In addition to approval of necessary permits by the City and County of San Francisco, Digital Television implementation at Sutro Tower will require the following:

1. Each existing television broadcaster operating at Sutro Tower must obtain its individual DTV station license from the FCC, a process which the FCC completed in April 1997;

2. In conjunction with such DTV licensing, the FCC would assign a channel number and power limit to each DTV station (in many if not all cases, a station's DTV channel number would be different from its existing channel number):

3. Each DTV station would be required under FCC rules to begin DTV broadcasting within a prescribed period of time; and

4. Any changes in tower height or configuration which would change the tower profile for purpose of airspace navigation must be notified and handled in accordance with the rules of the FCC and the Federal Aviation Administration (FAA). However, no such tower profile changes are anticipated or proposed in order to implement DTV at Sutro Tower.

2.4.3 General Plan

The project would be reviewed by the City Planning Commission in the context of applicable objectives and policies of the San Francisco General Plan. The following are some of the objectives and policies that may be relevant to the proposed project.

Objective 2 of the Commerce and Industry Element states: "Maintain and enhance a sound and diverse economic base and fiscal structure for the city." Policy 1 of this objective states: "Seek to retain existing commercial and industrial activity and to attract new such activity to the city."

Objective 12 of the Residence Element states: "To provide a quality living environment." Policy 1 of this objective states: "Assure housing is provided with adequate public improvements, services and amenities."

In the Environmental Protection Element, Objective 4, Policy 4: "Promote the development of nonpolluting industry and insist on compliance of existing industry with established industrial emission control regulations." Objective 7, Policy 2 states: "Protect land from changes that would make it unsafe or unsightly."

REFERENCES

PG&E, Mark Feiling, Industrial Power Engineer, telephone conversation, December 10, 1996.

William F. Hammett, Principal, Hammett & Edison, Inc., letter to Eugene Zastrow, Vice President and General Manager, Sutro Tower, Inc., July 13, 1993.

SECTION 3

INTRODUCTION

This section combines discussion of the environmental setting and analysis of impacts by topic. Setting and impacts are combined by topic so as to more readily ascertain project impacts.

The analysis of public health effects is based on two technical studies prepared for the project.

1. Hammett & Edison, Inc. analyzed existing and proposed radiofrequency levels in the vicinity of Sutro Tower in a study called *Sutro Tower, Inc. San Francisco, California, Engineering Analysis of Radiofrequency Exposure Conditions with Addition of Digital TV Channels*. This study is included as Appendix A of this EIR and is used as the basis for analysis of radiofrequency levels that would result due to the project.

2. Two experts, Peter Polson, Ph.D. and Louis N. Heynick, M.S., prepared a technical report for this project on whether exposure to radiofrequency radiation (RFR) adversely affects humans and other animals, which is called *Biological Effects of Radiofrequency Radiation (RFR): Possible Health Effects of RFR on Nearby Humans from Sutro Tower Digital Television Broadcasts*. Additional contributions were made by another expert. This report was also peer reviewed by the San Francisco Department of Public Health and an independent expert retained by the Health Department. This report is included as Appendix B of this EIR and is the basis for analysis of health effects that could occur due to RFR exposure from the project.

3.1 PUBLIC HEALTH EFFECTS

3.1.1 Background Information

Properties of Electromagnetic Frequencies

Electromagnetic waves come in two forms: ionizing and nonionizing electromagnetic waves. Nonionizing waves are further categorized as visible light and infrared radiation,

radiofrequency radiation (RFR), and extremely low frequency (ELF) electric and magnetic fields. RFR and ELF are further discussed below.

Ionizing Radiation

The shortest wavelengths, or highest frequencies, are ionizing electromagnetic radiation. The frequencies are the highest (above 1.5×10^{15} Hertz) of all electromagnetic waves. (The hertz is the unit for measuring frequency [in cycles per second] of the electromagnetic wave.) Ionizing radiations, such as ultraviolet light, X-rays, and radioactive emissions, has higher energy levels than nonionizing radiations.

In essence, ionizing radiation absorbed by a molecule yields enough energy to expel an electron from the molecule (ionize it), leaving it positively charged and thus enhancing the interactions of the molecule with its neighbors. Such interactions can alter the functions of biological molecules fundamentally and irreversibly in living organisms. Moreover, the damage caused by ionizing radiation can be cumulative.

No ionizing radiation is present at Sutro Tower or planned as a part of the project. As indicated above, RFR is a type of nonionizing radiation. As such, any potential health or other effects of ionizing radiation are not relevant to the analysis of potential effects from RFR.

Nonionizing Radiation

Nonionizing radiation consists of various forms of electric and magnetic fields. Such fields occur both naturally, among them the earth's magnetic field and the electric fields in the atmosphere (most prominent during storms), and artificially by electric generation and wireless communications. The energy level of these waves is too low to eject electrons from (or ionize) atoms or molecules.

Radiofrequency Radiation (RFR)

Television broadcasts involve electromagnetic energy at certain frequencies. Broadcast antennas are powered by an alternating electrical current. The rate at which the current alternates (or

changes from positive to negative), determines the frequency, expressed in hertz (Hz) or in millions of hertz (megahertz; MHz) or billions of hertz (gigahertz; GHz).

RFR includes electromagnetic waves or radiowaves in the frequency range up to 300 gigahertz (GHz or 1 billion cycles per second). These radiowaves are a form of nonionizing radiation. The wavelengths are longer than for ionizing radiation, and are used for transmission of radio and television signals such as the radiofrequency waves from Sutro Tower.

The energy content of individual quanta in RFR is so much smaller than ionizing radiation that relatively high rates (in relatively large numbers of quanta per unit time) are necessary to produce a physiologically significant amount of heat.[1] RFR heating immediately ends on stopping the exposure.

Exposure levels to RFR are generally referred to as "power densities" (the rate at which energy is available over a region of space) and are expressed in terms of milliwatts per square centimeter (a milliwatt is one-thousandth of a watt). In general, power density levels from a radiofrequency source decrease according to the inverse square principle; at twice the distance from the source, a point will receive one-fourth of the level of radiation exposure.

Sutro Tower currently emits RFR with a frequency range between 54-788 MHz during television and radio broadcasts. This RFR is the type of electromagnetic waves that is specifically analyzed in the Technical Report and within the text of this EIR.

Extremely Low Frequencies (ELF)

Within the class of nonionizing radiations, a basic difference exists in interaction between RFR and electric and magnetic fields at extremely low frequencies (ELF) (usually 60 Hz in the U.S.), such as those used in the transmission of electric power from generating stations to substations and thence to the ultimate consumers of electricity. The wavelength corresponding to 60 Hz is

[1] **physiologically significant amount of heat:** An energy input sufficient to stimulate a change or changes in thermoregulatory body functions such as sweating, breathing rate, and blood flow rate, or to cause changes in cellular functions such as firing rates of nerve cells and beating rates of heart cells, or to cause changes in biochemical functions such as activity levels of enzymes and amounts of proteins produced by cells.

more than 3,100 miles. Thus, people near a power line are in its "induction" zone (meaning at distances of only a fraction of a wavelength. By contrast, the wavelength corresponding to 626 megahertz (MHz), which is the midband frequency of the Sutro DTV broadcast transmitter, is approximately 1.6 ft.

Controversy surrounds reports of the adverse effects on humans from exposure to the electric and magnetic fields present in homes from the power lines supplying electricity to the house, the electric fields from operating appliances within the home, and those from any nearby high-voltage power lines. Radio and television frequencies such as are broadcast from Sutro Tower are millions of orders of magnitude higher (shorter waves) than electric power line frequencies. Thus the interactions with biological bodies differ between radio/television signals and power line frequencies.

No extremely low frequencies are emitted from Sutro Tower for broadcasting television and radio signals. Electricity is used to power operations at Sutro Tower, including to operate the transmitters and receivers. As for any consumer of electricity, extremely low frequencies would be used.

RFR Regulatory Safety Guidelines

In 1991, the Institute of Electrical and Electronic Engineers (IEEE) issued a set of guidelines for human exposure to RFR developed by the American National Standards Institute (ANSI). In 1992, these guidelines were adopted by ANSI, and are referred to as *ANSI/IEEE Guidelines (1992).*

The standards were based on a relatively large body of scientific investigation and literature which generally concluded that the principal concern regarding health effects from exposure to RFR was associated with an increase in body temperature. Another conclusion inherent within the standards is that exposures below 4 watts per kilogram of body weight (4.0 W/kg) do not cause a hazardous increase in body heat. This level is approximately the level achieved by exposure to 10 milliwatts per square centimeter (10 mW/cm^2). The standards then applied a safety factor of 50 times in "uncontrolled environments" (general public exposure) and a factor of 10 times for "controlled environments" (workplace exposure). Hence, the resulting standards for the frequency range from 30 to 300 MHz are 0.2 mW/cm^2 for general public exposure, and 1 mW/cm^2 for workplace exposure.

In December 1996, the FCC adopted revised guidelines *(FCC 96 Guidelines)* which place limits on RFR exposure.. These guidelines are generally based on recommendations found in *NCRP Report 86* and are identical to the 1992 *ANSI/IEEE Guidelines* in the radio and television frequency range which are currently broadcast and the range proposed to be broadcast from Sutro Tower. These RFR exposure guidelines were designed to protect the health of human beings exposed, either accidentally or voluntarily to RFR in the environment or the workplace. These guidelines are based on consideration of RFR exposures which may be acute or chronic, thermal (heat-based) or nonthermal.

The *FCC 96 Guidelines* cover the frequency range from 300 kHz to 100 GHz. RFR currently emitted from Sutro Tower falls within this range with: (1) television and radio broadcasts between 54-788 MHz, (2) private radio transmissions between 160-950 MHz, and (3) microwave transmissions between 2-23 GHz. In the FCC adopted DTV frequency range (460-806 MHz), the maximum permissible power densities for exposure in uncontrolled environments are in the range 383-672 microwatts per square centimeter (0.38-0.67 milliwatts per square centimeter).

For occupational exposures over the range of 54 to 806 MHz the lowest maximum permissible incident freespace power density is 1.0 milliwatts per square centimeter squared, applicable for the frequency range 30-300 MHz, with a 6 minute averaging time. Over the range 300 to 806 MHz, the maximum permissible power density ranges from 1.00 to 2.69 milliwatts per square centimeter squared. These are the frequency ranges relevant to Sutro Tower.

Other exposure guidelines are also discussed in the Appendix B Technical Report. For general population exposures, the maximum permissible power densities are one-fifth as great.

3.1.2 Approach and Methodology

Public Health Effects Approach and Methodology

The Appendix B Technical Report reviewed papers selected as being representative of the many thousands published in scientific journals, typically after peer review, through mid-1996 with additions up to mid-1997. Papers were selected which made major contributions towards resolving major biophysics and physiology questions regarding RFR, which have been addressed

in numerous research studies. Studies which show potential health effects were chosen along with subsequent studies responding to the same questions. With a few exceptions, presentation at scientific symposia or abstracts thereof have been excluded on the assumptions that they were not peer-reviewed or that detailed peer-reviewed account of such studies may appear subsequently. The selected papers were then analyzed for the adequacy of their analyses and their relevance to Sutro Tower.

If a study found no relationship of disease or death with exposure to RFR, the findings were "negative." If a study found a relationship of disease or death with exposure to RFR, the findings were "positive."

Information from this report is summarized within the EIR text.

Radiofrequency Levels Approach and Methodology

To gather data for this EIR, Hammett & Edison, Inc. conducted a study, *Sutro Tower, Inc. San Francisco, California, Engineering Analysis of Radiofrequency Exposure Conditions with Addition of Digital TV Channels.* The study characterizes radiofrequency radiation (RFR) levels in the vicinity of Sutro Tower. This study is included as Appendix A.

In 1988, Hammett & Edison measured RFR at 480 locations within a ¾ mile radius of Sutro Tower, using a calibrated Holaday Instruments Broadband Exposure Meter, Model HI-3001. Hammett & Edison has taken subsequent measurements in 1991 and 1993.

On December 5, 1996, Hammett & Edison took spot measurements at ten locations using a Holaday Instruments Broadband Exposure Meter, Model HI-3004, which had been calibrated on October 14, 1996. This meter is more sensitive than the previously used Holaday HI-3001. A representative of the San Francisco Department of Public Health accompanied Hammett & Edison during the RFR measurements. Figure 5 shows where the measurements were taken.

Hammett & Edison wrote a computer program which calculated potential RFR at 8,900 locations across San Francisco, including at 3,150 points within an approximate 1½ mile radius of the tower, calculating both existing conditions (NTSC broadcasts only) and proposed conditions NTSC plus DTV broadcasts). For purpose of predictive analysis, the calculations assumed a

higher power lever for DTV than could probably be installed and operated at Sutro Tower. An analysis of the two sets of data shows that the calculated 1996 existing levels were higher and therefore more conservative than the actual measured levels recorded in 1988, 1991, 1993, or spot-checked in 1996. The program then calculated power density for each station, and fractions contributed by each were summed at 8,900 points. (See Appendix A for the methodology.)

3.1.3 Environmental Setting

RFR Levels in the Vicinity of Sutro Tower

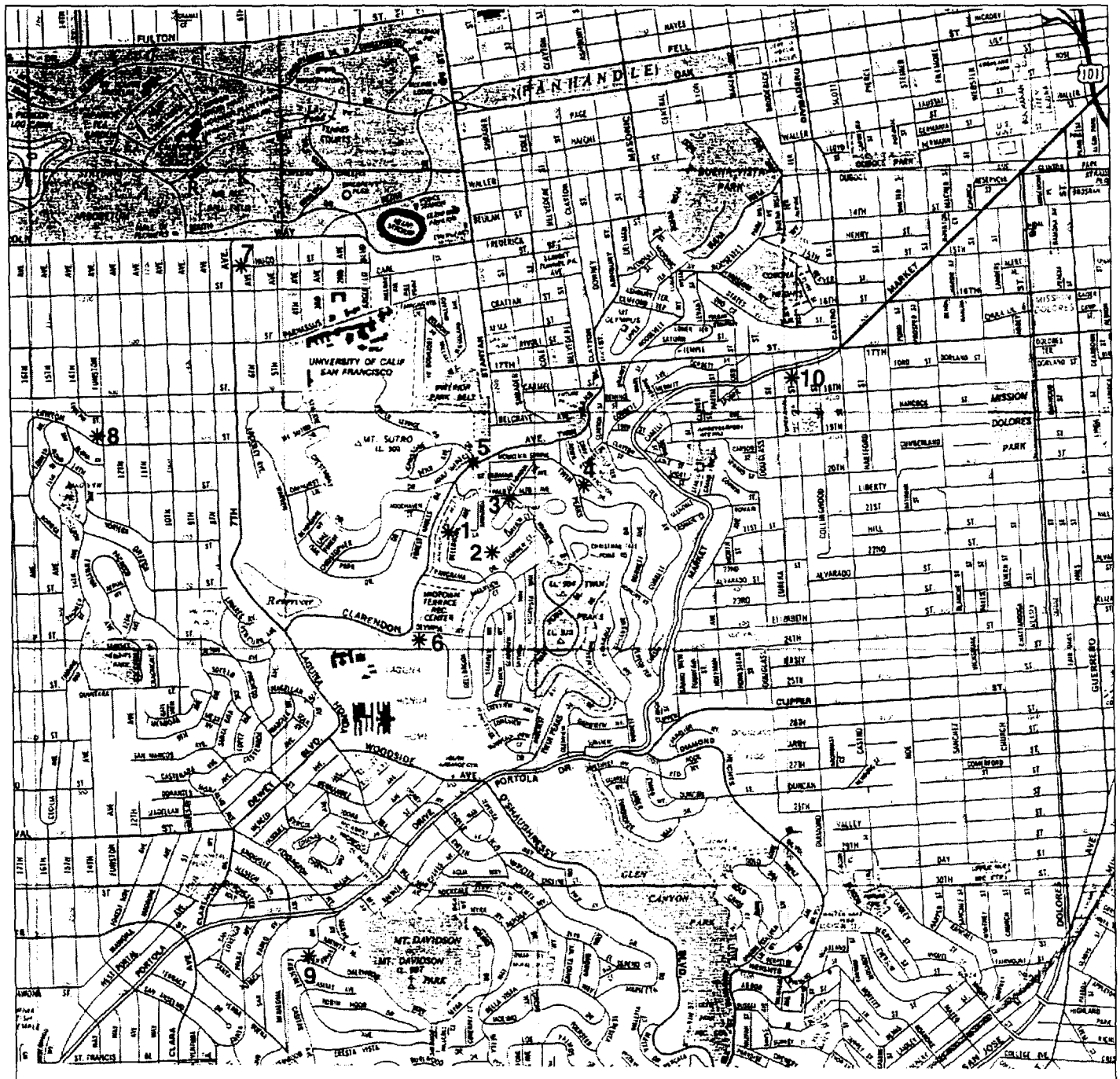
Table 2 shows measured and calculated existing energy levels and power densities in relation to the *FCC 96 Guidelines* for the ten locations shown on Figure 5.

Of the ten locations measured for RFR in December 1996, the highest RFR level measured was 0.0229 milliwatts per square centimeter (mW/cm^2) at location 2. The highest existing RFR level calculated was 0.0247 mW/cm^2, also at location 2 (see Figure 5). This calculated value was at 11.5 percent of the *FCC 96 Guidelines.*

The approximate power density at distances from Sutro Tower as a percent of the *FCC 96 Guidelines* follows:

Approximate Power Density	Approximate Distance from Sutro Tower
10 - 15%	at tower to about one city block
5- 10%	about two city blocks
1 - 5%	about nine city blocks
0.5 - 1%	about 18 city blocks
<0.5%	more than 18 city blocks

The highest measured and calculated levels of existing public exposure to RFR from Sutro Tower, at a sensitive receptor (residence) is at Farview Court, approximately one block from the tower. The calculated level of 0.025 mW/cm^2 is at about 12.7 percent of the federal safety standard. Other sensitive receptors live about one block or more from the tower. The average existing radiofrequency level at a distance of 1 kilometer (about ten blocks) of Sutro Tower is 0.0034 mW/cm^2, which is about 1.7 percent of the federal safety standard for public exposure.



0 0.1 0.2 0.3 0.4 0.5

mile

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Source: Hammett & Edison, Inc. 1997;
AAA, San Francisco, CA 1979

Project No. 961005NA	Sutro Tower DTV EIR	LOCATION OF RFR MEASUREMENTS	Figure 5
Woodward-Clyde Consultants			

961005NA-3200/031797/wcc/graphics/gos,mci

TABLE 2

COMPARISON OF EXISTING RADIOFREQUENCY POWER DENSITY WITH EXISTING CALCULATED VALUES

Measurement Location [a]	Measured Power Density [b, c]	Calculated Power Density [d]	Calculated % FCC Guidelines [e, f, g]
1	0.0229	0.0247	11.4
2	0.0234	0.0269	11.5
3	0.0077	0.0171	6.98
4	0.00076	0.0066	2.54
5	0.0014	0.0095	3.88
6	0.0020	0.0035	1.64
7	0.00011	0.0011	0.47
8	0.00038	0.0009	0.41
9	0.00045	0.0007	0.32
10	0.00013	0.0014	0.53

[a] Measurement locations are shown on Figure 5, page 3-8. These were selected arbitrarily at various distances from Sutro Tower.

[b] These values are in mW/cm^2 (milliwatts per centimeter squared).

[c] Power densities were measured on December 5, 1996, with Holaday HI-3004 Broadband Exposure Meter.

[d] Calculations are based on formulas in Appendix A.

[e] Percent of standard is based on applicable limits for public exposures of unlimited duration.

[f] Standard is based on applicable limits for public exposures of unlimited duration and the power densities are in mW/cm^2.

[g] Power densities under the *FCC 96 Guidelines* range from 0.2 mW/cm^2 for Channel 2 up to 0.522 mW/cm^2 for Channel 66.

Source: Hammett & Edison, 1997

Most of the stations at Sutro Tower have stand-by "auxiliary" antennas on the Tower, too, so that they can continue to serve the public if their main antennas on top of the Tower should fail or if work needs to be done on those antennas. The auxiliary antennas are mounted mostly at the first rung of the Tower, and some handle less power than the main antennas. Table 1, page 2-7 in Section 2.0, lists those stations having auxiliary facilities at Sutro.

Because of the lower UHF powers and/or the changed positions of the energy sources, the power density in the neighborhoods near Sutro Tower from the auxiliary antennas is often lower than that from the main antennas. In some cases, the shorter distance to the antennas might dominate, and the exposure level form the auxiliary antennas might exceed that of the main antennas. In all cases, though, the total RF energy under any condition of auxiliary operation is less than what the government allows for continuous exposure, and is intermittent and short-term in nature.

No new auxiliary facilities are currently proposed for the DTV stations, and it is likely that none will be constructed until the end of the FCC transition period for all stations to have switched over to new DTV broadcasting capabilities, and terminated NTSC broadcasts.

Worker Health and Safety

For a facility that emits RFR, the occupational environment presents potential hazards to the workers. These hazards include accidents (i.e., cuts, bruises, falling) and potential exposure to RFR at close range. The types of occupational hazards seen at Sutro Tower are routine for television and radio broadcast towers.

Laws and Regulations

State and federal regulations exist regarding worker safety. Cal/OSHA and the Federal Communications Commission (FCC) have both established limits for personnel exposure to RFR. The FCC limits are more stringent than the Cal/OSHA requirements. See Section 3.1.3, RFR Regulatory Safety Guidelines, for a discussion specific to the *FCC 96 Guidelines* which apply to occupational RFR exposure.

RFR Protection Rules at Sutro Tower

Sutro Tower, Inc. has set up RFR protection rules for personnel who work on the tower. The rules contained herein were adopted in May, 1996, and are expected to be modified from time to time as safety issues evolve.

A program of independent measurements has been implemented which requires taking measurements anytime the facility plans to make a change in the facility which is likely to increase exposure. In addition, every time one of the broadcast stations is required to renew its operating license, it must take RFR measurements.

Warning signs are posted at the entrances to areas where exposure levels may exceed permissible levels without protective clothing.

Access to tower locations above Level 4 (see Figure 3 in Section 2, Project Description, page 2-6) during main antenna operation is not allowed. The only exception is for personnel wearing complete body RF protective clothing including suit, hood, gloves and boots on the main walkways on levels 5 and 6 and the catwalk above level 6.

Access to tower locations above ground, up to the bottom of Level 3 is not allowed during auxiliary antenna operation. Auxiliary antenna operation is signaled by the flashing red light in the lobby, outside the front door, at the foot of the elevator steps, and on Level 2 outside the elevator door.

All stations have installed and must maintain a dry contact closure indicating auxiliary antenna operation which activates a visual and aural auxiliary antenna alarm system. The aural alarm is a siren at the foot of the tower elevator steps and on Level 2 which sounds for approximately one minute whenever an auxiliary antenna is energized. When the alarm is activated all workers on the outside of Level 2 have been instructed to immediately cease work and proceed as rapidly as possible to the interior of the level. Further movement will be at the direction of the Sutro Tower manager or designated coordinator. The visual alarm, which operates at all times during auxiliary operation, is discussed above.

Working or climbing on energized antennas is not allowed under any conditions.

Under all conditions, only authorized personnel may ride the tower elevator to any location as long as the restrictions described above are observed. The elevator must not be operated with safety interlocks defeated. Riders are allowed only inside the elevator car. The Elevator operator must have received operator training. The weight limit of 750 pounds must not be exceeded.

The Level 4 elevator interlock must be kept on except when used by people wearing proper RF protective clothing including suit, hood, gloves and boots.

Personnel must carry a Sutro Tower portable two-way radio which is in contact with a person carrying a Sutro Radio whenever that person is on the tower or in the elevator. The radio must be tested before ascent.

All stations must notify Sutro Tower, Inc. in advance of scheduled maintenance operations on auxiliary antennas. Sutro Tower, Inc. will coordinate scheduled auxiliary antenna operation with scheduled maintenance activities. Stations must coordinate with Sutro Tower, Inc. in ~~a~~ advance of any maintenance or installation activity planned on the second level.

Sutro Tower, Inc. will determine which antennas pose a potential hazard to the proposed maintenance work and will notify affected stations of the proposed schedule. During the work period the affected stations will not energize their auxiliary antennas without first receiving clearance from Sutro Tower, Inc. All stations will supply a prioritized list of names and phone numbers of people to notify when auxiliary antenna restrictions are necessary.

Worker Safety Compliance

Once a month Sutro Tower, Inc. usually conducts a safety inspection of the premises. The results of these inspections are discussed at monthly safety meetings where progress toward fixing any safety problems is reported. (Sutro, 1996)

In 1996, one reported accident occurred at Sutro Tower. One of the employees was injured by a sliver of metal lodging in his eye. (Lincoln, 1997)

3.1.4 PUBLIC HEALTH EFFECTS

RFR Levels Resulting from Implementing the Sutro Tower DTV EIR Project

This section is based on the study conducted by Hammett & Edison, Inc. which is included as Appendix A of this EIR.

Regarding distance, the closest residence is about 250 feet away from the base of the tower, and over 800 feet from the closest antenna. The closest public roadway is about 150 feet from the tower. As noted in the Environmental Setting discussion, the highest calculated level of existing radiofrequency power emissions at a sensitive receptor near Sutro Tower is at Farview Court, approximately one block from the tower. The maximum existing radiofrequency power emission of about 0.025 mW/cm^2 currently resulting from radio and television broadcasts from Sutro Tower, is at about 12.7 percent of the allowable maximum under the *FCC 96 Guidelines*.

With the addition of DTV antennas, the broadcast emissions at the closest sensitive receptor would result in RFR levels of about 0.029 mW/cm^2 or 14.3 percent of the allowable maximum under the *FCC 96 Guidelines*. These levels in turn drop off rapidly with increased distance from Sutro Tower. (Refer to Table 3 for a comparison of existing to proposed RFR at ten other selected locations.) Once the NTSC signals are no longer broadcast, then the power densities would drop below existing power levels.

Summary of Potential Biological Effects

DTV service is expected to use average effective radiated powers that are below the present NTSC analog system peak power. This means that a DTV station would radiate a signal with an average effective radiated power that is about one-eighth (12 percent) of the present average power radiated by the traditional television technology. As a consequence, with introduction of DTV, public exposure to RFR due to the DTV signal alone would actually be only a fraction of the present values associated with the NTSC system. However, in view of the manner in which the FCC has decided that the DTV system shall be implemented in the U.S., an approximate 9-year period will result in which DTV signals will be broadcast simultaneously with the current NTSC signals. During this period of overlap, the additional DTV service will slightly increase

ambient environmental RF fields from the television service. In terms of average RF field exposure levels, this will amount to an anticipated 12 percent increase.

Following the introductory period for DTV, the older NTSC system signals will be eliminated, leaving only the lower DTV signals. This will result in an overall drop in environmental RF fields in the long term due to DTV broadcasting.

The Appendix B Technical Report analyzed literature and studies which investigated potential health effects on humans and other animals. In summary, the general conclusion of the Technical Report is that to the extent that health effects have been identified, they have been associated with RFR levels that were high enough to have thermal effects (cause a hazardous increase in body temperature).

The 1992 *ANSI/IEEE Guidelines* first established a threshold level of RFR exposure at which it was generally agreed that adverse health effects, including thermal effects, could occur. A safety factor of 50 times (i.e., divide the lowest established level know to cause adverse effect by 50) was established for uncontrolled environments (public exposure). These guidelines were subsequently adopted into the *FCC 96 Guidelines.* Hence, the maximum public exposure levels resulting from the proposed project would be 50 times lower than the lowest level at which thermal effects were found to occur.

The Technical Report, the San Francisco Department of Public Health, and an independent expert all conclude that although there is controversy surrounding health effects, the substantial weight of scientific evidence indicates that human exposure at or below levels of RFR prescribed by the *FCC 96 Guidelines* would not be harmful to human health.

As mentioned in the section above, the maximum exposures from the proposed project would be at about 14.3 percent of the *FCC 96 Guidelines.* These levels in turn drop off rapidly with increased distance from Sutro Tower. Experimental data indicate that relatively low-level RFR exposure is not cumulative. At the levels expected from project implementation, adverse health effects are not anticipated.

Concerns have been expressed regarding the effect of RFR on pacemakers. RFR would not be expected to impact a person from the general population wearing a pacemaker, due to distance

TABLE 3

COMPARISON OF EXISTING MEASURED RADIOFREQUENCY POWER DENSITY WITH FUTURE CALCULATED VALUES

Measurement Location [a]	Existing Measured Power Density [b, c]	Existing Calculated		Future Calculated		% Increase [i]
		Power Density [d]	% FCC Guidelines [e, f, g]	Power Density [h]	% FCC Guidelines [e, f]	
1	0.0229	0.0247	11.4%	0.0275	12.1%	6.1%
2	0.0234	0.0269	11.5%	0.0295	12.2%	6.1%
3	0.0077	0.0171	6.98%	0.0181	7.23%	3.6%
4	0.00076	0.00663	2.54%	0.00693	2.62%	3.1%
5	0.0014	0.00951	3.88%	0.0105	4.12%	6.2%
6	0.0020	0.00350	1.64%	0.00372	1.70%	3.7%
7	0.00011	0.00110	0.470%	0.00120	0.494%	5.1%
8	0.00038	0.000880	0.407%	0.000883	0.408%	0.25%
9	0.00045	0.000700	0.316%	0.000892	0.368%	16%
10	0.00013	0.00139	0.529%	0.00150	0.558%	5.5%

[a] Measurement locations are shown on Figure 5, page 3-7. These were selected arbitrarily at various distances from Sutro Tower.

[b] These values are in mW/cm2 (milliwatts per centimeter squared).

[c] Power densities were measured on December 5, 1996, with Holaday HI-3004 Broadband Exposure Meter.

[d] Calculations for existing values are for NTSC broadcasts and are based on formulas in Appendix A.

[e] Percent of standard is based on applicable limits for public exposures of unlimited duration.

[f] Standard is based on applicable limits for public exposures of unlimited duration and the power densities are in mW/cm^2.

[g] Power densities under the *FCC 96 Guidelines* range from 0.2 mW/cm^2 for Channel 2 up to 0.522 mW/cm^2 for Channel 66.

[h] Calculations for future values include DTV and NTSC broadcasts and are based on formulas in Appendix A.

[i] The percent increase is based on the change between the existing calculated RFR emissions and the future calculated emissions. This takes into account any physical anomalies that could occur due to actual conditions.

Source: Hammett & Edison, 1997

from the source and the type of RFR broadcast. Even at these closest possible locations (about 150 feet to the nearest roadway and about 250 feet to the nearest residence), RFR levels are not expected to affect operation of a pacemaker because neither DTV or NTSC TV have low frequency pulses of the type to which pacemakers are most sensitive.

While the substantial weight of scientific research has indicted that no adverse health effects would result at low power levels (i.e., less than the *FCC 96 Guidelines*), some findings have been contrary. The Technical Report includes an in-depth analysis of studies that have found some potential adverse health effect and generally concludes that those studies do not refute the general conclusion that the *FCC 96 Guidelines* establish safe RF exposure levels.

The Technical Report concludes that the adverse effects identified were the result of a thermal effect (a measurable increase in body or cell temperature); or the studies were either not reliable (for reasons stated in the reports such as flawed methodologies, lack of appropriate controls, etc.); or that the evidence for adverse effects was inconclusive and in contradiction with the substantial weight of reliable scientific evidence which indicated that there would not be any adverse effect from RFR levels at or below those permitted in the *FCC 96 Guidelines.* A brief narrative summarizing the areas of research, the findings of the studies, and the conclusion of the Technical Report is presented below.

As mentioned above, the full text of the Technical Report prepared for this project, *Biological Effects of Radiofrequency Radiation (RFR): Possible Effects of RFR on Nearby Humans from Sutro Tower Digital Television Antennas* is contained in Appendix B. Note that next to each topic heading is the section number that corresponds to the topic heading of the Technical Report.

Epidemiologic / Occupational Studies (see Appendix B, Sections 3.1 and 3.2)

Epidemiologic studies look at relatively widespread disease occurring in a population or community at a particular time. These studies did not conduct experimental research, rather they collected data through interviews, medical records, personal histories, etc. Epidemiologic studies reviewed for this report were all prepared to determine health effects on people. Health effects analyzed included mortality, cancer and brain tumor incidence, and other general health effects. Other epidemiologic studies analyzed whether chronic exposure of mothers to RFR during

pregnancy or of fathers to RFR would cause anomalies or birth defects including Downs Syndrome in their offspring.

One epidemiologic study was conducted for possible cancer effects due to RFR from Sutro Tower. (Selvin, et al., 1992) The Study found no evidence by any of three methods that specific childhood cancers were more common near Sutro Tower than elsewhere in the City of San Francisco. Subsequent RF measurements were taken by Dr. Raymond Neutra and Dr. Michael Yost of the California Department of Health Services who were accompanied by representatives of the community and the San Francisco Department of Public Health. These measurements showed that the study area did not have higher than normal RFR levels.

Taken collectively, epidemiologic studies analyzed yielded little or no reliable scientific evidence that chronic exposure to RFR at levels within current exposure guidelines is hazardous to human health or that chronic exposure of mothers during pregnancy or of fathers to RFR at levels at or below federal standards would cause anomalies in their offspring.

Thus, the substantial weight of reliable epidemiologic evidence indicates that broadcast transmissions from the Sutro Tower DTV project, which would emit RFR at a maximum of about 14.3 percent of the emissions allowable by the current federal standards at the closest sensitive receptor, are unlikely to cause cancer, birth defects, or other human health effects to people in the general population.

RFR and Ocular Changes (see Appendix B, Sections 3.3 and 4.1)

Ocular effects means eye damage such as cataracts. Epidemiologic studies based on military records, questionnaires, and surveys have been conducted to ascertain effects on the human eye. Through experimental studies of retinal examinations, people exposed to radar equipment and to various types of electronic equipment have been compared to people who have not been so exposed. In addition, eye damage to animals has also been studied experimentally.

On occasion, accidental exposure to relatively high RFR levels has occurred to workers close to RFR sources, but this would not be anticipated to occur to nearby sensitive receptors. One of the studies reviewed for this EIR reported that when exposure to relatively high RFR levels

occurred, vision was not affected in any of the subjects, although ophthalmologic examinations showed various eye abnormalities.

Taken collectively, the studies on potential ocular (eye) effects yielded little or no reliable scientific evidence that chronic exposure to levels of RFR below the federal standards would cause damage to human eyes.

The substantial weight of reliable experimental and epidemiologic evidence indicates that broadcast transmissions from the Sutro Tower DTV project which would emit RFR at a maximum of about 14.3 percent of the emissions allowable by the current federal standards at the closest sensitive receptor is unlikely to cause effects to the eyes of people in the general population.

Auditory Effects (see Appendix B, Sections 3.4 and 4.2)

Auditory effects means the perception of RFR as audible clicks in the head. Studies have been conducted on both humans and other animals. Experimental evidence indicates that an RFR pulse can produce a temperature difference in the head that is large enough to generate a transient pressure wave. This wave is then transmitted by bone conduction to the middle ear, and is perceived as sound. Persons with impaired hearing are unable to hear such clicks, and animals with nonfunctioning inner ears do not exhibit RFR-pulse-induced responses.

Epidemiologic and experimental studies have concluded that the perceived click is not the result of direct brain stimulation from RFR, but is a thermal impact of RFR emissions several thousand times stronger than project emissions at the nearest sensitive receptor. Taken collectively, these studies on potential auditory effects yielded no reliable scientific evidence that chronic exposure to levels of RFR below the federal standards would cause hearing effects or damage to humans.

Thus, the substantial weight of reliable experimental and epidemiologic evidence indicates that broadcast transmissions from the Sutro Tower DTV project that would emit RFR at a maximum of about 14.3 percent of the emissions allowable by the current federal standards at the closest sensitive receptor is unlikely to cause hearing effects to the general population.

RFR Shock and Burn Effects (see Appendix B, Section 3.5)

The *ANSI/IEEE (1992) Guidelines* and *FCC 96 Guidelines* include maximum exposure limits for avoidance of RFR shock and burn effects. However, such effects are not relevant to the Sutro Tower DTV project because the proposed DTV frequencies (500-734 MHz) are higher than 100 MHz, the practical limiting frequency for which shock and burn effects occur.

Mutations, DNA Altering and Carcinogenic Effects (see Appendix B, Section 4.3)

Mutation effects means that mutations to animal cells occur. DNA altering effects means that changes to DNA would occur. Carcinogenic effects means cancer causing effects. Little or no reliable experimental evidence exists that exposure to RFR induces mutations in bacteria, yeast, or fruit flies. Regarding mammalian tissues, some of the studies of carcinogenic effects that yielded negative results (no relationship of disease or death with exposure to RFR) and others that yielded positive results (relationship of disease or death with exposure to RFR) were questionable because of the likelihood of the presence of uncontrolled non-RFR factors.

Collectively, the various RFR-bioeffects investigations provide little or no reliable scientific evidence that exposure of RFR at levels within current standards produces mutations or DNA altering effects, or that such RFR induces or promotes any form of cancer. Thus, the substantial weight of reliable scientific evidence is that exposure to RFR from the Sutro Tower DTV broadcasts, which would be at a maximum of about 14.3 percent of the federal standards at the closest sensitive receptor, are unlikely to cause any of these effects in the general population.

Potential Anatomical Aberrations in Developing Fetuses (see Appendix B, Section 4.4)

Some studies have analyzed the potential for RFR induced effects on anatomical aberrations in developing fetuses. Anatomical aberrations mean alterations in development and birth defects which occur in fetuses before birth. Experiments on animals indicate harmful changes upon exposure to RFR levels high enough to increase temperature several degrees. One study found that RFR thermal effects yielded lower weights of their live fetuses, but this has not been replicated. For mice, evidence exists that anatomical aberrations would occur only at thermal levels that are close to killing the pregnant females.

Thus, the only reported potential anatomical aberrations in developing fetuses are those related to thermal exposure effects of RFR. The project would not result in thermal-related RFR effects. The substantial weight of reliable scientific evidence is that because the project would be at a maximum of about 14.3 percent of the federal standards at the closest sensitive receptor, it is unlikely to cause fetal development effects in the general population.

Central Nervous System Effects (see Appendix B, Section 4.5)

Central nervous system effects include RFR effects on the blood-brain barrier, the central nervous system, and the brain. Studies have been done on animals. In vitro studies of the central nervous system found no effects except when there were exposures at thermal RFR levels.

Changes in the central nervous system were seen at relatively low specific absorption rates in two studies, but their significance with regard to possible human health hazards is unclear. Taken collectively with other results that indicated effects ascribable to local increases in brain temperature, it is unlikely that exposure to RFR levels that do not raise local brain temperatures in humans would cause adverse effects.

One study (Sanders et al., 1984) found effects in rat brains at 200 MHz and 591 MHz; its findings are relevant to the RFR from the Sutro Tower DTV broadcasts which would emit RFR in the 500-734 MHz range. However, as noted in Appendix B, the equivalent power densities used in the study were higher than those currently and proposed to be emitted from Sutro Tower (13.8 milliwatts per square centimeter compared to less than 0.03 milliwatts per square centimeter).

Evoked responses are electrical responses in the central nervous system or brain as a result of electrodes, sounds, or flashing lights stimulating brain activity. Little or no reliable scientific evidence exists that evoked responses of people would be affected at Sutro Tower by RFR because levels would be below current exposure guidelines.

There are contradictory findings about the RFR-induced calcium-efflux effect (involving altering the amount of calcium binding to cells and tissues). Resolution of this issue is not likely in the foreseeable future. This effect, if valid, appears to be a non-thermal effect. However, little or no

reliable scientific evidence exists that any health effects are associated with the calcium efflux effect.

The results of one researcher indicate that pulsed and continuous wave RFR affect rat behavior and neurochemistry in the absence of biologically important changes in temperature. There is no evidence that the effects observed in these laboratory studies are pathological. It should be noted that the experiments have not been replicated by other researchers.

The project would not result in thermal effects nor expose people to power densities greater than allowed by federal guidelines. The substantial weight of reliable scientific evidence is that because the closest sensitive receptor would be exposed at a maximum of about 14.3 percent of the allowable emissions under the *FCC 96 Guidelines,* RFR from the project would not result in these possible human health hazards.

Effects on the Immune and Blood Systems (see Appendix B, Sections 4.6 and 4.7)

Effects on the immune and blood system are effects on white and red blood cells. Experimental studies have been conducted with animals. The most recent studies have shown that where exposure to RFR adversely affected white blood cells or resulted in hemoglobin loss and/or potassium-ion loss, the effects were of thermal origin (i.e., due to elevation of temperature).

Thus, the only potential effects from RFR exposure on the immune and blood systems are those related to thermal effects. The substantial weight of reliable scientific evidence is that because the project would be at a maximum of about 14.3 percent of the federal standards at the closest sensitive receptor, it would not cause thermal effects in the general population and would not be expected to result in immune or blood system effects.

Contrasts among various lifespan studies analyzed involve not only different exposure intensities, but pulsed versus continuous waveforms, various frequency, and various animal species. These differences prevent drawing a general conclusion about effects on lifespan, but there appears to be a tendency towards enhanced lifespan for mildly thermal (elevated temperature) exposures but reduced lifespan when RF exposure is combined with chemical carcinogens. There is little or no reliable scientific evidence for effects on lifespan or immune function at exposure levels below the *FCC 96 Guidelines.*

Physiology and Biochemistry Effects (see Appendix B, Section 4.8)

Physiology and biochemistry effects include those related to the heart, heart rate, body temperature regulation, blood cells, organ functions, and hormones. Experimental studies have been conducted with animals. Various effects of RFR on the heat regulatory systems of mammals and on their behavioral responses due to RFR induced thermal effects are evident. Because the effects of RFR on the hormone systems of animals are ascribable to increased body heat, to stresses engendered by the experimental situation, or to both, no clear evidence exists that such effects would occur in humans exposed to RFR at levels which do not produce increases in body temperature. In experimental studies, when non-conducting electrodes were used, heart rates were altered only at RFR levels that yielded rises in temperature or otherwise added thermal burdens to the animal. Little or no valid experimental evidence has been found to suggest that the functions of hearts or specific tissues therefrom are affected by exposure to RFR in the absence of temperature increases.

Various studies in which cardiovascular effects were sought from exposure of live animals to RFR only resulted in impacts at thermal-inducing RFR levels, as evidenced by increased respiratory rates and other manifestations of heat stress. Also, no relation between blocked blood flow and RFR exposure was found, an indication that humans with heart problems are unlikely to be affected by exposure to RFR at or below the *FCC 96 Guidelines* maximum allowable levels. Hormone system and heart rate effects, and other cardiovascular effects were altered at only RFR levels that yielded thermal effects. No thermal effects would be anticipated due to project implementation. The substantial weight of reliable scientific evidence is that because the project would be at a maximum of about 14.3 percent of the federal standards at the closest sensitive receptor, it is unlikely to cause such effects in the general population.

RFR Effects on Animal Behavior (see Appendix B, Section 4.9)

Effects on animal behavior means the potential for an animal to change its behavior as a result of exposure to RFR. Evidence exists that changes in behavioral patterns induced by RFR are due to thermal effects, either to minimize the absorption of heat in normal or warm ambient environments or to obtain warmth in relatively cold environments.