SECTION 5

# Electric Transmission

## 5.1 Introduction

This section describes the electric transmission facilities associated with the Modesto Irrigation District (MID) Electric Generation Station (MEGS) located in the City of Ripon (City), California (State). Section 5.2 discusses the laws, ordinances, regulations, and standards (LORS) associated with the MEGS facility. Section 5.3 provides a description of the subtransmission facilities. Section 5.4 addresses the subtransmission interconnection engineering. Section 5.5 addresses subtransmission line safety and nuisance.

## 5.2 Applicable Laws, Ordinances, Regulations, and Standards

This section provides a list of LORS that apply to the proposed subtransmission line engineering as well as subtransmission line safety and nuisance.

### 5.2.1 Federal

There are no federal LORS related to subtransmission system engineering or transmission line safety and nuisance.

### 5.2.2 State

#### 5.2.2.1 Design and Construction

Table 5-1 lists the LORS applicable to the design and construction of the proposed subtransmission line and substation.

**TABLE 5-1**
Design and Construction LORS

| 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. |
| ANSI/IEEE 693 "IEEE Recommended Practices for Seismic Design of Substations" | Provides recommended design and construction practices. |
| IEEE 1119 "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations" | Provides recommended clearance practices to protect persons outside the facility from electric shock. |
| IEEE 998 "Direct Lightning Strike Shielding of Substations" | Provides recommendations to protect electrical system from direct lightning strikes. |
| IEEE 980 "Containment of Oil Spills for Substations" | Provides recommendations to prevent release of fluids into the environment. |

ANSI American National Standards Institute
CCR California Code of Regulations
IEEE Institute of Electrician and Electronic Engineers

#### 5.2.2.2 Electric and Magnetic Fields

The LORS pertaining to EMF interference are shown in Table 5-2.

**TABLE 5-2**
Electric and Magnetic Field LORS

| LORS | Applicability |
|---|---|
| ANSI/IEEE 644-1994 “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. |

#### 5.2.2.3 Hazardous Shock

Table 5-3 lists the LORS regarding hazardous shock protection for the project.

**TABLE 5-3**
Hazardous Shock LORS

| LORS | Applicability |
|---|---|
| Title 8 CCR Section 2,700, 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. |

#### 5.2.2.4 Communication Interference

The LORS pertaining to communication interference are shown in Table 5-4.

**TABLE 5-4**
Communications Interference LORS

| LORS | Applicability |
|---|---|
| Title 47 Code of Federal Regulations (CFR) 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. |
| CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration Project 82-AFC-2, Final Decision, Compliance Plan 13-7). | Prescribes the CEC’s RI-TVI mitigation requirements, developed and adopted by the CEC in past siting cases. |

### 5.2.2.5 Aviation Safety

Table 5-5 lists the aviation safety LORS that may apply to the proposed construction and operation of MEGS.

**TABLE 5-5**
Aviation Safety LORS

| LORS | Applicability |
|---|---|
| Title 14 CFR Part 77 “Objects Affecting Navigable Air Space.” | Describes the criteria used to determine whether a “Notice of Proposed Construction or Alteration” (NPCA, FAA Form 7460-1) is required for potential obstruction hazards. |
| Federal Aviation Administration (FAA) Advisory Circular No. 70/7460-1G, “Obstruction Marking and Lighting.” | Describes the FAA standards for marking and lighting of obstructions as identified by Federal Aviation Regulations Part 77. |

### 5.2.2.6 Fire Hazards

Table 5-6 shows the LORS governing fire hazard protection for MEGS.

**TABLE 5-6**
Fire Hazard LORS

| LORS | Applicability |
|---|---|
| Title 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. |
| General Order 95 (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). |

In addition to the above LORS, MID voluntarily adopts portions of California Public Utilities Commission (CPUC) general orders and decisions listed in Table 5.2-7 for incorporation into MID standards.

**TABLE 5-7**
CPUC General Orders and Decisions

| LORS | Applicability |
|---|---|
| General Order 95 (GO-95), CPUC, “Rules for Overhead Electric Line Construction.” | CPUC rule covers required clearances, grounding techniques, maintenance, and inspection requirements. |
| General Order 128 (GO-128), CPUC, “Rules for Construction of Underground Electric Supply and Communications Systems.” | Establishes requirements and minimum standards to be used for the station AC power and communications circuits. |

**TABLE 5-7**
CPUC General Orders and Decisions

| LORS | Applicability |
|---|---|
| General Order 52 (GO-52), CPUC, "Construction and Operation of Power and Communication Lines." | Applies to the design of facilities to provide or mitigate inductive interference. 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. |
| CPUC Decision 93-11-013. | CPUC position on EMF reduction. |
| General Order 131-D (GO-131), 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. |
| Public Utilities Code (PUC), Sections 21656-21660. | Discusses the permit requirements for construction of possible obstructions in the vicinity of aircraft landing areas, in navigable air space, and near the boundary of airports. |

### 5.2.3 Local

There are no local LORS related to transmission system engineering or transmission line safety and nuisance.

## 5.3 Subtransmission Facilities

MEGS will require a new 0.25-mile double-circuit 69-kV subtransmission line that will extend from the project site to the MID Stockton Substation. A fiber optic communications cable will also be installed. Each generator will be connected to a GSU transformer, via a 13.8-kV breaker, and then to a 69-kV line power circuit breaker. From the breakers the new subtransmission line will exit MEGS traveling east across South Stockton and parallel to the private road into the Fox River Paper Plant. The line may be on the north or the south side of this private road, depending on arrangements that are made with the landowner. If the double-circuit subtransmission line is built on the north side of the road, it will be overbuilt on an existing 17-kV alignment. The subtransmission line will extend along the private road until it reaches the Stockton Substation. The proposed subtransmission line/fiber optic alignment will require the installation of approximately 7 new wood or metal poles. The new poles are expected to be approximately 60 feet tall. At the substation, two new bays will be added to accommodate the new circuits. The route of the proposed 69-kV subtransmission line alignment is shown in Figure 2-1.

Given the short distance of the subtransmission line route, alternative interconnections were not considered.

## 5.4 Subtransmission Interconnection Engineering

Load flow studies indicate adequate system performance of the existing subtransmission system with the addition of the new MEGS generating units.

The "N-1" contingencies (ISO Planning Standards were followed that stipulate single transmission line outages with the largest generator already out of service, which is essentially an "N-2" condition) with the most significant effects are summarized in spreadsheet form in Appendix 5-1 for 2005 and 2006. There is a significant increase in "N-1" contingency loading on some Northwest Area MID lines, but no overloads due to the addition of the MEGS generators. The studies also indicate a 10 to 20 percent decrease in the "N-1" contingency loadings on other MID transformers and lines, and there is essentially no change in the "N-1" contingency loadings on Turlock Irrigation District's (TID's) lines. There is a 4 percent (2005) and 1 percent (2006) increase in the "N-1" contingency loading for the remaining Tracy-East Altamont Energy Center (EAEC) line when the first Tracy-EAEC line is lost, but a 3 percent (2005) and 1 percent (2006) decrease in the "N-1" contingency loading for the remaining EAEC-Westley line when the first EAEC-Westley line is lost. However, for TID and MID system "N-1" contingencies, modeling shows a 2 percent (2005) and 1 percent (2006) increase on the Tracy-EAEC lines, and a 2 percent (2005) and 3 percent (2006) decrease on the EAEC-Westley lines, for the "N-1" contingency loadings due to the addition of the MEGS generators.

The Appendix 5-2 figures are power load flow diagrams that demonstrate the MID and surrounding system performance. Figures 1A (2005)/2A (2006) and 1B (2005)/2B (2006) show the MID 69-kV system with and without the MEGS generators online. Figures 1C (2005)/2C (2006) and 1D (2005)/2D (2006) show the MID 115-kV and 230-kV system with and without the MEGS generators online.

No "N-2" (as explained above for "N-1," "N-2" scenarios would involve three elements being out of service, e.g., the largest generator plus two transmission elements) scenarios were considered during the course of these contingency studies, as MID does not typically plan for "multiple" subtransmission outages (i.e., beyond one transmission line and one generator). MID's 69-kV substations are fed by a looped subtransmission network, and accordingly system outages are rare. Since the probability of "N-2" outages for this portion of the system is low, as is the likelihood of an "N-2" outage occurring coincident with peak loading conditions, MID has decided not to over-design its system and adversely impact its rates by planning for a higher degree of reliability than is warranted by past performance.

An "N-2" transient stability analysis was performed both with and without the MEGS units online for 2006. Plots of system frequency and voltage for the surrounding 230-kV and 115-kV intertie system busses, along with MID's other generation station busses and TID's 115-kV Walnut Energy Center (WEC) bus, are shown in Appendix 5-3. These plots were generated during a simulated 6-cycle fault on the Parker Station 230-kV bus and subsequent clearing of the two 230-kV transmission lines feeding Parker Station. Based on this analysis, MID concluded that the addition of the MEGS generators inside MID's 69-kV subtransmission system would not degrade system transient stability performance, nor would it contribute to system instability.

Short-circuit analysis was performed by MID using the Electrocon International, Inc.'s CAPE (Computer-Aided Protection Engineering) analysis tool. Results of this analysis indicate that due to the addition of the MEGS generators, the available fault current will increase and the interrupting rating of eight MID 69-kV subtransmission circuit breakers will be exceeded by more than 10 percent. Hence, these circuit breakers will need to be replaced. Those substation circuit breakers are as follows: Finney 6012; Standiford 6653, 6655, and 6658; and Enslen 6612, 6614, 6617, and 6619.

# 5.5 Subtransmission Line Safety and Nuisance

## 5.5.1 Electrical Clearances

Typical high-voltage overhead subtransmission 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 safe operation of the line. The safety clearance required around the conductors is determined by normal operating voltages, conductor temperature, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in the CPUC General Order 95 (GO-95). Utilities, regulators, and local ordinances may specify additional clearances. Clearances are specified for:

- Distance between each energized conductor
- 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, etc.
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The proposed subtransmission interconnection will be designed to meet all applicable code clearance requirements. Since the designer must take into consideration many different situations, the generalized dimensions provided in Figure 5-1 should be regarded as typical for 69-kV lines and not absolute. The minimum ground clearance for 69-kV and 17-kV conductors per GO-95 are 30 feet and 25 feet, respectively, based on the road-crossing minimum. This is the design clearance for the 60° F operating temperature of the line. The final design value will be consistent with GO-95. The interconnection line will also carry a fiber optic communication wire (approximately 0.5 inch in diameter) that will carry voice, data, and protection information for MID's use. The communication conductor minimum clearance of 18 feet above ground, required by the GO-95, will be maintained.

## 5.5.2 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 very 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 60 Hertz (Hz) electric and magnetic fields cause these effects.

### 5.5.2.1 Electric and Magnetic Field Evaluation

Power lines, electrical wiring, and electrical machinery and appliances all produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the power system of the United States have a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second.

The 60-Hz power line fields are considered extremely low frequency as compared to AM radio, which operates at up to 1,600,000 Hz (1,600 kHz); television at 890,000,000 Hz (890 mHz); cellular telephones at 900 mHz; microwave ovens at 2,450,000,000 Hz (2.4 gHz); and X-rays at about 1 billion Hz. Higher frequency fields have shorter wavelengths and greater energy in the field. Microwave wavelengths are several inches and have enough energy to cause heating in conducting objects. Higher frequencies such as X-rays have enough energy to cause ionization (breaking of molecular bonds.) At the frequency associated with electric power transmission (60 Hz), the electric and magnetic fields have a wavelength of 3,100 miles and have very low energy that does not cause heating or ionization.

Transmission line electric fields are produced by electrical charges (voltage) on the energized conductor. The electric field strength is directly proportional to the line's voltage and inversely proportional to distance from the conductors. The strength of the electric fields is measured in units of kilovolts per meter (kV/m).

Magnetic fields around transmission lines are produced by the current that flows through the line conductors. The magnetic field strength is directly proportional to the line's current and inversely proportional to the distance from the conductors. Magnetic fields are expressed in units of milligauss (mG).

Considerable research has been conducted over the last 30 years on the biological effects of the power frequency electric and magnetic fields. The majority of scientific and governmental reviews of the entire body of research and opinion on this subject have concluded that the adverse effects are unlikely. Certain biological effects are well known and documented. However, additional research is ongoing with regard to human health effects. Because the health-effect studies have had contradictory results, and offer no conclusion about whether the fields are harmful or not, some states, California in particular, choose not to specify maximum levels of EMF. Instead, the State mandates a program of managing EMF exposure to the public, encouraging electric utilities to use low-cost techniques on new projects to reduce the levels of EMF when possible. This EMF reduction approach is integral to the design of the MEGS project. In addition, the EMF levels themselves have been calculated.

EMF calculations were made for the 69-kV line between the generating station and existing Stockton Substation.

Each GSU ties directly to a 69-kV breaker. Two new bays will be added to the Stockton Substation to accommodate these circuits. At full-load, the new generating units will transmit 100 MVA to the substation, which equates to 418 amperes per phase. Electric and magnetic field strengths were calculated at one meter above ground for G.O. 95 minimum conductor height at Stockton Avenue for two possible line configurations (with and without distribution underbuild) and various operating conditions (one or two circuits in service). Table 5-8 summarizes the values of electric (E) and magnetic (B) fields from the line.

**TABLE 5-8**
EMF Field Strength from MEGS – Stockton Substation Line

| | E Field (kV/m) | B Field (mG) |
|---|---|---|
| Double-circuit with one circuit operating | 0.369 | 20.541 |
| Double-circuit with distribution underbuild | 0.116 | 2.726 |
| Double-circuit with two circuits operating | 0.234 | 10.475 |

The standard MID design for a double-circuit 69-kV subtransmission line and underbuilt 17-kV distribution were assumed for these calculations. The 17-kV conductors are typically arranged horizontally at a minimum height of 25 feet above ground. The horizontal 69-kV conductors are typically located 8 feet above the distribution with a 5-foot separation between subtransmission conductors. For configurations without distribution underbuild, the minimum 69-kV clearance to ground is 30 feet.

MID will implement "no/low cost" measures to reduce magnetic fields by using reverse phasing for any double-circuit subtransmission lines.

### 5.5.2.2 Radio and Television Interference Evaluation

Electric corona occurs when the potential of a conductor in air is raised to such a value that the dielectric strength of the surrounding air is exceeded (*Standard Handbook for Electrical Engineers, 11th Ed.*). Radio and television interference (RI) can occur when corona is present on a transmission line, though this phenomenon is usually limited to extra-high voltage lines (345 kV and above).

RI rarely occurs on 69-kV subtransmission lines because of their relatively low potential and the smooth surfaces of the conductors and hardware. MID operates approximately 200 miles of 69-kV lines, and almost never receives any noise or RI complaints from these facilities. Nonetheless, all complaints will be investigated, and if the subtransmission lines are found to be at fault, they will be corrected. Therefore, RI is not expected to be a problem for the new MEGS Stockton subtransmission line.

### 5.5.3 Aviation Safety

The proposed MEGS Project is located approximately 10 miles northwest of the Modesto Airport and 7 miles southwest of the Oakdale Airport. Stockton Metropolitan Airport is 12 miles to the north.

Federal Aviation Regulations, Part 77, establishes standards for determining obstructions in navigable air space and sets forth requirements for notification of proposed construction. These regulations require notification for any construction over 200 feet above ground level. In addition, notification is required if the obstruction is less than specified heights and falls within restricted air space in the approach to airports. No new subtransmission line structures are required at the site for interconnection of MEGS. New subtransmission structures will be along the subtransmission line route. Those structures will be about 60 feet tall and will not fall within restricted airport air space.

### 5.5.4 Fire Hazards

The 69-kV subtransmission system will be designed and constructed in accordance with applicable provisions of GO-95, which establish clearances and tree trimming to mitigate fire hazards. The subtransmission line route will be kept clear of brush and other combustible material. MID will provide trained and qualified maintenance personnel to maintain the interconnection and immediate area in accordance with accepted industry practices.

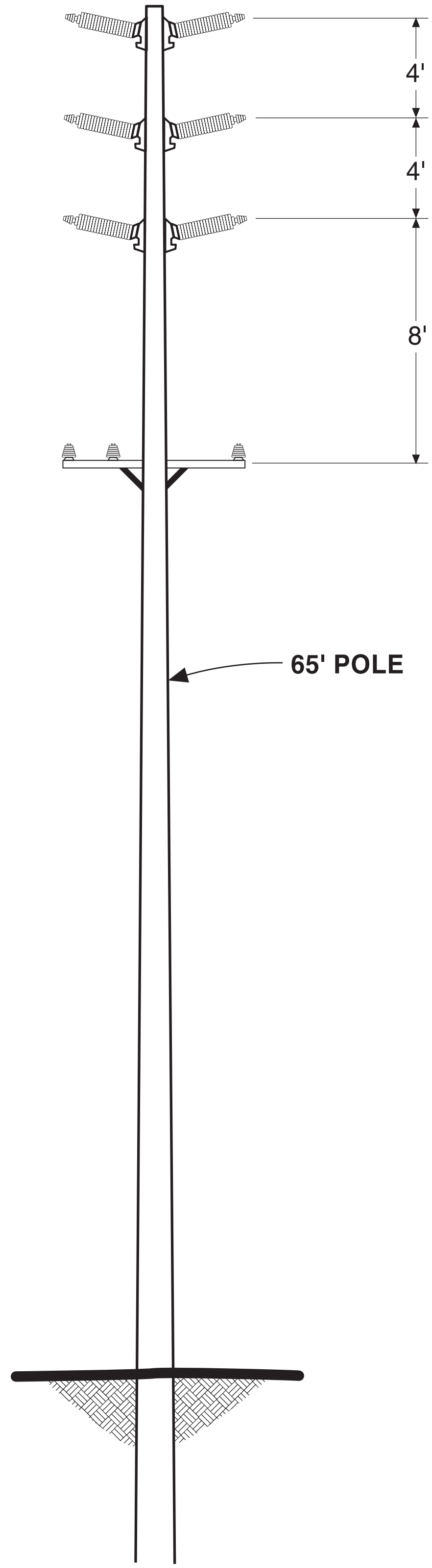


**FIGURE 5-1**
**SUBTRANSMISSION LINE POLES**
MID ELECTRIC GENERATION STATION

W022003005RDD_11 (4/8/03)

CH2MHILL