Sunlighten
Sauna EMI Test
Document Number: VTE-3200

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<tr><td colspan="4">Vitatech Electromagnetics Review and Acceptance Status
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<tr><td>☒</td><td>Code 1.</td><td colspan="2">AC 50/60 Hz magnetic flux density levels are within acceptable levels</td></tr>
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(signature)</td><td colspan="2"></td></tr>
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<tr><td colspan="4">Acceptance by Vitatech Electromagnetics does not relieve the designer/supplier from full compliance with their contractual obligations and does not constitute Vitatech Electromagnetics approval of design, details, calculations, analyses, test methods or materials developed or selected by the designer/supplier.</td></tr>
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Foreword

During September of 2017, Vitatech Electromagnetics, LLC defined a set of testing parameters and steps to simplify and standardize the measurement of electromagnetic emissions from sauna heating elements. The bandwidth for surveying the sauna heating elements was limited to 10 to 1,000 hertz (Hz) for AC-ELF electric fields with a compact field analyzer and 0 to 3,000 hertz for a laboratory grade fluxgate magnetometer. In conjunction, these two sensor types provide a complete profile of the electromagnetic emissions of a sauna heating element. Note: the recorded measurements are of electromagnetic interference (EMI) emissions absorbed by the torso of sauna occupants sitting in the saunas. The recorded values are not of a single heating element. Reports produced after September 2017 include the new standardization, ergo have a different format.

Background

On November 5th, 2020 Electrical Engineer Kyle Quinn, employed by Vitatech Electromagnetics LLC (Vitatech), recorded alternating current (AC) electromagnetic interference (EMI) for frequencies from 10-Hertz (Hz) to 1,000-Hz for electric fields and 10-Hz to 3,000-Hz for magnetic fields. Recording was conducted to identify EMI generated by sauna models sold by Sunlighten. Testing was conducted in Sunlighten's warehouse in Lenexa, KS. The objective of the test was to determine the maximum EMI that a user would be exposed to during typical use of the saunas. The EN 55035:2017 of 1 A/m (12.57 mG RMS) for 60 Hz magnetic and IEEE Std C95.6-2002 threshold for maximum torso exposure for the general public at 60-hz is 5,000 volts-per-meter (V/m) RMS for electric fields.

	E-Field [V/m RMS]	**B-Field [mG RMS]**
Standard	IEEE Std C95.6-2002	EN 55035:2017
Level	5,000 volts-per-meter (V/m) RMS @ 60 Hz	1 A/m (12.57 mG RMS)

Table: Standards and Levels

Conclusion

All maximum magnetic and electric field peaks recorded within the saunas are well below the levels set in the EN 55035:2017 for magnetic fields and IEEE Std C95.6-2002 for electric fields standards. Though there are guidelines for an individual's exposure to electromagnetic fields, there are no North American regulations nor laws regarding the maximum permissible exposure.

This completes the Sunlighten Inc. – Sauna EMI test documentation and assessment. Please direct all questions about testing or products to Sunlighten Inc.

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		B-Field [mG RMS]
Sensor		Bartington Mag-03
Frequency Range		10 to 3,000 Hz
Sauna Model	Amplify II	0.11 mG RMS
	mPulse Believe	0.16 mG RMS
	mPulse Conquer	0.66 mG RMS
	Signature IV	0.86 mG RMS
	Solo	0.57 mG RMS

Table: Maximum Measurements from Saunas, Magnetic Field

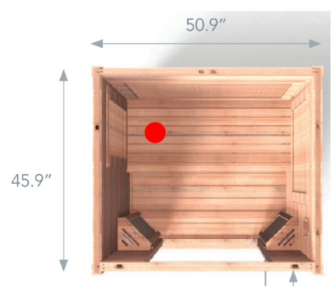


Image: Amplify II Sensor Placement

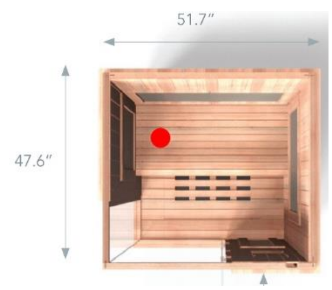


Image: mPulse Believe Sensor Placement

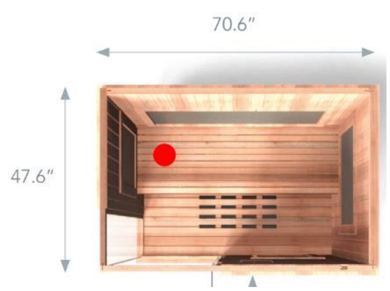


Image: mPulse Conquer Sensor Placement

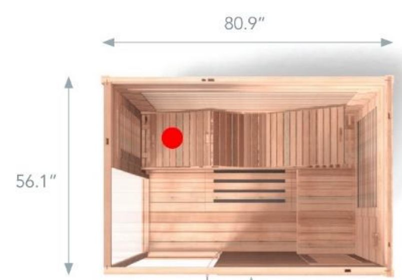


Image: Signature IV Sensor Placement

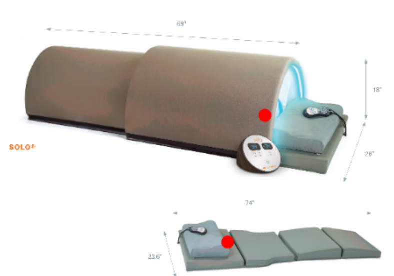


Image: Solo Sensor Placement

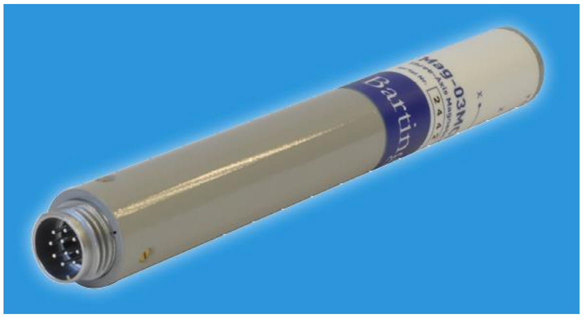
Survey Equipment

NARDA EHP-50f

The NARDA EHP-50f records electric field strength in Volt-per-meter(V/m) and magnetic field strength in micro-Tesla (µT) from one (1) hertz to four-hundred thousand hertz (400 kH). With a measurement range of 5 mV/m to 100 kV/m for electric fields and 0.3 nano-Tesla to 100 micro-Tesla for magnetic fields. The EHP-50f system when used with the EHP-TS software interface has a resolution of 0.1 mV/m for electric fields and 0.1 nT for magnetic fields.

FREQUENCY					
	Range (SPAN)	**Fstart**	**Fstop**	**Resolution**	**Bandwidth RBW**
All measurement functions except Weighted Peak	400 kHz [a)]	4800 Hz	400 kHz	976.56 Hz	3600 Hz
	100 kHz	1200 Hz	100 kHz	244.14 Hz	900 Hz
	10 kHz	120 Hz	10 kHz	24.414 Hz	90 Hz
	2 kHz	24 Hz	2 kHz	4.8828 Hz	18 Hz
	1 kHz	12 Hz	1 kHz	2.4414 Hz	9 Hz
	500 Hz	6 Hz	500 Hz	1.2207 Hz	4.5 Hz
	200 Hz [a)]	2.4 Hz	200 Hz	0.48828 Hz	1.8 Hz
	100 Hz [a)]	1 Hz	100 Hz	0.24414 Hz	0.9 Hz
Weighted Peak mode		1 Hz to 400 kHz			
LEVEL [b)]		**Electric Field**		**Magnetic Field**	
Level range (manual selection)	Low Range	5 mV/m to 1 kV/m		0.3 nT to 100 µT	
	High Range	500 mV/m to 100 kV/m		30 nT to 10 mT	
Overload limit		200 kV/m		20 mT	
Dynamic range		106 dB		110 dB	
Display resolution (NBM-550)	Low Range	4 digits, ≥ 1 mV/m		4 digits, ≥ 0.1 nT	
	High Range	4 digits, ≥ 0.1 V/m		4 digits, ≥ 0.1 µT	
DANL displayed average noise level (f ≥ 50 Hz and SPAN ≤ 1 kHz)		5 mV/m (isotropic) 3 mV/m (single axis)		0.3 nT (isotropic) 0.2 nT (single axis)	
E/H field immunity		< 10 V/m @ 1 mT (H field)		< 0.2 µT @ 20 kV/m (E field)	
UNCERTAINTY [b)]		**Electric Field**		**Magnetic Field**	
Expanded measurement uncertainty [c)]		±9 % (typ. ±5 %) @ 40 Hz to 100 kHz, ≥ 1 V/m		±5.6 % (typ. ±3 %) @ 40 Hz to 100 kHz, ≥ 200 nT	
Flatness @ 100 V/m, 2 µT	5 Hz to 40 Hz	±0.35 dB (5 Hz to 400 kHz)		±0.7 dB	
	40 Hz to 100 kHz			±0.35 dB	
	100 kHz to 400 kHz			±0.7 dB	
Linearity (referred to 100 V/m, 2 µT)		±0.2 dB (1 V/m to 1 kV/m)		±0.2 dB (200 nT to 10 mT)	
Isotropic response		±0.54 dB typ.		±0.12 dB typ.	
Temperature deviation (typ. at 55 Hz) (referred to 23 °C, 50 % relative humidity)		-0.004 dB/°C (-20 °C to 55 °C)		-0.008 dB/°C (-20 °C to 23 °C) +0.013 dB/°C (23 °C to 55 °C)	
Humidity deviation (typ. at 55 Hz) (referred to 23 °C, 50 % relative humidity)		+0.011 dB/% (10 % - 50 % humidity) +0.022 dB/% (50 % - 90 % humidity)		-0.007 dB/% (10 % - 50 % humidity) +0.01 dB/% (50 % - 90 % humidity)	

Bartington Mag-03, standard



3-axis fluxgate magnetometer is used to record static DC, quasi-static DC and AC ELF magnetic flux density data. The Bartington has a maximum range of ±1 Gauss (±100 µT), a bandwidth of 0 Hz to 3,000 Hz (-3 dB points), with a resolution of <70 pT, and a noise level of 6 to <10 pTRMS /√Hz. Three channel static DC, quasi-static DC and AC ELF data from the Bartington fluxgate probe was be sampled at 7680 Hz with a National Instruments (NI) USB-4431 24-bit Signal Analyzer A/D system, stored in portable laptop and processed by a proprietary program that displays the peak-to-peak AC ELF and DC / quasi-static DC three-axis Bx, By and Bz data in units of milligauss (mG), and, provides a Fast Fourier Transform (FFT) analysis in units of RMS of the AC power harmonic content.

Mag-03® Specifications

Performance	
Number of axes	Three
Polarity	+ve non-inverting output when pointing North
Bandwidth (-3dB)	3kHz
Measurement noise floor: basic version standard version low noise version	 >10 to 20pTrms/√Hz at 1Hz 6 to ≤10pTrms/√Hz at 1Hz <6pTrms/√Hz at 1Hz
Scaling error	<±0.5%
Orthogonality error	<0.5°
Alignment error (Z axis to reference face)	<0.1° (Mag-03MS-NC only)
Single sensor axis to body	<3.5° (Mag-03IE sensors only)
Linearity error	<0.0015%
Frequency response	0 to 1kHz maximally flat, ±5% maximum at 1kHz
Excitation breakthrough	<20mV pk-pk at 15.625kHz typical (3kHz bandwidth) <400mV pk-pk at 15.625kHz typical (5kHz bandwidth)

AC ELF EMF Health Issues
Vitatech defines AC ELF magnetic flux density emissions according to six orders of magnitude from low, elevated, high, very high, extremely high to potentially hazardous:

> **First order** of magnitude 1- to 9.9-mG as low,
> **Second order** of magnitude 10- to 99-mG as elevated,
> **Third order** of magnitude 100- to 999-mG as high,
> **Fourth order** of magnitude 1000- to 9,999 mG (1 - 9.9 Gauss) as very high,
> **Fifth order** 10,000- to 99,999-mG (10 - 99.9 Gauss) as extremely high.
> **Sixth order** 100,000- to 999,999-mG (100 - 999.9 Gauss) as potentially hazardous.

Warning: at AC ELF magnetic flux density levels exceeding 50 Gauss (10 mA/m2 induced current density threshold used by WHO, ACGHI, CENELEC, DIN/VDE, NRPG & NCRP), the human body experiences physiological and / or neurological responses because of induced currents within body tissues, organs, and neurons. The actual biological effect depends on the magnitude, polarization, proximity and exposure time to extremely high and potentially hazardous magnetic field sources. Finally, information about AC ELF EMF Health Issues and Vitatech's 10 mG (1 μT) recommended long-term human exposure limit are discussed in the next section.

AC ELF Electromagnetic Interference (EMI)
Electromagnetic induction occurs when time-varying AC magnetic fields couple with any conductive object including wires, electronic equipment, and people, thereby inducing circulating currents and voltages. In unshielded (susceptible) electronic equipment (computer monitors, video projectors, computers, televisions, LANs, diagnostic instruments, magnetic media, etc.) and signal cables (audio, video, telephone, data), electromagnetic induction generates electromagnetic interference (EMI), which is manifested as visible screen jitter in displays, hum in analog telephone/audio equipment, lost sync in video equipment and data errors in magnetic media or digital signal cables.

Magnetic flux density susceptibility can be specified in one on three terms: Brms, B peak-to-peak (p-p) and B peak (p) according to Equation 1 below:

$$Equation\ 1{:}B_{rms} = \frac{B_{p-p}}{2\sqrt{2}} = \frac{B_P}{\sqrt{2}}$$

The objective of the AC ELF EMF testing services performed for the sauna panel heater was to identify the peak magnetic flux density levels emanating from the device under load and compare the recorded magnetic field data with both current federal/state/industry standards and Vitatech Electromagnetics' recommendation for long-term human health exposure.

It should be noted that all recorded magnetic flux density level within this report is presented in units of milligauss root mean square (RMS)

AC ELF Magnetic Field Health Issues, Standards & Guidelines

Currently, there are no Federal standards for AC ELF electric and magnetic field levels. The National Energy Policy Act of 1992 authorized the Secretary of the Department of Energy (DOE) to establish a five-year, $65 million EMF Research and Public Information Dissemination (RAPID) Program to ascertain the effects of ELF EMF on human health, develop magnetic field mitigation technologies, and provide information to the public. In May 1999, the NIEHS Director Kenneth. Olden, Ph.D. delivered his final report, Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields, to Congress that stated the following in the Cover Letter and Executive Summary below:

> The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and **chronic lymphocytic leukemia in occupationally exposed adults... The NIEHS concludes that ELF-EMI exposure cannot be recognized at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard.**

U.S. & International Organizational AC ELF EMF Standards

The International Commission on Non-Ionizing Radiation Protection (IRPA/INIRC) have established 833 mG maximum human exposure limit over 24 hours for the general public and 4,167 mG for occupational workers. Whereas The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a 10,000 mG (10 Gauss) exposure limit over 24 hours for occupational workers, but specifies 1,000 mG (1 Gauss) as a maximum exposure for workers with cardiac pacemakers.

New York State Public Service Commission AC ELF EMF Standards

Effective September 1990, the State of New York Public Service Commission (PSC) "began a process looking toward the adoption of an interim magnetic field standard for future major electric transmission facilities". The Commission concludes that a prudent approach should be taken that will avoid unnecessary increases in existing levels of magnetic field exposure. Therefore, future transmission circuits shall be designed, constructed and operated such that magnetic fields at the edges of their rights-of-way will not exceed 200 mG when the circuit phase currents are equal to the winter-normal conductor rating. They also established an electric field strength interim standard of 1.6 kV/m electric transmission facilities.

IARC June 2002 Report

In June 2002, the International Agency for Research on Cancer (IARC) issued a 400+ page report formally classifying extremely low frequency magnetic fields as **possibly carcinogenic to humans** based on studies of EMF and childhood leukemia. **This is the first time that a recognized public health organization has formally classified EMF as a possible cause of human cancer**. IARC found that, while selection bias in the childhood leukemia studies could not be ruled out, pooled analyses of data from a number of well-conducted studies show a fairly consistent statistical association between childhood leukemia and power-frequency residential magnetic fields above 4 milliGauss (mG), with an approximately two-fold increase in risk that is unlikely to be due to chance.

IARC is a branch of the World Health Organization. The IARC classification of EMF was made by a panel of scientists from the U.S. National Institute of Environmental Health Sciences, the U.S. Environmental Protection Agency, the U.K. National Radiological Protection Board, the California Department of Health Services, EPRI, and other institutions around the world.

Switzerland's February 2000 AC ELF Standard

The Swiss Bundersrat in February 2000 set by law an emission control limit of 10 mG from overhead and underground transmission lines, substations, transformer vaults and all electrical power sources.

VitaTech's & NCRP Draft Recommended 10 mG Standard

Section 8.4.1.3 option 3 in the National Council of Radiation Protection and Measurements (NCRP) draft report published in the July/August 1995 issue of Microwave News (visit the Microwave News Homepage <www.microwavenews.com> for the entire draft report) recommended the following on the next page:

> **8.4.1.3 Option 3:** An exposure guideline of 1 μT (10 mG) and 100 V/m: A considerable body of observations has documented bioeffects of fields at these strengths across the gamut from isolated cells to animals, and in man. Although the majority of these reported effects do not fall directly in the category of hazards, many may be regarded as potentially hazardous. Since epidemiological studies point to increased cancer risks at even lower levels, a case can be made for recommending 1 μT (10 mG) and 100 V/m as levels not to be exceeded in prolonged human exposures. Most homes and occupational environments are within these values, but it would be prudent to assume that higher levels may constitute a health risk. In the short term, a safety guideline set at this level would have significant consequences, particularly in occupational settings and close to high voltage transmission and distribution systems, but it is unlikely to disrupt the present pattern of electricity usage. These levels may be exceeded in homes close to transmission lines, distribution lines and transformer substations, in some occupational environments, and for users of devices that operate close to the body, such as hair dryers and electric blankets. From a different perspective, adoption of such a guideline would serve a dual purpose: first, as a vehicle for public instruction on potential health hazards of existing systems that generate fields above these levels, as a basis for "prudent avoidance"; and second, as a point of departure in planning for acceptable field levels in future developments in housing, schooling, and the workplace, and in transportation systems, both public and private, that will be increasingly dependent on electric propulsion.