4.5 ELECTROMAGNETIC FIELDS

This section presents information on electromagnetic fields and interference related to the BEP and SVRTP alternatives. Information in this section is based on the *Electromagnetic Fields (EMF) Report* (Earth Tech, 2003).

4.5.1 ELECTROMAGNETIC FIELDS AND ELECTROMAGNETIC INTERFERENCE

EMFs are associated with electromagnetic radiation, which is energy in the form of photons. Radiation energy spreads as it travels and has many natural and human-made sources. The electromagnetic spectrum, the scientific name given to radiation energy, includes light, radio waves, and x-rays, among other energy forms.

EMFs have electrical and magnetic field components. Electric fields result from the strength of the electric charge (voltage), with DC generating stronger EMFs than AC at a given voltage, while magnetic fields result from the motion of the charge (current). Electric field strength is measured in units of volts per meter (V/m) and is greater the higher the voltage. Field strength deteriorates rapidly with distance from the source. Magnetic field strength has several units of measure; the most commonly used are milligauss (mG), gauss (G), microTesla (μT), and Tesla (T). One milligauss equals 0.001 of a gauss; ten milligauss equal one microTesla; one microTesla equals 0.000001 of a Tesla. Magnetic fields also deteriorate with distance but readily pass through most objects. Magnetic fields are typically the radiation of concern when evaluating EMFs.

The commonly known human-made sources of EMF are electrical systems such as electronics, telecommunications, electric motors, and other electrically powered devices. The radiation from these sources is invisible, non-ionizing, and low frequency. Generally, in most living environments, the level of such radiation plus background natural sources of EMF are low and not considered hazardous.

Although modern society increasingly relies on electromagnetic systems, strong EMFs are not associated with the normal living and working environment. Examples of EMF intensities from human activities include the following:

- Overhead power transmission line: 32 to 57 mG (range of exposure to utility workers)
- Household appliances: 8 to 165 mG (at a distance of 27 cm, or 12 inches)
- Computer video display: 2 to 4 mG (at 35 cm, or 16 inches)
- Rail vehicle (electrically powered): 400 mG (at 110 cm, or 43 inches from the vehicle floor) to 1,500 mG (at floor level)

For comparison, in the natural environment apart from human activity, the earth's static magnetic field varies from 300 mG (30 µT) at the equator to over 600 mG (60 µT) at the magnetic poles. In the San Jose area, the earth has a natural static magnetic field of about 510 mG (approximately 50 µT).

The more primary concern over EMF exposure is the potential biological and health effects to individuals as the number of EMF-generating activities increases, resulting in increased human exposure.

Another concern over EMF generation is the potential interference to other electromagnetic systems that can result when new or more intense sources of radiation are introduced into the environment. Electromagnetic interference (EMI) may include interruption, obstruction, or other degradation in the effective performance of electronics and electrical equipment. In addition, EMF may cause disturbances to sensitive scientific instruments similar to those typically found in laboratories, hospitals, and universities.

For personal home and business computer systems, a common problem is magnetic interference to computer monitors when used near alternating current (AC) or varying direct current (DC) magnetic fields. Computer monitors, particularly large screen monitors, are susceptible to interference created from nearby electrical sources, such as electrical panels, transformers, currents within internal systems wiring, or transmission and distribution lines.

Data corruption can also occur on magnetic or film media from very high magnetic fields. The potential for computer monitor interference and data corruption on magnetic media from the operation of the SVRTP or BEP alternatives is extremely small. Magnetic media materials (fare cards, credit cards, laptop computers with hard drives, and so forth) are routinely carried by passengers, not only on BART but also on many other DC powered transit systems throughout the world, with no reported negative effects.

4.5.2 HEALTH CONCERNS

Short-term human health effects from exposure to elevated levels of EMFs are well established, such as effects on the central nervous system and heating of the body. Long-term effects from exposure to lower levels of EMFs continue to be studied. Several reports have proposed a link between EMF exposures and such health problems as cancer, including childhood leukemia. The preponderance of authoritative scientific studies, however, has found no firm evidence of long-term health risks from low-intensity EMF exposures. Despite the lack of scientific evidence of harm, the public continues to express concern and health and regulatory agencies continue to study the matter.

4.5.3 EXISTING ELECTROMAGNETIC FIELDS

The existing EMF environment varies depending upon location, as EMF levels are typically site-specific. For example, commercial/industrial centers using major electrical systems and areas near high voltage lines or other power transmission networks would likely have higher EMF levels than residential and undeveloped areas. Because EMF levels in the SVRTC are not likely to be affected by implementation of the No Build Alternative, the following discussion of existing conditions is based on implementation of the BEP and SVRTP alternatives and measured EMF levels along the SVRTC.

The BEP and SVRTP alternative alignments would pass through agricultural, urban, and suburban environments. Land uses within urbanized areas vary from industrial to commercial to residential. The proposed SVRTC was surveyed to identify potential businesses or other sites that might be influenced by potential magnetic field levels when BART operates over this corridor. The San Jose Medical Center at 675 East Santa Clara Street was identified as a location of particular concern because the operation of magnetic resonance imaging (MRI) systems housed at the facility could be at risk for electromagnetic interference. On December 9, 2004, the San Jose Medical Center was closed and the facility vacated. No other sensitive uses immediately adjacent to the SVRTC have been identified at this time.

Field measurements to establish existing EMF conditions at specific locations along the corridor were completed in December 2001. Both DC and power frequency AC magnetic fields were measured. Table 4.5-1 shows measurements taken at points along the BEP and SVRTP alternative alignments to establish current EMF levels.

Table 4.5-1: EMF Levels at SVRTC Locations

Alternative	Location	Vertical Field Peak (in Gauss / µT)
SVRTP and BEP	At Berryessa Road crossing of proposed ROW	1.1 G / 110 µT
SVRTP and BEP	Center island of Montague Expressway (east side) at North Capitol Avenue (VTA – Tasman East LRT line ROW)	1.4 G / 140 µT
SVRTP	Southwest corner of 28th and East Santa Clara streets	1.7 G / 170 µT
SVRTP	Along north side of East Santa Clara Street between Market Street and North 1st Street	.9 – 1.4 G
SVRTP	Along north side of West Santa Clara Street between Terraine Street and Notre Dame Street	90 µT – 140 µT
SVRTP	At Caltrain Depot on Railroad Avenue at Palm Drive, Santa Clara (near airport)	1.0 – 1.4 G

Source: Earth Tech, Inc., 2003.

As shown by Table 4.5-1, the proposed SVRTC contains no known sources of high-level radiation or severe EMF risks to the general public. EMF exposures, although common, are low-level.

4.5.4 REGULATORY CONSIDERATIONS

Government

Neither the federal government nor the State of California has set standards for EMF exposures. The Federal Drug Administration, Federal Communications Commission, United States Department of Defense, and USEPA at various times have considered guidelines. The California Department of Education has established a policy of "prudent avoidance" for the location of schools in the vicinity of high voltage power lines. Several states and other countries have standards for electrical field exposures.

Professional Organizations

The American Conference of Governmental Industrial Hygienists (ACGIH) publishes annual threshold limit values (TLVs) for chemical substances and physical agents, as well as biological exposure indices (BEIs). In the 2001 TLVs and BEIs published by the ACGIH, threshold limit values are recommended for static (DC) magnetic flux densities to which it is believed that nearly all persons may be repeatedly exposed day after day without adverse health effects. According to the ACGIH, these values may be used as guides in the control of exposure to static magnetic fields but should not be regarded as fine lines between safe and dangerous levels.

The ACGIH guidelines suggest that routine occupational exposures should not exceed 60,000 µT to the whole body, or 600,000 µT to the body's limbs on a daily, time-weighted average basis (ACGIH, 2001). Recommended ceiling values are 2 Tesla (2,000,000 µT) for whole body, and 5 T for the limbs. Safety hazards may exist from the mechanical forces exerted by the magnetic field upon ferromagnetic tools and medical implants. Cardiac pacemakers and similar medical electronic device wearers should not be exposed to field levels exceeding 0.5 T (500,000 µT). These values are listed in Table 4.5-2.

Table 4.5-2: ACGIH Guidelines for EMF Exposure

Guideline	Whole Body	Limbs
Daily Average	60,000µT	600,000µT
Ceiling Values	2T	5T
Medical Device Wearers	0.5T	N/A

Source: ACGIH, 2001.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published reference levels for general public exposure to time-varying magnetic fields (unperturbed rms values) of 40,000 µT for frequencies below 1 hertz (ICNIRP, 1998). This reference level is given for the condition of maximum coupling of the field to the exposed individual, thereby providing maximum protection. The value is obtained from the basic restrictions by mathematical modeling and by extrapolation from the results of laboratory investigation. The ICNIRP guidelines on limits of exposure to static magnetic fields suggest that continuous exposure of the general public should not exceed a magnetic flux density of 40,000 µT (ICNIRP, 1994).

The guidelines published by ICNIRP and ACGIH both recommend exposure limits well above those typically found within the passenger or pedestrian exposure fields from BART. Since the SVRTP and BEP alternatives would employ the same vehicles and propulsion system as those currently in use on BART, EMF influence on operators or passengers within the vehicles will not change from current operation levels.

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