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SECTION 3

Electric Transmission

3.1 Introduction

This section discusses the transmission interconnection between the Stanton Energy Reliability Center (SERC) and the existing electrical grid, and the potential effects that operation of the facility will have on the flow of electrical power in the project region. The following topics are discussed:

- The proposed electrical interconnection between SERC and the electrical grid
- The impacts of the electrical interconnection on the existing transmission grid
- Potential nuisances (electrical effects, aviation safety, and fire hazards)
- Safety of the interconnection
- Description of applicable laws, ordinances, regulations, and standards (LORS)

SERC will be located in the City of Stanton, Orange County, California, on parcels totaling 3.978 acres west of the Southern California Edison (SCE) Barre Substation. This location was selected, in part, for its proximity to the Barre Substation, to which SERC will interconnect via a new 66-kilovolt (kV) underground transmission line, approximately 0.35 mile in length.

Sections 3.2 and 3.3 discuss the details regarding the transmission alternatives investigated and the results of the transmission interconnection studies.

3.2 Transmission Lines Description, Design, and Operation

The SERC will be interconnected with the regional electrical grid by a new, approximately 0.35-mile-long, single-circuit, three-phase, 66-kV generator tie-line. The proposed 66-kV line runs east from the project site, crossing under Dale Avenue and paralleling the Union Pacific railway along the boundary of the property on which the Barre Peaker is located, turning northeast to connect with the Barre Substation. Figure 1.3-1 (Section 1.3) presents the proposed transmission route between the SERC and the Barre Substation.

As stated previously, a project objective is to provide resource adequacy support services delivered to SCE's Metro Bulk service planning area through the SCE Barre Substation.

3.2.1 Underground Transmission Line Characteristics

The interconnecting 66-kV transmission circuit will consist of a single-circuit configuration constructed underground, except for a transition pole located at the boundary of the SERC property immediately west of Dale Avenue. At this point, the line will surface and extend up a single pole to a disconnection device. From this point forward to the Barre Substation, the line will be owned and operated by SCE. Also from this point forward, the line will return to its underground vault and travel the remainder of the way to the Barre Substation 66-kV bus structure, where it will surface inside of the substation to connect. Figure 3.2-1 shows a transmission pole similar to the SERC single pole west of Dale Avenue.

3.2.2 66-kV Barre Substation Characteristics

At this time, SCE has not provided detailed drawings of the Barre Substation.

3.2.3 SERC Switchyard Characteristics

The SERC switchyard will use a single 66-kV circuit breaker for the two generating units and two battery systems, with one generator step-up transformer. The 66-kV circuit breaker will have an interrupting rating of at least 40 kiloamperes (kA). The 13.8-kV switchyard and all equipment therein will be designed for an interrupting capacity of at least 63 kA. The main 66-kV buses, as well as the bays, will be designed to carry at least 3,000 amperes on a continuous basis.

Startup and standby power will be supplied through the generator step-up transformers and four auxiliary transformers. Auxiliary controls and protective relay systems for the SERC switchyard will be located in SERC's switchyard control building.

3.3 Transmission Interconnection Studies

SERC, LLC filed an Interconnection Request (IR) with SCE on April 28, 2014 (in the Cluster 7 Interconnection Request window). SCE, in cooperation with the California Independent System Operator (CAISO), prepared the Phase I Interconnection Study (dated December 17, 2014) and Phase II Interconnection Study (dated November 24, 2015 as modified by Addendum #1 dated June 24, 2016), which considered the potential system impacts of the proposed SERC interconnect (Appendix 3A). The 2015 study assumes a 151.6-megawatt (MW) generating facility at Stanton that is approximately 50 percent larger than this proposal and, therefore, represents the worst-case scenario in terms of potential effects on the transmission system. The results of the Phase II study provide the California Energy Commission (CEC) with the information that it needs to conduct an environmental assessment of the impacts of the transmission and interconnection facilities.

3.3.1 New Equipment Installation

The IR Studies indicate that the following equipment will be installed by SCE:

- The new 66-kV position and related alterations at the Barre switch rack
- The segment of a 66-kV generation tie-line under Dale Avenue and through the Barre 66-kV substation property
- The segments of each of two fiber optic cables inside the Barre Substation property line
- Lightwave, channel bank(s), and associated equipment at Barre Substation and at SERC
- The revenue load meters

The following will be installed by SERC, LLC:

- The 66-kV generation tie-line from SERC to the last structure on SERC property to the west of Dale Avenue
- The fiber optic cables to provide two separately routed telecommunication paths for the line protection relays
- The CAISO metering equipment (voltage and current transformers and CAISO meters) and metering cabinet for SCE revenue meter
- The following 66-kV line protection relays to be installed at SERC:
  - One (1) General Electric L90 current differential relay with dual dedicated digital communication channels on diverse paths to Barre Substation
  - One (1) Schweitzer Engineering Laboratories 311L current differential relay with dual dedicated digital communication channels on diverse paths to Barre Substation

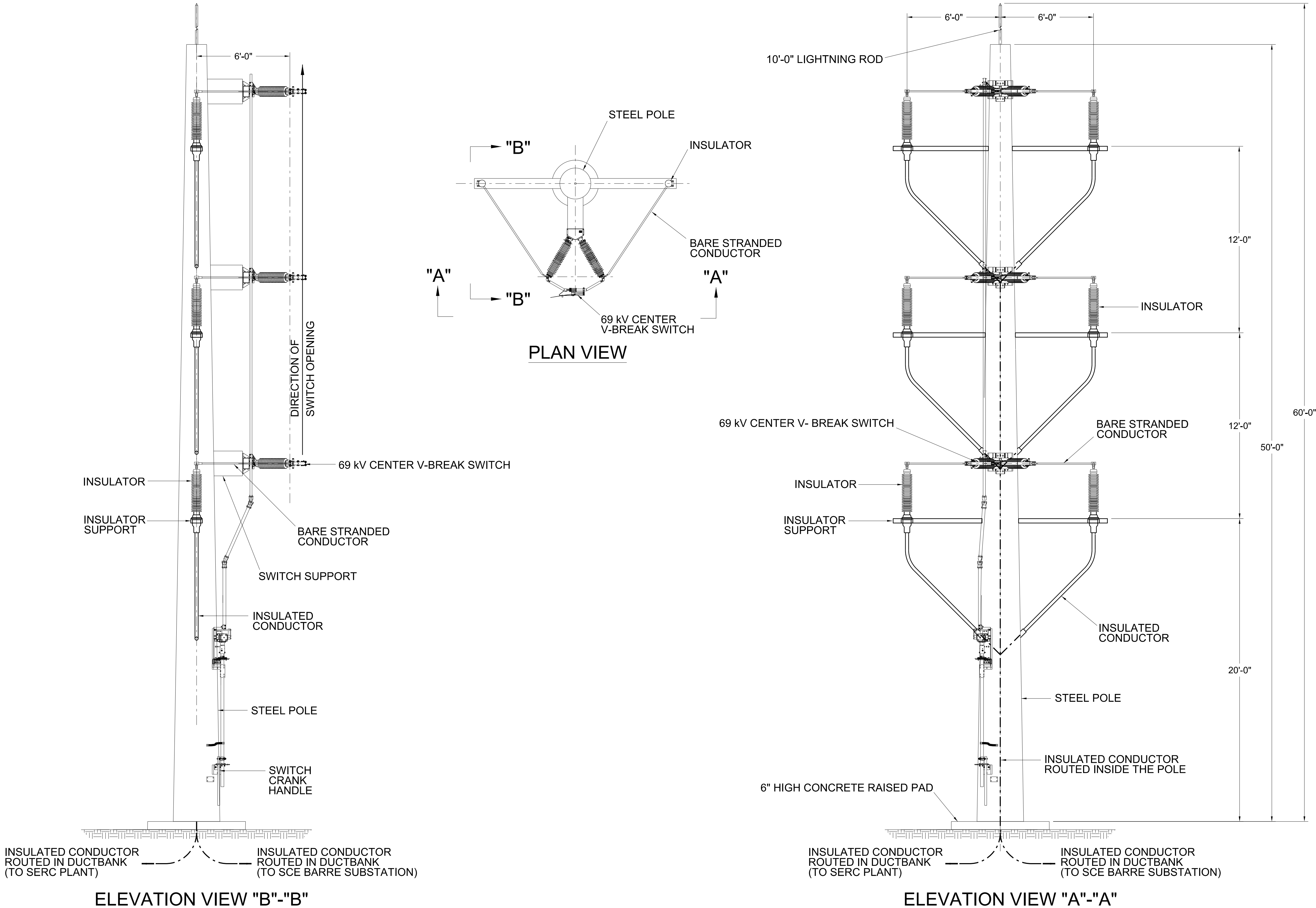

Figure 3.2-1
Transmission Pole
Stanton Energy Reliability Center AFC
Stanton, California

ch2m.

3.3.2 System Impact Studies

The IR Studies assessed the effects of the addition of Cluster 7, including SERC (at 151 MW), to the local electrical system under various conditions of stress.

3.3.2.1 Power Flow Reliability Assessment

- **Steady State Power Flow**—The IR Studies did not identify any power flow issues on the Bulk Electric System that could not be addressed with the use of CAISO Congestion Management or previously approved transmission upgrades.
- **Thermal Overloads**—The IR Studies did not identify any power flow issues on the Barre 66 kV sub-transmission system.
- **Voltage Performance**—The project is required to provide power factor regulation capability to alleviate power flow nonconvergence and maintain the transmission transfer capability.
- **Mitigation**—No power flow mitigation would be required.

3.3.2.2 Short Circuit Duty

3.3.2.2.1 Short-circuit Study Results

The IR Studies determined the impact on circuit breakers of adding the Cluster 7 projects. The IR Studies conclude that the individual contribution from each project in Cluster 7, Phase II, will be determined after the overstressed circuits are identified. Each project in the cluster will be responsible for its share of the upgrade cost.

Short circuit duty at the Barre Substation 220-kV facilities would exceed the maximum nameplate ratings of all of Barre's existing 220-kV breakers, and upgrades to address this would be very expensive and would take 4 years to complete. This circumstance is temporary, however, as it depends partly on the retirement schedule for the generating units currently using Once-Through Cooling (OTC), some of which are likely to be shut down resulting from State of California policies that raise the standards for environmental protection required of plants that wish to continue to use OTC. The CAISO's recommended mitigation for this situation is to place limits on SERC operation until OTC unit shutdown reduces the potential stress on the breakers. Because most of the short circuit duty increase is attributed to SERC and because SCE selected SERC specifically to replace OTC generators expected to retire, SERC may be subject to limitation if OTC retirements do not take place soon enough to resolve this breaker capacity issue by the time the SERC comes online.

3.3.2.2.2 Substation Ground Grid Duty

CAISO concluded that ground grid studies are required to further understand ground grid issues at several substations and that SERC would be required to pay for these studies because SERC operation would potentially cause issues at the following substations:

- Huntington Beach 220 kV
- Lewis 220 kV
- Barre 66 kV
- Fullerton 66 kV
- Gilbert 66 kV
- Kindler 66 kV
- La Palma 66 kV
- Lampson 66 kV
- Marion 66 kV
- Sunny Hills 66 kV

3.3.2.3 Transient Stability Evaluation

The IR Studies find transient stability performance to be acceptable.

3.3.2.4 Power Factor Requirements

SERC will be designed to maintain a composite power delivery at continuous rated power at the Point of Interconnection at a power factor within the range of 0.95 lead/lag for asynchronous generation and 0.90 lagging to 0.95 leading at generator terminals for synchronous generators. Additionally, the SERC will be designed to accommodate a voltage-ampere reactive schedule provided by SCE. SCE will determine whether the voltage-ampere reactive schedule is necessary based on future rearrangements of SCE's transmission.

3.3.2.5 Deliverability Assessments

SERC does not contribute to any on-peak deliverability constraint.

3.4 Transmission Line Safety and Nuisances

This section discusses safety and nuisance issues associated with the proposed electrical interconnection.

3.4.1 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 required safety clearance required for the conductors is determined by considering factors such as the normal operating voltages, conductor temperatures, short-term abnormal voltages, windblown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. The line will conform to the minimum clearances specified in the California Public Utilities Commission (CPUC) General Order (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, and airports
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The transmission interconnection for SERC will be designed to meet applicable national, state, and local clearance requirements.

3.4.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware attributable to high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. 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.

3.4.2.1 Electric and Magnetic Fields

Operating power lines, similar to energized components of electrical motors, home wiring, lighting, and other electrical appliances, produce electric and magnetic fields commonly referred to as an electromagnetic field (EMF). The EMF produced by the alternating current (AC) electrical power system in the U.S. has a frequency of 60 hertz, 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 (i.e., 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 kV per meter. 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, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current (i.e., increased amperes produce a stronger magnetic field). The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss. 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 EMFs. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMFs is harmful. In the absence of conclusive or evocative evidence, some states, including California, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use cost-effective techniques to reduce the levels of EMFs.

3.4.2.2 Audible Noise and Radio and Television Interference

Corona from a transmission line may result in the production of audible noise or radio and television interference. 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.

3.4.2.3 EMFs, Audible Noise, and Radio and Television Interference Assumptions

It is important to remember that EMFs, audible noise, and radio and television interference near power lines vary with regard to the line design, line loading, distance from the line, and other factors.

Electric fields, corona, audible noise, and radio and television interference depend on line voltage and not on the level of power flow. Because line voltage remains nearly constant for a transmission line during normal operation, the audible noise associated with the 66-kV lines in the area will be of the same magnitude before and after the project.

Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above. Since SERC will be connected at 66-kV voltage level, it is expected that no corona-related design issues will be encountered.

The magnetic field is proportional to line loading (amperes), which varies as demand for electrical power varies and as generation from the generating facility is changed by the system operators to meet changes in demand.

Construction and operation of SERC, including the interconnection of the facility with SCE'S transmission system, are not expected to result in significant increases in EMF levels, corona, audible noise, or radio and television interference.

3.4.2.4 Induced Current and Voltages

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. The mitigation for hazardous and nuisance shocks is to ensure 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.

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

The proposed 66-kV transmission interconnection line will be constructed in conformance with CPUC GO-95 and Title 8 California Code of Regulations (CCR) 2700 requirements. Therefore, hazardous shocks are unlikely to occur as a result of project construction, operation, or maintenance.

3.4.3 Fire Hazards

The proposed 66-kV transmission interconnection will be designed, constructed, and maintained in accordance with applicable standards including GO-95, which establishes clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards. The SERC will maintain the underground gen-tie corridor and immediate area in accordance with existing regulations and accepted industry practices that will include identification and abatement of fire hazards.

3.5 Laws, Ordinances, Regulations, and Standards

This section provides a list of applicable LORS that apply to the proposed transmission line, substations, and engineering.

3.5.1 Design and Construction

Table 3.5-1 lists the LORS for the design and construction of the proposed transmission line and switchyard.

Table 3.5-1. Design and Construction LORS for the Proposed Transmission Line and Switchyard

LORS	Applicability
Title 8 CCR, Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.
GO-52, CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities subject to CPUC's jurisdiction to provide or mitigate inductive interference.
ANSI/IEEE 593, "IEEE Recommended Practices for Seismic Design of Substations"	Recommends design and construction practices.
IEEE 1119, "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Recommends clearance practices to protect persons outside the facility from electric shock. Applies to the design of facilities subject to CPUC's jurisdiction to provide or mitigate inductive interference.
IEEE 980, "Containment of Oil Spills for Substations"	Recommends preventions for release of fluids into the environment.

Notes:

ANSI = American National Standards Institute
IEEE = Institute of Electrical and Electronics Engineers

3.5.2 Electric and Magnetic Fields

The LORS pertaining to EMF are listed in Table 3.5-2.

Table 3.5-2. Electric and Magnetic Field LORS

LORS	Applicability
Decision 93-11-013, CPUC	CPUC position on EMF reduction.
GO-131-D, CPUC, "Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California"	CPUC construction application requirements, including requirements related to EMF reduction.
ANSI/IEEE 544-1994, "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard procedure for measuring EMF from an electric line that is in service.

3.5.3 Hazardous Shock

Table 3.5-3 lists the LORS regarding hazardous shock protection that apply to the transmission interconnection and the overall project.

Table 3.5-3. Hazardous Shock LORS

LORS	Applicability
8 CCR 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical equipment to provide practical safety and freedom from danger.
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.

Table 3.5-3. Hazardous Shock LORS

LORS	Applicability
NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C	Covers grounding methods for electrical supply and communications facilities.

Note:

NESC = National Electrical Safety Code

3.5.4 Communications Interference

The LORS pertaining to communications interference are listed in Table 3.5-4.

Table 3.5-4. Communications Interference LORS

LORS	Applicability
47 CFR 15.25, "Operating Requirements, Incidental Radiation"	Prohibits operations of any device emitting incidental radiation that causes interference to communications; the regulation also requires mitigation for any device that causes interference.
GO-52, CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines, and specifically applies to the prevention or mitigation of inductive interference.

3.5.5 Aviation Safety

Table 3.5-5 lists the aviation safety LORS that may apply to the proposed transmission interconnection and the overall project.

Table 3.5-5. Aviation Safety LORS

LORS	Applicability
Title 14 CFR, Part 77, "Objects Affecting Navigable Airspace"	Describes the criteria used to determine whether a "Notice of Proposed Construction or Alteration" (FAA Form 7450-1) is required for potential obstruction hazards.
FAA Advisory Circular No. 70/7450-1G, "Obstruction Marking and Lighting"	Describes the FAA standards for marking and lighting of obstructions as identified by FAA Regulations Part 77.

Note:

NPCA = Notice of Proposed Construction or Alteration

3.5.6 Fire Hazards

Table 3.5-6 lists the LORS governing fire hazard protection for the proposed transmission interconnection and the overall project.

Table 3.5-6. Fire Hazard LORS

LORS	Applicability
14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards, and specifies when and where standards apply.
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.

Table 3.5-6. Fire Hazard LORS

LORS	Applicability
GO-95, CPUC, "Rules for Overhead Electric Line Construction," Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electric transmission line and fire safety (hazards).

3.5.7 Jurisdiction

Table 3.5-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, or enforce the above-referenced LORS. Table 3.5-7 also identifies the responsibilities of these agencies as they relate to SERC construction, operation, and maintenance.

Table 3.5-7. National, State, and Local Agencies with Jurisdiction over Applicable LORS

Agency or Jurisdiction	Responsibility
FAA	Establishes regulations for marking and lighting of obstructions in navigable airspace (AC No. 70/7450-1G).
CEC	Jurisdiction over new transmission lines associated with thermal power plants that are 50 MW or more (PRC 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the first point of interconnection with the grid (PRC 25107).
CPUC	Regulates construction and operation of overhead transmission lines (GO-95).
CPUC	Regulates construction and operation of power and communications lines for the prevention of inductive interference (GO-52).
Local Electrical Inspector	Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (NFPA 70).
City of Stanton	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances. Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection.

Note:

PRC = Public Resources Code