16 CORONA AND INDUCED CURRENT EFFECTS

16.1 INTRODUCTION

This chapter provides a discussion of corona and induced current effects associated with operation of high-voltage electric transmission lines. These effects include audible noise, radio, television and computer monitor interference, gaseous effluents, shock potential, and fuel ignition. Because these effects are common to all transmission lines, they are discussed as generally applicable; however, they have been determined to be negligible or non-existent for the proposed project. Therefore, no significant impacts would result and mitigation measures are not required.

16.2 CORONA

Corona is a phenomenon associated with all energized transmission lines. Under certain conditions, the localized electric field near an energized conductor can be sufficiently concentrated to produce a tiny electric discharge that can ionize air close to the conductors (Electric Power Research Institute (EPRI), 1982). This partial discharge of electrical energy is called corona discharge, or corona. Several factors, including conductor voltage, shape and diameter, and surface irregularities such as scratches, nicks, dust, or water drops can affect a conductor's electrical surface gradient and its corona performance. Corona is the physical manifestation of energy loss, and can transform discharge energy into very small amounts of sound, radio noise, heat, and chemical reactions of the air components.

Because power loss is uneconomical and noise is undesirable, corona on transmission lines has been studied by engineers since the early part of this century. Many excellent references exist on the subject of transmission line corona (e.g., EPRI, 1982). Consequently, corona is well understood by engineers and steps to minimize it are one of the major factors in transmission line design for extra high voltage transmission lines (345 to 765 kilovolts (kV)). Corona is usually not a design issue for power lines rated at 230 kV and lower. The conductor size selected for the project's transmission line is of sufficient diameter to lower the localized electrical stress on the air at the conductor surface and would further reduce already low conductor surface gradients so that little or no corona activity would exist under most operating conditions.

16.2.1 Audible Noise

Transmission lines can generate a small amount of sound energy during corona activity. This audible noise from the line can barely be heard in fair weather conditions on higher voltage lines. During wet weather conditions, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops.

For a discussion of the regulatory framework for noise impacts, see Chapter 12: Noise. Using computer modeling software developed by the Bonneville Power Administration (BPA) (BPA, 1977), audible noise values can be calculated for transmission lines experiencing corona activity. This modeling indicates that, during wet weather conditions, audible noise levels of approximately 46.6 to 49.6 A-weighted decibels (dBA) would occur within the right-of-way for the proposed transmission line loop. These calculated levels are below the U.S. Environmental Protection Agency (EPA) outdoor activity noise guideline of 55 dBA and are similar to the range of audible noise levels measured in general rain conditions (41-63 dBA) (EPA, 1974; Institute of Electrical and Electronics Engineers, 1974; Miller, 1978). Under fair weather conditions, the calculated audible noise levels of approximately 21.6 to 24.6 dBA within the right-of-way for the proposed transmission line loop are below the sound level for a library (35 dBA). Audible noise will decrease with distance away from the proposed transmission line loop. Presently, the proposed transmission line loop is located within an open farmland area, where residences, businesses, and other receptors are not present. Due to all of these factors, impacts from corona noise would be less than significant.

16.2.2 Radio and Television Interference

Overhead transmission lines do not, as a general rule, interfere with normal radio or TV reception. There are two potential sources for interference: corona and gap discharges. Corona discharges cause short pulses of voltage and current to be propagated along the transmission line, resulting in radio frequency noise in the vicinity of the line. Gap discharges are different from corona and can occur on low voltage distribution lines. Gap discharges can take place at locations where tiny electrical separations (gaps) develop between mechanically connected metal parts (for example, on broken or poorly fitting line hardware, such as insulators, clamps, or brackets). A small electric spark discharge across the gap can create unwanted electrical noise.

Typically, corona interference to radio and television reception is not a design problem. Interference levels both in fair weather and in rain are extremely low at the right-of-way edge for 230 kV and lower transmission lines, and will usually meet or exceed reception guidelines of the Federal Communications Commission (FCC). Generally, interference due to gap discharges is less frequent for high voltage transmission lines than lower voltage lines. Moreover, gap discharge noise sources can be located and repaired. Thus, impacts due to corona or gap interference with radio and television reception would be less than significant. The large majority of interference complaints have been found to be attributable to sources other than power lines.

16.2.3 Computer Monitors

Personal computer monitors using cathode ray tubes (CRTs) can be susceptible to magnetic field interference. Magnetic field interference results in disturbances to the image displayed on the CRT monitor, often described as screen distortion, “jitter,” or other visual defects. The extent of interference depends on 60 Hertz (Hz) magnetic field intensity, monitor orientation, monitor design, and the monitor’s vertical refresh rate for the image. Although the potential for CRT computer monitor interference exists, the proposed transmission line loop is located within an open farmland area, where computer monitors are commonly not present. The threshold of about 10 milligauss (mG) for CRT computer monitor interference is achieved at approximately 120 feet from the transmission line center under average/normal loading conditions.

Image distortion does not occur on liquid crystal display (LCD) monitors used on portable computers (Electricity Supply Association of Australia, 1996) and now routinely used for desktop computers as well. Moreover, computer monitor interference is a recognized problem in the video monitor industry. As a result, there are manufacturers who specialize in monitor interference solutions and shielding enclosures. Possible solutions to computer monitor interference issues are widely available and include: relocation of the monitor, use of magnetic shield enclosures, software programs to adjust the monitor's vertical refresh rate, and replacement of cathode ray tube monitors with liquid crystal displays. Impacts from interference with computer monitors would thus be less than significant.

16.2.4 Gaseous Effluents

Corona activity on electrical conductors surrounded by air can produce very tiny amounts of gaseous effluents: ozone and nitrogen oxide (NO_x). Ozone is the primary photochemical oxidant, representing 90-95 percent of the total.

Ozone is a naturally occurring part of the air, with typical rural ambient levels around 10 to 30 parts per billion (ppb) at night and peaks of 100 ppb and higher (EPRI, 1982). In urban areas, concentrations greater than 100 ppb are common. After a thunderstorm the air may contain 50 to 150 ppb of ozone, and levels of several hundred ppb have been recorded in large cities and in commercial airliners. Ozone is also given off by welding equipment, copy machines, air fresheners, and many household appliances. The National Ambient Air Quality Standard for oxidants is 120 ppb, not to be exceeded as a peak one-hour concentration on more than one day a year. The standard for NO_x is 140 ppb.

Gaseous effluents can be produced by corona activity on high voltage transmission line electrical conductors during rain or fog conditions, and can occur for any configuration or location. Typically, concentrations of ozone at ground level for 230 kV and lower voltage transmission lines during heavy rain are significantly less than the most sensitive instruments can measure (which is about one ppb), and thousands of times less than ambient levels. Nitrogen oxides are even less. Thus, the project would not create any significant adverse impact on the ambient air quality of the project area.

16.3 INDUCED CURRENTS

Electric currents can be induced by electric and magnetic fields in conductive objects near transmission lines. For magnetic fields, the concern is for very long objects parallel and close to the line. However, the majority of concern is related to the potential for small electric currents to be induced by electric fields in metallic objects close to transmission lines. Metallic roofs, vehicles, vineyard trellises, and fences are examples of objects that can develop a small electric charge in proximity to high voltage transmission lines.

Object characteristics, degree of grounding, and electric field strength affect the amount of induced charge. An electric current can flow when an object has an induced charge and a path to ground is presented. The amount of current flow is determined by the impedance of the object to ground and the voltage induced between the object and ground. The amount of induced current that can flow is important to evaluate because of the potential for nuisance shocks to people and the possibility of accidental ignition of fuel. Induced current is commonly measured in units of milliamperes (mA) (i.e., one mA is 0.001 amperes of electric current). The National Electric Safety Code (NESC) has set an induced current limit of five mA for objects under transmission lines (American National Standards Institute, 2002).

16.3.1 Shock Potential

The proposed transmission line loop will have the highest electric field within the right-of-way of approximately 3.93 kilovolt per meter (kV/m) calculated in the region under the conductors at the lowest point of sag. Other locations on the right-of-way will be less. The calculated electric field will be approximately 0.09 kV/m at the right-of-way edge. Induced currents can be calculated for common objects for a set of theoretical (worst-case) assumptions: the object is perfectly insulated from ground, located in the highest field, and touched by a perfectly grounded person. Calculations can be made using experimentally determined induction coefficients and the calculated electric field (EPRI, 1982). Table 16-1 summarizes the calculated induced current for common objects placed on the right-of-way for the theoretical conditions previously stated.

Table 16-1: Calculated Induced Current for Objects Near 230 kV Line for Theoretical Conditions

Object	Length (feet)[1]	Induced Current Coefficient (mA/kV/m)	Induced Current	
			Near Midspan (mA)	Right-of-way Edge (mA)
Pickup truck	17	0.10	0.39	0.01
Farm Tractor and Wagon	31	0.30	1.18	0.03
Combine	30	0.38	1.49	0.03
School Bus	34	0.39	1.53	0.04
Tractor-trailer	52	0.64	2.52	0.06

[1]For large objects (30 feet and larger), these calculations assume that the object is oriented parallel to the transmission line loop within the maximum electric field strength. For objects perpendicular to the transmission line loop, the induced current would be less.

The maximum electric field only occurs on a small portion of the right-of-way, and perfect insulation and grounding states are not common, but even using these worst-case measurements, the calculated induced current values for the pickup truck, farm tractor pulling crop wagon, school bus, and tractor-trailer are below hazardous levels where a person could not let go of an object (nine mA for men and six mA for women). Therefore, this transmission line loop will comply with the National Electrical Safety Code requirements limiting induced currents on objects to five mA or less, and impacts due to shock would be less than significant.

Because agricultural irrigation pipes contact moist soil, electric field induction is generally negligible, but annoying currents could still be experienced from magnetic field coupling to the pipe. Pipe runs laid at right angles to the transmission line loop will minimize magnetically induced currents, although such a layout may not always be feasible. If there are induction problems, they can be mitigated by grounding and/or isolating the pipe runs. Any impacts are thus less than significant.

16.3.2 Fuel Ignition

Theoretical calculations indicate that if a number of unlikely conditions exist simultaneously, a spark could release enough energy to ignite gasoline vapors (EPRI, 1982). This could not occur if a vehicle were simply driven or parked under a transmission line. Rather, several specific conditions need to be satisfied: a large gasoline-powered vehicle would have to be parked in an electric field of about five kV/m or greater (Deno, 1985). A person would have to be refueling the vehicle while standing on damp earth and while the vehicle is on dry asphalt or gravel. The fuel vapors and air would have to mix in an optimum proportion. Finally, the pouring spout must be metallic. The chances of having all the conditions necessary for fuel ignition present at the same time are extremely small. Very large vehicles (necessary to collect larger amounts of electric charge) are often diesel-powered, and diesel fuel is less volatile and more difficult to ignite. Typically for 230 kV and lower transmission lines, electric field levels within the right-of-way are far too low for the minimum energy necessary for fuel ignition under any practical circumstances. Additionally, the proposed transmission line loop is located within an open farmland area, where gasoline stations and vehicle refueling activities are not present. Therefore, fuel ignition does not pose a significant hazard and any impacts would be less than significant.

16.4 MITIGATION MEASURES

Because corona and induced current effects associated with the project are less than significant, mitigation measures are not required.

16.5 REFERENCES

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