



Electric and Magnetic Fields in California Public Schools

This fact sheet is intended for those interested in learning about electric and magnetic field (EMF) exposure in schools. Specifically, this document will explain significant results of the California Electric and Magnetic Fields Program's School Exposure Assessment Survey (*The Electric and Magnetic Field Exposure Assessment of Powerline and Non-Powerline Sources for California Public School Environments*¹) and will describe how to compare the Survey's results with EMF measurements of your school.

This document, however, does not go into depth about electric and magnetic fields or the research being conducted on them. For general EMF information, please consult our other fact sheets, all of which can be found on the "General Information" page of our web site.



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The School Exposure Assessment Survey

Over the past several decades, various studies have been conducted to determine if EMF causes disease. Although some studies have determined that there could be a health risk associated with magnetic field (MF) exposure, evidence has not been conclusive. However, because of the possible association between magnetic field exposure and childhood leukemia, the California EMF Program contracted Enertech Consultants in 1996 to conduct *the Electric and Magnetic Field Exposure Assessment of Powerline and Non-Powerline Sources for California Public School Environments*.

This three-year long survey aimed to (1) identify and describe power frequency (60 Hz) magnetic fields (MF) found in schools, (2) assess costs of reducing exposure to EMF in California Public Schools, and (3) use the collected data to influence policy regarding EMF levels and sources in schools².

How the Survey was Conducted

Magnetic fields were the main focus of this survey, and these results are summarized here. Electric fields and transient field results can be found in the main report. Technicians measured fields in various school areas, including classrooms, staff-occupied indoor areas, student occupied indoor areas, and outdoor areas (including playgrounds). For all the schools combined, measurements were taken in a total of 5,403 areas, 3,193 of which were classrooms³. Once collected, these measurements were entered into a comprehensive database where they were categorized and analyzed. Measurements were given in milligauss (mG), the unit used to measure magnetic strength.

How The Survey Data Relates To Your School

As it is unknown whether magnetic fields are a health hazard, it is impossible to determine a "safe" level of MF exposure. Consequently, the survey aimed to reveal what typical school MF levels and sources are, so concerned schools can compare their measurements and associated sources to those of other California schools.

The following is an example of how you could compare your measurements:
Your school had measurements taken, revealing that the average MF level in your classroom is 2.11 mG. You can then compare this measurement to those in this fact sheet. Table 2 of this document reveals that 0.39 mG is the average magnetic field in California classrooms. By comparing this number with your measurement of 2.11 mG, you can see that the MF levels of your classroom are above average, and that 95% of schools surveyed had measurements less than yours.

California Electric and Magnetic Fields Program

A Project of the California Department of Health Services and the Public Health Institute

Survey Results

Table 1 reveals that 79.9% of surveyed school **areas** had average magnetic fields less than 1 mG. Only 6.9% of school areas had average magnetic fields greater than 2 mG. 83.1% of school **classrooms** had average magnetic fields less than 1 mG, and only 5.7% of **classrooms** had average magnetic fields greater than 2 mG⁴.

Table 2 is a specific breakdown of survey measurements. This table shows percentiles of average magnetic field levels in the school areas and classrooms surveyed. The average fields measured in school **areas** were less than 0.42mG for 50% of the areas. 90% of the **areas** had average magnetic fields less than 1.58 mG, or conversely, only 10% of areas had levels of 1.58 mG or greater. Only 5% of **classrooms** had average fields below 0.09 mG⁵.

Table 3 shows the average field measurements for other school areas measured⁶. For example, 90% of surveyed sports fields had average fields less than 0.35 mG.

In some instances, the magnetic field levels correspond to how many electrical devices (“operator sources”) exist in the area. In other words, a place with many lights and

appliances turned on, such as a home economics classroom or a kitchen, is likely to have higher magnetic field levels than a regular school classroom. In other instances, MF levels are a result of additional factors, such as wiring errors or nearby power lines.

Higher than Average Measurements

The survey also identified specific sources of the fields, so as to determine how great of a magnetic field each particular source, if acting alone, would emit in a classroom. The five sources most frequently found to cause higher than average magnetic fields are (in order of most to least common): net currents; fluorescent lights; distribution lines; electrical panels; and office equipment⁷.

The field source which produced large magnetic field values in the greatest amount of classrooms was net currents. Normally, current flows from the power source to the appliance and back to the power source. The current flowing one way generates a magnetic field which is cancelled by the field generated by the current flowing back. When wiring is not connected correctly, the forward and return currents have different intensities. The difference between the two is called the “net current.” The field due to the net current is not canceled and extends over a relatively large distance from the wire.

It is important to note that net currents, the most frequent source of higher than average magnetic field levels, do not need to exist since they are solely the result of wiring which does not conform to the wiring code. The codes are intended to reduce fire and shock hazards. High readings should therefore serve as an encouragement to check internal wiring errors.

Table 1: Average Magnetic Field Levels in Schools

	<1mG	>2mG	>3mG	>4mG
Areas	79.9%	6.9%	3.0%	1.5%
Classrooms	83.1%	5.7%	2.1%	1.2%

Table 2: Percentiles of Average Magnetic Field Levels

	5th Percentile	50th Percentile	90th Percentile
Areas	0.06 mG	0.42 mG	1.58 mG
Classrooms (portable and regular)	0.09 mG	0.39 mG	1.48 mG

Table 3: Percentiles of Average Field Measurements in School Areas

	5th Percentile	50th Percentile (median)	90th Percentile
School Sports Field	0.01 mG	0.07 mG	0.35 mG
Playground	0.01 mG	0.15 mG	0.53 mG
Outdoor Areas	0.01 mG	0.20 mG	0.83 mG
School Classrooms (portable)	0.10 mG	0.30 mG	1.01 mG
School Classrooms (regular)	0.09 mG	0.42 mG	1.53 mG
Computer Classrooms	0.21 mG	0.59 mG	2.08 mG
Home Economics Classrooms	0.26 mG	0.82 mG	2.87 mG
Kitchens	0.25 mG	1.05 mG	3.03 mG

The specific location in which the magnetic field readings are taken influences the measurements. For example, if measurements are taken in a classroom located directly above the school's power transformer, it is quite likely that the measurements are going to be extraordinarily higher than an average classroom's measurements.

At this point in time, we do not know what is a safe level of exposure, what is hazardous exposure, or if either exist. However, if your measurements are significantly higher than the California school average, reduction to average levels may be desirable if you are concerned about magnetic field exposure. And if your school intends to reduce MF levels, it is important to determine which sources produce large magnetic fields in your school since those are the field sources that would need the most immediate attention in order to reduce your school's magnetic field levels.

School versus Home Averages

In a separate survey, the California Department of Health Services measured the strength of magnetic fields in 700 San Francisco Bay Area Homes⁸. Measurements, taken in the bedroom, family room, kitchen, and at the front door, revealed magnetic field averages similar to those of school averages. Table 4 shows the average magnetic field measurements in 50% and 90% of homes surveyed. As the table reveals, in 90% of both school areas and homes, magnetic field levels were below 1.58 mG⁹.

Average field levels in homes are typically close to the same, if not slightly higher, than levels in schools. Consequently, if you are concerned about a child's total daily magnetic field exposure, you may also want to consider checking field levels both in the home and school environments, since children, when not in school, spend a large portion of their time at home.

Table 4:
Average Magnetic Field Exposure in Schools and Homes

	50%	90%
School Areas	<0.42 mG	<1.58 mG
Homes	<0.71 mG	<1.58 mG

Area Versus Personal Measurements

To obtain data for both the School Exposure Assessment Survey and the EMF in Bay Area Homes Survey, consultants took area measurements of magnetic fields.

This means consultants used meters which measured fields found in specific areas. However, area measurements do not necessarily represent a person's exposure. In a sub-study¹⁰ to the School Exposure Survey, 30 teachers of two of the participating schools were asked to wear measurement meters while at school. Their personal classroom measurements were later compared to the area measurements found in their classrooms. 16 of the teachers' personal measures were similar to their classroom area measures, while 9 teachers had lower personal measures and 5 had higher personal measures than their area measures.

There are several possible reasons for these differences: 1) personal exposure measurements depend on the actual locations in the classroom where the individual spends most of his/her time while the area measurement is the average of measurements taken at many point in the entire area; 2) fields may vary from day to day, and area measurements and personal measurements were taken on different days; and 3) personal measurements may be strongly affected by intense exposures due to electrical devices such as copiers, computers, overhead projectors, TV/VCRs, and fish tank pumps. These sources do not have a significant affect on area measurements since they usually only affect a couple of the many individual measurements that go into determining the average area measurement. However, they can greatly affect one's personal exposure if operating one or more of these devices is a routine part of that individual's work pattern.

Low and No Cost EMF Reduction Options

To help analyze options and cost estimates of reducing magnetic fields in schools, Enertech Consultants and Power Engineers created a computer program entitled *The California School EMF Reduction Cost Program*. This program provides cost estimates for various location scenarios and for various methods of reducing magnetic fields in and around California schools.

Additionally, the California EMF Program created a list of No and Low Cost Options for reducing field levels. Most of these options are ideal for new schools or schools planning to remodel. These options are found in the *School Design Guidelines Checklist*¹¹.

Some low-cost options from the *Checklist* are:

- Confirm that existing wiring and grounding meet electrical codes, and correct any faulty wiring or grounding (repairs of wiring errors that cause large net currents could occur

during routine maintenance checks).

- Insure that new building additions do not increase magnetic fields in existing areas.
- Rearrange usage of space if existing facilities are too difficult to change. For example, a room next to a facility with high magnetic fields can be turned into a storage room during remodeling, rather than a classroom or other area where people spend large amounts of time.

Current Government Initiatives

The California Department of Education has enacted policy regulations that require new schools to be of certain distances away from the edge of a transmission line “right-of-way” (the area immediately surrounding the power line). 1994 regulations require new schools to be set back 100 feet for 50-133 kV lines, 150 feet for 220-230 kV lines, and 350 feet for 500-550 kV lines¹². These distances are not based on biological evidence of a health hazard associated with electric and magnetic fields, but rather on the knowledge that magnetic fields strength decreases to background levels with increasing distance. The Federal government has conducted magnetic field research, but has not enacted any regulations¹³.

Getting Measurements Taken At Your School

Any school can have magnetic field measurements taken to determine how their school compares to others. Most utility companies in California will take free measurements for their customers. Some EMF consultants can take more detailed magnetic field measurements for a fee.

Resources About EMF In Schools

The executive summary of the “Exposure Assessment Survey” and the “School Design Guidelines Checklist” can be accessed from the “General Information” page of our web site. The “Residential Measurements Fact Sheet” will be accessible from the “General Information” page around mid-year 2001. The entire “Exposure Assessment Survey,” which contains specific magnetic field level breakdowns for all school areas surveyed, can be obtained by contacting: City Copy Center, 580 14th Street, Oakland, CA 94612 or (510) 763-0193.

¹ “Electric and Magnetic Field Exposure Assessment of Powerline and Non-Powerline Sources for California Public School Environments.” California EMF Program and Enertech Consultants. (January 2000).

² Ibid., S-1.

³ Ibid., S-3.

⁴ Ibid., S-5, S-6.

⁵ Ibid., 8-9 .

⁶ Ibid., section 8.

⁷ Ibid., S-9, Table 3.

⁸ EMF in Bay Area Homes Study. The California EMF Program.

⁹ Ibid., 8-9. “California Exposure Assessment Study.” Preliminary Findings. The California EMF Program and Gerri Lee. (1998):5-6.

¹⁰ Sub-study conducted by Geraldine Lee of the California Department of Health Services in 1997.

¹¹ “EMF Checklist for School Buildings and Ground Construction.” California EMF Program and Brooks Cavin, III. (1996).

¹² “Rationales for Statewide Policies Addressing Magnetic Fields in Public Schools.” California EMF Program, Brock Bernstein and H. Keith Florig. (November 2000, draft copy): 17.

¹³ “Short Factsheet on EMF.” California EMF Program. (1999): 3.