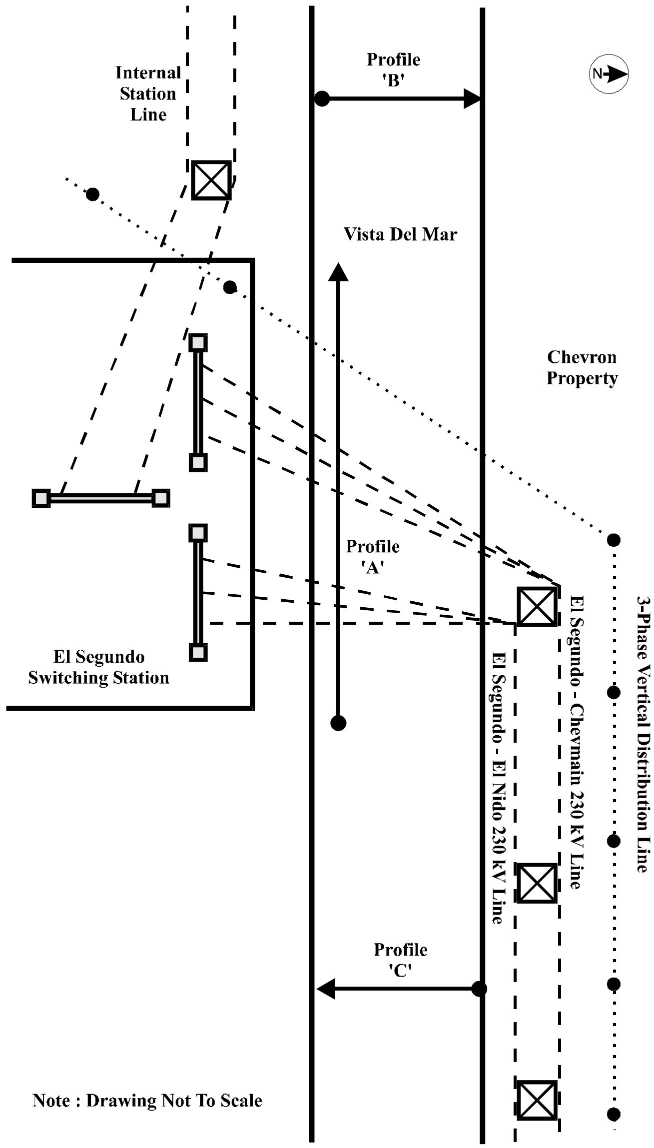
Figure 5.18-3 presents a graph of the measured electric field as a lateral profile away from the internal station line just west of the station on Vista Del Mar (Profile 'B'). Electric field measurements were initiated about 50 feet from the northern station line circuit on Vista Del Mar and proceeded across the street to the opposite sidewalk. As shown, the measured electric field varies from about 6 V/m to about 27 V/m (0.006 – 0.027 kV/m), depending upon location.

Electric field lateral profile measurements were also conducted for the overhead 230 kV transmission line. Measurements were initiated at a distance of about 25 feet from the El Segundo – El Nido 230 kV circuit, which was the closest public access point to the line near the Chevron facility. Measurements proceeded away from the power line (south) to the southern edge of Vista Del Mar (Profile 'C'). Figure 5.18-4 presents the graph of these electric field lateral profile measurements. As shown, the electric field ranged from about 20 V/m to a maximum of about 140 V/m (0.020 – 0.140 kV/m) near the southern circuit (El Segundo – El Nido).

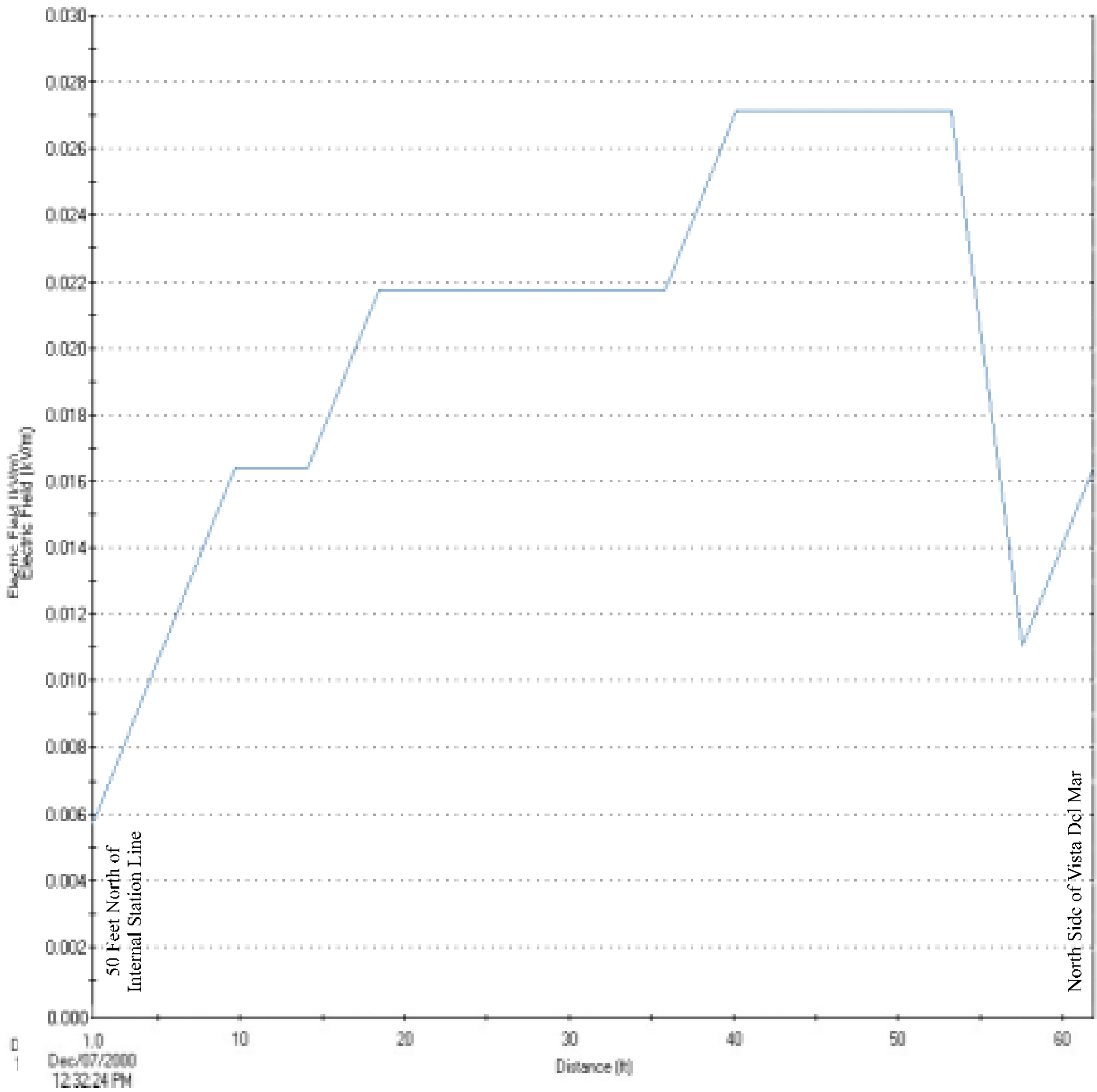
Due to objects located along Vista Del Mar (trees, fences, moving and parked cars, and other objects), electric field levels were partially shielded by these objects. Therefore, electric field values can vary greatly, depending upon location and proximity to local shielding objects.

Calculations. A computer program originally developed by the Bonneville Power Administration was used to perform the field calculations (BPA 1977). Ground clearances and span lengths can vary throughout the length of each of the transmission line segments due to the irregular terrain. Since these elevation variations are present, the minimum conductor ground clearance was assumed for each power line modeled.

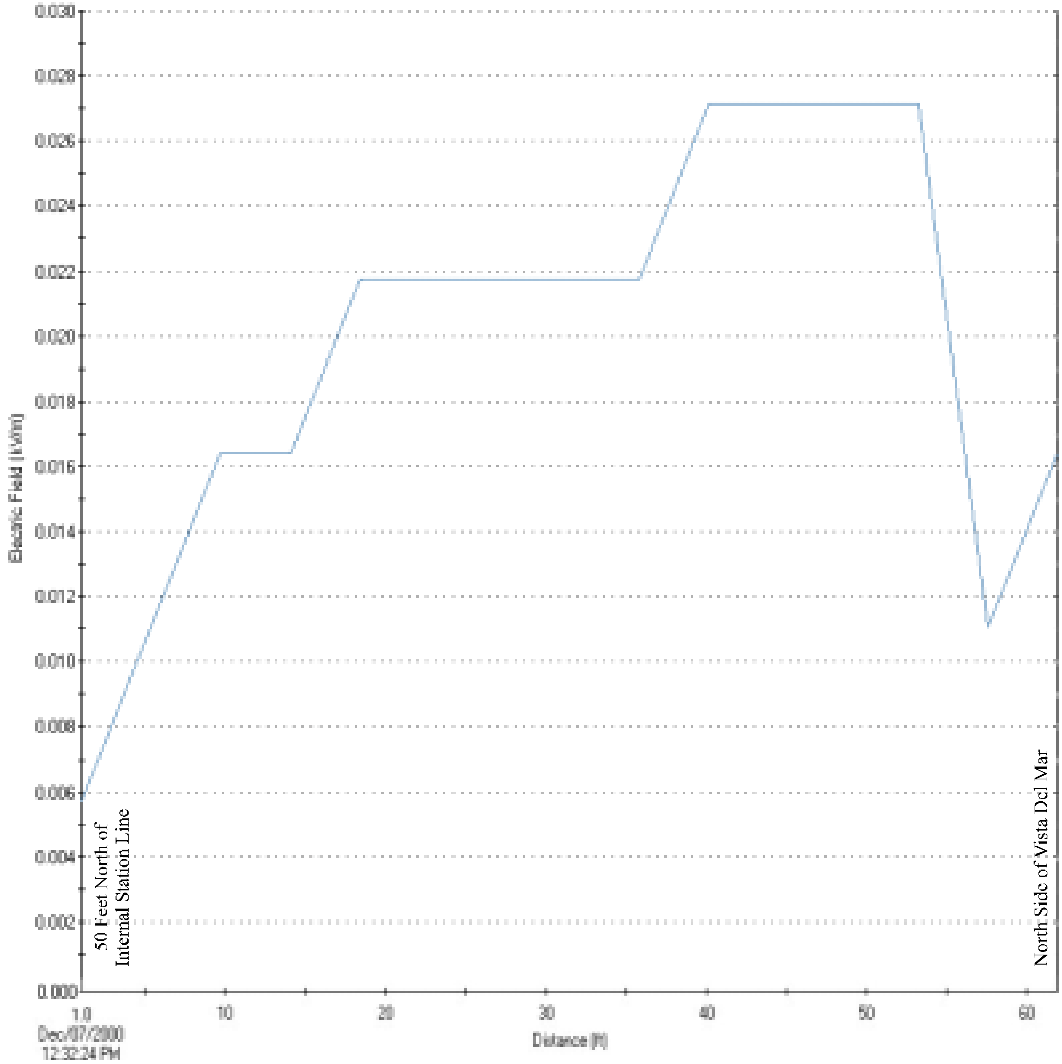
Angle structures were not specifically modeled in the calculations for the following reasons: electric fields values in most cases will not be significantly greater than the values calculated for other structures modeled (this is because the strongest fields usually occur away from the angle structure near the mid span of the transmission line), and angle structures make up a small percentage of the line. Therefore, only straight segments of transmission line were modeled.



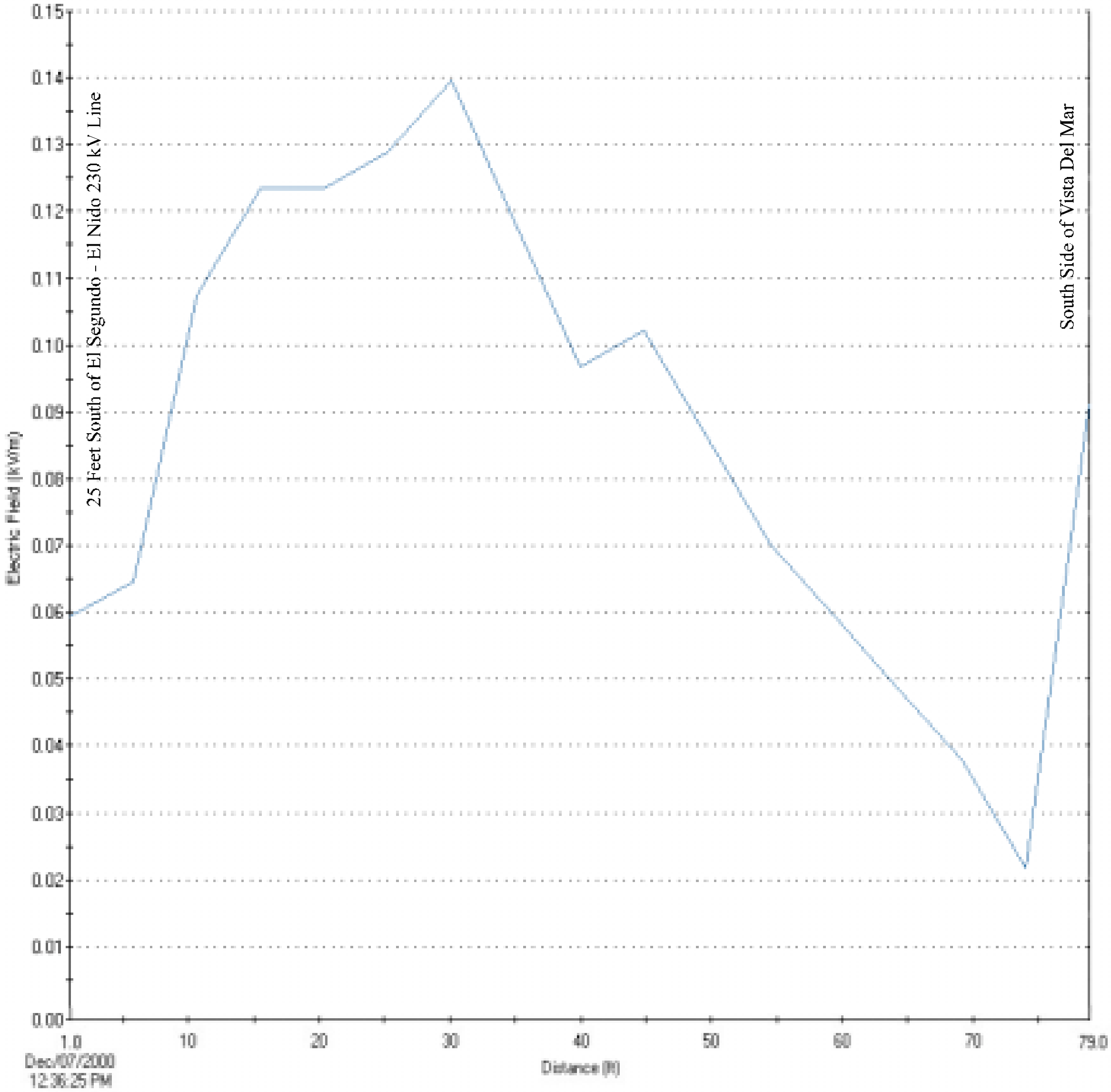
El Segundo Power Redevelopment Project	Figure 5.18-1. Diagram of El Segundo Generating Station with Field Measurement Locations	2000
El Segundo Power II LLC		



El Segundo Power Redevelopment Project	**Figure 5.18-2. Electric Field Measurements Along Perimeter of El Segundo Switching Station Vista Del Mar (Profile 'A')**	2000
El Segundo Power II LLC		



El Segundo Power Redevelopment Project	Figure 5.18-3. Electric Field Lateral Profile Measurements From El Segundo Switching Station Internal Station Line Across Vista Del Mar (Profile 'B')	2000
El Segundo Power II LLC		



El Segundo Power Redevelopment Project	Figure 5.18-4. Electric Field Lateral Profile Measurements of Overhead 230 kV on Vista Del Transmission Lines Mar (Profile 'C')	2000
El Segundo Power II LLC		

Certain assumptions were made to generate a reasonable worst case scenario for electric field calculation purposes. These assumptions included: a 5 percent overvoltage condition; all minimum ground clearances occur simultaneously for each configuration; and currents were balanced and had a phasing of A = 0 degrees, B = 240 degrees, and C = 120 degrees. It is important in these calculations to properly and consistently designate the phase relationship of the conductors. In modern electrical systems, power is generated by three-phase generators. Each phase is connected to one conductor of the transmission line and called ‘Phase A,’ ‘Phase B,’ or ‘Phase C.’ This designation is followed through the entire system from generator to substation. Because the system operates with all generators in synchronism, currents in Phase A are displaced in time from currents in Phases B and C. By convention, Phase A has designated equal to 0 degrees, Phase B equal to 240 degrees, and Phase C equal to 120 degrees. These values are essential to the calculations and are part of the assumptions made here.

Calculations were performed at midspan for a typical span length of the double circuit 230 kV transmission line. The minimum ground clearance was assumed to be about 50 feet. The transmission line geometry and conductor information is presented in Figure 5.2-5. Phasing arrangement was designated as “Unlike” phasing. The conductor is an ACSR conductor (“Curlew”, 54/7 stranding, 1.246 inch diameter), with two subconductor bundles spaced 12 inches apart per phase. Vertical phase spacing is 20 feet, with a horizontal phase separation of 28 ½ feet between circuits. A shield wire is located on centerline at the top of the structure, 15 feet above the top phase conductor. The shield wire is a Fiber Optic Ground Wire (FOGW) with a diameter of 0.642 inches. The right-of-way width was cited as 90 feet.

The calculated electric field values for a typical span length will be different (lower) that those measured at the El Segundo Generating Station on Vista Del Mar, since the transmission lines leave the station in a horizontal phase arrangement and change to a vertical phase arrangement at the first tower across from the station. Because of the horizontal phasing arrangement and phase separation, electric field levels will be higher at the station than along a typical transmission line span with a vertical phasing arrangement. Even at the Profile ‘B’ location, which is along the first span of vertical phase configuration, the field influence of the phase conductors crossing Vista Del Mar will affect field levels within the first span or two. Without having the necessary line geometry information at the station, it is not possible to model the section of transmission line as it leaves the station. Localized grounded objects will also provide electric field shielding, and therefore make comparisons of measured field values with calculated unperturbed field values difficult.

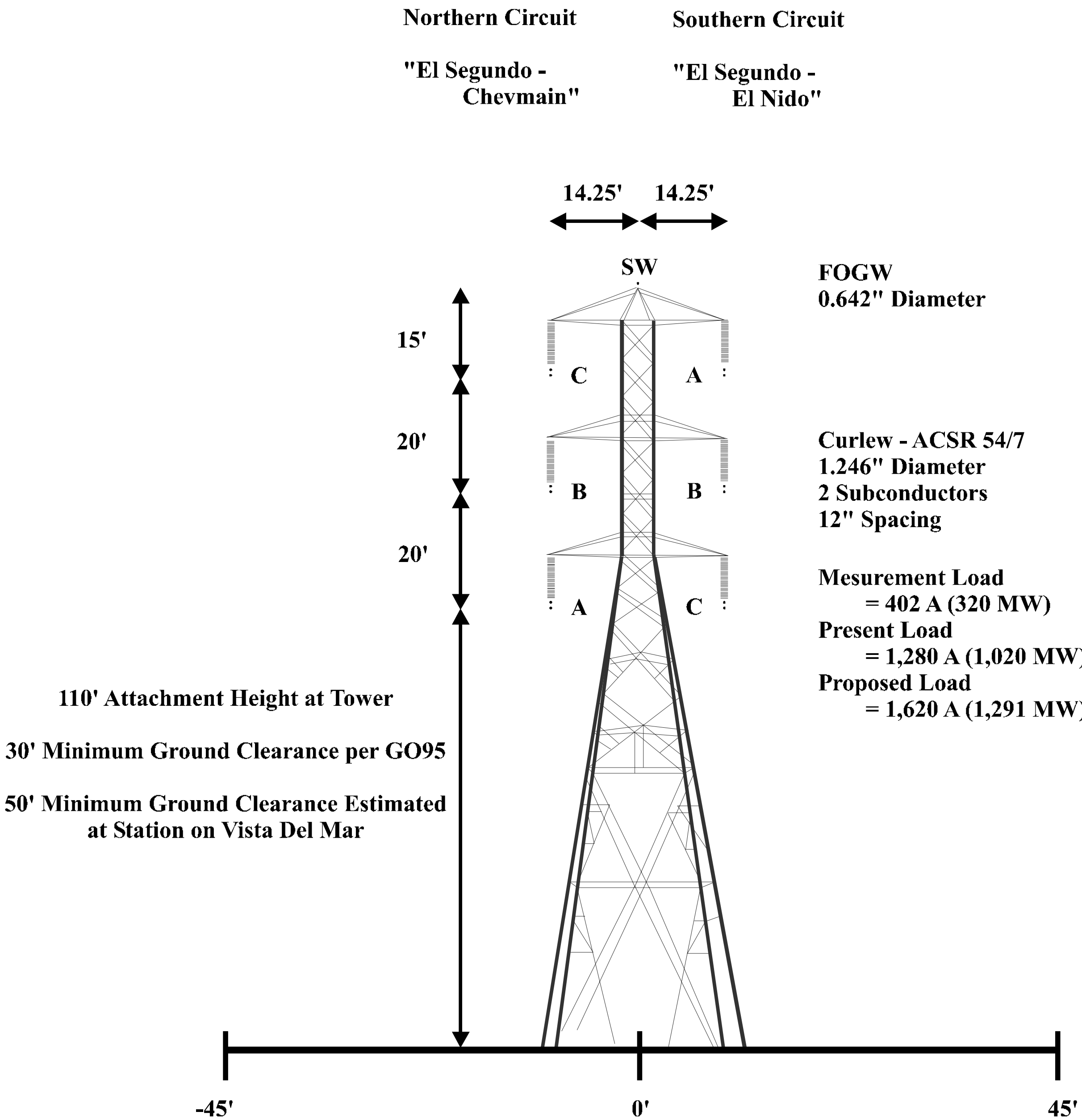


Figure 5.18-5. Diagram of Typical Transmission Line Geometry for Computer Modeling of Fields

Figure 5.18-6 presents the electric field calculations for a typical transmission line span at midspan. As shown, the electric field decreases rapidly with distance away from the transmission line circuits. The maximum calculated electric field within the right-of-way was 1,111 V/m (1.111 kV/m). At the designated right-of-way edge (+/- 45 feet from centerline), the calculated electric field has decreased to 764 V/m (0.764 kV/m). The electric field values will remain unchanged due to changes in line loading, since the electric field is a function of line voltage and not line amperage.

Calculated electric field values are also presented in tabular form in Table 5.18-2.

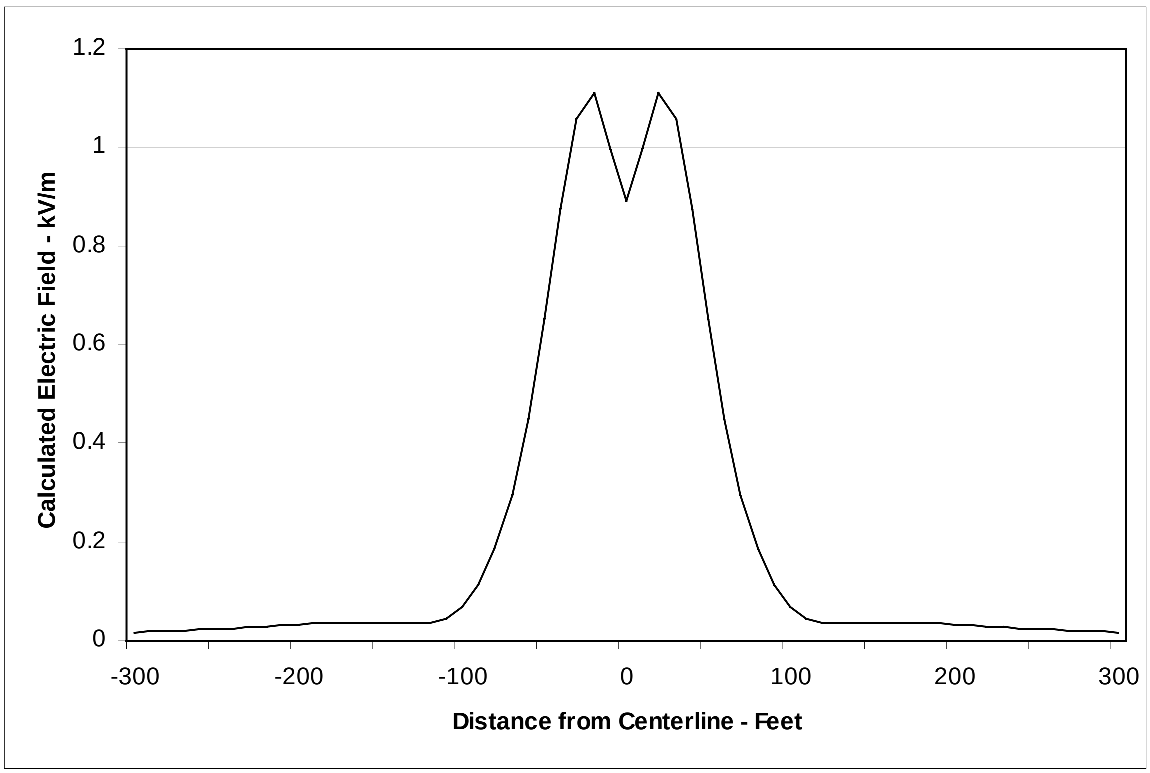


Figure 5.18-6. Calculated Unperturbed Electric Field Values for the Typical 230 kV Transmission Line Geometry

TABLE 5.18-2 SUMMARY OF ELECTRIC FIELD CALCULATIONS

Distance from Centerline (Feet)	Calculated Electric Field (kV/m)
-300	0.018
-290	0.019
-280	0.020
-270	0.021
-260	0.023
-250	0.024
-240	0.026
-230	0.027
-220	0.029
-210	0.031
-200	0.033
-190	0.035
-180	0.036
-170	0.038
-160	0.038
-150	0.038
-140	0.038
-130	0.036
-120	0.036
-110	0.044
-100	0.068
-90	0.114
-80	0.187
-70	0.297
-60	0.451
-50	0.652
-40	0.876
-30	1.060
-20	1.111
-10	0.997
0	0.891
10	0.997
20	1.111
30	1.060
40	0.876
50	0.652
60	0.451
70	0.297
80	0.187
90	0.114
100	0.068
110	0.044
120	0.036
130	0.036
140	0.038
150	0.038
160	0.038
170	0.038
180	0.036
190	0.035
200	0.033
210	0.031
220	0.029
230	0.027
240	0.026
250	0.024
260	0.023
270	0.021
280	0.020
290	0.019
300	0.018

Electric Fields – Estimated Project Effects. The measured electric fields from the El Segundo Generating Station and the 230 kV overhead transmission lines are typical of other lines of this voltage classification. These transmission lines have been in operation at a voltage rating of 230 kV for several years. The proposed changes to the El Segundo Generation Station to increase power production should not change the voltage rating or size of the conductors for these transmission circuits. Therefore, electric field levels near the El Segundo Generating Station and overhead 230 kV transmission lines should remain relatively unchanged from their present levels. Table 5.18-3 summarizes the measured and calculated electric field levels from the substation and overhead 230 kV transmission lines.

TABLE 5.18-3

SUMMARY OF ELECTRIC FIELD MEASUREMENTS AND CALCULATIONS

	Measured Electric Field		**Calculated Electric Field**		
Location	**Minimum**	**Maximum**	**ROW Edge**	**Maximum on ROW**	**ROW Edge**
Profile 'A' – Perimeter of Substation (on Vista Del Mar)	100 V/m (0.100 kV/m)	4,400 V/m (4.4 kV/m)	-	-	-
Profile 'B' – Lateral Profile from Internal Station Line	6 V/m (0.006 kV/m)	27 V/m (0.027 kV/m)	-	-	-
Profile 'C' – Overhead 230 kV Transmission Lines	20 V/m (0.020 kV/m)	140 V/m (0.140 kV/m)	1,107 V/m (1.1.07 kV/m)	1,111 V/m (1.111.kV/m)	1,107 V/m (1.1.07 kV/m)

5.18.2.2 Magnetic Fields

Overview. An electric current flowing in a conductor (electric equipment, household appliance, power circuits, etc.) creates a magnetic field. The most commonly used magnetic field intensity unit of measure is the gauss (G). For most practical applications, the gauss is too large, so a much smaller unit, the milligauss (mG), is used for reporting magnetic field magnitudes. The milligauss is one thousandth of a gauss. As a general reference, the earth has a natural static or direct current (DC) magnetic field of about 0.500 gauss, or 500 mG, in the El Segundo area (Merrill 1983:20). As with electric fields, the magnetic fields from electric power facilities and appliances differ from static (or DC) fields because they are caused by the flow of 60 Hz alternating currents. Power frequency magnetic fields also reverse direction at a rate of 60 cycles per second- corresponding to the 60 Hz operating frequency of the power systems in the United States.

Since the magnetic field is caused by the flow of an electric current, a device must be operated to create a magnetic field. Magnetic field strengths of a large number of common household appliances were measured by the Illinois Institute of Technology Research (IITRI) for the U.S. Navy (Gauger 1985), and by Enertech Consultants for the Electric Power Research Institute (EPRI) (Silva 1989). Typical magnetic field values for some appliances are presented in Table 5.18-4 to facilitate a better understanding of magnetic field strength values.

There are many sources of magnetic fields encountered in everyday activities. Two major research projects have been done to estimate public exposure to ambient 60 Hz magnetic fields. This work was done to identify typical levels encountered by people inside homes and elsewhere. In the first study, a large number of residences located throughout the United States were measured to determine the sources and characteristics of residential magnetic fields (Enertech, 1993). The following table summarizes the results of spot (point-in-time) magnetic field measurements made in the rooms of almost 1,000 residences. The average measured value for all rooms in this study was 0.9 mG.

TABLE 5.18-4

MAGNETIC FIELDS FROM HOUSEHOLD APPLIANCES

Appliance	**Magnetic Field (mG) 12 inches Away**	**Maximum**
Electric Range	3 to 30	100 to 1,200
Electric Oven	2 to 25	10 to 50
Garbage Disposal	10 to 20	850 to 1,250
Refrigerator	0.3 to 3	4 to 15
Clothes Washer	2 to 30	10 to 400
Clothes Dryer	1 to 3	3 to 80
Coffee Maker	0.8 to 1	15 to 250
Toaster	0.6 to 8	70 to 150
Crock Pot	0.8 to 1	15 to 80
Iron	1 to 3	90 to 300
Can Opener	35 to 250	10,000 to 20,000
Mixer	6 to 100	500 to 7,000
Blender, Popper, Processor	6 to 20	250 to 1,050
Vacuum Cleaner	20 to 200	2,000 to 8,000
Portable Heater	1 to 40	100 to 1,100
Fans/Blowers	0.4 to 40	20 to 300
Hair Dryer	1 to 70	60 to 20,000
Electric Shaver	1 to 100	150 to 15,000
Color TV	9 to 20	150 to 500
Fluorescent Fixture	2 to 40	140 to 2,000
Fluorescent Desk	6 to 20	400 to 3,500
Circular Saws	10 to 250	2,000 to 10,000
Electric Drill	25 to 35	4,000 to 8,000

TABLE 5.18-5

SUMMARY OF SPOT ROOM MEASUREMENTS IN THE UNITED STATES (992 RESIDENCES) - MG

	All Rooms				
Values Exceeded in:	**Median**	**Average**	**Kitchen**	**Bedroom(s)**	**Highest Room ***
50 % of Residences	0.5	0.6	0.7	0.5	1.1
25 % of Residences	1.0	1.1	1.2	1.0	2.1
10 % of Residences	1.7	2.1	2.4	2.0	3.8
5 % of Residences	2.6	3.0	3.5	2.9	5.6
1 % of Residences	5.8	6.6	6.4	7.7	12.2

* Any room in which spot field measurement had the highest value.

Another comprehensive study of contemporary magnetic field exposure was recently performed for the U.S. Department of Energy (Enertech, 1998). The objective of this work was to characterize personal magnetic field exposure of the general population. This was accomplished by randomly selecting over 1,000 people throughout the United States and recruiting these people to wear a recording magnetic field meter during a typical 24-hour period, including all activity inside and away from the place of residence (Silva 1999). The study population was selected in a manner to be representative of the general population. The measurement population (both genders) included about 874 adults and 138 children. The U.S. 24-hour average for all people in this study was 1.25 mG. The following tables summarize results for fractions of the U.S population that exceed selected magnetic field levels and the exposure levels measured for different occupations.

Transmission Lines. 60 Hz transmission line magnetic fields are generated by the current flowing on the phase conductors. Similar to the electric field, field strengths decrease with distance away from the line. Unlike electric fields that vary little over time, magnetic fields are not constant over time because the current on any power line changes in response to increasing and decreasing electrical load.

TABLE 5.18-6

PERCENTAGE OF U.S. POPULATION WITH AVERAGE FIELD EXPOSURE EXCEEDING GIVEN VALUES

Average 24-Hr Field	Estimated Portion	95% Confidence Interval	Population Range
> 0.5 mG	76.3%	73.8 % - 78.9 %	197 - 211 million
> 1 mG	43.6%	41 % - 46.5 %	109 - 124 million
> 2 mG	14.3%	11.9 % - 17.2 %	31.8 - 45.9 million
> 3 mG	6.3%	4.8 % - 8.3 %	12.8 - 22.2 million
> 4 mG	3.35%	2.4 % - 4.7 %	6.4 - 12.5 million
> 5 mG	2.42%	1.67 % - 3.52 %	4.5 - 9.4 million
> 10 mG	0.43%	0.21 % - 0.90 %	0.56 - 2.4 million
> 15 mG	0.1%	0.02 % - 0.55 %	50 thousand - 1.5 million

TABLE 5.18-7

AVERAGE MAGNETIC FIELD EXPOSURE DURING WORK FOR DIFFERENT OCCUPATIONS

Occupation	n	Average Field At Work
Managerial, professional, specialty	204	1.64 mG
Technical, sales, administrative, support	166	1.58 mG
Service: Protective, food, health, cleaning	71	2.74 mG
Farming, forestry, fishing	19	0.91 mG
Precision production, craft, repair, operators, fabricators, laborers	128	1.73 mG
Electrical	16	2.15 mG

Methodology. For existing transmission lines, magnetic field measurements can be performed to characterize the magnetic field as a function of distance away from the line. Measurements are conducted at 1 meter (3.28 feet) above ground level and parallel to the line at varying distances, in accordance with IEEE Standards for field measurements of transmission lines (IEEE 1994). Measurement of the magnetic field can also be performed in a similar manner for other types of electrical facilities (substations, switchyards, transformers, etc.).

In cases where a transmission line cannot be accessed or is proposed to be constructed, magnetic field values can be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program to create a model of the transmission line. The software then calculates the power frequency magnetic field at locations of interest. Results obtained with computer models have been compared with measurement data for operating power lines and calculation accuracy has been evaluated. Typically, the computer model will calculate magnetic field values to within +/- 5 percent of actual field measurements.

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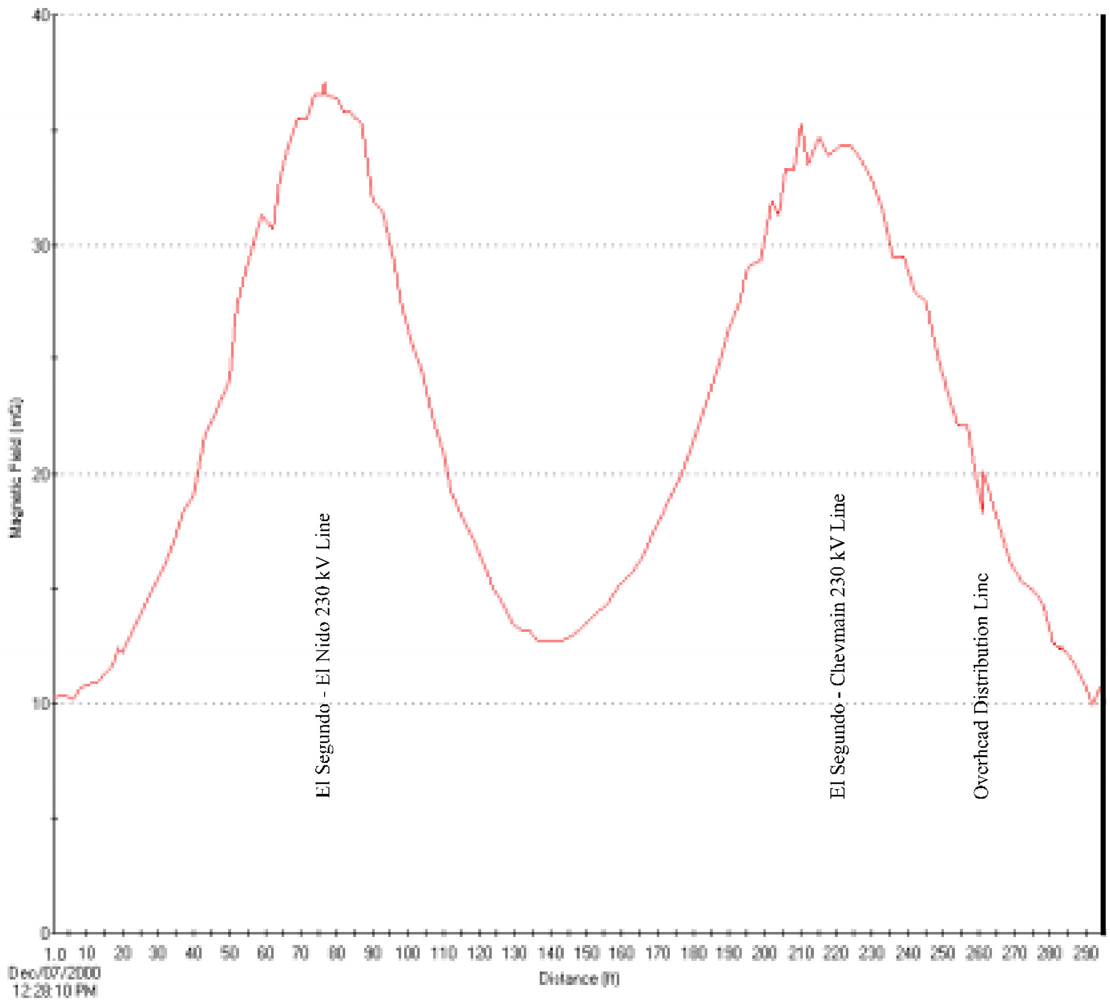
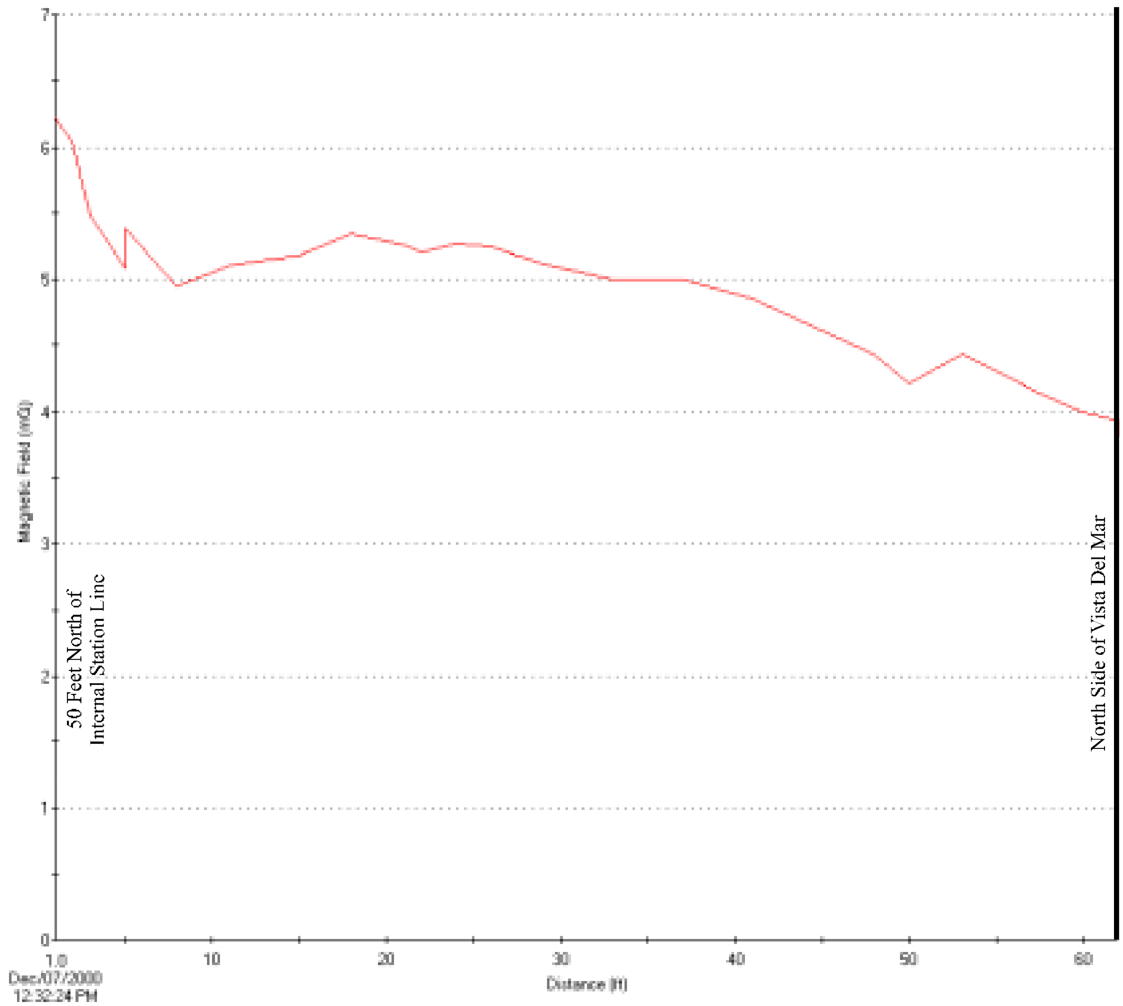
Magnetic field measurements were conducted along the outside perimeter of the El Segundo generating station substation along Vista Del Mar. These measurements were made to characterize existing magnetic field levels at the closest public access to the station. Figure 5.18-1 presents a diagram of the station with locations where the magnetic field measurements were conducted. Measurements were made along the perimeter of the station, along Vista Del Mar, and underneath of the El Segundo – Chevmain and El Segundo – El Nido 230 kV overhead transmission line circuits (Profile ‘A’). Figure 5.18-7 presents a graph of measured magnetic field along the perimeter of the station. As shown, the magnetic field varies from about 10 mG to a maximum of about 37 mG underneath of the El Segundo – El Nido overhead 230 kV transmission line as it crosses Vista Del Mar.

Figure 5.18-8 presents a graph of the measured magnetic field as a lateral profile away from the internal station line just west of the station on Vista Del Mar (Profile ‘B’). Magnetic field measurements were initiated about 50 feet away from the northern station line circuit on Vista Del Mar and proceeded across the street to the opposite sidewalk. As shown, the measured magnetic field varies from about 6.2 mG near the line to about 3.9 mG near the northern edge of Vista Del Mar.

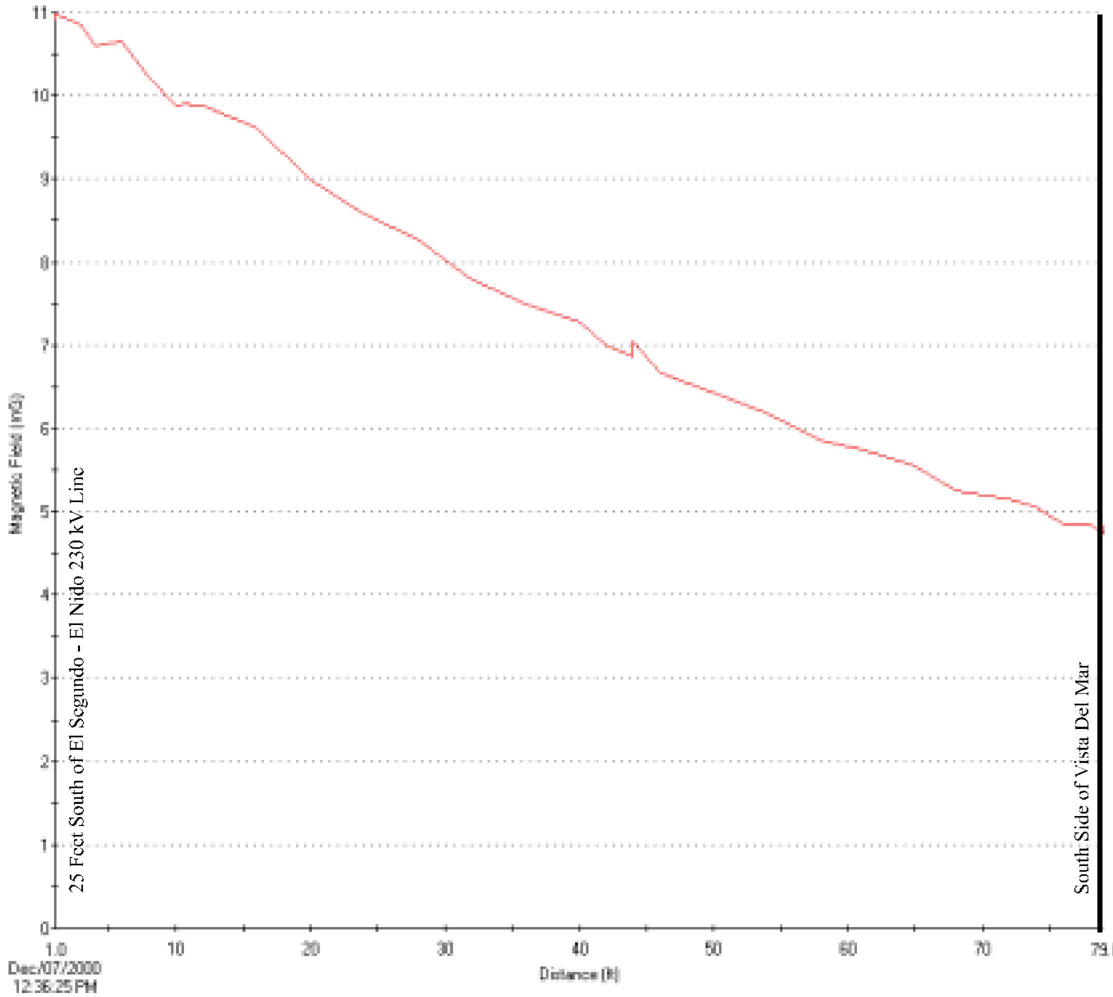
Magnetic field lateral profile measurements were also conducted for the overhead 230 kV transmission line. Measurements were initiated at a distance of about 25 feet from the El Segundo – El Nido 230 kV circuit, which was the closest public access point to the line near the Chevron facility. Measurements proceeded away from the power line (south) to the southern edge of Vista Del Mar (Profile ‘C’). Figure 5.18-9 presents the graph of these magnetic field lateral profile measurements. As shown, the magnetic field ranged from about 11 mG near the southern circuit (El Segundo – El Nido) down to about 4.8 mG near the southern edge of Vista Del Mar.



El Segundo Power Redevelopment Project	Figure 5.18-7. Magnetic Field Measurements Along Perimeter of El Segundo Switching Station on Vista Del Mar (Profile ‘A’)	2000
El Segundo Power II LLC		



El Segundo Power Redevelopment Project **El Segundo Power II LLC**	Figure 5.18-8. Magnetic Field Lateral Profile Measurements From El Segundo Switching Station Internal Station Line Across Vista Del Mar (Profile 'B')	2000



El Segundo Power Redevelopment Project **El Segundo Power II LLC**	Figure 5.18-9. Magnetic Field Lateral Profile Measurements of Overhead 230 kV Transmission Lines on Vista Del Mar (Profile 'C')	2000

Calculations. A computer program originally developed by the Bonneville Power Administration was used to perform the field calculations (BPA 1977). Ground clearances and span lengths can vary throughout the length of each of the transmission line segments due to the irregular terrain. Since these elevation variations are present, the minimum conductor ground clearance was assumed for each power line modeled.

Angle structures were not specifically modeled in the calculations for the following reasons: magnetic fields values in most cases will not be significantly greater than the values calculated for other structures modeled (this is because the strongest fields usually occur away from the angle structure near the mid span of the transmission line), and angle structures make up a small percentage of the line. Therefore, only straight segments of transmission line were modeled.

Certain assumptions were made to generate a reasonable worst case scenario for magnetic field calculation purposes. These assumptions included: all minimum ground clearances occur simultaneously for each configuration; and currents were balanced and had a phasing of A = 0 degrees, B = 240 degrees, and C = 120 degrees. It is important in these calculations to properly and consistently designate the phase relationship of the conductors. In modern electrical systems, power is generated by three-phase generators. Each phase is connected to one conductor of the transmission line and called 'Phase A,' 'Phase B,' or 'Phase C.' This designation is followed through the entire system from generator to substation. Because the system operates with all generators in synchronism, currents in Phase A are displaced in time from currents in Phases B and C. By convention, Phase A has been designated equal to 0 degrees, Phase B equal to 240 degrees, and Phase C equal to 120 degrees. These values are essential to the calculations and are part of the assumptions made here.

The direction of current flow for all of the transmission lines was assumed to be in the same direction.

Calculations were performed at midspan for a typical span length of the double circuit 230 kV transmission line. The minimum ground clearance was assumed to be about 50 feet. The transmission line geometry and conductor information is presented in Figure 5.18-5. Phasing arrangement was designated as "Unlike" phasing. Vertical phase spacing is 20 feet, with a horizontal phase separation of 28 ½ feet between circuits. A shield wire is located on centerline at the top of the structure. Calculations were performed for three different loading conditions, as summarized in Table 5.18-8.

TABLE 5.18-8

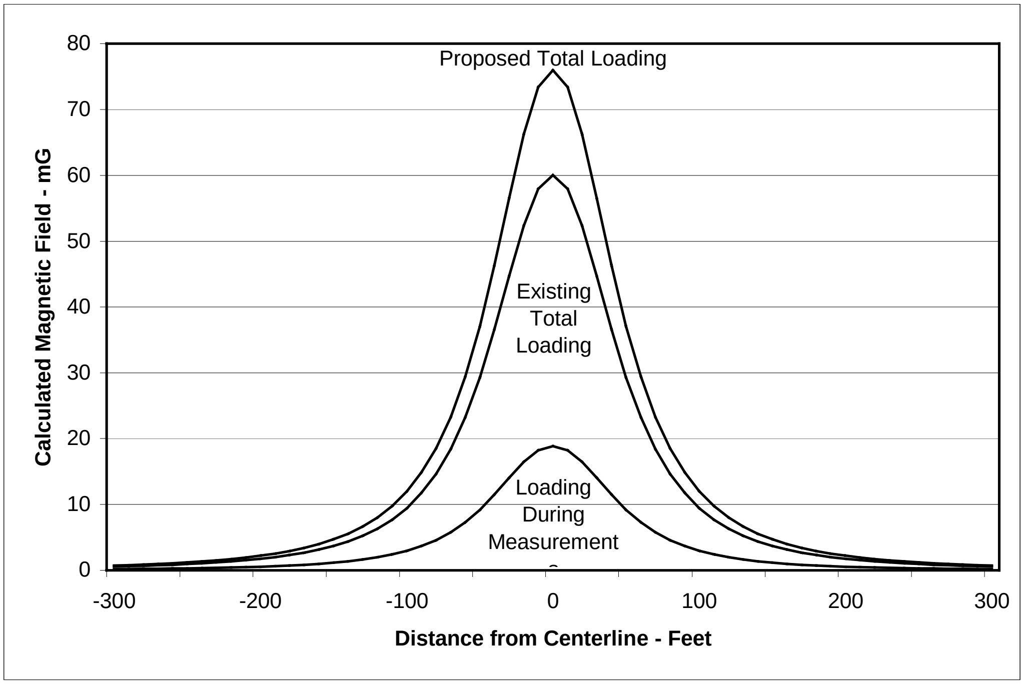
SUMMARY OF LOADING CONDITIONS USED FOR MAGNETIC FIELD CALCULATIONS

Load Description	Load (MW)	Load (Amperes per Phase per Circuit)
During Field Measurements	320	402
Existing Total Output	1020	1280
Proposed Total Output	1291	1620

The calculated magnetic field values for a typical span length will be different (lower) that those measured at the El Segundo Generating Station on Vista Del Mar, since the transmission lines leave the station in a horizontal phase arrangement and change to a vertical phase arrangement at the first tower across from the station. Because of the horizontal phasing arrangement and phase separation, magnetic field levels will be higher at the station than along a typical transmission line span with a vertical phasing arrangement. Even at the Profile 'B' location, which is along the first span of vertical phase configuration, the field influence of the phase conductors crossing Vista Del Mar will affect field levels within the first span or two. Without having the necessary line geometry information at the station, it is not possible to model the section of transmission line as it leaves the station.

Figure 5.18-10 presents the magnetic field calculations for a typical transmission line span at midspan. As shown, the magnetic field decreases rapidly with distance away from the transmission line circuits. The maximum calculated magnetic field within the right-of-way was18.9 mG for loading during field measurements, 60.0 mG for loading of existing total output, and 76.0 mG for loading at proposed total output. At the designated right-of-way edge (+/- 45 feet from centerline), the calculated magnetic field has decreased to 15.3 mG for loading during field measurements, 48.7 mG for loading of existing total output, and 61.6 mG for loading at proposed total output.

Calculated magnetic field values are also presented in tabular form in Table 5.18-9.



El Segundo Power Redevelopment Project	Figure 5.18-10 Magnetic Field Values for the Typical 230 kV Transmission Line Geometry	2000
El Segundo Power II LLC		

TABLE 5.18-9. SUMMARY OF MAGNETIC FIELD CALCULATIONS

Distance from Centerline (Feet)	Measurement Loading - Calculated Magnetic Field (mG)	Existing Total Output - Calculated Magnetic Field (mG)	Proposed Total Output - Calculated Magnetic Field (mG)
-300	0.2	0.6	0.7
-290	0.2	0.6	0.8
-280	0.2	0.7	0.9
-270	0.2	0.8	1.0
-260	0.3	0.9	1.1
-250	0.3	1.0	1.2
-240	0.3	1.1	1.4
-230	0.4	1.2	1.5
-220	0.4	1.4	1.7
-210	0.5	1.5	2.0
-200	0.6	1.8	2.2
-190	0.6	2.0	2.6
-180	0.7	2.3	2.9
-170	0.9	2.7	3.4
-160	1.0	3.2	4.0
-150	1.2	3.7	4.7
-140	1.4	4.4	5.6
-130	1.7	5.3	6.7
-120	2.0	6.3	8.0
-110	2.4	7.7	9.8
-100	3.0	9.5	12.0
-90	3.7	11.7	14.8
-80	4.6	14.6	18.5
-70	5.8	18.4	23.3
-60	7.3	23.2	29.4
-50	9.2	29.3	37.1
-40	11.5	36.6	46.3
-30	14.0	44.7	56.5
-20	16.4	52.3	66.2
-10	18.2	58.0	73.4
0	18.9	60.0	76.0
10	18.2	58.0	73.4
20	16.4	52.3	66.2
30	14.0	44.7	56.5
40	11.5	36.6	46.3
50	9.2	29.3	37.1
60	7.3	23.2	29.4
70	5.8	18.4	23.3
80	4.6	14.6	18.5
90	3.7	11.7	14.8
100	3.0	9.5	12.0
110	2.4	7.7	9.8
120	2.0	6.3	8.0
130	1.7	5.3	6.7
140	1.4	4.4	5.6
150	1.2	3.7	4.7
160	1.0	3.2	4.0
170	0.9	2.7	3.4
180	0.7	2.3	2.9
190	0.6	2.0	2.6
200	0.6	1.8	2.2
210	0.5	1.5	2.0
220	0.4	1.4	1.7
230	0.4	1.2	1.5
240	0.3	1.1	1.4
250	0.3	1.0	1.2
260	0.3	0.9	1.1
270	0.2	0.8	1.0
280	0.2	0.7	0.9
290	0.2	0.6	0.8
300	0.2	0.6	0.7

Magnetic Fields – Estimated Project Effects. The measured magnetic fields from the El Segundo Generating Station and the 230 kV overhead transmission lines are typical of other lines of this voltage classification. These transmission lines have been in operation for several years. The proposed changes to the El Segundo Generation Station to increase power production will increase the loading on these transmission circuits, creating higher magnetic field levels. This estimated increase is about 26 percent of the present loading (from about 1,020 MW up to an increased output of about 1,291 MW). Since magnetic fields are directly proportional to loading, it is anticipated that existing magnetic field levels during total plant output could increase by approximately 26% during the proposed total plant output loading condition. Table 5.18-10 summarizes the measured and calculated magnetic field levels from the substation and overhead 230 kV transmission lines.

TABLE 5.18-10

SUMMARY OF MAGNETIC FIELD MEASUREMENTS AND CALCULATIONS

	Measured Magnetic Field (mG)		Calculated Magnetic Field (mG)		
Location	**Minimum**	**Maximum**	**ROW Edge**	**Maximum on ROW**	**ROW Edge**
Profile 'A' – Perimeter of Substation (on Vista Del Mar)	10 mG	37 mG	-	-	-
Profile 'B' – Lateral Profile from Internal Station Line	3.9 mG	6.2 mG	-	-	-
Profile 'C' – Overhead 230 kV Transmission Lines					
During Measurement Loading –	4.8 mG	11 mG	10.3 mG	18.9 mG	10.3 mG
Total Existing Output –			32.8 mG	60.0 mG	32.8 mG
Proposed Total Output -			41.5 mG	76.0 mG	41.5 mG

5.18.2.3 Pacemakers

Overview. One area of concern related to the electric and magnetic fields of transmission lines has been the possibility of interference with cardiac pacemakers. There are two general types of pacemakers: asynchronous and synchronous (IITRI 1979). The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference because it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker, on the other hand, pulses only when its sensing circuitry determines that pacing is necessary. The concern is that interference could result from transmission line electric or magnetic fields, and cause a spurious signal in the pacemaker's sensing circuitry (Sastre, 1997). However, when these pacemakers detect a spurious signal, such as an induced 60 Hz current, they are programmed to revert to an asynchronous or fixed pacing mode of operation and return to synchronous operation within a specified time after the signal is no longer detected. The issue for pacemakers is if power line fields could adversely affect their operation.

Pacemakers – Estimated Project Effects. The potential for pacemaker interference from power line fields depends on the manufacturer, model, and implantation method, among other factors. Studies have determined thresholds for interference of the most sensitive units to be about 2,000 to 12,000 mG for magnetic fields and about 1.5 to 2.0 kV/m for electric fields (University of Rochester 1985). The calculated electric and magnetic fields on the right-of-way and at the right-of-way edge are below these values. However, measured electric fields underneath of these overhead lines on Vista Del Mar, where they exit the station and cross over the street (changing from a horizontal to vertical phasing configuration) exceeded the electric field threshold (measured electric field levels reached about 4.4 kV/m). These measured electric field values are also above the limit value of 1 kV/m suggested for occupational exposure to electric fields (ACGIH 1999). It is unclear that reversion to a fixed pacing mode is harmful since pacemakers are routinely put into reversion with a magnet to test operation and battery life. Some new pacemaker models are dual chamber devices that can be more sensitive to external interference. Some of these dual chamber units may experience inappropriate pacing behavior (prior to reversion to fixed pacing mode) in electric fields as low as 1.2 to 2 kV/m, while other models appear unaffected in fields up to 20 kV/m. The biological consequences of brief, reversible pacemaker malfunction are mostly benign. An exception would be an individual who has a sensitive pacer and is completely dependent on it for maintaining all cardiac rhythms. For such an individual, a malfunction that compromised pacemaker output or prevented the unit from reverting to the fixed pacing mode, even brief periods of interference, could be life-threatening (Sastre 1997:8-2). The precise coincidence of events (i.e. pacer model, field characteristics, biological need for full function pacing) would generally appear to be a rare event.

These transmission lines have been in operation at a voltage rating of 230 kV for several years. The proposed changes to the El Segundo Generation Station to increase power production should not change the voltage rating or size of the conductors for these transmission circuits. Therefore, electric field levels near the El Segundo Generating Station and overhead 230 kV transmission lines should remain relatively unchanged from their present levels. The potential risk of pacemaker interference at completion of the project should remain relatively unchanged from existing conditions due to electric fields.

Calculated magnetic field levels are well below the threshold for potential risk of pacemaker interference. Measured magnetic field levels under the 230 kV transmission lines at the station reached a maximum of about 37 mG for a loading condition of 320 MW. The proposed total output loading of 1,291 MW would represent a load increase of about 403%. Since magnetic fields are directly proportional to load, it is anticipated that a maximum magnetic field of about 150 mG would therefore be present at this location, which again is well below the threshold for potential risk of pacemaker interference due to magnetic fields.

5.18.2.4 Computer Interference

Overview. Personal computer monitors using cathode ray tubes (CRTs) can be susceptible to magnetic field interference. The magnetic fields that occur in the normal operation of the electric power system can be of sufficient intensity to affect computer monitors under certain conditions. Magnetic field interference results in disturbances to the image displayed on the CRT monitor, often described as screen distortion, "jitter," or other visual defects (Banfi, 2000). In most cases it can be annoying, and at its worst, it can prevent use of the monitor. The extent of interference depends on 60 Hz magnetic field intensity, monitor orientation, monitor design, and the monitor's vertical refresh rate. Magnetic field levels as low as 2 to 5 mG can cause some computer monitor interference, depending upon the type of monitor.

Computer Interference – Estimated Project Effects. Computer monitors that use cathode ray tubes, or CRTs, could experience image jitter lines in proximity to the 230 kV transmission lines under existing and proposed loading conditions. Under the proposed total output loading condition, the potential for computer monitor interference could exist within 200 feet from centerline of the transmission line. This image distortion does not occur on liquid crystal display (LCD) monitors common on most portable computers (ESAA 1996:40). Computer monitor interference is a recognized problem in the video monitor industry. As a result, there are manufacturers who specialize in monitor interference solutions and shielding enclosures. Possible solutions to this problem include: relocation of the monitor, use of magnetic shield enclosures, software programs to adjust the monitor's vertical refresh rate, and replacement of cathode ray tube monitors with liquid crystal displays.

5.18.2.5 Human Health Studies

Overview. Over the past two decades or so there has been significant concern over the potential for exposure to EMF to adversely affect human health. There have been a variety of health concerns that included a variety of diseases and other health endpoints such as reproductive outcome. The possible effect of EMF on human health was originally focused on electric fields, but much of the recent research has focused on magnetic fields. Some of the initial concern was raised by studies done in Denver that reported the a positive association between cancer incidence and homes that were near certain power line configurations that were thought to produce high levels of magnetic fields (Wertheimer, 1979; 1981). Since then, much research has been done to evaluate the potential for EMF exposure to affect human health. Some of these studies have generally found no conclusive evidence of harmful effects from typical power line and substation electric and magnetic fields. However, some studies during this period did report the potential for harmful effects to humans. Complicating resolution of this issue is the lack of knowledge as to what characteristics of electric and magnetic field exposure (if any) need to be considered to assess human exposure effects. The exposure most often considered is intensity or magnitude of the field. There is a consensus among the medical and scientific communities that there is insufficient evidence to conclude that EMF causes adverse health effects. Neither the medical nor scientific communities have been able to provide any foundation upon which federal or state regulatory bodies could establish a standard or limit for exposure that is known to be either safe or harmful.

There is a large body of EMF health literature. Perhaps the best way to evaluate the potential for EMF exposure to affect human health is to consider some of the extensive scientific literature reviews of the extant research conducted by independent reviewer committees. The Oak Ridge Associated Universities (ORAU) established a panel at the request of The Committee on Interagency Radiation Research and Policy Coordination, to perform an independent scientific review and evaluate the reported health hazards of exposure to extremely low frequency electric and magnetic fields. The panel reviewed about 1,000 journal articles published within the last 15 years. The ORAU panel completed their EMF literature review and published a report (ORAU 1992).

In the conclusions to the report the authors state (ORAU 1992: VIII-10-10-11-11):

"This review indicates that there is no convincing evidence in the published literature to support the contention that exposures to extremely low-frequency electric and magnetic fields (ELF-EMF) generated by sources such as household appliances, video display terminals, and local power lines are demonstrable health hazards."

It says later in the report:

"Although exposure to ELF-EMF does not appear to constitute a public health problem, there is evidence that these fields may produce some biological effects, such as changes in the pattern of secretion of the hormone melatonin and enhancement of healing of bone fractures. These findings and those described elsewhere in this report suggest areas of some scientific interest and warrant consideration for further research."

The report concludes with:

"This review does not provide justification for a major expansion of the national research effort to investigate the health effects of ELF-EMF. In the broad scope of research needs in basic science and health research, any health concerns over exposures to ELF-EMF should not receive a high priority."

American Medical Association. The AMA adopted recommendations of its Council on Scientific Affairs (CSA) regarding EMF health effects. The report was prepared as a result of a resolution passed at the 1993 annual meeting. The following statements were adopted and are based on the CSA's review of EMF epidemiologic and laboratory studies to date, as well as on several major literature reviews (AMA, 1994: 12):

- *That no scientifically documented health risk has been associated with the usually occurring levels of electromagnetic fields; nevertheless, the American Medical Association should continue to monitor developments and issues related to the subject.*

- *That the AMA should encourage research efforts sponsored by agencies such as the National Institutes of Health, the U.S. Department of Energy, and the National Science Foundation to continue on exposures to electromagnetic fields and their effects, average public exposures, occupational exposures, and the effects of field surges and harmonics.*

- *That the AMA should support the meeting of an authoritative, multidisciplinary committee under the auspices of the National Academy of Sciences or the National Council on Radiation Protection and Measurements to make recommendations about exposure levels of the public and workers to electromagnetic fields and radiation.*

American Cancer Society. In the journal, *A Cancer Journal for Clinicians*, the American Cancer Society (ACS) reviewed EMF residential and occupational epidemiologic research in an article written by Dr. Clark W. Heath, Jr., ACS's vice president of epidemiology and surveillance research. Dr. Heath reviews 13 residential epidemiologic studies of adult and childhood cancer and reported the following (ACS 1996: 42):

The weakness and inconsistent nature of epidemiologic data, combined with the continued dearth of coherent and reproducible findings from experimental laboratory research, leave one uncertain and rather doubtful that any real biological link exists between EMF exposure and carcinogenicity.

National Institute of Environmental Health Sciences. The federal government has recently completed a $60-million EMF research program managed by the National Institute of Environmental Health Sciences (NIEHS) and the U.S. Department of Energy (DOE). This comprehensive EMF research program was called EMF RAPID (Research And Public Information Dissemination) Program. At the conclusion of this major effort, the NIEHS submitted a report to the U.S. Congress on their findings (NIEHS, 1999).

Among other things, the NIEHS concluded that:

"The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm." (NIEHS 1999:36).

The NIEHS report also included the following conclusions:

Epidemiological studies have serious limitations in their ability to demonstrate a cause and effect relationship whereas laboratory studies, by design, can clearly show that cause and effect are possible. Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done in cells fail to support a causal relationship between exposure to ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings. (NIEHS 1999:ii).

The NIEHS agrees that the associations reported for childhood leukemia and adult chronic lymphocytic leukemia cannot be dismissed easily as random or negative findings. The lack of positive findings in animals or in mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but cannot completely discount the finding. The NIEHS also agrees with the conclusion that no other cancers or non-cancer health outcomes provide sufficient evidence of a risk to warrant concern. (NIEHS 1999:36).

The National Toxicology Program routinely examines environmental exposures to determine the degree to which they constitute a human cancer risk and produces the 'Report on Carcinogens' listing agents that are 'known human carcinogens' or 'reasonably anticipated to be human carcinogens.' It is our opinion that based on evidence to date, ELF-EMF exposure would not be listed in the 'Report on Carcinogens' as an agent 'reasonably *anticipated to be a human carcinogen.' This is based on the limited epidemiological evidence and the findings from the EMF-RAPID Program that did not indicate an effect of ELF-EMF exposure in experimental animals or a mechanistic basis for carcinogenicity*. (NIEHS 1999:37).

The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards. We also encourage technologies that lower exposures from neighborhood distribution lines provided that they do not increase other risks, such as those from accidental electrocution or fire. (NIEHS 1999:37-38).

Health Effects – Estimated Project Effects. There has been public concern over the potential for exposure to EMF to adversely affect human health. The consensus among the medical and scientific communities is that there is insufficient evidence to conclude that EMF causes adverse health effects. Neither the medical nor scientific communities have been able to provide any foundation upon which federal or state regulatory bodies could establish a standard or limit for exposure that is known to be either safe or harmful. The 230 kV transmission line project would produce electric and magnetic fields which are typical of other similar transmission lines already in operation (with similar line design, loading, and voltage classification characteristics). However, there are no federal or state standards related to the human health effects from electric and magnetic fields to serve as a basis for determining a level of impact.

5.18.2.6 Electric And Magnetic Field Standards

Overview. A number of states have set some type of electric or magnetic field limit. In addition, other organizations have established field exposure standards or guidelines. Existing EMF guidelines or limits are summarized in the following tables.

TABLE 5.18-11

STATE REGULATIONS FOR TRANSMISSION LINE FIELDS

State	Field Limit
Montana	1 kV/m at edge of right-of-way (in residential areas)
Minnesota	8 kV/m maximum on right-of-way
New Jersey	3 kV/m at edge of right-of-way
New York	1.6 kV/m at edge of right-of-way
	200 mG at edge of right-of-way
North Dakota	9 kV/m maximum on right-of-way
Oregon	9 kV/m maximum on right-of-way
Florida	10 kV/m for 500 kV Lines- maximum on right-of-way
	2 kV/m for 500 kV Lines- at edge of right-of-way
	8 kV/m for 230 kV and smaller Lines- maximum on right-of-way
	2 kV/m for 230 kV and smaller Lines- at edge of right-of-way
	200 mG for 500 kV Lines- at edge of right-of-way
	250 mG for double circuit 500 kV Lines- at edge of right-of-way
	150 mG for 230 kV and smaller Lines- at edge of right-of-way

Source: OTA, 1989.

TABLE 5.18-12

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

Occupational Threshold Limit Values for 60-Hz EMF	
Electric Field Occupational Exposures Should Not Exceed :	**Magnetic Field Occupational Exposures Should Not Exceed**
25 kV/m (from 0 Hz to 100 Hz)	10 G (10,000 mG)
Prudence dictates the use of protective Devices (e.g. suits, gloves, insulation) in fields above 15 kV/m.	
For workers with cardiac pacemakers Or similar medical electronic devices, Maintain exposure at or below 1 kV/m (1,000 V/m).	*For workers with cardiac pacemakers or similar medical electronic devices, maintain exposure at or below 1 G (1,000 mG).*

Source: ACGIH 1999.

TABLE 5.18-13

INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION

Exposure (60 Hz)	Electric Field	Magnetic Field
Occupational :		
Reference Levels for Time-Varying Fields	8.333 kV/m (8,333 V/m)	4.167 G (4,167 mG)
Current Density for Head and Body	10 mA/m^2 (25 kV/m)	10 mA/m^2 (5 G)
General Public :		
Reference Levels for Time-Varying Fields	4.167 kV/m (4,167 V/m)	0.833 G (833 mG)
Current Density for Head and Body	2 mA/m^2 (5 kV/m)	2 mA/m^2 (1 G)

Source: ICNIRP, 1998.

EMF Standards – Estimated Project Effects. There are no EMF standards for the state of California for transmission line fields. The calculated electric field of 1.107 kV/m at the right-of-way edge and 1.111 kV/m maximum within the right-of-way for the 230 kV transmission line would comply with most existing standards from other states. The calculated magnetic field of 61.6 mG at the right-of-way edge (under the proposed total output loading) for the 230 kV transmission line would comply with other state standards. Both calculated electric and magnetic field levels are well below the guidelines established by the ACGIH and the ICNIRP.

Measured electric fields underneath of the 230 kV overhead transmission lines on Vista Del Mar reached a maximum of about 4.4 kV/m, where they exit the station and cross over the street (changing from a horizontal to vertical phasing configuration). These measured electric field values are above the limit value of 1 kV/m suggested for occupational exposure to electric fields for people with pacemakers (refer to the section on Pacemakers). However, these transmission lines have been in operation at a voltage rating of 230 kV for several years, and the proposed changes to increase power production should not change the voltage rating or size of the conductors for these transmission circuits.

Mitigation Electric and magnetic field calculations indicate that no mitigation measures will be necessary for the proposed project, as the only change may be increased magnetic field levels when the total electrical output of the proposed project is greater than current operation.

5.18.2.6 Induced Currents

Overview. Electric currents can be induced by electric and magnetic fields in conductive objects near to transmission lines. For magnetic fields, the concern is for very long objects parallel and close to the line. The majority of concern is about the potential for small electric currents to be induced by electric fields in metallic objects close to transmission lines. Metallic roofs, vehicles, vineyard trellises, and fences are examples of objects that can develop a small electric charge in proximity to high voltage transmission lines. Object characteristics, degree of grounding, and electric field strength affect the amount of induced charge. An electric current can flow when an object has an induced charge and a path to ground is presented. The amount of current flow is determined by the impedance of the object to ground and the voltage induced between the object and ground. The amount of induced current that can flow is important to evaluate because of the potential for nuisance shocks to people and the possibility of other effects such as fuel ignition.

The amount of induced current can be used to evaluate the potential for harmful or other effects. Previous work on appliance leakage current can provide some insight into this issue. Leakage (and induced) current is commonly measured in units of milliamperes, mA (i.e. one mA is 0.001 amperes of electric current). Most appliances have a leakage current that flows through the body of the user. Usually the amount of current is very small and is below the threshold of perception. Many factors affect how much current flows. In addition to appliance design and age, contact resistance and insulation from ground affect the magnitude of current that flows through the user. Appliance leakage currents have been measured for a variety of appliances and levels ranged from 0.002 mA to tens of mA (Kahn 1966, Stevenson 1973). There is a U.S. standard for the leakage current from appliances that was developed to minimize the potential for electric shock hazards and sudden involuntary movements that might result in an accident (ANSI 1992). The standard limits appliance leakage current to 0.5 mA for portable appliances and 0.75 mA for stationary or fixed appliances. The standard was developed with consideration of the variable threshold of human perception of electric current. Different people and different situations produce a range of current perception values. As an example, when an average person grips an energized conductor, the median (50-percentile) threshold for perception of an AC electric current is 0.7 mA for women and 1.1 mA for men (Dalziel 1972, EPRI 1982). If the current is gradually increased beyond a person’s perception threshold, it becomes bothersome, and possibly startling. With sufficiently large currents, the muscles of the hand and arm involuntarily contract and a person cannot release the gripped object. The reasonably safe value at which 99.5 percent can let-go (0.5 percent cannot) is 9 mA for men and 6 mA for women (Bridges 1985:10). An equivalent let-go value of 5 mA has been estimated for children (EPRI 1982:377). However, before the current flows in a shock situation, contact must be made, and in the process of establishing contact a small arc occurs. This causes a withdrawal reaction that, in some cases, may be a hazard if the involuntary nature of the reaction causes a fall or other accident. Consideration of let-go currents was the basis for the National Electric Safety Code (NESC) to set an induced current limit of 5 mA for objects under transmission lines (ANSI 1996:72-73).

Induced Currents – Estimated Project Effects. The 230 kV transmission line has the highest measured electric field of approximately 4.4 kV/m in the region under the conductors as they cross Vista Del Mar next to the station. Calculated electric field levels on the transmission line right-of-way will be less (approximately 1.1 kV/m maximum within the right-of-way and 0.764 kV/m at the right-of-way edge). These fields are similar to many other 230 kV transmission lines presently in operation. Induced currents can be calculated for common objects for a set of theoretical (worst-case) assumptions: the object is perfectly insulated from ground, located in the highest field, and touched by a perfectly grounded person. Calculations can be made using experimentally determined induction coefficients and the calculated electric field (EPRI 1982:356). The following table summarizes calculated induced current for common objects placed on the right-of-way for the theoretical conditions previously stated.

TABLE 5.18-14
CALCULATED INDUCED CURRENT FOR OBJECTS NEAR 230 KV LINE FOR THEORETICAL CONDITIONS

Object	Length	Induced Current Coefficient- mA/ kV/m	Induced Current for Calculated Electric Field Levels: 1.1 kV/m Near Midspan	Induced Current for Calculated Electric Field Levels: 0.764 kV/m at Right-of-way edge
Midsize Automobile	15 ft	0.088	0.10 mA	0.07 mA
Pickup truck	17 ft	0.10	0.11 mA	0.08 mA
School Bus	34 ft	0.39	0.43 mA	0.30 mA
Tractor-trailer	52 ft	0.64	0.70 mA	0.49 mA

Object	Length	Induced Current Coefficient- mA/ kV/m	Induced Current for Measured Electric Field Levels 4.4 kV/m at Vista Del Mar
Midsize Automobile	15 ft	0.088	0.39 mA
Pickup truck	17 ft	0.10	0.44 mA
School Bus	34 ft	0.39	1.72 mA
Tractor-trailer	52 ft	0.64	2.82 mA

The maximum measured electric field only occurs on a small portion of the line route and calculated electric field levels along the transmission line right-of-way are much lower than those measured. Perfect insulation and grounding states are not common, but for these assumptions the calculated induced current values for the midsize automobile, pickup truck, school bus, and tractor-trailer are below hazardous levels where a person could not let go of an object (9 mA for men and 6 mA for women). Therefore, this transmission line will comply with the National Electrical Safety Code requirements limiting induced currents on objects to 5 mA or less. At the right-of-way edge, the calculated induced current values are below the threshold of perception.

Industrial operations can occur on or near a transmission line right-of-way. Long fences parallel to a transmission line can present an induced current situation, especially if the fence posts are non-metallic and insulate wires from ground. This problem is solved by frequently grounding the fence with a ground rod connected to the fencing wire (usually done during power line construction). Irrigation systems may often incorporate long runs of metallic pipes that can be subject to field induction when located parallel and close to transmission lines. Because the metallic pipes contact moist soil, electric field induction is generally negligible, but annoying currents could still be experienced from electric field coupling to the pipe. Pipe runs laid at right angles to the transmission line will minimize induced currents, although such a layout may not always be feasible. If there are induction problems, they can be mitigated by grounding and/or insulating the pipe runs.

Since these transmission lines have been in operation for several years, and the proposed changes to increase power production should not change the voltage rating or size of the conductors for these transmission circuits, electric field levels from these lines should remain relatively unchanged from their present levels; therefore the potential for induced currents should also remain unchanged from existing conditions.

5.18.2.8 Fuel Ignition

Overview. If a vehicle were to be refueled under a high-voltage transmission line, a possible safety concern could be the potential for accidental fuel ignition. The source of fuel ignition could be a spark discharge into fuel vapors collected in the filling tube near the top of the gas tank. The spark discharge would be due to current induced in a vehicle (insulated from ground) by the electric field of the transmission line and discharged to ground through a metallic refueling container held by a well-grounded person.

Fuel Ignition – Estimated Project Effects. Theoretical calculations show that if a number of unlikely conditions exist simultaneously, a spark could release enough energy to ignite gasoline vapors (EPRI 1982: 381). This could not occur if a vehicle were simply driven or parked under a transmission line. Rather, several specific conditions would need to be satisfied: A large gasoline-powered vehicle would have to be parked in an electric field of about 5 kV/m or greater (Deno 1985). A person would have to be refueling the vehicle while standing on damp earth and while the vehicle is on insulating dry asphalt or gravel. The fuel vapors and air would have to mix in an optimum proportion. Finally, the pouring spout must be metallic. The chances of having all the conditions necessary for fuel ignition present at the same time are extremely small. Very large vehicles (necessary to collect larger amounts of electric charge) are often diesel-powered, and diesel fuel is less volatile and more difficult to ignite. The 230 kV transmission line electric field levels are too low (about 0.764 to 1.111 kV/m calculated and 4.4 kV/m measured) for the minimum energy necessary for fuel ignition under any practical circumstances. One additional consideration would be gasoline stations located near the right-of-way edge. The low electric fields of the transmission line would be further reduced to almost zero due to shielding by typical metallic coverings over the refueling area and by the presence of any nearby light poles or trees (Deno 1987). A typical tractor-trailer gasoline truck used to replenish the underground fuel storage tanks is commonly grounded during fuel handling operations, and this is done to eliminate electric discharges. Therefore, fuel ignition does not pose a significant hazard.

5.18.2.9 Corona Effects

Overview. One of the phenomena associated with all energized electrical devices, including high-voltage transmission lines, is corona. Under certain conditions, the localized electric field near an energized conductor can be sufficiently concentrated to ionize air close to the conductors (EPRI 1982:169). This can result in a partial discharge of electrical energy called a corona discharge, or corona. Several factors, including conductor voltage, shape and diameter, and surface irregularities such as scratches, nicks, dust, or water drops can affect a conductor’s electrical surface gradient and its corona performance. Corona is the physical manifestation of energy loss, and can transform discharge energy into very small amounts of sound, radio frequency noise, heat, and chemical reactions of the air components.

Because power loss is uneconomical and noise is undesirable, corona on transmission lines has been studied by engineers since the early part of this century. Many excellent references exist on the subject of transmission line corona (e.g. EPRI 1982). Consequently, corona is well understood by engineers and steps to minimize it are one of the major factors in transmission line design. Corona is a design consideration for transmission lines rated at 230 kV and higher. A corona design feature of the 230 kV transmission line is the use of large-diameter bundled subconductors and corona rings at hardware attachment points. The use of large-diameter bundled conductors lowers the electrical stress on the air at the conductor surface so that corona activity is at low levels under most operating conditions.

5.18.2.9 Audible Noise

Overview. Operation of high voltage transmission lines and electric substation equipment can create audible noise. Transmission lines can generate a small amount of sound energy during corona activity. This audible noise from the line can barely be heard in fair weather conditions on higher voltage lines. During wet weather conditions, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops. Audible noise will decrease with distance away from the power line. For substations, electrical transformers are generally the main source of audible noise (other than the associated power lines).

Public concerns can develop concerning audible noise from electrical facilities in close proximity to residences. The U.S. Environmental Protection Agency (EPA) has an outdoor activity noise guideline of 55 dBA (EPA 1974). This value represents the sound energy averaged over a 24-hour period; it has a 10 dBA nighttime weighting (between 10:00 PM and 7:00 AM) (EPRI, 1982).

Ambient, or background noise, is the all-encompassing noise associated with a given environment (usually a composite of sounds from many near and far sources). Outdoors, average nighttime ambient noise is, in general, lower than daytime ambient levels by approximately 5 dB. This difference, however, is widely affected by the characteristics of the area and environment. Ambient noise is usually most critical at nighttime during the summer, when people are resting, windows are often left open, and traffic noise is usually at a minimum. Average ambient daytime and nighttime sound levels for various types of neighborhoods are presented in Table 5.18-15.

TABLE 5.18-15

AVERAGE AMBIENT SOUND LEVELS

	A-Weighted Ambient Sound Level (dBA)	
Type of Neighborhood	**Day**	**Night**
Rural	35	35
Residential Suburban	40	35
Residential Urban	45	40
Commercial	50	45
Industrial	55	50

During corona activity, transmission lines (primarily those rated at 345 kV and above) can generate a small amount of sound energy. This audible noise can increase during foul weather conditions. Water drops may collect on the surface of the conductors and increase corona activity so that a crackling or humming sound may be heard near a transmission line. Audible noise decreases with distance away from a transmission line. Transmission line audible noise is measured in decibels using a special weighting scale, the “A” scale that responds to different sound characteristics in a manner similar to the response of the human ear. Corona-induced noise tends to be broadband and can sometimes have a pure tone as well (usually at 120 Hz). Some typical noise levels are given in the following table (EPA 1974, IEEE 1974, Miller 1978):

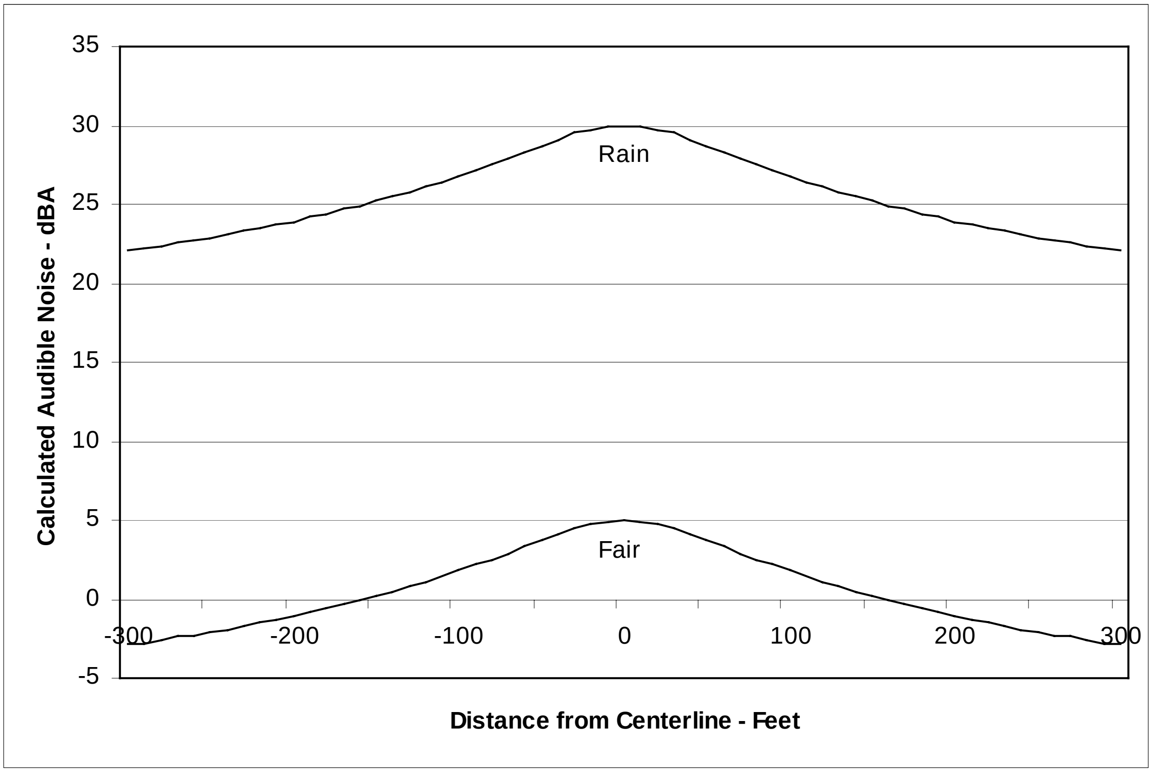
TABLE 5.18- 16

TYPICAL SOUND LEVELS FOR COMMON SOURCES IN A-WEIGHTED DECIBELS

Source/Location	Sound Level
Threshold of Hearing	0 dBA
Motion Picture Studio- Ambient	20 dBA
Library	35 dBA
Chicago Suburbs- nighttime minimum	40 dBA
Wind in Deciduous Trees (2-14 mph)	36-61 dBA
Falling Rain (Variable Rainfall Rates)	41-63 dBA
Tomato Field on California Farm	44 dBA
Small Town/Quiet Suburb	47-53 dBA
Private Business Office	50 dBA
Light Traffic at 100 ft Away	50 dBA
Average Residence	50 dBA
Large Retail Store	60 dBA
Accounting Office	60 dBA
Boston- Inside House on Major Avenue	68 dBA
Average Traffic on Street Corner	75 dBA
Inside Sports Car (50 mph)	80 dBA
Los Angeles- ¾ mile from Jet Landing	86 dBA
Inside New York Subway Train	95 dBA
Loud Automobile Horn (at 1 m)	115 dBA

Audible noise levels on well-designed 230 kV lines are usually not noticeable. For example, a typical calculated rainy weather audible noise for a 230 kV transmission line at the right-of-way edge is about the same or less than ambient levels in a library or typical daytime residential environments, and much less than background noise for wind and rain.

Calculations. In cases where a transmission line cannot be accessed or is proposed to be constructed, audible noise values can be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program. The software then calculates what the audible noise will be at a defined location, based upon the input data. Computer models have been developed by the Bonneville Power Administration (BPA 1977) and computational results compare well with actual measurement data.



El Segundo Power Redevelopment Project	Figure 5.18-11	Calculated Audible Noise Levels for the 230 kV Transmission Line	2000
El Segundo Power II LLC			

Audible Noise – Estimated Project Effects Calculated audible noise levels due to corona were also made for each of three transmission line configurations using computer modeling (BPA 1977). Figure 5.18-11 presents a graph of the calculated audible noise for both fair weather and rainy weather conditions for the 230 kV transmission line. Table 5.18-17 presents a tabular summary of the same calculated audible noise levels.

TABLE 5.18-17

CALCULATED AUDIBLE NOISE LEVELS FOR THE 230 KV TRANSMISSION LINE

Distance from Centerline (Feet)	Calculated Audible Noise Rain (DBA)	Calculated Audible Noise Fair (DBA)
-300	22.1	-2.9
-290	22.2	-2.8
-280	22.4	-2.6
-270	22.6	-2.4
-260	22.7	-2.3
-250	22.9	-2.1
-240	23.1	-1.9
-230	23.3	-1.7
-220	23.5	-1.5
-210	23.7	-1.3
-200	23.9	-1.1
-190	24.2	-0.8
-180	24.4	-0.6
-170	24.7	-0.3
-160	24.9	-0.1
-150	25.2	0.2
-140	25.5	0.5
-130	25.8	0.8
-120	26.1	1.1
-110	26.4	1.4
-100	26.8	1.8
-90	27.2	2.2
-80	27.5	2.5
-70	27.9	2.9
-60	28.3	3.3
-50	28.7	3.7
-40	29.1	4.1
-30	29.5	4.5
-20	29.7	4.7
-10	29.9	4.9
0	30.0	5.0
10	29.9	4.9
20	29.7	4.7
30	29.5	4.5
40	29.1	4.1
50	28.7	3.7
60	28.3	3.3
70	27.9	2.9
80	27.5	2.5
90	27.2	2.2
100	26.8	1.8
110	26.4	1.4
120	26.1	1.1
130	25.8	0.8
140	25.5	0.5
150	25.2	0.2
160	24.9	-0.1
170	24.7	-0.3
180	24.4	-0.6
190	24.2	-0.8
200	23.9	-1.1
210	23.7	-1.3
220	23.5	-1.5
230	23.3	-1.7
240	23.1	-1.9
250	22.9	-2.1
260	22.7	-2.3
270	22.6	-2.4
280	22.4	-2.6
290	22.2	-2.8
300	22.1	-2.9

Mitigation. Since these transmission lines have been in operation for several years and the proposed changes to increase power production should not change the voltage rating for these transmission circuits, audible noise levels should remain unchanged from their present levels. As a result, no mitigation measures are planned.

5.18.2.11 Radio And TV Interference

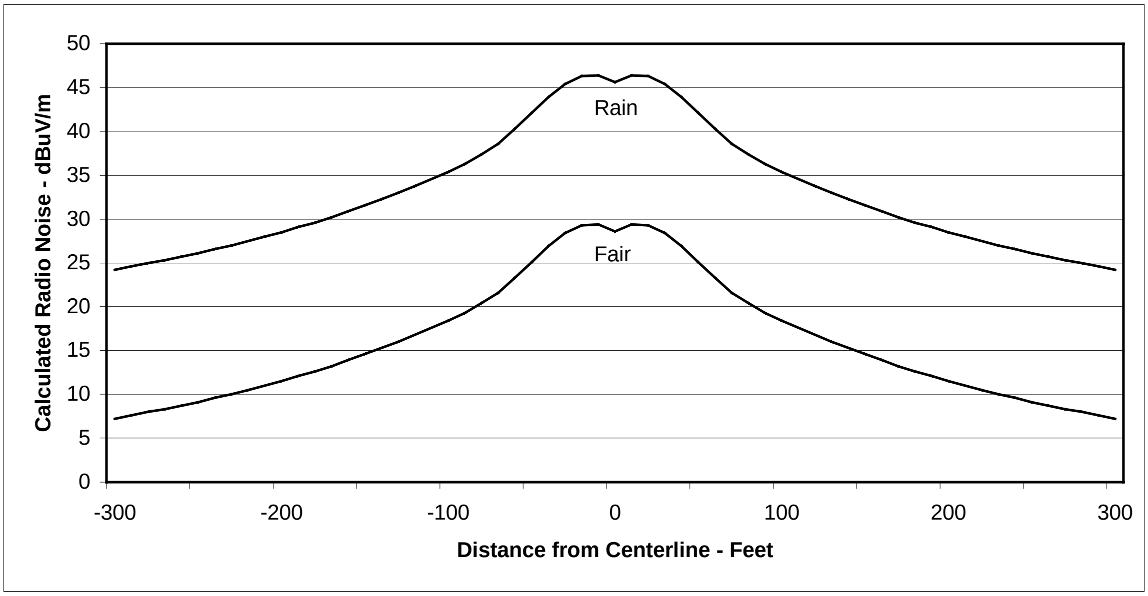
Overview. Overhead transmission lines do not, as a general rule, interfere with radio or TV reception. There are two potential sources for interference: corona and gap discharges. As described earlier, corona discharges can sometimes generate unwanted radio frequency electrical noise. Corona-generated radio frequency noise decreases with distance from a transmission line and also decreases with higher frequencies (when it is a problem, it is usually for AM radio and not the higher frequencies associated with TV signals). Gap discharges are different from corona. Gap discharges can develop on power lines at any voltage and are more frequently found on smaller distribution lines. They can take place at tiny electrical separations (gaps) that can develop between mechanically connected metal parts. A small electric spark discharges across the gap and can create unwanted electrical noise. The severity of gap discharge interference depends on the strength and quality of the transmitted radio or TV signal, the quality of the radio or TV set and antenna system, and the distance between the receiver and power line.

Calculations. In cases where a transmission line cannot be accessed or is proposed to be constructed, radio noise and television interference values can be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program. The software then calculates what the audible noise will be at a defined location, based upon the input data. Computer models have been developed by the Bonneville Power Administration (BPA 1977) and computational results compare well with actual measurement data.

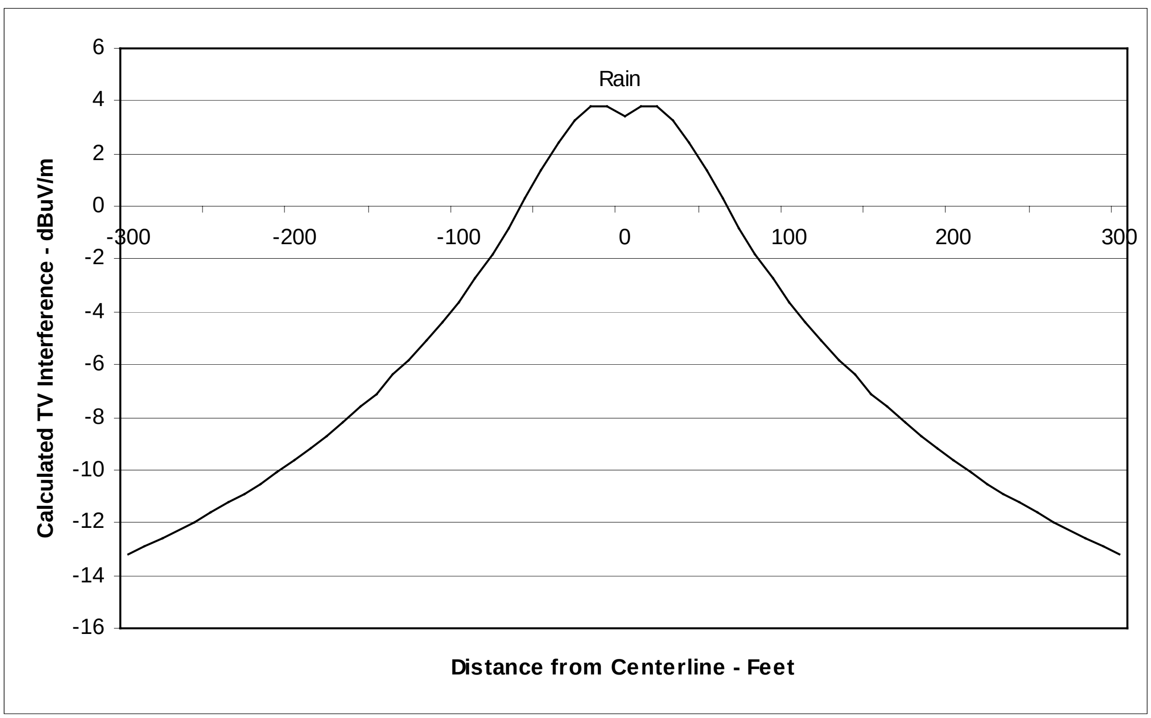
Radio and TV Interference – Estimated Project Effects. Field calculations were performed using a computer program originally developed by the Bonneville Power Administration (BPA 1977). Calculated radio and TV interference levels in fair weather and in rain at the edge of the right-of-way for the 230 kV transmission line are typical for lines of this voltage class. There has been a significant amount of work done to quantify radio and TV noise and provide design methods to mitigate this phenomenon during design (e.g. EPRI 1982, IEEE 1971, 1972, 1976). The potential for interference will depend, among other things, on the signal strength, receiver design, antenna, and transmission line noise level in the signal bandwidth. A signal-to-noise ratio (SNR) can be calculated and reception can be evaluated using the reception guidelines of the Federal Communications Commission (FCC). In general, the 230 kV transmission line should not cause radio and TV interference in either fair or wet weather conditions due to corona noise. However, the extent of interference cannot be evaluated without knowledge of local signal strengths to facilitate calculation of anticipated SNRs.

Figure 5.18-12 presents the calculated radio noise levels for the 230 kV transmission line. As shown, the calculated audible noise levels reaches about 29 dBuV/m in fair weather and about 46 dBuV/m during wet weather conditions. Figure 5.18-13 presents the calculated TV noise interference levels for the transmission line. The calculated maximum television interference level within the right-of-way is about 3.8 dBuV/m during wet weather conditions, much lower than the calculated radio noise levels. Table 5.18-18 presents a tabular summary of the radio noise and television interference calculations. Calculations were performed for an altitude of 0 feet with a radio interference antenna height of 6.6 feet and a TV antenna height of 9.8 feet under fair and rain conditions. The reference frequency for the calculations is 1 MHz for radio noise and 75 MHz for TV noise. Results are presented in decibels (dB) above a reference level of 1 uV/m.

Gap discharge noise is the most commonly noticed form of power line radio interference. Gap discharges can occur on broken or poorly fitting line hardware, such as insulators, clamps, or brackets. In addition, tiny electrical arcs can develop on the surface of dirty or contaminated insulators, but this interference source is less significant than gap discharge. Hardware is designed to be problem-free, but corrosion, wind motion, gunshot damage and insufficient maintenance contribute to gap formation. Often the source of gap noise is not due to power lines. The large majority of interference complaints are found to be attributable to sources other than power lines: poor signal quality, poor antenna, door bells, and appliances such as heating pads, sewing machines, freezers, ignition systems, aquarium thermostats, fluorescent lights, etc. (IEEE 1976). Generally, interference due to gap discharges is less common on high-voltage transmission lines. The reasons that high voltage transmission lines have fewer problems include: predominate use of steel structures, fewer structures, greater mechanical load on hardware, and different design and maintenance standards. Gap discharge interference can be avoided or minimized by proper design of the transmission line hardware parts, use of electrical bonding where necessary, and by careful tightening of fastenings during construction. Individual sources of gap discharge noise can be readily located and corrected. Arcing on contaminated insulators can be prevented by increasing the insulation in high contamination areas and with periodic washing of insulator strings.



El Segundo Power Redevelopment Project **El Segundo Power II LLC**	Figure 5.18-12 Calculated Radio Noise Profile for the 230 kV Transmission Line	2000



El Segundo Power Redevelopment Project **El Segundo Power II LLC**	Figure 5.18-13 Calculated TV Noise Interference for the 230 kV Transmission Line	2000

TABLE 5.18-18.
CALCULATED RADIO NOISE & TELEVISION INTERFERENCE LEVELS

Distance from Centerline (Feet)	Radio Interference Rain (DBuV/m)	Radio Interference Fair (DBuV/m)	Television Interference (DBuV/m)
-300	24.2	7.2	-13.2
-290	24.6	7.6	-12.9
-280	25.0	8.0	-12.6
-270	25.3	8.3	-12.3
-260	25.7	8.7	-12.0
-250	26.1	9.1	-11.6
-240	26.6	9.6	-11.2
-230	27.0	10.0	-10.9
-220	27.5	10.5	-10.5
-210	28.0	11.0	-10.1
-200	28.5	11.5	-9.6
-190	29.1	12.1	-9.2
-180	29.6	12.6	-8.7
-170	30.2	13.2	-8.2
-160	30.9	13.9	-7.6
-150	31.6	14.6	-7.1
-140	32.3	15.3	-6.4
-130	33.0	16.0	-5.8
-120	33.8	16.8	-5.1
-110	34.6	17.6	-4.4
-100	35.4	18.4	-3.6
-90	36.3	19.3	-2.7
-80	37.4	20.4	-1.8
-70	38.6	21.6	-0.8
-60	40.3	23.3	0.3
-50	42.1	25.1	1.4
-40	43.9	26.9	2.4
-30	45.4	28.4	3.3
-20	46.3	29.3	3.8
-10	46.4	29.4	3.8
0	45.6	28.6	3.4
10	46.4	29.4	3.8
20	46.3	29.3	3.8
30	45.4	28.4	3.3
40	43.9	26.9	2.4
50	42.1	25.1	1.4
60	40.3	23.3	0.3
70	38.6	21.6	-0.8
80	37.4	20.4	-1.8
90	36.3	19.3	-2.7
100	35.4	18.4	-3.6
110	34.6	17.6	-4.4
120	33.8	16.8	-5.1
130	33.0	16.0	-5.8
140	32.3	15.3	-6.4
150	31.6	14.6	-7.1
160	30.9	13.9	-7.6
170	30.2	13.2	-8.2
180	29.6	12.6	-8.7
190	29.1	12.1	-9.2
200	28.5	11.5	-9.6
210	28.0	11.0	-10.1
220	27.5	10.5	-10.5
230	27.0	10.0	-10.9
240	26.6	9.6	-11.2
250	26.1	9.1	-11.6
260	25.7	8.7	-12.0
270	25.3	8.3	-12.3
280	25.0	8.0	-12.6
290	24.6	7.6	-12.9
300	24.2	7.2	-13.2

5.18.3 Stipulation to Standard Conditions

As a means of cooperating with the CEC and establishing a conciliatory relationship, and an open efficient AFC process that allows the Commission to utilize its resources in the most efficient manner possible, ESPR expresses a willingness to stipulate to and accept the following CEC standard general conditions as promulgated by the CEC that apply to the issue area of Transmission Line Safety and Nuisance.

TLSN-1: Construction of Transmission Line per Regulations. Project owner shall construct any necessary transmission line, should it be determined that new transmission facilities will be constructed, according to the requirements of GO-95 and Title 8, Section 2700 et seq. of the California Code of Regulations.

Verification: Thirty days before start of transmission line construction, the project owner shall submit to the Commission's Compliance Project Manger (CPM) a letter signed by a California registered electrical engineer affirming that the transmission line will be constructed according the requirements of GO-95 and Title 8 Section 2700 et seq. of the California Code of Regulations.

TLSN-2: Identify and Correct Transmission Line Interference Problems. The project owner shall make every reasonable effort to identify and correct, on a case-specific basis, all complaints of interference with radio or television signals from operation of transmission lines and related facilities. In addition to any transmission repairs, the relevant corrective actions should include, but shall not be limited to, adjusting or modifying receivers, adjusting or repairing, replacing or adding antennas, antenna signal amplifiers, filters, or lead-in cables.

The project owner shall maintain written records for a period of five years, of all complaints of radio or television interference attributable to operation together with the corrective action taken in response to each complaint. All complaints shall be recorded to include notations on the corrective action taken. Complaints not leading to a specific action or for which there was no resolution should be noted and explained. The record shall be signed by the project owner and also the complainant, if possible, to indicate concurrence with the corrective action or agreement with the justification for a lack of action

Verification: All reports of line-related complaints shall be summarized and included in the Annual Compliance Report to the CPM.

TLSN-3: Measure Magnetic Field Strengths. The project owner shall engage a qualified consultant to measure the strengths of the line electric and magnetic fields before beginning construction and after the project is energized. Measurements should be made at appropriate points along the route to allow verification of design assumptions relative to field strengths.

The areas to be measured should include switching stations, on-site switchyards, and any residences near the right-of-way.

Verification: The project owner shall file a copy of the ***first*** set of pre-project measurements with the CPM at least 30 days before the start of construction. The post-project measurements shall be filled within 30 days after the day the line was energized.

TLSN-4: The project owner shall ensure that the transmission line right-of-way is kept free of combustible material as required under the provisions of Public Resources Code, section ***4292*** and California Code of Regulations, section 1250.

Verification: The project owner shall provide a summary of inspection results and any fire prevention activities along the right-of-way in the annual compliance report.

TLSN-5: The project owner shall send a letter to all owners of property within or adjacent to the right-of-way at least sixty (60) days prior to the first transmission of electricity.

Protocol: The letter shall include the following:

- a discussion of the nature and operation of a transmission line;
- a discussion of the project owner's responsibility for grounding existing fences, gates, and other large permanent chargeable objects within the right-of-way regardless of ownership;
- a discussion of the property owner's responsibility to notify the project whenever the property owner adds or installs a metallic object which would require grounding as noted above; and
- a statement recommending against fueling motor vehicles or other mechanical equipment underneath the line.

Verification: The project owner shall submit the proposed letter to the CPM for review and approval at least thirty (30) days prior to mailing to the property owners, and shall maintain a record of correspondence (notification and response) related to this requirement in a compliance file.

The project owner shall notify the CPM in the first Monthly Compliance Report that letters have been mailed and that copies are on file.

TLSN-6: The project owner shall ensure the grounding of any ungrounded permanent metallic objects within the right-of-way, regardless of ownership. Such objects shall include fences, gates, and other large objects. These objects shall be grounded according to procedures specified in the National Electrical Safety Code.

In the event of a refusal by the property owner to permit such grounding, the project owner shall so notify the CPM. Such notification shall include, when possible, the owner's written objection. Upon receipt of such notice, the CPM may waive the requirement for grounding the object involved

At least ten (10) days before the line is energized, the project owner shall transmit to the CPM a letter confirming compliance with this Condition

5.18.4 Mitigation

There are no potential impacts or cumulative impacts due to the proposed project. As a result, no mitigation measures are required.

5.18.5 LORS Compliance

The Project will transmit power through existing transmission lines. As a result, federal state and local LORS that address aviation safety, fire hazards and construction of new transmission lines are not applicable to the Project. LORS that are applicable or potentially applicable to the ESPR Facility in the context of transmission line safety and nuisance are outlined in Table 5.18-19. The ESPR Facility will operate in accordance with all LORS applicable to transmission line safety and nuisance, as presented in Table 5.18-19.

TABLE 5.18-19

LORS APPLICABLE TO TRANSMISSION LINE SAFETY AND NUISANCE

LORS Section	AFC Section	Jurisdiction	Authority	Administering Agency	Requirements/Compliance
5.18-3 Transmission Line Safety and Nuisance	5.9, 5.18.5.1	Federal	14 CFR Part 77, “Objects Affecting Navigable Airspace.”	Federal Aviation Administration (FAA)	Completion of “Notice of Proposed Construction or Alteration” (NCPA), FAA Form 7460-1H.
	5.18.3, 5.18.5.2	Federal	47 CFR § 15.25, “Operating Requirements, Incidental Radiation.”	FAA	Mitigation for any device that causes communications interference.
	5.18.2, 5.18.5.2	State	General Order 52(GO-52) CPUC, “Construction and Operation of Power and Communication Lines.”	California Public Utility Commission (CPUC)	Prevent or mitigate inductive interference.
	5.18.3, 5.18.5.2	State	General Order 95 (GO-95) CPUC, “Rules for Overhead Electric Line Construction”.	CPUC, CEC	Design and construct line in compliance with GO-95.
	3.6, 5.18.2, 5.18.5.2	State	High Voltage Electric Safety Orders, Title 3, CCR §2700 et Seq	CPUC	Requirements and standards for operating and maintaining electrical installations and equipment.

TABLE 5.18-19

(CONTINUED)

LORS Section	AFC Section	Jurisdiction	Authority	Administering Agency	Requirements/Compliance
	5.18.5.2	State	Fire Prevention Standards for Electrical Utilities 14 CCR §1250	CPUC	Specific utility related measures for fire prevention.
	5.18.5.3	Local	City of El Segundo General Plan - 1992	City of El Segundo Economic Development Dept.	Design and construct in compliance with policies.
	5.18.5.4	Industry	SCE Interconnection Study	California Independent Operator	Study currently being written assesses transmission capacity availability.
	5.18.5.4	Industry	National Electrical Safety Code Part 2: Safety Rules for Overhead Lines		Specifies the national safe operating clearances applicable in areas where line might be accessible to the public

5.18.5.5 Agencies and Agency Contacts

Agencies with jurisdiction to issue permits and/or enforce LORS related to transmission line safety and nuisance are listed in Table 5.18-20.

TABLE 5.18-20

AGENCY CONTACTS

Agency	Contact	Telephone
California Public Utilities Commission		(415) 703-2782
Federal Aviation Administration	Dave Kessler	(310) 725-3500
California ISO	Ron Daschmans	(916) 351-2120
City of El Segundo	Jim Hansen	(310) 322-4670

5.18.5.6 Permits

There are no identified permits for transmission line safety and nuisance.

5.6 REFERENCES

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Adequacy Issue: Adequate ____ Inadequate ____ **DATA ADEQUACY WORKSHEET** Revision No. ____ Date ____________

Technical Area: **Transmission Line Safety & Nuisance** Project: ____________ Technical Staff: ____________

Project Manager: ____________ Docket: ____________ Technical Senior: ____________

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (i) (2) (A) A	…discussion of the need for the additional electric transmission lines, substations, or other equipment, the basis for selecting principal points of junction with the existing electric transmission system, and the capacity and voltage levels of the proposed lines, along with the basis for selection of the capacity and voltage levels.	Section 5.1.8.1, page 5.18-1, Section 3.6.1, and Section 3.6.2		
Appendix B (i) (2) (B)	A discussion of the extent to which the proposed electric transmission facilities have been designed, planned, and routed to meet the transmission requirements created by additional generating facilities planned by the applicant or any other entity.	Section 3.6.1 and Section 3.6.2		

Adequacy Issue: Adequate ____ Inadequate ____ **DATA ADEQUACY WORKSHEET** Revision No. ____ Date ________

Technical Area: **Transmission Line Safety & Nuisance** Project: ________ Technical Staff: ________

Project Manager: ________ Docket: ________ Technical Senior: ________

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (b) (2) (C)	A detailed description of the design, construction, and operation of any electric transmission facilities, such as power lines, substations, switchyards, or other transmission equipment, which will be constructed or modified to transmit electrical power from the proposed power plant to the load centers to be served by the facility. Such description shall include the width of rights of way and the physical and electrical characteristics of electrical transmission facilities such as towers, conductors, and insulators. This description shall include power load flow diagrams which demonstrate conformance or nonconformance with utility reliability and planning criteria at the time the facility is expected to be placed in operation and five years thereafter; and NA Refer to Transmission System Engineering Data Adequacy Worksheet.	NA		
Appendix B (b) (2) (D)	A description of how the route and additional transmission facilities were selected, and the consideration given to engineering constraints, environmental impacts, resource conveyance constraints, and electric transmission constraints.	NA		

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. ____ Date ____

Technical Area: **Transmission Line Safety & Nuisance** Project: ____ Technical Staff: ____

Project Manager: ____ Docket: ____ Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (18) (A)	The locations and a description of the existing switchyards and overhead and underground transmission lines that would be affected by the proposed project. NA Refer to Transmission System Engineering Data Adequacy Worksheet.	NA		
Appendix B (g) (18) (B)	An estimate of the existing electric and magnetic fields from the facilities listed in (A) above and the future electric and magnetic fields that would be created by the proposed project, calculated at the property boundary of the site and at the edge of the rights of way for any transmission line. Also provide an estimate of the radio and television interference that could result from the project.	Section 5.18.2, pages 5.18-1 through 5.18-27 Section 5.18.2.11, pages 5.18-44 through 5.18-47		
Appendix B (g) (18) (C)	Specific measures proposed to mitigate identified impacts, including a description of measures proposed to eliminate or reduce radio and television interference, and all measures taken to reduce electric and magnetic field levels.	Section 5.18.3, pages 5.18-48 through 5.18-50		

Adequacy Issue:	Adequate ____	Inadequate ____	DATA ADEQUACY WORKSHEET	Revision No. ____	Date ____
Technical Area:	**Transmission Line Safety & Nuisance**		Project: ____	Technical Staff: ____	
Project Manager: ____			Docket: ____	Technical Senior: ____	

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (h) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, and permits applicable to the proposed project, and a discussion of the applicability of each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed.	Section 5.18.5, pages 5.18-50 through 5.18-52 Table 5.18-19		
Appendix B (h) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Section 5.18.5.5, page 5.18-53 Table 5.18-20		
Appendix B (h) (2)	A discussion of the conformity of the project with the requirements listed in subsection (h)(1)(A).	Various (See Table 5.18-19) Section 5.18.5, page 5-18.50		
Appendix B (h) (3)	The name, title, phone number, and address, if known, of an official within each agency who will serve as a contact person for the agency.	Section 5.18.5.5, page 5.18-53		
Appendix B (h) (4)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	NA		