5.14 Transmission Line Safety and Nuisance

This section discusses safety and nuisance issues associated with the transmission system improvements that will interconnect the BSEP with the LADWP transmission system. This section discusses the general aspects of the transmission interconnection and also addresses electric and magnetic fields changes that would occur as a result of the Project.

5.14.1 LORS Compliance

This section provides a list of applicable LORS that apply to the proposed transmission system improvements. The Project will comply with the applicable LORS during construction and operation.

5.14.1.1 Design and Construction

Table 5.14-1 lists the applicable LORS for the design and construction of the proposed transmission system improvements.

Table 5.14-1 Transmission System Design and Construction LORS

LORS	Applicability	Where Discussed in AFC
GO-128, CPUC, “Rules for Underground Electric Line Construction”	Covers required clearances, grounding techniques, maintenance, and inspection requirements.	Section 5.14.1
Title 8 CCR, Section 2700 et seq. ‘’High Voltage Electric Safety Orders’’	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.	Section 5.14.1
GO-52, CPUC, “Construction and Operation of Power and Communication Lines”	Applies to the design of facilities to provide or mitigate inductive interference.	Section 5.14.1
ANSI/IEEE 593, “IEEE Recommended Practices for Seismic Design of Substations”	Recommends design and construction practices.	Section 5.14.1
IEEE 1119, “IEEE Guide for Fence Safety Clearances in Electric-Supply Stations”	Recommends clearance practices to protect persons outside of the facility from electric shock.	Section 5.14.1
IEEE 998, “Direct Lightning Stroke Shielding of Substations”	Recommends protections for electric system from direct lightning strikes.	Section 5.14.1
IEEE 980, “Containment of Oil Spills for Substations”	Recommends preventions for release of fluids into the environment.	Section 5.14.1

Electrical Clearances

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

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

Substation/Switchyard Design

The Project anticipates a direct interconnection with the LADWP transmission system at the breaker-and-a-half Barren Ridge Switching Station fed from either the switchyard at the Project's power block (Option 1) or a new approximately 400 by 240 foot, 230 kV BSEP three breaker ring bus switching station adjacent to the existing LADWP ROW west of SR-14, with an additional line extending between the new Project switching station and the Barren Ridge Switching Station (Option 2). The layout of the proposed Project plant switchyard is shown in Figure 2-11 in AFC Section 2.0, Project Description, and the layout of the proposed BSEP Switching Station is shown in Figure 2-16. Both facilities will be constructed in conformance with all applicable LORS, specifically, IEEE 1127-1998, which deals with substation and switchyard design in order to minimize ambient noise and EMF generated from substations, and is discussed in later sections. A perimeter fence will be constructed around the switching station to keep pedestrian traffic away from live equipment and from exposure to EMF.

5.14.1.2 Aviation Safety

Table 5.14-2 lists the applicable LORS regarding aviation safety with respect to the proposed transmission system improvements.

Table 5.14-2 Transmission System Aviation Safety LORS

LORS	Applicability	Where Discussed in AFC
Title 14, Part 77 of the Code of Federal Regulations (CFR), ”Objects Affecting the Navigable Air Space”	Describes the criteria used to determine the need for a Federal Aviation Administration (FAA) “Notice of Proposed Construction or Alteration” in cases of potential obstruction hazards.	Section 5.14.3
FAA Advisory Circular No. 70/7460-1G, “ Proposed Construction and/or Alteration of Objects that May Affect the Navigation Space”	Addresses the need to file the “Notice of Proposed Construction or Alteration” (Form 7460) with the FAA in cases of potential for an obstruction hazard.	Section 5.14.3

5.14.1.3 Interference with Radio Frequency Communication

Table 5.14-3 lists the applicable LORS regarding radio frequency communications with respect to the proposed transmission system improvements.

Table 5.14-3 Transmission System Radio Frequency Communication LORS

LORS	Applicability	Where Discussed in AFC
Title 47, CFF, Section 15.2524, Federal Communications Commission (FCC)	Prohibits operation of devices that can interfere with radio-frequency communication	Section 5.14.3
California Public Utilities Commission (CPUC) General Order 52 (GO-52)	Governs the construction and operation of power and communications lines to prevent or mitigate interference.	Section 5.14.3
CEC staff, Radio Interference and Television Interference(RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC’s RI-TVI mitigation requirements, developed and adopted by the CEC in past siting cases.	Section 5.14.3

5.14.1.4 Audible Noise

Table 5.14-4 lists the applicable LORS regarding audible noise with respect to the proposed transmission system improvements.

Table 5.14-4 Transmission System Audible Noise LORS

LORS	Applicability	Where Discussed in AFC
IEEE 1127-1998 IEEE Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility	Specifies standards for minimizing audible noise emitted from substations and switchyards through recommended design practices	Sections 5.14.1 and 5.14.3
Kern County General Plan, Noise Element	County Code Noise Limits	Section 5.14.3

5.14.1.5 Hazardous and Nuisance Shocks

Table 5.14-5 lists the applicable LORS regarding hazardous and nuisance shocks with respect to the proposed transmission system improvements.

Table 5.14-5 Transmission System Hazardous and Nuisance Shocks LORS

LORS	Applicability	Where Discussed in AFC
CPUC GO-95, "Rules for Overhead Electric Line Construction"	Governs clearance requirements to prevent hazardous shocks, grounding techniques to minimize nuisance shocks, and maintenance and inspection requirements.	Section 5.14.3
Title 8, California Code of Regulations (CCR) Section 2700 et. Seq. "High Voltage Safety Orders"	Specifies requirements and minimum standards for safely installing, operating, working around, and maintaining electrical installations and equipment.	Section 5.14.3
National Electrical Safety Code	Specifies grounding procedures to limit nuisance shocks. Also specifies minimum conductor ground clearances.	Section 5.14.3
Institute of Electrical and Electronics Engineers (IEEE) 1119, "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Specifies the guidelines for grounding-related practices within the right-of-way and substations	Section 5.14.3

5.14.1.6 Electric and Magnetic Fields

Table 5.14-6 lists the applicable LORS regarding electric and magnetic fields (EMF) with respect to the proposed transmission system improvements.

Table 5.14-6 Transmission System Electric and Magnetic Fields LORS

LORS	Applicability	Where Discussed in AFC
CPUC, GO-131-D "Rules for Planning and Construction of Electric Generation Line and Substation Facilities in California	Specifies application and noticing requirements for new line construction including EMF reduction.	Section 5.14.3
CPUC Decision 93-11-013	Specifies CPUC requirements for reducing power frequency electrical and magnetic fields.	Section 5.14.3
IEEE 1127-1998 IEEE Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility	Specifies standards for minimizing EMF emitted from substations and switchyards through recommended design practices	Sections 5.14.1 and 5.14.3
American National Standards Institute (ANSI/IEEE) 644-1944 Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines	Specifies standard procedures for measuring electric and magnetic fields	Section 5.14.3

5.14.1.7 Fire Hazards

Table 5.14-7 lists the applicable LORS regarding fire hazards with respect to the proposed transmission system improvements.

Table 5.14-7 Transmission System Fire Hazards LORS

LORS	Applicability	Where Discussed in AFC
14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and conductor clearances when and where standards apply.	Section 5.14.3
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Section 5.14.3
GO-95, CPUC, "Rules for Overhead Electric Line Construction," Section 35	Covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards)	Section 5.14.3

5.14.1.8 Involved Agencies and Required Permits

No specific permits are required that relate specifically to transmission line safety and nuisance issues; therefore no involved agencies are identified.

5.14.2 Affected Environment

The affected environment related to the transmission system is considered to be the area along the new transmission line from the power block to the Project's interconnection point with the LADWP transmission system, either at the Barren Ridge Switching Station (Option 1) or to the new proposed Project switching station and then along the LADWP right-of-way to Barren Ridge (Option 2). Figures 2-4 and 2-5 in Section 2.0, Project Description show the location of the generator step-up transformer (GSU) and the transmission line connecting the Project's plant site switchyard to the LADWP transmission grid. Figure 2-16 shows the layout of the proposed new switching station for the second option for interconnection described in Section 2.0.

5.14.3 Impacts

5.14.3.1 Aviation Safety

The Project is located approximately six miles north of the California City Municipal Airport and approximately 20 miles northwest of Edwards Air Force Base (AFB). As EMF issues that affected aircraft communications or avionics likely would be considered a hazard to aircraft operations, there is no available information to suggest that such issues have arisen from the operation of existing transmission lines in the general Project vicinity area, and because only a short new transmission line is required by the BSEP, it is reasonable to assume that no adverse affects would be generated by the Project and impacts on aviation safety would be less than significant. Given that all Project structures leading from the switchyard to the interconnection point would be less than 200 feet in height and are not less than 20,000 feet from an airport, no proposed structure will be identified as an object affecting navigable airspace according to Title 14 Section 77 of the CFR. Although it is not expected that the FAA will require a "Notice of Proposed Construction and Alteration (Form 7460), Beacon Solar intends to submit a Form 7640 to the FAA.

5.14.3.2 Radio Frequency Communications

Transmission line-related radio-frequency interference is one of the indirect effects of transmission line operation and is produced by the physical interactions of line electric fields. Such interference is due to the radio noise produced by the action of the electric fields on the surface of the energized conductor. The process involved is known as corona discharge and can occur within gaps between the conductor and insulators or metal fittings. Since the level of interference depends on factors such as line voltage, distance from the line to the receiving device, orientation of the antenna, signal level, line configuration and weather conditions, maximum interference levels are not specified as design criteria for modern transmission lines. The level of any such interference usually depends on the magnitude of the electric fields involved and the distance from the line. However, the potential for such impacts is minimized by reducing the line electric fields and locating the line away from inhabited areas.

Due to the remoteness from inhabited areas of the Project transmission line and proposed BSEP switching station (under one of the two transmission options only), no adverse effects to local communication networks are anticipated. The Project transmission line and switching station would be built and maintained in keeping with standard practices that minimize surface irregularities and discontinuities. Moreover, the potential for such corona-related interference is usually of concern for lines of 345 kV and above, and not the BSEP 230 kV line.

5.14.3.3 Audible Noise

Corona may result in the production of audible noise from a transmission line. Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Also, irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities. Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above. Since the Project will be connected at 230 kV, it is expected that no corona-related design issues will be encountered. Additionally, research by the Electric Power Research Institute (EPRI, 1982) has shown that the fair-weather audible noise from modern transmission lines to be generally indistinguishable from background noise at the edge of a right-of-way of 100 feet or more.

An additional source of audible noise is transformer hum caused by extension and contraction of the core laminations when magnetized. Should the second option for interconnection be implemented, no transformers are proposed as part of the new BSEP switching station. Additionally, in comparison to transmission line conductors, the bus bar and bus bar connections within the switchyard contain fewer imperfections and therefore, are less of a contributing factor to audible noise than the incoming transmission lines. On the plant side, GSU transformer hum is insignificant in comparison to plant operation and therefore, will not add any appreciable audible noise to the noise levels discussed in Section 5.8, Noise.

5.14.3.4 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air at the surface of the energized conductor and suspension hardware due to very high electric field strength. Corona effects were described above and are generally considered in the context of audible noise and radio frequency interference. Field effects are the voltages and currents that may be induced in nearby conducting objects. A transmission line's inherent electric and magnetic fields cause these effects.

Induced Current and Voltages

Hazardous shocks are those that could result from direct or indirect contact between an individual and the energized line, whether overhead or underground. Such shocks are capable of serious physiological harm or death and remain a driving force in the design and operation of transmission and other high-voltage lines.

A conducting object, such as a vehicle or person in an electric field, will experience induced voltages and currents. The strength of the induced current will depend on the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground and could be characterized as a nuisance shock. Proper design standards will be implemented to prevent hazardous and nuisance shocks by ensuring that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations low enough to prevent vehicle short-circuit currents from exceeding 5 milliamperes (mA).

The Project's transmission interconnection will be constructed in conformance with CPUC GO-95 and Title 8 CCR 2700 requirements. These regulations require sufficient grounding to ensure that hazardous shocks do not occur. Therefore, hazardous shocks are unlikely as a result of Project construction, operation, or maintenance. A shield wire will be installed as a feature of the Project. Additionally, shocks are effectively minimized through grounding procedures specified in the National Electrical Safety Code (NESC) and the joint guidelines of the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE).

Electric and Magnetic Fields

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

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

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

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

EMF Assumptions. It is important that any discussion of EMF include the assumptions used to calculate the values and to remember that EMF in the vicinity of power lines varies based on a variety of factors including, line design, the presence of other lines in the ROW, line loading, and distance from the line. The electric field depends upon the line voltage and 230 kV has been used nominally throughout this AFC as the LADWP utilizes the nominal voltage of 230 kV. The use of 230 kV in this document is consistent with the industry use of 230 kV to describe the nominal standard voltage for this class of system. The magnetic field is proportional to the line loading (amperes), which varies based on the interconnected power system loading, and the power output of the generating facility as output changes to meet increases or decreases in demand for electric power or as the solar insolation varies. The line loading values were based on the nominal load carried by each line section.

The arrangement of the transmission lines in the ROW is another important consideration for the field calculation. The BSEP interconnection will utilize a new ROW; therefore, no other lines are considered in this study. The phase arrangement of each line has been entered into the model used for the field calculation and phase splitting has been utilized to reduce EMF at ground level. The phase arrangement is indicated in the conceptual pole configuration in Figure 5.14-1.

EMF Calculations. The GE PSLF (General Electric Power System Load Flow) program calculates the electric fields expressed in kilovolts per meter (kV/m) and the magnetic fields expressed in milli-Gauss (mG). The various inputs for the calculations include voltage, maximum load in amperes, current angle (phasing), conductor diameter and spacing, along with relative location of conductors and shield wires. The elevation used for the conductors is the lowest point of the conductors which corresponds to the midpoint between two tangent structures where the conductor sag is the greatest. Table 5.14-8 shows the input values used for modeling and Figure 5.14-1 shows the pole design used for phase configuration and circuit height. The EMF calculation inputs are as follows:

1) All calculations are based on the EPRI Red Book methods (2nd Edition, 1982 - infinite straight wire with flat earth approximation).
2) These approximations are only valid for low frequency (50-60Hz) AC transmission lines.
3) Bundles are modeled with an equivalent conductor as per EPRI Red Book 8.3.1.
4) The effects of earth return currents (earth resistivity) are ignored when calculating the magnetic field.
5) Wire position is determined by the currently displayed weather case.
6) Wire height used is the height of the wire where the target point is projected upon it.
7) All calculations assume the ground is flat with the same elevation as that of centerline.
8) Station offset is measured from the BSEP switchyard take-off structure

Meter height above centerline ground: 3.28 (ft)

Cross section offset for graph +/-: 75.00 (ft)

Result interval for graph: 5.00 (ft)

Table 5.14-8 EMF Study Conductor Information

Line	Conductor OD (inches)	No. of Conductors	Load Amperes
BSEP Plant Switchyard/Barren Ridge —BSEP Switching Station	1.108	1	750

Figures 5.14-2 and 5.14-3 summarize the results of the PLSF EMF Simulation of the interconnecting transmission line and the numerical results at the edges of the ROW are included in Table 5.14-9.

Table 5.14-9 EMF Study Edge-of-ROW Calculation Results

Station Offset (ft)	Station Offset (ft)	B Real (mG)	B Imag. (mG)	B Phase Angle (deg)	B rms Res (mG)	E Real (kV/m)	E Imag. (kV/m)	E Phase Angle (deg)	E Axis Angle (deg)	E rms Res (kV/m)
3,517	-75.00	10.169	9.32496	42.5	13.797	0.057	0.19378	73.5	266.0	0.202
3,517	75.00	11.960	9.57103	38.7	15.318	0.122	0.14499	49.8	93.7	0.189

From Figures 5.14-2 and 5.14-3, the maximum magnitude of the magnetic and electric fields at the edge of the ROW is 15 mG and 0.2 kV/m, respectively. While the State of California does not set a statutory limit for electric and magnetic field levels, the CPUC, which regulates electric transmission lines, mandates EMF reduction as a practicable design criterion for new and upgraded electrical facilities. As a result of this mandate, the regulated electric utilities have developed their own design guidelines to reduce EMF at each new facility. The CEC, which regulates transmission lines to the first point of connection, requires generators to follow the existing guidelines that are in use by local electric utilities or transmission-system owners.

In keeping with the goal of EMF reduction, the interconnections of the BSEP will be designed and constructed using the principles outlined in the directives of the CPUC by developing design procedures compliant with Decision 93-11-013 and General Orders 95, 128, and 131-D.

The primary techniques for reducing EMF anywhere along a transmission line are to:

- Increase the pole height for overhead design,
- Use compact pole-head configuration,
- Minimize the current on the line, and
- Optimize the orientation of the line phases.

According to IEEE 1127-1998, EMF at the fence line of substations and switchyards is insignificant with respect to the incoming transmission lines and therefore was not considered in the EMF study. The incoming transmission lines will be designed to maintain minimum ground clearances until within the proposed BSEP switching station and Barren Ridge Switching Station fence lines and thus were included in the study. Due to the decrease in EMF as the square of the distance from the current-carrying conductors and to location of the BSEP interconnecting lines parallel to rather than within the existing LADWP ROW, there is expected to be a less than significant contribution to the EMF at the edge of the BSEP transmission line ROW from the existing LADWP lines above what has been indicated by this study. Also due to the remoteness of the ROW to pedestrian traffic, any small increase in EMF due to the existing LADWP lines above the values provided by this study are not expected to have any adverse effects.

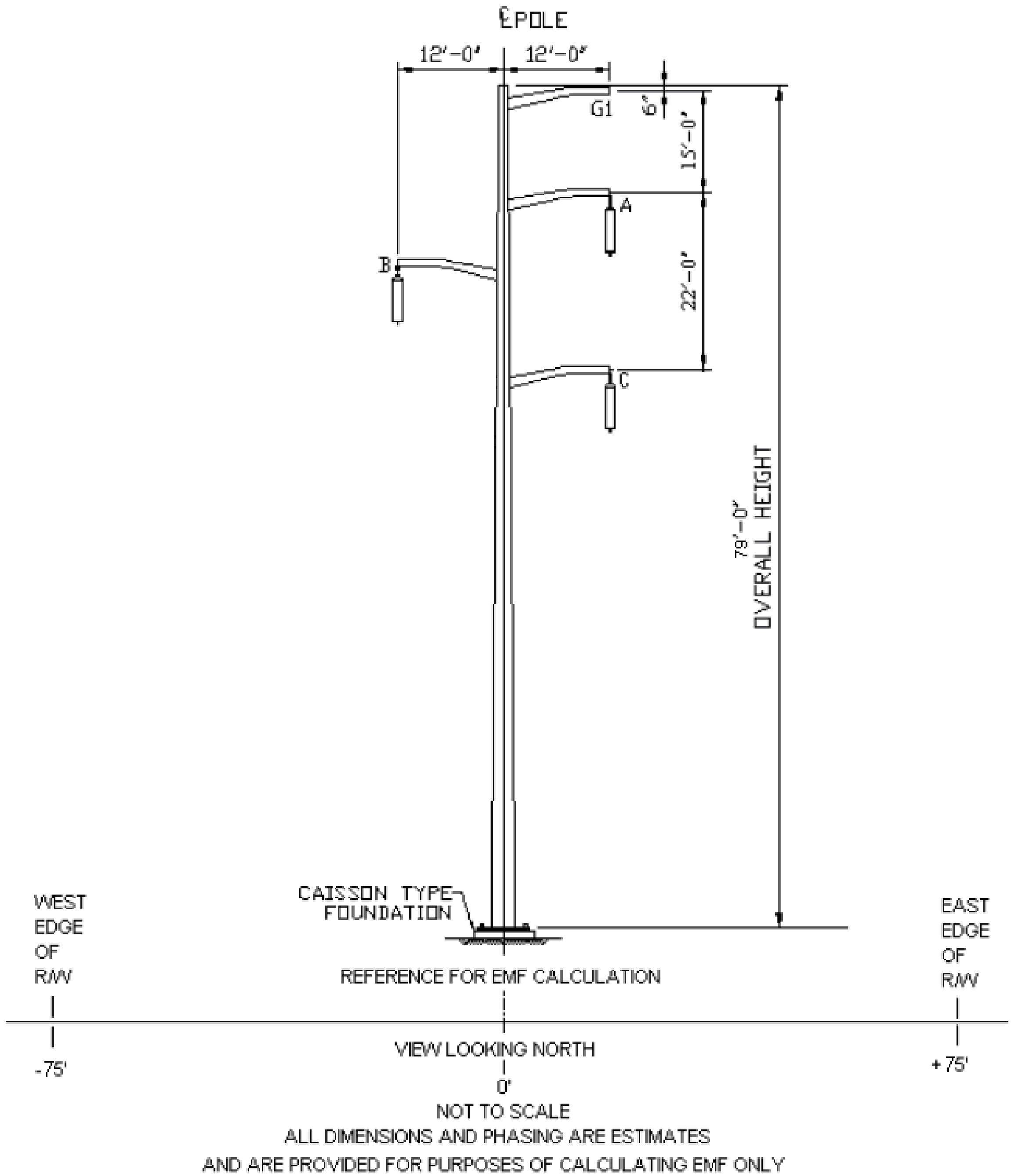
Anticipated EMF levels are typical for both BSEP interconnections as designed. If required, the pre- and post-interconnection verification measurements will be made consistent with IEEE guidelines and will provide sample readings of EMF at the edge of right-of-way. Additional measurements will be made upon request for locations of particular concern.

5.14.3.5 Fire Hazards

The proposed 230 kV transmission interconnection lines will be designed, constructed, and maintained in accordance with the CPUC’s GO-95, which establishes clearances from other man-made and natural structures as well as tree-trimming requirements to reduce/avoid fire hazards. The Project will maintain the onsite portions of the transmission line route and immediate area in accordance with existing regulations and accepted industry practices that will include identification and abatement of any fire hazards. The offsite portions of the transmission line will be owned and operated by LADWP and the line and immediate area also will be maintained in accordance with applicable requirements and standard good practices that include fire protection.

5.14.4   Mitigation Measures

No significant transmission line-related impacts were identified as a result of the Project studies. The Project will be designed, constructed, operated, and maintained in accordance with the applicable LORS and to minimize EMF at the edges of the right-of-way. Impacts will be less than significant with Project implementation as described in this section (e.g., insulators and hardware selected to minimize corona noise; pre- and post-Project noise surveys performed to document ambient condition change caused by the line, and procedures to investigate and resolve interference complaints). No additional mitigation is required. However, should additional currently unforeseen issues arise, they will be addressed to ensure that impacts remain less than significant.



Map Location

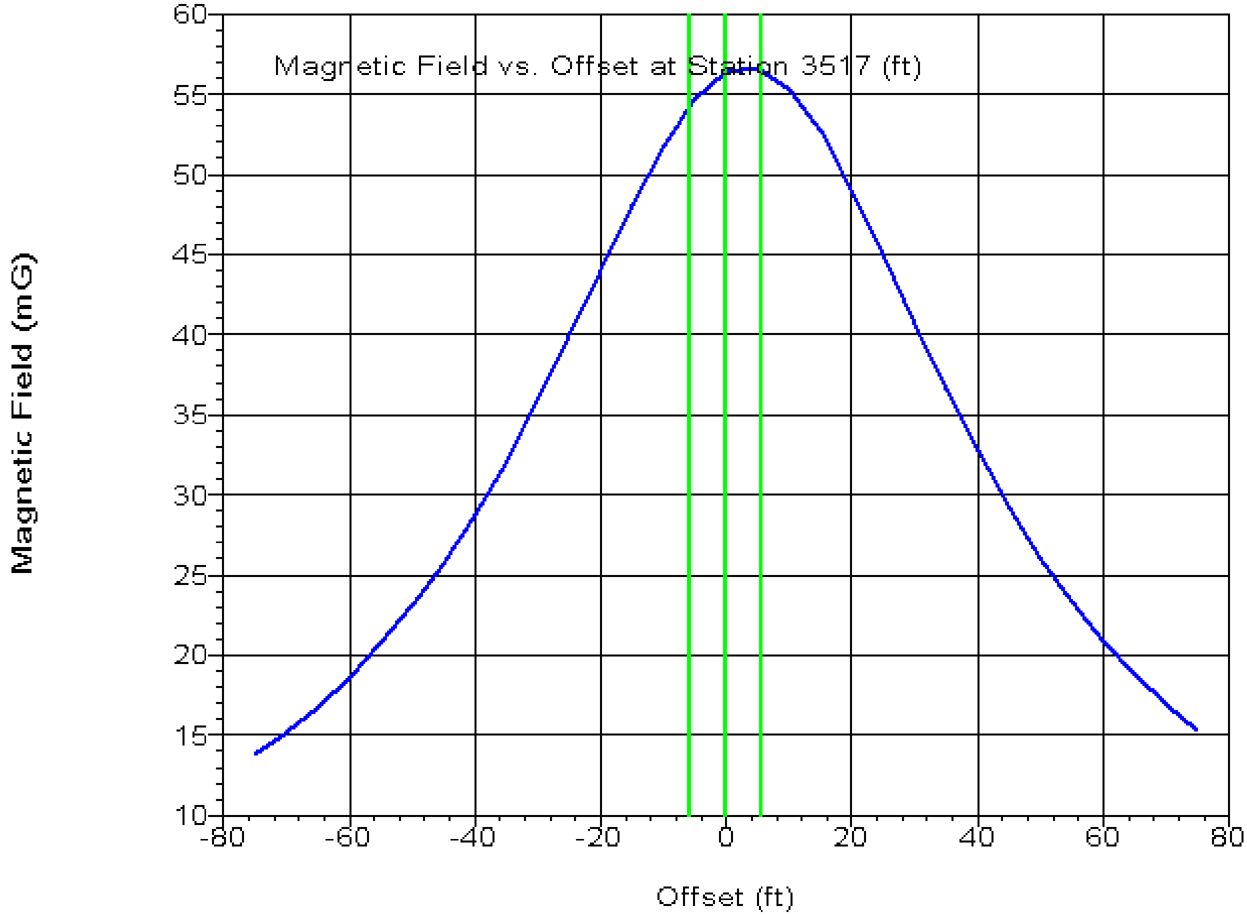
Beacon Solar Energy Project

Figure 5.14-1
230 kV Single Circuit
Structure Evaluation

Beacon Solar

ENSR | AECOM

Project: 10056-014
Date:March 2008



Map Location

Beacon Solar Energy Project

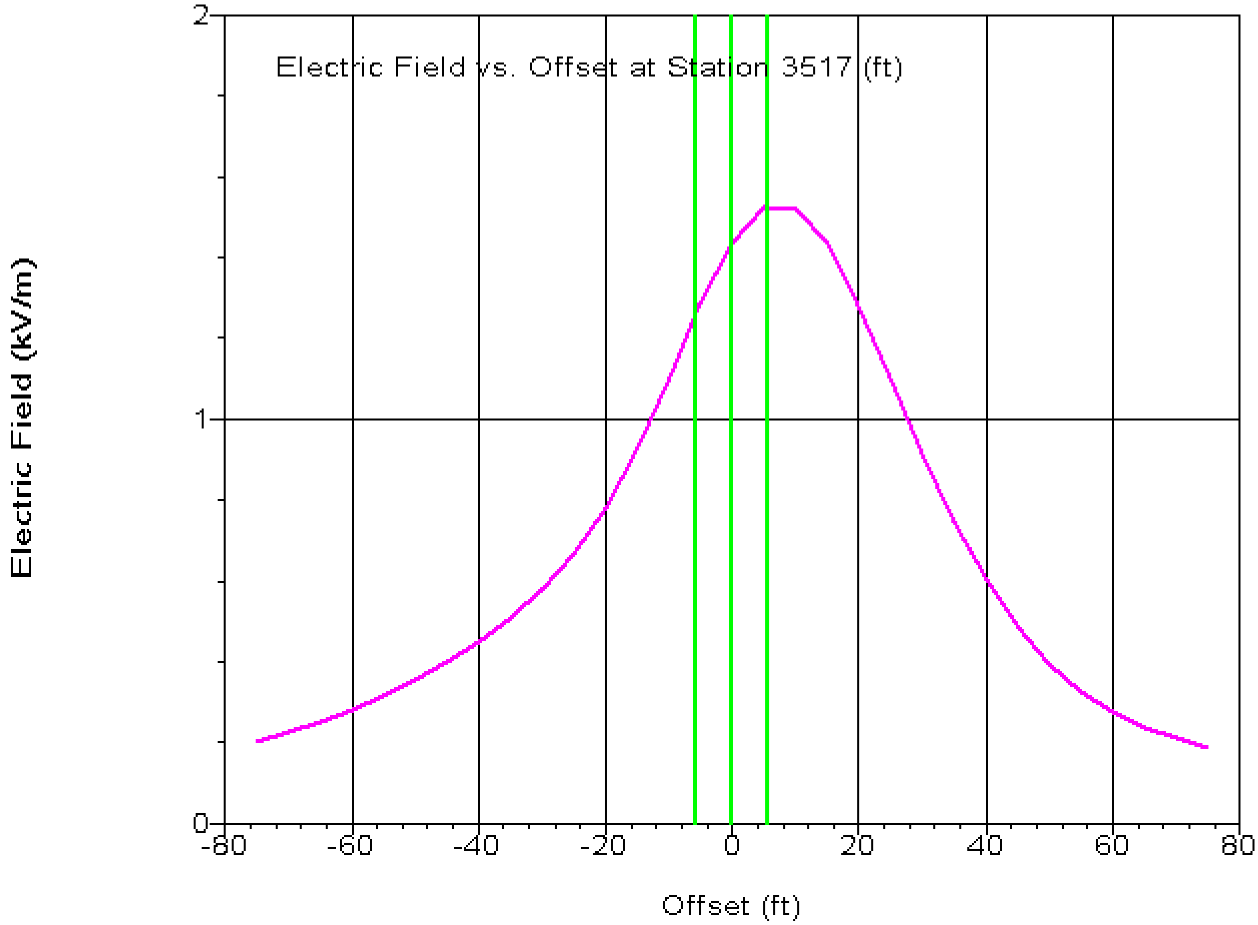
Figure 5.14-2
230 kV Single Circuit
Magnetic Field

Beacon Solar

ENSR | AECOM

Project: 10056-014
Date:March 2008

Y:\Projects\FPL\Beacon_Solar_Energy_Project\MXD\AFC_2007_12\Figure_5-14-2_Single_Circuit_Magnetic_Field.mxd



Map Location

Beacon Solar Energy Project

Figure 5.14-3
230 kV Single Circuit
Electric Field

Beacon Solar

ENSR | AECOM

Project: 10056-014
Date:March 2008