C.9 PUBLIC HEALTH, SAFETY, AND NUISANCE

C.9 PUBLIC HEALTH, SAFETY AND NUISANCE

This section provides information regarding electric and magnetic fields (EMF) associated with the proposed Northeast San Jose Transmission Reinforcement Project's electric utility facilities and the potential effects related to public health, safety and nuisance. This section also addresses additional concerns related to power line fields, including corona and audible noise; radio, television, electronic equipment interference; induced currents and shock hazards; and effects on cardiac pacemakers.

Section C.9.1 describes the general types of effects that could result from transmission line operation, and Section C.9.2 defines specific project impacts and mitigation measures.

C.9.1 ENVIRONMENTAL BASELINE AND REGULATORY SETTING

C.9.1.1 General Characteristics of the Study Region and Project Area

From an EMF perspective, the environment in the project area can be characterized as having two general types of land uses. The first area, in the northern and eastern portion of the study region, is along the Interstate 880 corridor and includes the Bayside Business Park. In this area, existing electric and magnetic fields will be more prevalent from the use of electronic appliances or equipment and existing electric transmission and distribution lines. The second area, in the western and southern portion of the study region, includes undeveloped lands and natural areas. In this area, electric and magnetic fields are anticipated to be less common but still present in the vicinity of existing power lines and facilities such as the Water Pollution Control Plant.

C.9.1.2 Electric and Magnetic Fields (EMF)

C.9.1.2.1 *Background and Definitions*

Defining EMF. Electric and magnetic fields are separate phenomena and occur both naturally and as a result of human activity across a broad electrical spectrum. The weather and the earth's geomagnetic field cause naturally occurring electric and magnetic fields. These fields also occur from human activity, caused by technological application of the electromagnetic spectrum for uses such as communications, appliances, and the generation, transmission, and local distribution of electricity.

The electric and magnetic fields from power lines change their direction over time. The rate of this change in direction is referred to as a frequency, and represents the number of times the fields change direction each second. For power lines in the United States, the frequency of change is 60 times per second and is defined as 60 Hertz (Hz) power. In Europe and many other countries, the frequency of electric power is 50 Hz. Radio and communication waves operate at much higher frequencies: 500,000 Hz to 1,000,000,000 Hz. The information presented in this document is limited to the EMF from power lines at frequencies of 50 or 60 Hz.

Electric power flows across transmission systems from generating sources to serve electrical loads within the community. The transmission line's voltage and the current determine the apparent power

flowing over a transmission line. The higher the voltage level of the transmission line, the lower the amount of current needed to deliver the same amount of power. For example, a 115 kV transmission line with 200 amps of current will transmit approximately 40,000 kilowatts (kW), and a 230 kV transmission line requires only 100 amps of current to deliver the same 40,000 kW.

Electric Fields. Electric fields from power lines are created whenever the lines are energized, with the strength of the field dependent directly on the voltage of the line creating it. Electric field strength is typically described in terms of kilovolts per meter (kV/m). Electric field strength declines rapidly as the distance from the source increases. Electric fields are shielded by most objects or materials, including trees or houses.

At reasonably close distances, electric fields of sufficient strength in the vicinity of power lines can cause the same phenomena as the static electricity experienced on a dry winter day, or like clothing just removed from a clothes dryer. This electric field may result in electric discharges (shocks) when touching long metal fences or large vehicles located near a transmission line. Another potential impact to public health from electric transmission lines is the hazard of electric shock: Electric shocks from transmission lines are generally the result of accidental or unintentional contact by the public with the energized wires.

Magnetic Fields. Magnetic fields from power lines are created whenever current flows through power lines at any voltage. The strength of the field is directly dependent on the current in the line. Magnetic field strength is typically measured in milligauss (mG). Similar to electric fields, magnetic field strength attenuates rapidly with distance from the source. Unlike electric fields, magnetic fields are not easily shielded by objects or materials that are located between the lines and the receptors.

The nature of a magnetic field can be illustrated by considering a household appliance. When the appliance is energized by being plugged into an outlet, but not turned on, an *electric* field will be generated around the cord and appliance, but no *magnetic* field will be present since there is no current flowing through the appliance. If the appliance is switched on, the *electric* field will still be present and a *magnetic* field will be created. The electric field strength is directly related to the magnitude of the voltage from the outlet and the magnetic field strength is directly related to the magnitude of the current flowing in the cord and appliance.

C.9.1.2.2 *EMF Levels*

Electric and magnetic fields exist in the environment both naturally and as a result of human activities. The geomagnetic field of the earth ranges from 500 to 700 mG (Carstensen, 1987). In areas not immediately adjacent to transmission lines, electric and magnetic fields exist as a result of other electric power uses such as neighborhood distribution lines, household wiring, and electrical equipment or appliances. Public exposure to these fields is widespread and encompasses a very broad range of field intensities and durations. Research on ambient magnetic fields in homes and buildings in several western states found average magnetic field levels within rooms to be approximately 1 mG, while in the immediate area of appliances, the measured values ranged from 9 to 20 mG (Severson et al., 1988, and Silva, 1988).

Table C.9-1 indicates typical sources and levels of electric and magnetic field exposure the general public experiences from appliances.

Table C.9-1 Magnetic Field From Household Appliance

Appliance AP	Magnetic Field (mG)	
	12" Distant	Maximum
Electric Range	3 to 30	100 to 1,200
Electric Oven	2 to 25	10 to 50
Garbage Disposal	10 to 20	850 to 1,250
Refrigerator	0.3 to 3	4 to 15
Clothes Washer	2 to 30	10 to 400
Clothes Dryer	1 to 3	3 to 80
Coffee Maker	0.8 to 1	15 to 250
Toaster	0.6 to 8	70 to 150
Crock Pot	0.8 to 1	15 to 80
Iron	1 to 3	90 to 300
Can Opener	35 to 250	10,000 to 20,000
Mixer	6 to 100	500 to 7,000
Blender, Popper, Processor	6 to 20	250 to 1,050
Vacuum Cleaner	20 to 200	2,000 to 8,000
Portable Heater	1 to 40	100 to 1,100
Fans/blowers	0.4 to 40	20 to 300
Hair Dryer	1 to 70	60 to 20,000
Electric Shaver	1 to 100	150 to 15,000
Color TV	9 to 20	150 to 500
Fluorescent Fixture	2 to 40	140 to 2,000
Fluorescent Desk Lamp	6 to 20	400 to 3,500
Circular Saws	10 to 250	2,000 to 10,000
Electric Drill	25 to 35	4,000 to 8,000

Source: Gauger, 1985

C.9.1.2.3 *Public Health and EMF Studies*

For more than 20 years, questions have been asked regarding the potential effects within the environment of electric and magnetic fields from power lines. A significant amount of research has been conducted to provide some basis for response. Earlier studies focused primarily on interactions with the electric fields from power lines. In the late 1970s, the subject of magnetic field interactions began to receive additional public attention and research levels have increased.

A substantial amount of research investigating both electric and magnetic fields has been conducted over the past 15 years; however, much of the body of national and international research regarding EMF and public health risks remains contradictory or inconclusive.

Scientists have found that electric and magnetic fields can produce a number of biological effects. These range from slowed heart rates to changes in the rate at which the body produces various compounds. Some of these effects are apparently related to the electric field while others are thought to be due to the magnetic field. These effects have been difficult to determine and often are only detectable at field strengths well in excess of those to which the public is exposed from power lines. Although it has been found that EMF causes biological effects, there is no scientific basis to conclude that any of these biological effects have negative implications for public health at the field levels associated with power lines.

Research related to EMF can be grouped into three general categories: cellular level studies, animal and human experiments, and epidemiological studies. These studies have provided mixed results, with some studies showing an apparent relationship between magnetic fields and health effects while other similar studies do not.

Since 1979, public interest and concern specifically regarding magnetic fields from power lines has increased. This increase has generally been attributed to publication of the results of an epidemiological study (Wertheimer and Leeper, 1979). This study observed an association between the wiring configuration on transmission lines outside of homes in Denver and the incidence of childhood cancer. Following publication of the Wertheimer and Leeper study, more than 50 major epidemiological studies regarding EMF have been conducted.

C.9.1.2.4 *Scientific Panel Reviews*

Numerous panels of expert scientists have convened to review the data relevant to the question of whether exposure to power-frequency EMF is associated with adverse health effects. These evaluations have been conducted in order to advise governmental agencies or professional standard-setting groups. These panels of scientists first evaluate the available studies individually, not only to determine what specific information they can offer, but also in terms of their experimental design, methods of data collection, analysis, and suitability of the authors' conclusions to the nature and quality of the data presented. Subsequently, the individual studies, with their previously identified strengths and weaknesses, are evaluated collectively in an effort to identify whether there is a consistent pattern or trend in the data that would lead to a determination of possible or probable hazards to human health resulting from exposure to these fields.

These reviews include those prepared by international agencies such as the World Health Organization (WHO, 1984 and WHO, 1987) and the International Non-Ionizing Radiation Committee of the International Radiation Protection Association (IRPA/INIRC, 1990) as well as governmental agencies of a number of countries, such as the U.S. EPA, the National Radiological Protection Board of the United Kingdom, and the French and Danish Ministries of Health. In May 1999 the National Institute of Environmental Health Sciences (NIEHS) submitted to Congress its report titled, *Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*, containing mixed conclusions regarding EMF and health effects.

All of these panels have concluded that the body of data, as large as it is, does not provide evidence to conclude that exposure to EMF of the magnitude expected during the operation of electric transmission lines causes cancer or otherwise constitutes a health hazard.

Californa Research Programs. In coordination with the California Department of Health Services (DHS), the CPUC sponsors the California EMF Program, which conducts a wide range of research, and advisory programs. This program and its components are described in detail on two Internet websites:

http://www.dnai.com/ ~ emf/
http://www.cpuc.ca.gov/divisions/energy/environmental/emf/emfopen.htm

The EMF program under the CPUC and DHS is briefly described in the following sections.

Creation of the California EMF Program. CPUC Decision 93-11-013 (also described in Section C.9.1.2.6 following) created the California Electric and Magnetic Fields (EMF) Program to research and provide education and technical assistance on the possible health effects of exposure to electric and magnetic fields from powerlines and other uses of electricity. In addition to funding research and policy analysis on this issue, the EMF program provides education and technical assistance to government agencies, professional organizations, businesses, and members of the general public. Under the CPUC decision, this program is funded by money provided by the state's investor-owned utilities and is based in the DHS. The California EMF program produces periodic reports to the CPUC, and its goal is to make the research, policy analysis, and educational products useful to the CPUC in future decision-making. This Program is currently scheduled to end by December 31, 2001.

Program Organization. The DHS has assigned Dr. Raymond Richard Neutra of the Division of Environmental and Occupational Disease Control to head the EMF Program. Funding for the EMF program became available on January 1, 1994, and the Public Health Institute (PHI, formally the California Public Health Foundation) became the program's nonprofit fiscal manager on April 30, 1994. PHI assists DHS by staffing the Stakeholders Advisory Consultants (SAC), overseeing the extramural research unit and its subcontracts, and handling the fiscal and administrative matters of the education unit. After the formation of the SAC and an international search, the research director joined the staff on February 1, 1995.

Stakeholders Advisory Consultants. The CPUC decision that created the California EMF Program states that the involvement of stakeholders and the public is very important to the development of effective EMF policies. This decision asks DHS to determine what form of stakeholder and public involvement best meets its needs. DHS decided that the most appropriate role for the SAC would be to advise the program on the development of the research projects and on budgetary matters, and to monitor its progress to ensure that the scientific and technical staff can exercise their responsibility and authority to carry out an effective program on behalf of the CPUC. The EMF program assembled the SAC in 1994 and they have met several times a year since then.

One important function of the SAC is to serve as a forum where all citizens can ask questions and express their concerns about the possibility of health effects from exposure to EMF and express their opinions about EMF policy. All SAC meetings are open to the general public. Stakeholders' concerns about the research projects have surfaced through discussions that extended in some cases over several quarterly meetings. For some important issues, such as conflict of interest and property values research, consensus was not possible. In these cases the program tries to find solutions that are technically and scientifically sound while being responsive to the basic concerns of the various stakeholders.

Research Unit. The goal of the Research Unit is to help answer the following four questions that decision-makers face as they deal with the EMF issue:

- Is there a health problem? (risk research)
- Where is the problem? (exposure assessment and analysis)
- What can be done about it? (mitigation research)
- What should policymakers do, or what are the policy options and their pros and cons? (policy analysis)

In order to answer these questions, the program's research priority areas are policy analysis, exposure assessment, epidemiology, and electrical engineering and mitigation.

Education and Technical Assistance Unit. The goals of the Education and Technical Assistance unit are to:

- Provide a trustworthy and balanced source information about potential EMF health risks and mitigation options
- Provide technical and consultative services to state and local officials, professional organizations, and the public about EMF exposures and health risks thought to be related to EMF
- Facilitate and maximize opportunities for public input into program projects and goals and provide support and training to enable stakeholders to use and remain informed about the research program results
- Coordinate actions within DHS, with other California state and local agencies, and with programs sponsored by the federal government, other state governments, and investor-owned and municipal utilities
- Act as liaison between the program's Stakeholders Advisory Consultants and staff by organizing and facilitating meetings and preparing and distributing meeting minutes
- Provide education and support for stakeholders and the public through the program newsletter, and prepare and distribute important program materials.

To accomplish these goals, Education and Technical Assistance staff write and distribute educational materials, organize meetings and workshops for stakeholders and the general public, produce a newsletter to keep stakeholders and interested parties informed of program activities, and respond by telephone, mail, and electronic mail to questions raised by members of the public.

Program Synthesis Projects. This is the final phase of the EMF program, during which the research results will be reviewed and used as the basis for preparing reports and products to inform future discussions on this issue. As a result of SAC discussions, the DHS decided to pursue a program synthesis that includes four elements:

- An evaluation of the evidence of risk based on results of this program as well as other research
- A policy integration document to help decision-makers use the policy analyses' results
- A well thought-out process for releasing the data collected in and results of the research projects
- Opportunities for potential end-users of the research effort to familiarize themselves with complex technical documents

The addition of this program synthesis required two applications to the CPUC for no-cost extensions of the program.

C.9.1.2.5 *Policies, Standards, and Regulations*

A number of counties, states, and local governments have adopted or considered regulations or policies related to EMF exposure. The reasons for these actions have been varied; in general, however, the actions can be attributed to addressing public reaction to and perception of EMF as opposed to responding to the findings of any specific scientific research. Following is a brief summary of activity in this area.

International Guidelines. The International Radiation Protection Association, in cooperation with the World Health Organization, has published recommended guidelines (INRC, 1990) for electric and magnetic field exposures. For the general public, the limits are 5 kV/m (up to 24 hours a day) and 10 kV/m (for a few hours a day) for electric fields, and 1,000 mG (up to 24 hours a day) and 10,000 mG (for a few hours a day) for magnetic fields. Neither of these organizations have any governmental authority or recognized jurisdiction to enforce these guidelines. However, because they were developed by a broad base of scientists, these guidelines have been given merit and are considered by utilities and regulators when reviewing EMF levels from electric power lines.

Federal Guidelines. Although the U.S. EPA has conducted investigations into EMF related to power lines and health risks, no national standards have been established. The number of studies sponsored by the U.S. EPA, the Electric Power Research Institute (EPRI), and other institutions has increased dramatically in the past few years. Several bills addressing EMF have been introduced at the congressional level and have provided funding for research; however, no bill has been enacted that would regulate EMF levels.

The 1999 NIEHS report to Congress suggested that the evidence supporting EMF exposure as a health hazard was insufficient to warrant aggressive regulatory actions. The report did suggest passive measures to educate the public and regulators on means aimed at reducing exposures. NIEHS also suggested the power industry continue its practice of siting lines to reduce exposures and to explore ways to reduce the creation of magnetic fields around lines.

State Guidelines. Several states have adopted limits of electric field strength within transmission line rights-of-way (ROWs). Florida and New York are the only states that currently limit the intensity of magnetic fields from transmission lines. These regulations include limits within the ROW, as well as at the edge of the ROW and cover a broad range of values. Table C.9-2 lists the states regulating EMF and their respective limits. The magnetic field limits were based on an objective of preventing field levels from increasing beyond levels currently experienced by the public and are not based upon any link between scientific data and health risks (Morgan, 1991).

Table C.9-2 EMF Regulated Limits (by State)

Electric Field (kV/m)	Magnetic Field (mG)	Location	Application

Electric Field (kV/m)	Magnetic Field (mG)	Location	Application
Florida (codified)			
10		in ROW	500 kV Lines Single Circuit
2	200	edge of ROW	500 kV Lines Single Circuit
2	250	edge of ROW	500 kV Lines Double Circuit
8		in ROW	230 kV Lines or less
2	150	edge of ROW	230 kV Lines or less
Minnesota			
8		in ROW	> 200 kV
Montana (codified)			
1		edge of ROW	> 69 kV
7		in ROW	road crossings
New Jersey			
3	under consideration	edge of ROW	Guideline for complaints
New York			
1.6	200	edge of ROW	> 125 kV, > 1 mile
7		in ROW	public roads
11		in ROW	public roads
11.8		in ROW	other terrain
North Dakota			
9		in ROW	Informal
Oregon (codified)			
9		in ROW	230 kV, 10 miles

Source: Public Utilities Commission of Texas

Elsewhere in the United States, several agencies and municipalities have taken action regarding EMF policies. These actions have been varied and include requirements that the fields be considered in the siting of new facilities. The manner in which EMF is considered has taken several forms. In a few instances, a concept referred to as "prudent avoidance" has been adopted. Prudent avoidance, a concept proposed by Dr. Granger Morgan of Carnegie-Mellon University, is defined as "…limiting exposures which can be avoided with small investments of money and effort" (Morgan, 1991). Some municipalities or regulating agencies have proposed limitations on field strength, requirements for siting of lines away from residences and schools, and, in some instances, moratoria on the construction of new transmission lines. The origin of these individual actions has been varied, with some initiated by regulators at the time of new transmission line proposals within their community, and some by public grass-roots efforts.

C.9.1.2.6 *California Public Utilities Commission EMF Policy*

In 1991, the California Public Utilities Commission (CPUC) initiated an investigation into electric and magnetic fields associated with electric power facilities. By this investigation, all interested parties were notified that the Commission would take appropriate action on EMFs in response to a conclusion, based on scientific evidence, which indicates that a health hazard actually exists, and that a clear cause and effect relationship between utility property or operations and public health is established.

At the issuance of this investigation, the scientific community had not yet isolated the impact, if any, of utility-related exposures on public health. In the absence of a final resolution of the question of such impact, other jurisdictions and agencies have concluded that the best response to EMFs is to avoid unnecessary new exposure to EMFs if such avoidance can be achieved at a cost that is reasonable in light of the risk identified. Thus, if at a future time a health risk is determined to exist, government will have acted responsibly and rationally to avoid unnecessary exposure to that risk.

Interested parties were invited to comment on specific EMF issues identified in the investigation. In response to this invitation, comments were received from 23 independent organizations and individuals. Stemming from the investigation and subsequent meetings of the EMF working group, the Commission adopted Decision (D.) 93-11-013, which takes seven interim steps to address EMFs related to electric utility facilities and power lines. The Decision also designates the California Department of Health Services (DHS) as a program manager for EMF research and education programs. The mitigation measures that are in place as a result of this decision are described in Section C.9.2.2.1, and include the use of "low-cost" or "no-cost" mitigation measures for electric utilities under the CPUC's jurisdiction. The CPUC did not adopt any specific limits or regulation on EMF levels related to electric power facilities.

C.9.1.3 Other Field Related Public Concerns

Other public concerns related to electric power facility projects, which are safety or nuisance issues, include corona and audible noise, radio/television/electronic equipment interference, induced currents and shock hazards, and effects on cardiac pacemakers.

Corona and Audible Noise

Corona is the breakdown of air very near conductors. Corona and the associated noise occur when the electric field is locally intensified by irregularities on the conductor surface such as scratches or water drops (see also Section C.8, Noise and Vibration). Corona, as an issue for transmission lines, is more significant for extra-high voltage lines of 345 kV or above but will occur on lower voltage lines during rain or fog conditions. The physical manifestations of corona include a crackling or hissing noise and very small amounts of light. Besides the nuisance aspects of corona, it results in undesirable power loss over a transmission line. Therefore the design of transmission lines incorporates conductor and equipment that limit or eliminate corona.

Radio/Television/Electronic Equipment Interference

Corona can generate high frequency energy that may interfere with broadcast signals or electronic equipment. However, this problem is generally not a concern with transmission lines because they can be designed to minimize the interference. The Institute of Electrical and Electronic Engineers (IEEE) has published a design guide (Radio Noise Subcommittee 1971) that is used to limit conductor surface gradients so as to avoid electronic interference.

"Gap discharges" or "arcs" can also be a source of high frequency energy. Gap discharges occur when an arc forms across a gap in loose or worn line hardware. It is estimated that over 90 percent of interference problems for electric transmission lines are due to gap discharges. Line hardware is designed to be problem-free, but wind motion, corrosion and other factors can create a gap discharge condition. Gap discharges can be located and corrected by PG&E Co. as part of maintenance activities.

Electric fields from power lines do not typically pose interference problems for electronic equipment in businesses since buildings and walls shield the equipment to some extent. However, magnetic fields can penetrate buildings and walls thereby interacting with electronic equipment. Depending upon the sensitivity of equipment, the magnetic fields can interfere with equipment operation; this concern was raised during the EIR scoping period by a business park through which the proposed project would pass. Personal computer monitors can be susceptible to magnetic field interference. Magnetic field interference results in disturbances to the image displayed on the monitor, often described as screen distortion, "jitter," or other visual defects. In most cases it is annoying, and at its worst, it can prevent use of the monitor. This type of interference is a recognized problem in the video monitor industry. As a result, there are manufacturers who specialize in monitor interference solutions and shielding equipment. Possible solutions to this problem include: relocation of the monitor, use of magnetic shield enclosures, software programs, and replacement of cathode ray tube monitors with liquid crystal displays that are not susceptible to magnetic field interference.

Induced Currents and Shock Hazards

Power line fields can induce voltages and currents on conductive objects, such as metal roofs or buildings, fences, pipes, and vehicles. When a person or animal comes in contact with a conductive object, a perceptible current or small secondary shock may occur. Secondary shocks cause no physiological harm; however, they may present a nuisance.

Effects on Cardiac Pacemakers

An area of concern related to electric fields from transmission lines has been the possibility of interference with cardiac pacemakers. There are two general types of pacemakers: asynchronous and synchronous. The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference because it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker, however, pulses only when its sensing circuitry determines that pacing is necessary. Interference from transmission line electric field may cause a spurious signal on the pacemaker's sensing circuitry. However, when these pacemakers detect a spurious signal, such as a 60 Hz signal, they are programmed to revert to an asynchronous or fixed pacing mode of operation, returning to synchronous operation within a specified time after the signal is no longer detected. Cardiovascular specialists do not consider prolonged asynchronous pacing a problem, since some pacemakers are designed to operate that way. Periods of operation in this mode are commonly induced by cardiologists to check pacemaker performance. So, while transmission line electric fields may interfere with the normal operation of some of the older model pacemakers, the result of the interference is generally not harmful, and is of short duration (EPRI, 1985 and 1979).

C.9.2 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES FOR THE PROPOSED PROJECT

This section focuses on the environmental impacts of transmission line fields from the proposed Northeast San Jose Transmission Reinforcement Project. The project's anticipated EMF levels are reviewed relative to existing fields and policies/guidelines to assess impacts and to determine

mitigation measures. The other public concerns identified in Section C.9.1.3 are also addressed as they relate to transmission line fields.

C.9.2.1 Definition and Use of Significance Criteria

This section defines the standards used to determine the significance of impacts resulting from the proposed project. Generally, the basis for the determining the significance of impacts is by comparison with existing standards or regulations, and in the absence of regulations, is based on existing conditions in the project area from similar facilities in place today.

Electric and Magnetic Fields

There is no scientific conclusion that there are negative public health impacts due to EMF at the levels expected from electric power facilities. Further, there are no federal or state standards limiting human exposure to EMFs from transmission lines or substation facilities in California. Regulated utilities are bound only by the CPUC's "no-cost and low-cost" mitigation requirements. In other states, the standards or limits that have been adopted were based on an objective of keeping the field levels from new power lines similar to the field levels from existing lines.

Other Field Related Public Concerns

Corona and Audible Noise. There are no standards or regulations pertaining to corona levels on electric power facilities. The U.S. EPA has conducted extensive studies to identify the effects of certain sound levels on public health and welfare and has developed noise guidelines (U.S. EPA, 1974). These guidelines typically form the basis for community zoning requirements related to noise levels. For residential areas the U.S. EPA guidelines indicate noise should not exceed 55 decibels (dBA) between 7 a.m. and 10 p.m. or 45 dBA between 10 p.m. and 7 a.m. See also Section C.8.2.2 for discussion of noise standards.

Radio/Television/Electronic Equipment Interference. There are no local, state or federal regulations with specific limits on high frequency emissions from electric power facilities. Federal Communication Commission (FCC) regulations require that transmission lines be operated so that no harmful interference is produced (FCC regulations, section 15.25).

Induced Currents and Shock Hazards. The National Electrical Safety Code (NESC) specifies that transmission lines be designed to limit short circuit current from vehicles or large objects near the line to no more than 5 milliampere (mA). CPUC General Order 95 and the NESC also address shock hazards to the public by providing guidelines on minimum clearances to be maintained for practical safeguarding of persons during the installation, operation, or maintenance of overhead transmission lines and their associated equipment.

Effects on Cardiac Pacemakers. It has been reported that synchronous pacemakers can be affected by electric fields between 2 kV/m and 9 kV/m (EPRI, 1985; 1979). When a synchronous pacemaker is in a field in this range, a few older model pacemakers may revert to an asynchronous mode.

C.9.2.2 Environmental Impacts and Mitigation Measures

C.9.2.2.1 *Electric and Magnetic Fields*

EMFs levels in the project area would not change during construction of the proposed project, since the lines would not be energized during construction. After the line is energized, there would be continuous and long-term impacts to the surrounding environment due to EMFs.

For both overhead and underground transmission lines, EMF impacts are anticipated to be very localized. Using an optimized phase arrangement for the overhead transmission line, the magnetic field calculated by PG&E Co. will vary from approximately 113 mG at the center of the right-of-way to 38 mG at the edge of the right-of-way, diminishing to below 10 mG 100 feet from the line. As shown in Table C.9-2, the states that set limitations on EMF emissions at the edge of the right-of-way have limits between 150 and 250 mG, larger than PG&E Co.'s estimated levels.

For the underground portions of the transmission line alternatives, the EMF levels would also be localized. The magnetic field due to buried transmission lines depends greatly on the type of buried construction. In the areas of underground cable, magnetic fields may be higher immediately above the cable since the field source would be much closer to the ground surface than for overhead. However, the magnetic field is more concentrated near underground transmission cables and decreases more rapidly as you move away from the cable, resulting in greatly reduced fields compared with overhead portions of the line.

Methods to Reduce EMF

EMF levels from transmission lines can be reduced in three primary ways: shielding, field cancellation, or increasing the distance from the source.

- **Shielding**, which primarily reduces exposure to electric fields, can be actively accomplished by placing trees or other physical barriers along the transmission line right-of-way (ROW). Shielding also results from existing structures the public may use or occupy along the line. Since electric fields can be blocked by most materials, shielding is effective for the electric fields but is of limited effectiveness for magnetic fields

- **Field cancellation** is achieved in two ways. First, when the configuration places the conductors closer together, the interference, or cancellation, of the fields from each wire is enhanced. This technique has practical limitations because of the potential for short circuits if the wires are placed too close together. There are also worker safety issues to consider if spacing is reduced. Second, in instances where more than three phase wires are used, such as in the proposed project, cancellation can be accomplished by placing different phase wires next to each other

- The **distance between the source of fields and the public** can be increased by either placing the wires higher above ground or by increasing the width of the ROW to lengthen the distance from the lines to the receptor. For transmission lines, this method can prove effective in reducing fields because the field strength drops rapidly with distance. This method is especially effective with underground transmission lines, where field strength can drop approximately 25 percent when line burial is increased from 3 to 4 feet, and 40 percent when burial is increased from 3 to 5 feet (PG&E Co., Transmission Line EMF Design Guidelines, 1994).

CPUC No-Cost/Low-Cost EMF Mitigation Policy

In Decision 93-11-03, the CPUC addressed mitigation of EMF of utility facilities and implemented the following recommendations:

- No-cost and low-cost steps to reduce EMF levels
- Workshops to develop EMF design guidelines
- Uniform residential and workplace programs
- Stakeholder and public involvement
- A four-year education program
- A four-year non-experimental and administrative research program
- An authorization of federal experimental research conducted under the National Energy Policy Act of 1992.

The decision, involving no-cost and low-cost mitigation, was to be applied to new and reconstructed facilities and is applicable to the Northeast San Jose Transmission Reinforcement Project. The decision included considerable discussion as to the meaning of "low-cost," and stated the following:

> From Edison's analysis and DRA's few percentage points criteria, it is logical to define low cost to be in the range of 4 percent of the total cost of a budgeted project. We direct the utilities to use 4 percent as a benchmark in developing their EMF mitigation guidelines. We will not establish 4 percent as an absolute cap at this time because we do not want to arbitrarily eliminate a potential measure that might be available but cost more than the 4 percent figure. Conversely, the utilities are encouraged to use effective measures that cost less than 4 percent. Given the evolving body of research on EMF measures, we feel that 4 percent provides the utilities with sufficient guidance without hindering their ability to seek out or develop innovative measures and to reduce the cost to implement known measures.
>
> We further endorse the concept put forward by [Pacific Gas & Electric] and [San Diego Gas & Electric] that a mitigation measure should achieve some noticeable reduction. PG&E CO. and SDG&E define significant EMF reduction as 15 percent and 20 percent, respectively. Again we decline to adopt specific numbers because there is not sufficient scientific evidence upon which to base such findings.

In accordance with CPUC Decision 93-11-013, PG&E Co. has committed to incorporating "no cost" and "low cost" magnetic field reduction steps in the proposed transmission and substation facilities. PG&E Co. has not described the specific measures it proposes to reduce potential exposure to magnetic fields generated by the proposed facilities, but it states that the measures will be consistent with PG&E Co.'s "Transmission and Substation EMF Design Guidelines," which are presented on PG&E Co.'s website at http://www.pge.com/customer_services/other/emf/index.html. PG&E Co.'s design guidelines include the following measures that may be available to reduce the magnetic field strength levels from electric power facilities:

- Increase distance from conductors and equipment
- Reduce conductor spacing
- Minimize current
- Optimize phase configuration.

Based upon magnetic field analysis furnished by PG&E Co., incorporation of an optimized phase configuration as a low cost field reduction measure will result in a 55 percent reduction of the magnetic field at the edge of the right-of-way. Increasing the distance from conductors as a field reduction

measure has a more pronounced effect immediately beneath the line but is less effective when considering field levels at the edge of the right-of-way. Increasing the height of the line may greatly increase the cost of the project resulting in only minimal field reduction when remaining within the low cost threshold identified by the CPUC. In addition the increase in structure height necessary to accomplish a pronounced field reduction may significantly increase visual impacts for the project.

The Final Field Management Plan for EMF will be provided by PG&E Co. to the CPUC for review. It will include the following project information:

- A description of the project (cost, design, length, location, etc.)
- A description of the surrounding land uses using priority criteria classifications
- No-cost options to be implemented
- Priority areas where low-cost measures are to be applied
- Measures considered for magnetic field reduction and cost reduction
- A conclusion that states which options were selected and how areas were treated equivalently or why low-cost measures cannot be applied to this project.

While there is continuing public concern about the health effects of EMFs, the conclusions of completed research supports the conclusion that EMF from power lines is an adverse, but not significant, impact of the proposed project (**Class III**). At final project design and construction stages, PG&E Co. will incorporate mitigation measures consistent with the CPUC No-Cost/Low-Cost EMF Mitigation Policy. No further mitigation measures are recommended.

C.9.2.2.2 *Other Field Related Public Concerns*

Corona and Audible Noise

There may be some periodic impacts due to corona and audible noise during rain and fog conditions. Any low level hissing or crackling, although adverse, would only be noticeable in close proximity to the line and is not considered significant (**Class III**). While mitigation for adverse but not significant impacts is not required under CEQA, Mitigation Measure PS-1 is recommended to ensure that impacts are minimal.

Radio and Television Interference

Corona or gap discharges related to high frequency radio and television interference impacts are dependent upon several factors, including the strength of broadcast signals, and is anticipated to be very localized if it occurs. Individual sources of adverse radio/television interference impacts can be located and corrected on the power lines. Conversely, magnetic field interference with computer monitors can be corrected through shielding or changes at the monitor location. The following mitigation measures are recommended to reduce the potential impacts of interference to non-significant levels (**Class II**).

Impact: Transmission line operation could cause interference with radio/television signals or computer monitors.

PS-1 As part of the design and construction process for the proposed project and any selected alternatives, the Applicant shall limit the conductor surface electric gradient in accordance with the IEEE Radio Noise Design Guide.

PS-2 After energizing the transmission line, the Applicant shall respond to and document all radio/ television/equipment interference complaints received, dates of complaints and of PG&E Co.'s response actions, and the response action taken. These records shall be made available to the CPUC and the public for review upon request. All unresolved disputes shall be referred by PG&E Co. to the CPUC for resolution. These complaints will be handled according to the procedures defined in General Order 131-D, Section XIV(A).

Induced Currents and Shock Hazards in Joint Use Corridors

Induced currents and voltages on conducting objects near the proposed transmission lines represent a potential significant impact that can be mitigated. These impacts do not pose a threat in the environment if the conducting objects are properly grounded, and the following mitigation measure is recommended to reduce the potential impacts of induced currents to a less than significant level (**Class II**):

Impact: Induced currents and shock hazards pose potential hazards to people near the facilities.

PS-3 As part of the siting and construction process for the proposed project (or any selected alternative), the Applicant shall identify objects (such as fences, conductors, and pipelines) that have the potential for induced voltages and work with the affected parties to determine proper grounding procedures. (CPUC G095 and the NESC do not have specific requirements for grounding.) The Applicant shall install all necessary grounding measures prior to energizing the line. Thirty days prior to energizing the line, the Applicant shall notify in writing, subject to the review and approval of the CPUC, all property owners within and adjacent to the approved transmission line ROW of the date the line is to be energized. The written notice shall provide a contact person and telephone number for answering questions regarding the line and guidelines on what activities should be limited or restricted within the ROW.

The written notice shall describe the nature and operation of the line, and the Applicant's responsibilities with respect to grounding all conducting objects. In addition, the notice shall describe the property owner's responsibilities with respect to notification for any new objects require grounding and guidelines for maintaining the safety of the ROW.

The Applicant shall respond to and document all complaints received and the responsive action taken. These records shall be made available to the CPUC for review upon request. All unresolved disputes shall be referred by PG&E Co. to the CPUC for resolution. These complaints will be handled according to the procedures defined in General Order 131-D, Section XIV(A).

Cardiac Pacemakers

The electric fields associated with the proposed project's transmission lines may be of sufficient magnitude to impact operation of a few older model pacemakers to revert to an asynchronous pacing. Cardiovascular specialists do not consider prolonged asynchronous pacing to be a problem; periods of operation in this mode are commonly induced by cardiologists to check pacemaker performance. Therefore, while the transmission line's electric field may impact operation of some older model pacemakers, the result of the interference is of short duration and is not considered significant or harmful (**Class III**). No mitigation measures are required or recommended.

C.9.2.3 Cumulative Impacts and Mitigation Measures

There are no conclusively known cumulative impacts from transmission line and substation EMFs. No EMF mitigation measures are required or recommended beyond the no-cost, low-cost measures incorporated by PG&E Co. Operation of the proposed transmission lines increases the possibility for induced currents and shock hazards. These impacts are not cumulative and can be mitigated through proper grounding techniques on large metal objects in the vicinity of the lines. Operation of the proposed transmission lines increases the possibility for radio/television/equipment interference in the vicinity of the line. These impacts are not cumulative and can be mitigated by designing conductors and equipment to limit corona and gap discharges, correcting through maintenance any gap discharges from worn hardware, and by installing magnetic field shielding on sensitive equipment. Therefore, no significant cumulative impacts are anticipated.

C.9.2.4 Unavoidable Significant Impacts

EMF and other public concerns and safety hazard impacts can be controlled through proper design and routing of the Northeast San Jose Transmission Reinforcement Project and the incorporation of the mitigation measures defined in this section. For this reason, there will be no unavoidable significant public safety and health impacts from the proposed project.

C.9.3 ALTERNATIVE ALIGNMENTS AND SUBSTATION SITES

The proposed alternate alignments and substation sites would have similar EMF impacts due to the line design being similar for all of the proposed routes. Likewise, potential shock induced and public safety hazard impacts would be similar for all proposed routes, since the general design, construction, and operation of the transmission line would be the same regardless of the route chosen. Because of the similarity of the transmission line construction, the environmental impacts and mitigation measures will be similar to those discussed in Section C.9.2. The following issues are the only ones that present different impact situations for alternatives than for the proposed project.

San Jose Bomb Disposal Facility. A number of the alternative transmission line routes (Westerly Route Alternative, Westerly Upgrade Alternative, and NRS Alternative) pass the general vicinity of a San Jose Police Department facility used for training and disposal of bombs and explosive devices. Due to the distance from the alternative routes (over 1,400 feet), the field levels from the 230 kV transmission line will be essentially indistinguishable from existing fields and are not expected to

impact operation and use of this facility.

Kathryn Hughes Elementary School. The NRS Alternative substation is located approximately 1,000 feet south of an elementary school (the school is on the opposite side of Lafayette Street and the railroad tracks). At this distance, there would be no measurable EMF impacts at the school from the transmission line or substation. Also, according to the School Site Selection and Approval Guide (California Department of Education), schools should be located at least 150 feet from the edge of the easement for 220-230kV lines. Therefore, no EMF impact at the school would result.

Underground Through Business Park Alternative. Underground transmission lines have greater field strengths than overhead lines when the receptor is very near the buried line, but the field strengths decline very quickly with distance from the right-of-way. Increasing burial depth by one or two feet can reduce field strength considerably; this is a measure that may be considered by PG&E Co. to mitigate EMF emissions from an underground transmission line.

C.9.4 THE NO PROJECT ALTERNATIVE

The No Project Alternative will also have EMF and public health and safety impacts, since current flow on existing transmission lines would be expected to increase and other transmission lines and/or generation facilities would likely be built to provide the desired transmission capacity if the Northeast San Jose Transmission Reinforcement Project does not go forward. The types of impacts would be similar to those of the proposed project and alternatives, but the magnitude of the effects would be specific to the design of the No Project Alternative.

C.9.5 MITIGATION MONITORING PROGRAM

Table C.9-4 presents a summary of impacts of the proposed project and the Mitigation Monitoring Program recommended for mitigating public health, safety and nuisance impacts. This program outlines the location, responsible party, required monitoring activities, effectiveness criteria, and timing of each monitoring activity.

Table C.9-4 Mitigation Monitoring Program

ıct (Class)	Mitigation Measure	Location	Monitoring/Reporting Action	Effectiveness Criteria	Responsible Agency	Tim
Project and Alternatives						
d Audible Noise	**PS-1** Conductor selection to consider surface gradient design criteria.	Entire transmission line route.	Submit engineering report for selected conductor and analysis of surface gradient.	Engineering report shall present analysis of surface gradient and demonstrate compliance to IEEE Radio Noise Guide.	CPUC	Prior to cor
Television e (**Class II**)	**PS-2** Respond to interference complaints.	Entire transmission line route.	CPUC to review PG&E Co.'s documented complaints and action taken. This report should be submitted to CPUC at the end of each year for first two years of operation. Unresolved complaints submitted to CPUC.	Complaint summary demonstrates a lack of interference complaints, or documents the remedies utilized to resolve interference.	CPUC	First two ye operation.
rrents and ards (**Class II**)	**PS-3** Install grounding for metal buildings, fences, etc.	Entire transmission line route.	Document criteria for installing grounding and tabulate locations where grounding installed.	Design prevents electric shocks to public.	CPUC	Prior to ene transmissio
d magnetic ıss III)	No-cost, low-cost field reduction measures determined by PG&E Co. based on CPUC requirements.	Entire transmission line route.	Document no-cost, low-cost measures incorporated in line design.	Report documents amount of field reduction obtained through mitigation measures.	CPUC	Prior to cor

C.9.6 REFERENCES

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