SECTION 3.0

Electric Transmission

3.1 Introduction

This section discusses the transmission interconnection between the Contra Costa Generating Station (CCGS) and the existing electrical grid, and the anticipated impacts that operation of the facility will have on the flow of electrical power in the project region. This analysis contains the following discussions:

- The proposed electrical interconnection between the CCGS and the electrical grid
- The impacts of the CCGS 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)

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

3.2 Transmission Lines Description, Design, and Operation

The CCGS will be connected with the regional electrical grid by a 2.4-mile-long, single-circuit transmission line between the new CCGS switchyard (located within the CCGS site boundary) the 230-kilovolt (kV) Contra Costa Substation. This 230-kV line will be placed within the existing 80-foot-wide Pacific Gas and Electric Company (PG&E) 60-kV right-of-way that runs between the project site area and the substation.

Figure 3.2-1 shows the connection of the CCGS with PG&E's regional transmission system via a 2.4-mile-long, 230-kV transmission line extending to the PG&E Contra Costa Substation. Figure 3.2-2 is an electrical system one-line diagram that shows the electric transmission system in the vicinity of the CCGS. Figures 3.2-3a–c show typical support tower designs that could be used for the transmission line for a single-circuit option, double-circuit option, and for a location where the new line would cross under an existing transmission line, respectively.

3.2.1 Overhead Transmission Line Characteristics

The proposed interconnecting 230-kV transmission circuit will be designed with a double circuit 230-kV/60-kV TSP line, with arms in the double-circuit vertical configuration. The existing corridor would have the existing steel lattice towers replaced with steel-pole structures at appropriate intervals. The transmission line will consist of a single conductor per phase as determined by PG&E.

The proposed line will exit the CCGS onsite switchyard in a slack span configuration from the take-off structures, approximately 20 feet high. The exit span will vary in length to accommodate the route option selected and will connect the pull-off structures to a new steel-pole, single-circuit, heavy-angle structure. The heavy-angle structure will be constructed to accommodate the turn necessitated by the selected option. The steel-pole structures will be tangent-type design, will be spaced based on PG&E's engineering criteria, and will be 95 feet tall.

The insulators for the 230-kV generation tie line will be polymer or porcelain with overall lengths of approximately 8.5 feet to 10.5 feet for suspension insulators and overall lengths of approximately 11 feet to 16 feet for deadend insulators.

3.2.2 230-kV Interconnection Switchyard Characteristics

The interconnection 230-kV switchyard will utilize 230-kV gas-insulated circuit breakers in a breaker-and-a-half bus arrangement to obtain a high level of service reliability. The switchyard and all equipment will be designed for an interrupting capacity of at least 50,000 kiloampere (kA). The main buses and the bays will be designed to carry at least 2,000 amperes on a continuous basis.

Station service power will be provided via the local PG&E distribution facilities near the Switchyard or by a 230/13.8/4.16-kV step-down transformer. Auxiliary controls and protective relay systems for the 230-kV switchyard will be located in a control building or the GIS building separate from the power plant.

3.2.3 Power Plant Substation Characteristics

The power plant substation will utilize 230-kV gas-insulated circuit breakers with a single breaker for each of the three generating units and an individual generator step-up transformer for each of the three generating units. The substation and all equipment will be designed for an interrupting capacity of at least 50,000 kA. The main buses and the bays will be designed for to carry at least 3,000 amperes on a continuous basis.

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

3.3 Transmission Interconnection Studies

On May 15, 2008, the California Independent System Operator (CAISO) requested permission from the Federal Energy Regulatory Commission (FERC) to implement proposed reforms to the process. The CAISO filed a revised version of the proposal on June 27, 2008 (CAISO, 2008). Among the goals of the reform process are:

- Clearing the backlog of all IRs existing in the CAISO queue
  - Reduce the number of projects through increased IC financial commitments or project viability tests
  - Apply group study principles to the remaining projects
  - Develop procedures to ensure a more efficient interconnection of resources that more closely match system needs
- Provide interconnection applicants with reasonable cost and timing certainty
- Better integrate transmission planning with the generation interconnection process

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

FIGURE 3.2-1
INTERCONNECTION TO CONTRA COSTA SUBSTATION
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA

CH2MHILL

SAC\\ZION\SACGIS\PROJ\RADBACKENERGY\385962\MAPFILES\INTERCONNECTION_TLINE.MXD MHASKELL 6/12/2009 12:18:17

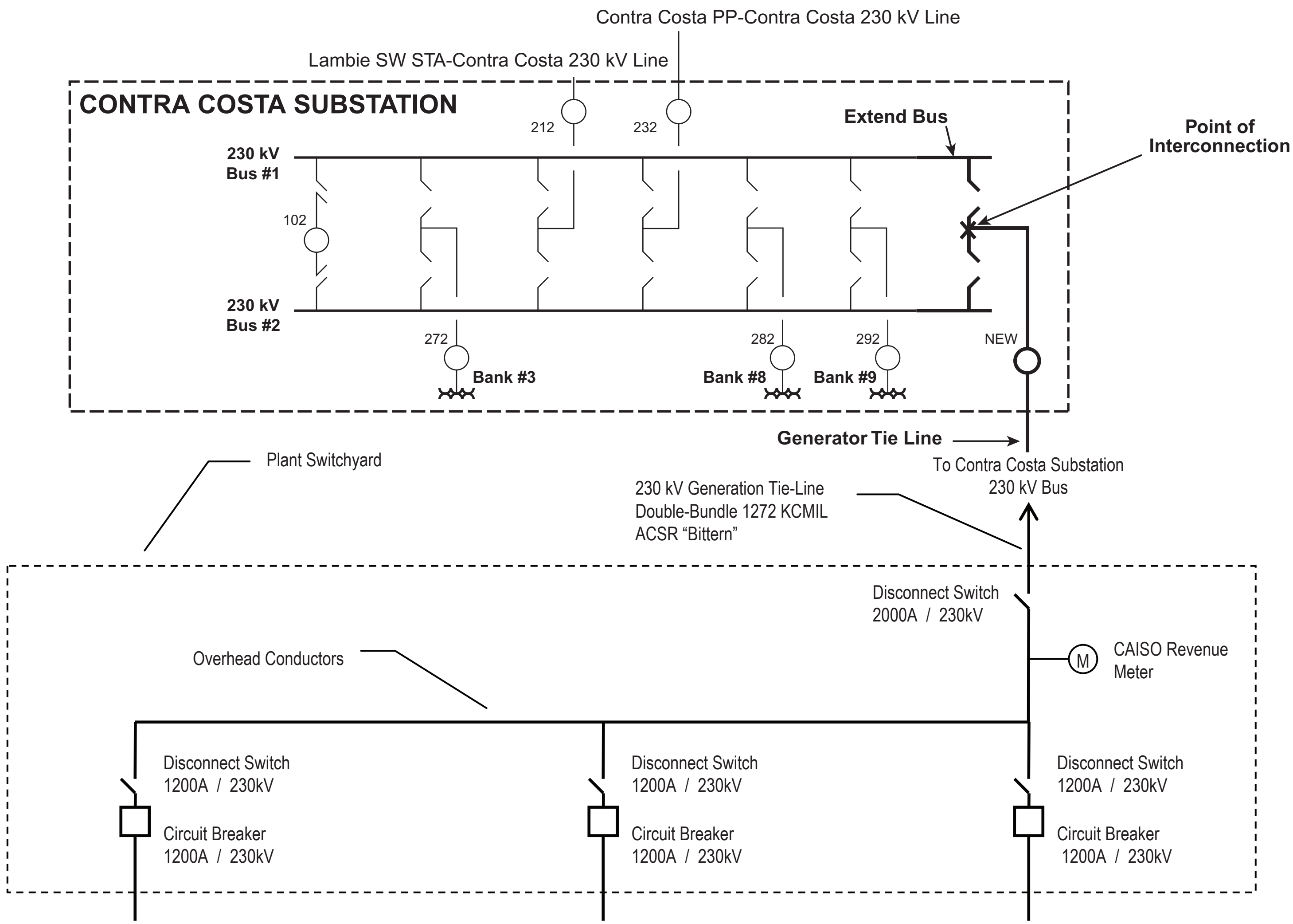
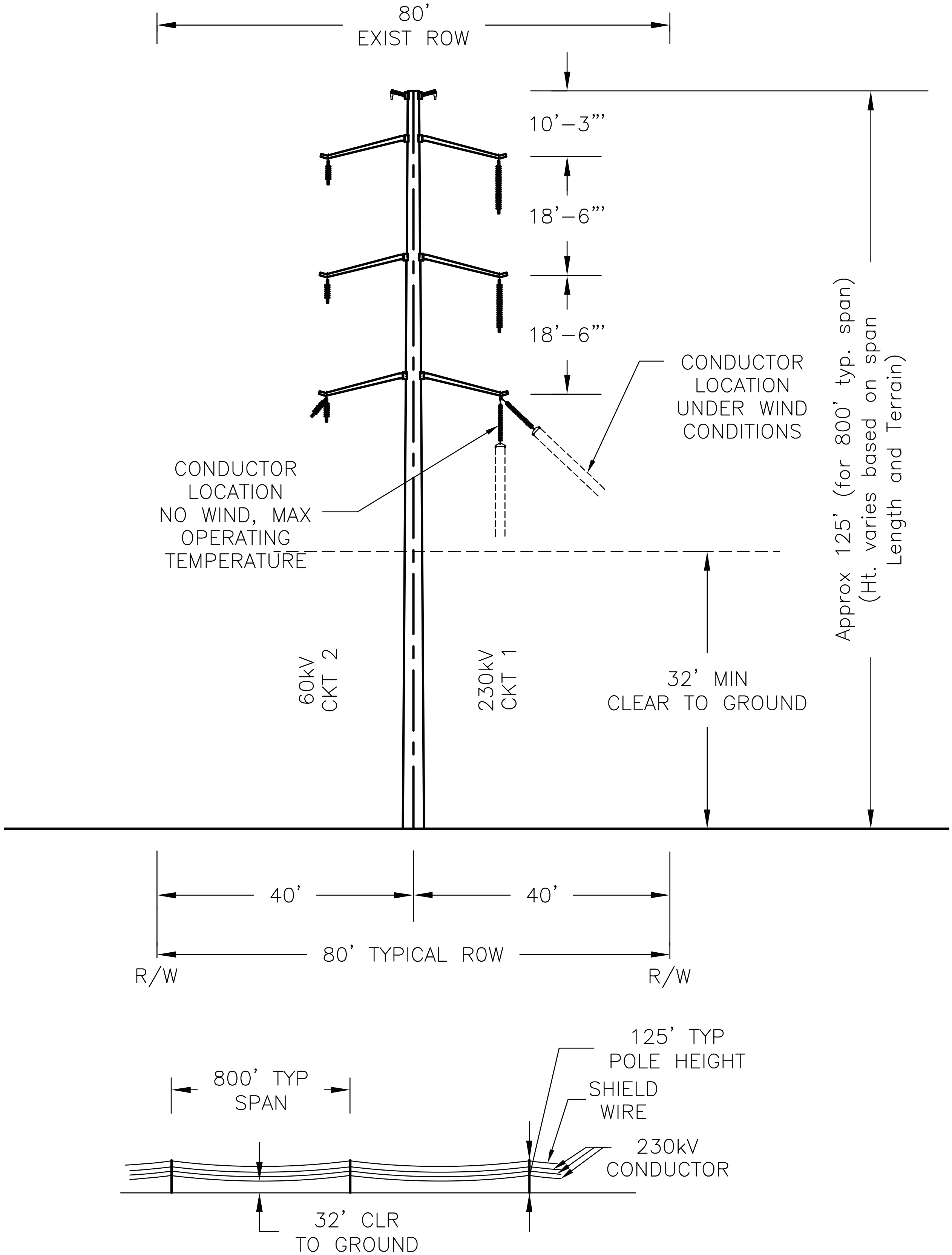
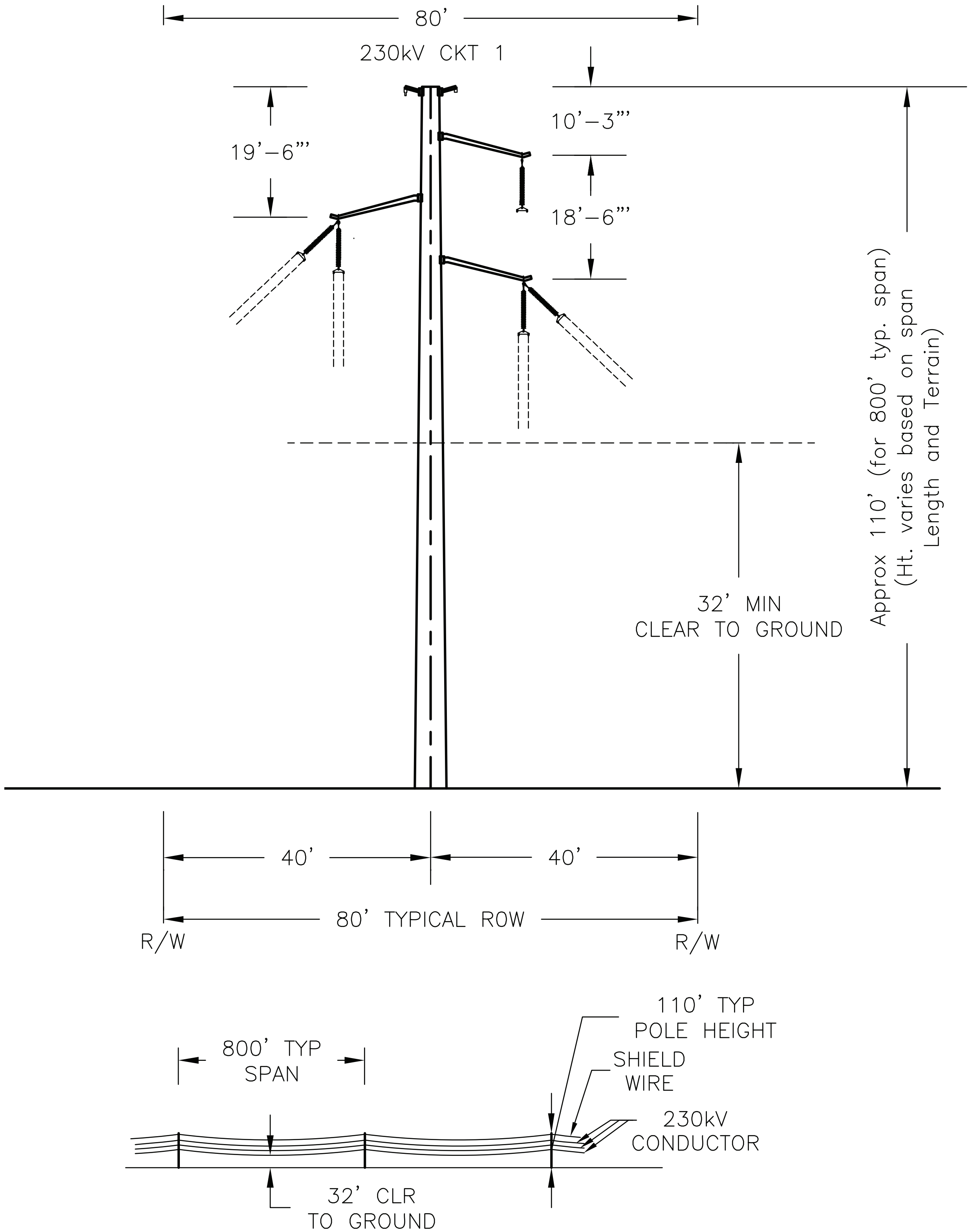


FIGURE 3.2-2
LOCAL SYSTEM SINGLE-LINE DIAGRAM
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA



Source: Black & Veatch Holding Company, 03/17/09, Drawing RBT_EX SH1 R1

FIGURE 3.2-3A
TYPICAL TRANSMISSION POLE DESIGN, DOUBLE-CIRCUIT OPTION
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA



Source: Black & Veatch Holding Company, 03/17/09, Drawing RBT_EX SH2 R1

FIGURE 3.2-3B
TYPICAL TRANSMISSION POLE DESIGN, SINGLE-CIRCUIT OPTION
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA

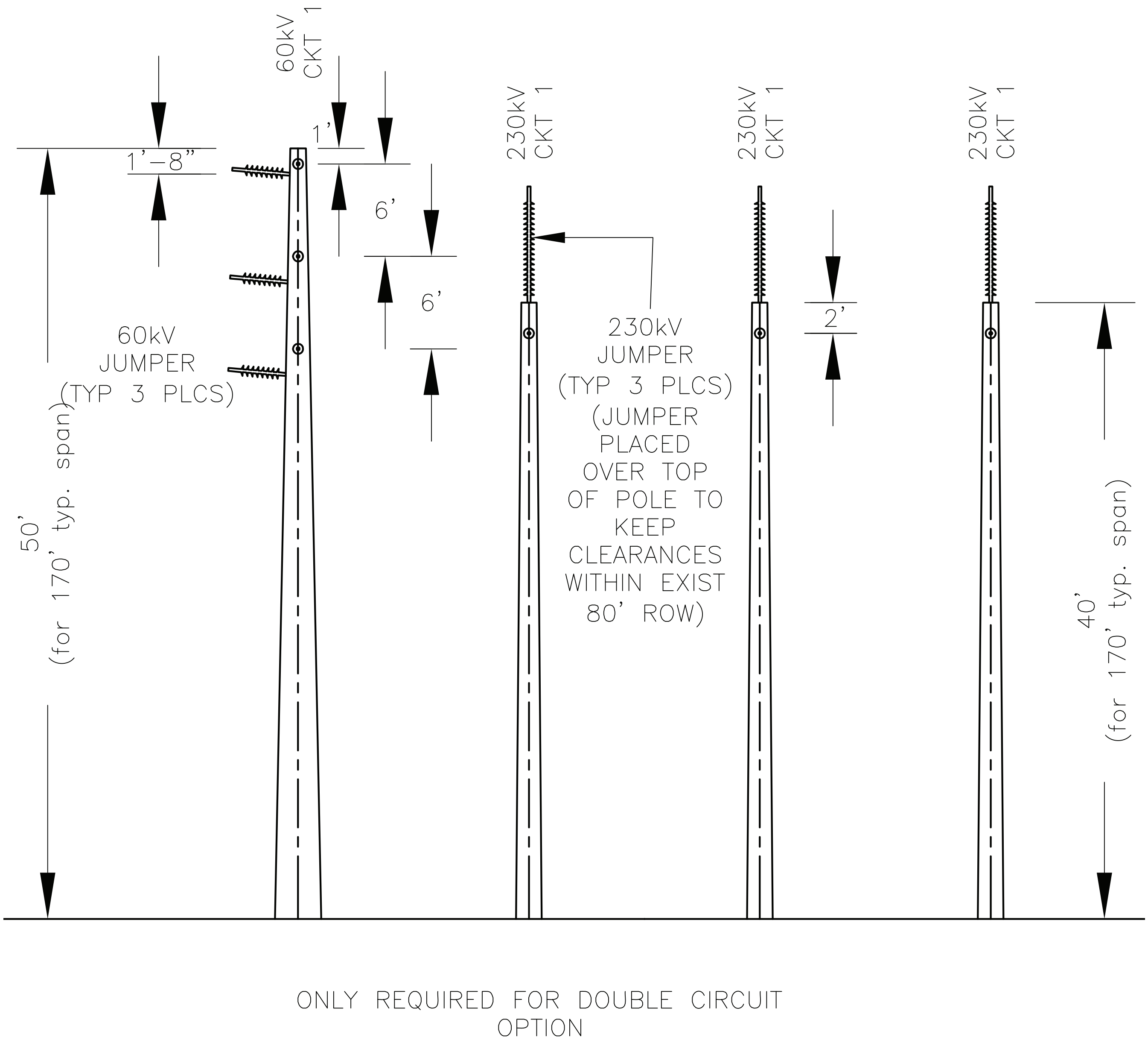


FIGURE 3.2-3C
TYPICAL TRANSMISSION
POLE DESIGN, LINE CROSSING
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA

Source: Black & Veatch Holding Company, 03/17/09, Drawing RBT_EX SH3 R1

EY042009002SAC Figure_3.2-3C.ai 06.19.09 tdaus

CH2MHILL

In many cases, system impact study show that network upgrades are needed to connect new generation to deliver the full project output from the first point of interconnection with the PG&E transmission system to the grid. Network upgrades can include transmission lines, transformer banks, substation breakers, voltage support devices and other equipment needed to transfer the generation output to the customer load. The specific network upgrades and their costs, if needed, are determined from the Feasibility Study, System Impact Study, and Facility Study of the CAISO Large Generating Unit Interconnection Procedure.

During 2007 and 2008, the CAISO, as directed by FERC, implemented Generator Interconnection Process Reform. A key element of the reform is that projects are now evaluated in groups called clusters, not in a serial, first-in, first-out manner. This reform has delayed the issuance of studies for projects that were to be included in the initial cluster (which CAISO labeled the "transition cluster"). The Contra Costa project is one such project. The original interconnection request for Contra Costa was filed by the Applicant in September 2007. The Applicant has paid the interconnection fee and has a position in the CAISO queue (see Appendix 3A for a copy of the Interconnection Study Process Agreement and proof of payment).

3.4 Transmission Line Safety and Nuisances

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

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. Minimum clearances are specified in the NESC (IEEE C2) and 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 the CCGS will be designed to meet appropriate 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 because of 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, like the energized components of electrical motors, home wiring, lighting, and 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, 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. 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 EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful. In the absence of conclusive or evocative evidence, some states, California in particular, 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 EMF.

Appendix 3B is a study conducted specifically for the CCGS transmission line interconnection to determine potential levels of EMF and possible reduction methods.

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 EMF, Audible Noise, and Radio and Television Interference Assumptions

EMF, 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 CCGS.

Corona typically becomes a design concern for transmission lines having voltages of 345-kV and above. Because the CCGS will be connected at 230-kV voltage level, no corona-related design issues are expected.

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.

The construction and operation of the CCGS, including the interconnection of the CCGS with PG&E'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 also can 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 lines 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. Notification also is required if the obstruction is lower than specified heights and falls within restricted airspace in the approaches to public or military airports and heliports. 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 public or military heliports, the restricted space extends 5,000 feet (0.8 nautical mile). The nearest public airport to the CCGS is the Funny Farm Airport, which is approximately 7 miles from the CCGS (36,960 feet). This is discussed further in Section 5.12, Traffic and Transportation.

Because the CCGS structures, including transmission structures, will be less than 200 feet tall, the FAA air navigation hazard review is unlikely to find that the project could cause a hazard to air navigation.

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. PG&E 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 Applicable 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 substations.

TABLE 3.5-1
Design and Construction LORS for the Proposed Transmission Line and Substations

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 for the prevention or mitigation of inductive interference”	Applies to the design of facilities to provide or mitigate inductive interference.
GO-95, CPUC, “Overhead electric line construction”	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).
GO-128, CPUC, “Construction or’ underground electric supply and communication systems”	Applies to the design and construction of underground transmission lines.
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 998, “Direct Lightning Stroke Shielding of Substations”	Recommends protections for electrical system from direct lightning strikes.
IEEE 980, “Containment of Oil Spills for Substations”	Recommends preventions for release of fluids into the environment.

ANSI = American National Standards Institute

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	Presents the CPUC position on EMF reduction.
GO-131-D, CPUC, “Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California”	Establishes the 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”	Presents the 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. LORS for the overall project are discussed in the appropriate section of this Application for Certification (AFC).

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 Alternating Current Substation Grounding"	Presents guidelines for assuring safety through proper grounding of alternating current outdoor substations.
NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C	Covers grounding methods for electrical supply and communications facilities.

3.5.4 Communication Interference

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

TABLE 3.5-4
Communication 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.
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 citing cases.

CEC = California Energy Commission

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. LORS for the overall project are discussed in the appropriate sections of this AFC.

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.
CPUC, Sections 21555-21550	Discusses the permit requirements for construction of possible obstructions in the vicinity of aircraft landing areas, in navigable airspace, and near the boundaries of airports.

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. LORS for the overall project are discussed in the appropriate sections of this AFC.

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 electrical 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 the construction, operation, and maintenance of the CCGS.

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).
Caltrans Department of Aeronautics	Grants permits to private heliports in California. May advise local jurisdictions regarding obstructions to helicopter navigation.
CEC	Jurisdiction over new transmission lines associated with thermal power plants that are 50 MW or more (Public Resources Code [PRC] 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the interconnection point to the utility grid (PRC 25107).
CEC	Jurisdiction over modifications of existing thermal power plants that increase peak operating voltage or peak kilowatt capacity 25 percent (PRC 25123).
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. (General Order No. 52)
Local Electrical Inspector	Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (National Fire Protection Association 70).
County of Contra Costa	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances.

3.5.8 References

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