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SECTION 3

# Electric Transmission

## 3.1 Introduction

This section discusses the transmission interconnection between the MREC and the existing electrical grid, and the potential impacts 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 MREC 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 LORS

MREC will be located in central Ventura County, on a 9.79-acre parcel east of the SCE Santa Clara Substation. This location was selected, in part, for its proximity to the Santa Clara Substation, to which MREC will interconnect via a new, approximately 6.6-mile-long, 230-kV transmission line. The existing transmission resources in the vicinity of the MREC are owned by SCE and are part of its service area.

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 MREC will be interconnected with the regional electrical grid by a new, approximately 6.6-mile-long, single-circuit, three-phase, 230-kV generator tie-line. The proposed 230-kV line runs west from the project site through agricultural areas, turning northwest, crossing the Santa Clara Valley and entering low hills to the north. Figure 1.2-2 (Section 1.2) presents the proposed transmission route between the MREC and the Santa Clara Substation.

As stated previously, a project objective is to provide peaking generation, storage, and voltage support services delivered to the Moorpark Subarea of the Big Creek/Ventura area through the SCE Santa Clara Substation. Access to the substation is constrained by a number of transmission lines that converge at the substation from the south and northwest, making the approach chosen (from the east and north) the most feasible approach. The chosen route generally runs through citrus orchards and other agricultural areas and avoids natural habitats as much as is feasible.

### 3.2.1 Overhead Transmission Line Characteristics

The interconnecting 230-kV transmission circuit will consist of a single-circuit configuration, supported by 36 new, steel monopole structures, ranging in height from 76.5 feet (H-frame) to 200 feet, located at appropriate intervals. Structure heights are as shown in Table 3-1.

Table 3-1 Generator tie-line structure heights

| Height (feet) | Number of Structures |
|---|---|
| 79.9 | 2 (H-frame) |
| 81 | 2 |
| 91 | 2 |
| 96 | 5 |

Table 3-1 Generator tie-line structure heights

| Height (feet) | Number of Structures |
|---|---|
| 101 | 1 |
| 106 | 13 |
| 116 | 2 |
| 121 | 1 |
| 126 | 2 |
| 131 | 1 |
| 1341 | 1 |
| 156 | 1 |
| 200 | 4 |
| | 36 |

The line will exit the MREC onsite switchyard from the take-off structures and will connect to the new steel-monopole, single-circuit structures. Figure 3.2-1 shows a typical monopole design.

### 3.2.2 230-kV Santa Clara Substation Characteristics

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

### 3.2.3 MREC Switchyard Characteristics

The MREC switchyard will use a single 230-kV circuit breaker for the five generating units and batteries, with a generator step-up transformer for each generating unit. The switchyard and all equipment will be designed for an interrupting capacity of at least 50 kiloamperes. The main buses, as well as the bays, will be designed to carry at least 2,000 amperes on a continuous basis.

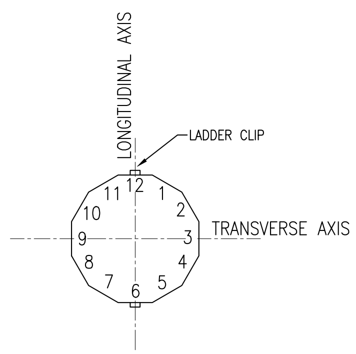
Startup and standby power will be supplied through the generator step-up transformers and four auxiliary transformers. Auxiliary controls and protective relay systems for the MREC switchyard will be located in the power plant control building.

## 3.3 Transmission Interconnection Studies

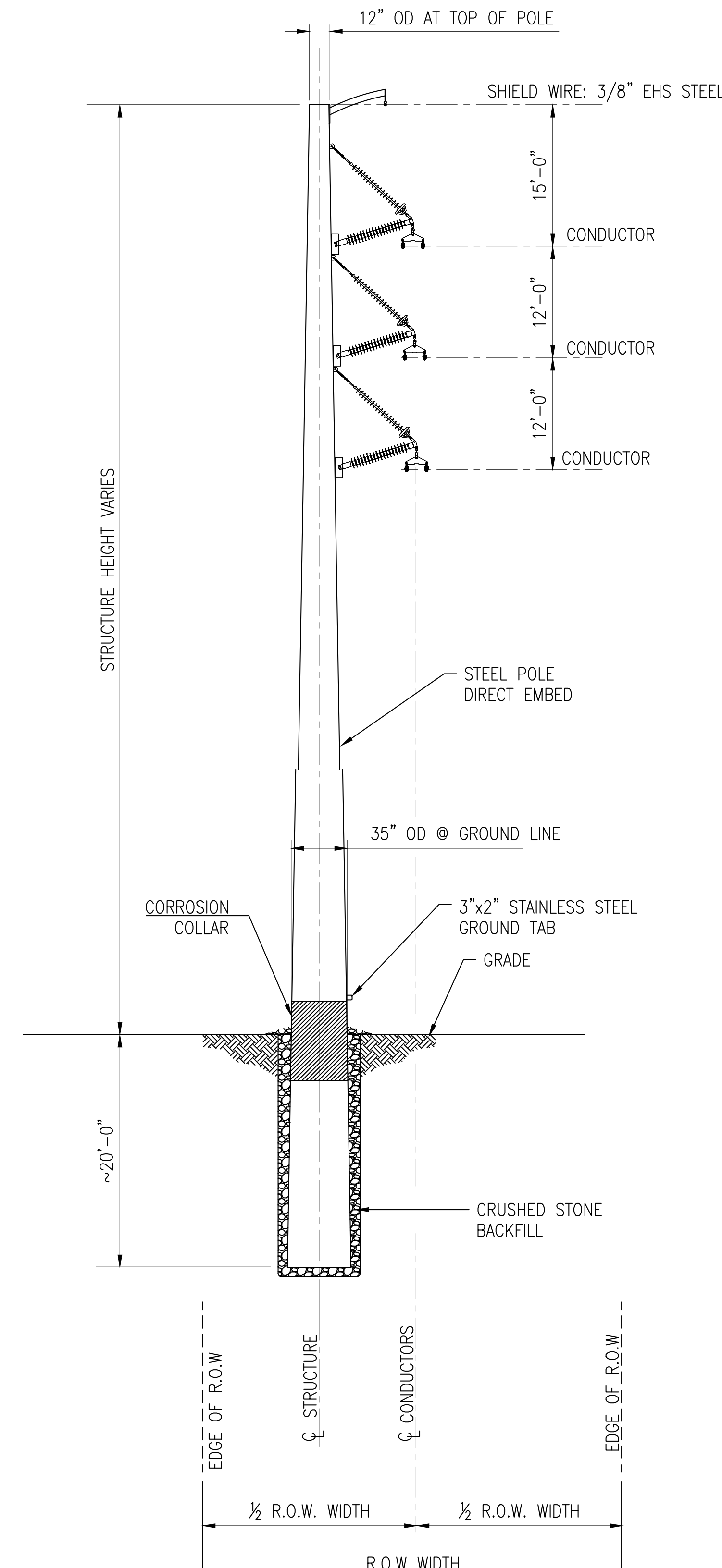
Mission Rock filed an Interconnection Request (IR) with the CAISO on April 30, 2014 and CAISO subsequently prepared the Cluster 7 Phase I Interconnection Study with an appendix considering the potential system impacts of the proposed MREC interconnect, dated December 14, 2014 (Appendix 3A). Mission Rock subsequently withdrew the MREC from the CAISO transmission queue.

The results of the 2014 CAISO study provide the CEC with the information that it needs to conduct an environmental assessment of the impacts of the transmission and interconnection facilities. MREC will submit a new IR with the CAISO in the next filing window in April 2016, so that the 2014 CAISO study can be updated. The CAISO study indicates that the following equipment will be installed by SCE:

- A new 230 kV position at Santa Clara Substation
- A segment of 230 kV gen-tie line inside the Santa Clara Substation property line
- Two telecommunication paths inside the Santa Clara Substation property line
- Retail load meters
- Lightwave, channel, and associated equipment at Santa Clara Substation and at the Generating Facility




DETAIL 1
LADDER CLIP ORIENTATION




ELEVATION VIEW
TANGENT POLE–TYPICAL
BRACED POST

## CONDUCTOR OPTIONS:

BUNDLED PARTRIDGE (266.8) ACSR
BUNDLED LINNET (336.4) ACSR
SINGLE DRAKE (795) ACSR

## DESIGN CONDITIONS:

WIND SPAN: 1000 FT.
WEIGHT SPAN: 1500 FT.
MAXIMUM LINE ANGLE: 1°
MAXIMUM CONDUCTOR TENSION: 16,750 POUNDS PER PHASE

## NOTES:

1. LADDER CLIPS SHALL BE ADDED TO BOTH LONGITUDINAL FLATS OF THE POLE (FLATS 6 & 12 AS SHOWN IN DETAIL 1). LADDER CLIPS SHALL BE INSTALLED OVER THE FULL LENGTH OF STRUCTURE, STARTING AT 9'–0" ABOVE THE GROUND LINE.

2. A GOOD POLE DESIGN WILL ATTEMPT TO MINIMIZE FOUNDATION DIAMETER AS WELL AS STRUCTURE WEIGHT. FOUNDATION DIAMETER WILL BE CONSIDERED FOR VENDOR SELECTION.

3. ALL POLES TO BE DESIGNED FOR ERECTION BY EITHER CRANE OR HELICOPTER. LIFT POINTS SHALL BE DESIGNATED FOR CRANE AND/OR HELICOPTER PICKUP. SEE SPECIFICATIONS FOR ALL OTHER REQUIREMENTS.

4. A WORKING VANG SHALL BE AVAILABLE NEAR ALL CONDUCTOR AND SHIELD WIRE LOADING POINTS. ALL WORKING VANG AND JUMPER ATTACHMENTS SHALL TRANSFER THE CONSTRUCTION LOAD CASE LOADING THROUGHOUT THE STRUCTURE AND INTO THE STRUCTURE FOUNDATION.

5. MANUFACTURER IS RESPONSIBLE FOR STRUCTURAL DESIGN OF THE VANGS. MANUFACTURER SHALL NOTIFY THE ENGINEER IF VANG DIMENSIONS AS SHOWN ARE NOT ADEQUATE TO SUPPORT ANY LOAD CASE.

6. CLEARANCES FOR THIS STRUCTURE DO NOT ALLOW FOR ENERGIZED MAINTENANCE.

7. POLE SHALL BE DESIGNED TO HAVE A TIP DEFLECTION OF NO MORE THAN 1% OF THE POLE'S ABOVE GROUND HEIGHT UNDER NORMAL LOAD CASE.

**Figure 3.2-1.**
**Typical Monopole Design**
Mission Rock Energy Center

Source: WorleyParsons, DWG NO. WP-100.05, REV. A, 2/18/14.

The following will be installed by Mission Rock:

- The 230-kV gen-tie line from the MREC to the last structure outside the Santa Clara Substation
- Fiber optic cable lines to provide two diversely routed telecommunication paths
- CAISO metering equipment (voltage and current transformers and CAISO meters)
- Line protection relays at the MREC end of the gen-tie line and at the MREC
  - One GE L90 current differential relay with dual dedicated digital communication channels to Santa Clara Substation
  - One SEL 311L current differential relay with dual dedicated digital communication channels to Santa Clara Substation
  - Two GE N60 relays (One each for Special Protection System [SPS] A and B) to trip the main generator breaker
  - One SEL – 2407 Satellite Synchronized Clock

The CAISO study assumed that the MREC would be a net 305 MW, combined-cycle facility and assessed the effects of the addition of Cluster 7, including MREC, to the local electrical system, under various conditions of stress. (The net output of the facility proposed in this AFC is 281 MW.) The following is a summary of the Steady State Power Flow results:

- No contribution thermal overloads assuming all facilities in service (N-0)
- No contribution to thermal overloads assuming a single-element outage (N-1)
- Contributes to thermal overloads on the following transmission lines assuming multiple-element outages (N-2)
  - Moorpark-Pardee No. 2 or No. 3 230 kV
  - Pardee-Santa Clara 230 kV
  - Pardee-Vincent No. 2 230 kV
  - Laguna Bell-Mesa No. 1 230 kV
- No power flow non-convergence issues under identified contingencies

Measures that could be required for MREC could include:

- Provide power factor regulation capability of 0.95 lead/0.90 lag at the generator terminal to alleviate power flow non-convergence and maintain South of Vincent transmission transfer capability
- SPS to trip the MREC under identified contingency outage conditions
- Participate in the Moorpark area SPS to monitor thermal overloads and trip generation under certain outage contingencies
- Local Delivery Network Upgrade is required for Laguna Bell-Mesa No. 1 230-kV Transmission Line Clearance Mitigation

## 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 MREC 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 due 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 AC electrical power system in the U.S has a frequency of 60 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 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; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss. 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 the level of power flow. Because line voltage remains nearly constant for a transmission line during normal operation, the audible noise associated with the 230-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 MREC will be connected at 230 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 MREC, 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 above for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those orientated parallel to the transmission line.

The proposed 230-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 Aviation Safety

Federal Aviation Administration (FAA) Regulations, 14 Code of Federal Regulations (CFR) Part 77, establish standards for determining obstructions in navigable airspace and set forth requirements for notification of proposed construction. These regulations require FAA notification for construction over 200 feet above ground level. In addition, notification is required if the obstruction is lower than specified heights and falls within restricted airspace in the approaches to public or military airports. For airports with runways longer than 3,200 feet, the restricted space extends 20,000 feet (3.3 nautical miles) from the runway. For airports with runways measuring 3,200 feet or less, the restricted space extends 10,000 feet (1.7 nautical miles). For heliports, the restricted space extends 5,000 feet (0.8 nautical miles).

The nearest public airport to MREC is Santa Paula Airport (SZP). SPZ is a general aviation airport and has a single runway that is 2,713 feet long and is approximately 18,000 feet (2.96 Nautical miles, 3.4 statute miles) from the MREC. Therefore, the MREC falls significantly outside the restricted airspace and FAA Part 77 restricted SZP air surfaces.

Since the MREC structures, including transmission structures, will be 200 feet tall or less and other larger transmission structures currently exist in the immediate vicinity, an FAA air navigation hazard review would not be likely to find that the project could cause a hazard to air navigation. Regardless, the MREC will submit FAA Form 7460-1, Notice of Proposed Construction or Alteration, for each of the 36 transmission structures to request that FAA review for any potential hazards to air navigation. Additional information related to aviation safety is provided in Section 5.12.2.5.

### 3.4.4 Fire Hazards

The proposed 230-kV transmission interconnection will be designed, constructed, and maintained in accordance with applicable standards including GO-95, which establishes clearances from other manmade and natural structures as well as tree-trimming requirements to mitigate fire hazards. The MREC will maintain the transmission line 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. |

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

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" (NPCA, 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. |

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. |
| 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 MREC 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). |
| County of Ventura | Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances.<br>Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection. |

PRC = Public Resources Code

# 3.6 References

California Independent System Operator (CAISO). 2008. Generator Interconnection Process Reform (GIPR) Revised Draft Proposal, June 27, 2008. Available at: http://www.caiso.com/1f42/1f42c00d28c30.html.

City of Santa Paula. 1998. *General Plan*. http://www.ci.santa-paula.ca.us/planning/GeneralPlan.htm. Amended 2000.