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Transmission System Engineering

3.1 Introduction

This section discusses the transmission interconnection between PRP and the existing electrical grid, and the anticipated impacts that operation of PRP will have on the flow of electrical power in the project region. This analysis contains the following discussions:

- The proposed electrical interconnection between PRP 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

3.2 Transmission Lines Description, Design, and Operation

The electric power produced by PRP will be transmitted to the electrical grid through an existing 66-kv gen-tie line through SCE's Ganesha-Simpson transmission line that will be reconductored as shown on Figure 1.2-3. New 397.5-thousand-circular-mil (kcmil) 66-kV conductor will replace 0.2 miles of the existing gen-tie line as shown on the referenced figure. The existing transmission monopoles will remain in place.

3.3 Transmission Interconnection Studies

AltaGas, the Interconnection Customer, submitted a completed Interconnection Request to SCE for their proposed project. The project requested a Point of Interconnection at SCE's Ganesha-Simpson 66-kV line located in Pomona, California. The Interconnection Customer elected that the project have Full Service Delivery Status.

In accordance with the Federal Energy Regulatory Commission-approved CAISO Appendix DD Generator Interconnection and Delivery Allocation Procedures, the project was grouped with Queue Cluster 8 Phase I projects to determine the impacts of the group as well as impacts of the project on the CAISO-controlled grid.

- SCE issued the following reports on January 15, 2016:
  - AltaGas Pomona Energy Inc, Queue Cluster 8 Phase I Report, Appendix 3A
  - Queue Cluster 8 Phase I, Attachment 8, Subtransmission Assessment Report, Chino 66-kV System, Appendix 3B
  - Queue Cluster 8 Phase I, Attachment 1, WDT1288 – Pomona Storage Project Interconnection Facilities, Network Upgrades and Distribution Upgrades, Appendix 3C
- These reports provide the following:
  - Transmission system impacts caused by the project
  - Distribution system impacts caused by the project
  - System reinforcements necessary to mitigate the adverse impacts caused by the project under various system conditions

The following will be installed by AltaGas:

- A switchyard with one 66/13.8-kV main step-up transformer with a 9.5 percent impedance on a 120 megavolt, ampere base.
- Install 0.2 miles 397.5-kcmil 66-kV line from the generating facility to a position designated by the Distribution Provider, outside of the Distribution Provider's SCE Ganesha-Simpson (WDT1288) Substation.
- Install All Dielectric Self Supporting fiber optic cable on the 66-kV line to a point designated by the Distribution Provider near the Distribution Provider's SCE WDT1288 Substation to provide one of two telecommunication paths required for the line protection scheme and the Remote Terminal Units.
- Install appropriate All Dielectric Self Supporting fiber optic cable from the Generating Facility to a point designated by the Distribution Provider near the SCE Ganesha-Simpson (WDT1288) Substation to provide the second telecommunication path required for the line protection scheme.
- Install all required CAISO-approved compliant metering equipment at the Generating Facility, in accordance with section 10 of the CAISO Tariff.
- Install relay protection to be specified by the Distribution Provider to match the relay protection used by the Distribution Provider at the SCE Ganesha-Simpson (WDT1288) Substation.

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

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 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.

The transmission interconnection for PRP 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 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; 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 use 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.

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

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 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 greater. Since PRP will be connected at a 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 PRP, 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.

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 transmission 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 66-kV transmission interconnection line will be constructed in conformance with CPUC GO-95 and Cal. Code Regs., Title 8 Section 2700 requirements. Therefore, hazardous shocks are unlikely to occur as a result of project construction, operation, or maintenance.

3.4.2.2 Aviation Safety

Federal Aviation Administration (FAA) Regulations, 14 Code of Federal Regulations (C.F.R.) 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 PRP is the Ontario International Airport (ONT). ONT is approximately 10 miles from PRP. Therefore, PRP falls significantly outside the restricted airspace and FAA Part 77 restricted SZP air surfaces.

3.4.2.3 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. PRP 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
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
Cal. Code Regs. Title 8 Sections 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.
CPUC, GO-52, "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.
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
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
CPUC Decision 93-11-013	CPUC position on EMF reduction.
CPUC, GO-131-D, "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
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
Cal. Code Regs. Title 8 Sections 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.

Note:

NESC = National Electrical Safety Code

3.5.4 Communication Interference

The LORS pertaining to communication interference are listed in Table 3.4-4.

Table 3.5-4. Communication Interference LORS
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
47 C.F.R. Section 15.25, "Operating Requirements, Incidental Radiation"	Prohibits operations of any device emitting incidental radiation that causes interference to communications; the regulation also requires mitigation for any device that causes interference.
CPUC, GO-52	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
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
Title 14 C.F.R. 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.

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
Small Power Plant Exemption Application for the Pomona Repower Project

LORS	Applicability
Cal. Code Regs. Title 14 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.
CPUC, GO-95, "Rules for Overhead Electric Line Construction," Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).

3.6 Agencies

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 3.4-7 also identifies the responsibilities of these agencies as they relate to PRP construction, operation, and maintenance.

Table 3.5-7. National, State, and Local Agencies with Jurisdiction over Applicable LORS
Small Power Plant Exemption Application for the Pomona Repower Project

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 (Pub. Res. Section 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the first point of interconnection with the grid (Pub. Res. Section 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).