COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS

2014 US-CHPS Criteria

New Construction and Renovation

Low-EMF Best Practices

Intent

Minimize exposure to extremely low frequency (ELF) magnetic fields.

EQ 15.1 – Low-EMF Wiring

EQ 15.2 – Low-EMF Best Practices

Numerous organizations recommend minimixing exposure to extremely-low frequency (ELF) electric and magnetic fields (EMF).

The US National Electrical Code (NEC) has been published since 1897 to promote safe electrical installations and to prevent fire hazards and electric shock. Wiring errors not only violate electrical code rules but may also cause unnecessary ELF magnetic field exposures. Wiring errors may occur in new construction or modernization projects, and inspections conducted by local code enforcement authorities may not detect the great majority of these problems.

In 2000, the expert panel of the California EMF Project (scientists of the California Department of Health Services on behalf of the California Public Utilities Commission) concluded based on the then-available scientific evidence that "*EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease, and miscarriage.*"

In 2002, the International Agency for Research on Cancer classified **extremely low frequency magnetic fields** (ELF MF) as possibly carcinogenic (monograph volume 80).

In 2006, the IEQ Indoor Environmental Quality Project committee of the **US National Institute of Building Sciences** recommended to keep magnetic field exposure levels in occupied areas below 2.5 mG (250 nT), and preferably below 1 mG (100 nT).

In 2009, the **Austrian Sustainability Building Council** with support by the Federal Ministry of Transportation, Innovation and Technology released its latest version of the Total Quality Building Assessment tool. This green building rating system includes a criterion for low ELF magnetic field exposure levels: less than 1 mG (100 nT) "excellent", 1-2 mG (100-200 nT) "very good" (summary of threshold levels in English).

In addition, many education technology tools such as desktop computers, laptops, tablets, and other electronic devices are sources of electromagnetic fields. When used within close range of the human body, a student's exposure to electromagnetic fields such as ELF magnetic and electric as well as radio-frequency electromagnetic fields may increase considerably. ELF magnetic fields were classified as possibly carcinogenic by the World Health Organization (WHO) International Agency for Research on Cancer (IARC) in 2002, and radio-frequency (RF) electromagnetic fields (including mobile phones) were classified as possibly carcinogenic by the WHO/IARC in 2011. In order to reduce the potential for adverse effects due to these exposures, it is important in school environments with children to apply the precautionary principle "as low as reasonably achievable (ALARA)" by providing low-EMF classrooms, specifying low-EMF IT equipment and wired Internet access network technology, and establishing low-EMF user practices.

EQ 15.1 – Low-EMF Wiring		**Credit**	
		2 points	
Applicability	**Verification**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

2 points	EQ 15.1	*No net current magnetic fields – Correct school wiring* The wiring in all school rooms shall be compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code. All school rooms shall be free of the following common wiring errors: a. Improperly wired subpanels (neutral-to-ground bond); b. Incorrect three-way switch wiring; c. Incorrect wiring of switched outlet circuits; d. Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits; e. Neutral-ground shorts (intentional or inadvertent) anywhere in the system. The correctness of the wiring shall be checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations, see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 below.

EQ 15.2 – Low-EMF Best Practices			**Credit** **1 - 2 points**
Applicability	**Verification**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

1 point	EQ 15.2.1	*Low EMF Best Practices for Computers* The District or equivalent governing body for a private school shall pass a resolution requiring: • Desktop computers, laptops, notebooks, and tablets be operated on a desk; operation of these devices on an occupant's lap or body is prohibited; computer workstation equipment must be greater than 2 feet from occupants. • Desktop computers, laptops, notebooks, and tablets be TCO-certified or laboratory tested to meet TCO Criteria "Mandate A.4.2" for EMF emissions. • Laptops or notebooks have an Ethernet port and a physical switch to conveniently disable all wireless radios at once and an adaptor with a 3-pin plug. • Only tablets that support a USB Ethernet adaptor for a wired network connection; operate tablets only in battery mode and not when plugged in.

OR 1 point	EQ 15.2.2	*Wired local area network (LAN) to reduce radio-frequency (RF) EMF* • Install a wired local area network (LAN) for Internet access throughout the school. Provide wired network connections for desktop computers, laptops, notebooks, and tablets. All wireless transmitters shall be disabled on all Wi-Fi-enabled devices. Provide wired input devices for computer workstations.
OR 1 point	EQ 15.2.3	*Wired Phones to reduce RF EMF in classroom* • Install easily accessible hard-wired phones for teacher and student use and prohibit installation and use of standard DECT cordless phones and cordless phones operating at 2.4 GHz and 5.8 GHz unless they have been laboratory tested to demonstrate that the cordless phone base station and handsets (whether placed in the charging station or not) do not emit RF EMF emissions in standby mode. • Prohibit the use of cell phones and other personal electronic devices in instructional areas / classrooms. Additionally, they shall be required to be powered off or be in airplane mode (sleep mode is not sufficient) except during fire-life-safety drills and incidents.

Implementation

EQ 15.1

ELF levels shall be measured using a professional 3-axis gaussmeter. The international standard unit for ELF magnetic fields is microtesla (μT) or nanotesla (nT). A nanotesla is 1/1000th of a microtesla. 1 mG is equivalent to 100 nT.

Special Consideration

The World Health Organization International Agency for Research on Cancer has classified ELF magnetic fields and radio-frequency (RF) electromagnetic fields as possibly carcinogenic based on scientific evidence surrounding incidence of childhood leukemia and brain cancer. Schools districts and design teams should:

1. Prohibit cell phone towers and base stations on school buildings or school property. (See siting)
2. Prohibit above ground transformers within 50ft from outdoor play, exercise and recreation areas. (See siting)
3. Run conduits for the future possibility of fiber optic connections.
4. Position electrical supply rooms and building power supply adjacent to low occupancy areas, among other strategies.

If using a wireless local area network (WLAN) for Internet access, choose the minimum number of access points and adjust the power output of the access points to the lowest maximum level required to meet the needs. Access points shall be placed a minimum distance of 16-32 feet (5-10 m) from where students and staff spend the majority of their time. The access points and Wi-Fi transmitters in the computer devices shall be turned off when not in use. Clearly label access points with warning signs.

Provide a Wireless-free Zone where cell phones, cordless phones, and Wi-Fi-enabled electronic devices shall not be used. Post clear signage at the door to instruct users on how to disable the wireless transmitters on their personal electronic devices (power off or airplane mode) before entering this space.

EMF Measurement Information

ELF EMF measurements are made with a professional 3-axis gaussmeter (broadband, minimum sensitivity: 0.2 mG (20 nT)). The ELF magnetic field exposure level at a given student seating area or workstation shall be as low as possible or less than 1 mG (100 nT) (tRMS – true root mean square). See Table 13. Measurements shall be taken on the floor in the foot area and across a vertical plane at half way between floor and edge of desk, at the edge of desk, and at 6 feet (180 cm). Retest ELF magnetic field exposure levels if the placement of workstations is changed or changes are made to the electrical installation.

RF EMF measurements are made with a professional RF meter or spectrum analyzer (minimum sensitivity: 0.02 V/m or -50 dBm; minimum frequency range 10 MHz – 3 GHz (preferably higher)). The radio-frequency electromagnetic field exposure level at a given student seating area or workstation shall be as low as possible or less than 0.2 V/m or 100 $\mu W/m^2$ (peak). Measurements shall be taken on the floor in the foot area and across a vertical plane halfway between the floor and the edge of the desk, at the edge of the desk, and at 6 feet (180 cm). Retest RF electromagnetic field exposure levels if IT equipment, electronic devices, or networks with wireless connectivity are installed or added.

Table 13: ELF EMF Exposure Guidelines and Reference Levels

EMF Emission Standard or Guideline	Performance Measure	Reference Level Band I ELF 5 Hz-2 kHz Magnetic field
CA EMF EMF Project Survey of 89 schools- 5,403 school rooms	20% of measured areas had average magnetic fields	>1 mG (100 nT)
EMF Working Group of the Austrian Medical Association – Exposure greater than 4 hours per day	Within normal limits	≤0.2 mG (20nT)
	Slightly above normal limits	0.2-1 mG (20-100 nT)
	Above normal limits	1-4 mG
	Far above normal limits	≥4 mG
Austrian Sustainability Building Council (2009) – *Total Quality Building Assessment* Rating System	Excellent	≤1 mG (100 nT)
	Very good	1-2 mG
	Good	2-4 mG
	Satisfactory	≥4 mG
IEQ Project Committee Recommendation of the U.S. National Institute of Building Sciences (2006)	Preferably	<1 mG (100 nT
	All occupied areas	<2.5 mG (250 nT)
TCO Criteria "Mandate A.4.2": – International sustainability standard for IT equipment (since 1992)	At 12-20" distance from equipment	≤2 mG (200 nT)
Federal Safety Guideline of Russia for Computer Workstations, including schools (2003	At 20" distance from equipment	≤2.5 mG (250 nT)
International Agency for the Research on Cancer/WHO (2002	Possibly carcinogenic Group 2B	>3-4 mG (300-400 nT) Increased childhood leukemia risk

Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System

15.2.1

No net current magnetic fields – Correct school wiring

The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of the following common wiring errors:

a. Improperly wired subpanels (neutral-to-ground bond);
b. Incorrect three-way switch wiring;
c. Incorrect wiring of switched outlet circuits;
d. Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits;
e. Neutral-ground shorts (intentional or inadvertent) anywhere in the system.

The correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations; see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 above.

15.2.2

Submit wiring diagrams indicating LAN wiring to all rooms with computers.

15.2.3

Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

Note: This may be in conflict with emergency communications in classrooms unless there are landline phones, or with the use of portable handheld devices required for standardized testing.

Documentation Requirements

Design Review

EQ 15.1 Reference specifications requiring compliance with the necessary codes including testing of rooms for compliance.

EQ 15.2.1 The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of common wiring errors.

EQ 15.2.2 Submit wiring diagrams indicating LAN wiring to all rooms with computers.

EQ 15.2.3 - Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

Construction Review

EQ 15.1 Measurement Report from a third party or testing lab documenting compliance of each classroom.

EQ 15.2.1: Provide a report from a third party or testing lab documenting that the correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations.

Resources

- National Electrical Code NFPA 70: www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70

- Suggested Protocol for School Electricians for Correcting Wiring Errors Causing Net Current Magnetic Fields www.ehib.org/emf/WiringProtocol.pdf
- Tracing EMFs in Building Wiring and Grounding. (book),Karl Riley (2005): www.magneticsciences.com/TracingEMFsBook.html
- Tracing Magnetic Fields in Building Wiring. (DVD) www.magneticsciences.com/TracingEMFsVideo.html
- California EMF Project- School Related Documents, www.ehib.org/emf/general.html#school School Design Guidelines http://www.ehib.org/emf/cklist.html
- ELECTRIC AND MAGNETIC FIELD EXPOSURE ASSESSMENT OF POWERLINE AND NON-POWERLINE SOURCES FOR CALIFORNIA PUBLIC SCHOOL ENVIRONMENTS, Luciano E. Zaffanelia, H. Christopher Hooper, Prepared for the Public Health Institute, California Department of Health Services EMF Program, , January 31,2000, www.ehib.org/emf/school_exp_ass_exec.pdf
- EU Directive 90/270/EEC (1990 May 29) on the minimum safety and health requirements for work with display screen equipment: eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31990L0270:EN:HTML
- Ministry of Health of the Russian Federation. 2003 Jun 30. [Sanitary and epidemiological norms on hygienic requirements for personal computers and work organization]. Norm No.: SanPiN 2.2.2./2.4.1340-03. (in Russian)
- Katharina Gustavs (2008): Options to Minimize Non-Ionizing Electromagnetic Radiation Exposures (EMF/RF/Static Fields) in Office Environments: buildingbiology.ca/wd/wp-content/uploads/2012/09/2008_Low_EMR_Office_Environment.pdf
- TCO standards for IT equipment: www.tcodevelopment.com
- Product search data base: http://79.136.114.89/pls/nvp/!tco_search
- Displays: tcodevelopment.com/manufacturer-resources/product-categories-2/displays/
- Notebooks: tcodevelopment.com/manufacturer-resources/product-categories-2/notebooks/
- Desktops: www.ultrasone.com/index.php/en/company/technology/ule-technology.html
- All-in-on PCs: tcodevelopment.com/manufacturer-resources/product-categories-2/all-in-one-pcs/
- Projectors: tcodevelopment.com/manufacturer-resources/product-categories-2/projectors/
- Headsets: tcodevelopment.com/manufacturer-resources/product-categories-2/headsets/
- Desktops: www.ultrasone.com/index.php/en/company/technology/ule-technology.html
- All-in-on PCs: tcodevelopment.com/manufacturer-resources/product-categories-2/all-in-one-pcs/
- Projectors: tcodevelopment.com/manufacturer-resources/product-categories-2/projectors/
- Headsets: tcodevelopment.com/manufacturer-resources/product-categories-2/headsets/
- Austrian Sustainability Building Council with support by the Federal Ministry of Transportation, Innovation and Technology: Total Quality Building Assessment tool www.oegnb.net/de/zertifikat.htm?typ=wb
  Threshold levels for ELF-modulated RF radiation: <10 µW/m^2 excellent / 10-100 µW/m^2 very good / 100-1000 µW/m^2 good / 1000-3000 µW/m^2 satisfactory
- EMF Working Group of the Austrian Medical Association (2012): EMF Guideline of the Austrian Medical Association for the diagnosis and treatment of EMF-related health problems and illnesses. freiburger-appell-2012.info/media/EMF%20Guideline%20OAK-AG%20%202012%2003%2003.pdf
  Benchmarks apply to regular exposure of more than four hours per day: <1 µW/m2 within normal limits / 1-10 µW/m2 slightly above normal limits / 10-1000 µW/m2 far above normal limits / >1000 µW/m2 very far above normal limits