

Sauna Works

Clearlight Infrared Sauna Heater

AC ELF EMF Testing and Mitigation Analysis Report

Document History:

Issue:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
1.0	September 14, 2016	JR & PZ	SC	LV	Initial Submittal

Vitatech Electromagnetics Review and Acceptance Status		
This decal is to be used for submitted documents requiring acceptance by Vitatech Electromagnetics.		
☐	Code 1.	All electromagnetic interference are within acceptable levels.
☐	Code 2.	AC 60 Hz magnetic flux density levels are within acceptable levels.
☐	Code 3.	Static and Quasi-static DC levels are within acceptable levels.
☐	Code 4.	Radio Frequency Power flux density levels and/or electric field strengths are within acceptable levels.
Review/Accepted by:		
(signature)		
Print Name:	Lou Vitale	Date: 09/14/2016
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September 14, 2016

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Subject: AC ELF EMF EMC Manetic Field Testing for Sauna Works/Clearlight Infrared Saunas

Dear Mr. Kaps,

Vitatech Electromagnetics, LLC (Vitatech) was commissioned by Sauna Works/Clearlight Infrared Sauna to perform comprehensive AC ELF EMF EMC and electric field (electromagnetic compatibility) testing for a 600 watt 240 V infrared sauna heater at our office in Virginia. Vitatech operated the heater under normal electrical load at its regular "ON/OFF" settings to identify the peak magnetic field emmision level emitted from the heater per full-compliance testing. In addition to the normal magnetic and electric field testing at the common power frequency of 60 Hz, Vitatech measured the AC ELF magnetic field emanating from the sauna heaters from 12 Hz to 50 kHz as spot readings to ensure low-level magnetic flux density levels at the harmonic frequencies as well. The testing was performed on Thursday, September 8, 2016 by EMF Engineers John Robie and Pengcheng Zhang.

Executive Summary

The results of the electromagnetic compatibility testing indicate that the sauna heater tested emitted very low electromagnetic fields (EMF) and meet all known federal, state, and industry standards. Vitatech recommends 10 mG or less for long term human exposure to electromagnetic fields (EMF). Additionally, the peak electric field strength levels recorded for the sauna heater is within ICNIRP's recommended 4,167 V/m human health exposure limit for the general public and fully complies with Vitatech's recommended exposure threshold.

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 of three terms: B_{rms} , $B_{\text{peak-to-peak}}$ ($B_{\text{p-p}}$) and B_{peak} (B_{p}) according to Equation 1 below:

$$B_{\text{rms}} = \frac{B_{\text{p-p}}}{2\sqrt{2}} = \frac{B_{\text{p}}}{\sqrt{2}} . \quad (1)$$

Purpose

The objective of the AC ELF EMF testing services performed for the sauna heater was to identify the peak magnetic flux density levels emanating from the sauna heater under normal ON and OFF settings and compare the recorded data with both current federal/state/industry standards and Vitatech's 10 mG RMS recommended long-term human health exposure as presented in *Exhibit A, Recommended 50/60 Hz Magnetic Field Human Exposure & EMI Immunity Standards (July 2015)*. It should be noted that all recorded time-varying 60 Hz magnetic flux density levels within this report are presented in peak-to-peak units of mG (milligauss) in the B_x , B_y , and B_z axes, then converted to B_r resultant RMS (root-mean-square) units. All electric field strength levels are presented in isotropic V/m (volt-per-meter) units, which is similar to the B_r resultant for magnetic fields.

AC ELF Magnetic Flux Density Site Assessments & Conclusions

Vitatech recorded mapped and spot-reading AC ELF magnetic flux density levels as a set of data plots to ascertain the magnetic field emission profile of the Clearlight 600 watt 240 volt sauna heater. Note that all AC magnetic flux density levels were recorded in units of milligauss RMS (root-mean-square). In addition to magnetic field measurements, electric field measurements were also taken on the sauna heater to evaluate its electric field emission profile. A detailed assessment of the recorded magnetic flux density data is presented as a series of graphics, see attached Figure #1 through Figure #15. A detailed assessment of the electric field data is presented as a series of graphics, see attached Figure #16 through Figure #19. Lastly, decay models of the magnetic field in different directions are presented in Figure #20.

Figure Descriptions

Figure #1 - Experimental Setup

Figure #1 presents the experimental setup for the magnetic flux density measurements of the 600 watt 240 V Clearlight infrared sauna heater. The sauna heater is secured to unistrut, thereby attached to the fork of a forklift using chains. The sauna heater remains level throughout the experiment. By utilizing the hydraulic system of the forklift, the height of the sauna heater relative to ground level can be adjusted. A FieldStar 1000 Triaxial Gaussmeter is secured to the bottom of a mapping wheel. Magnetic flux density is measured within a 14' $\times$ 20' box surrounding the sauna heater.

Figure #2 - Background AC ELF Magnetic Flux Density Levels

Figure #2 presents the background magnetic flux density levels of the experiment environment measured as the 600 watt 240 V sauna heater is turned OFF (disconnected). Data is presented as a contour map of isolines. Elevated fields are present on the right (+ x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the 60 Hz electrical panel has little to no effect on the magnetic flux density levels within close proximity to the center point of the sauna heater. Additionally, note that the emission of the 60 Hz electrical panel may vary (isolines extending further away or contracting closer to the source) based on electrical current load of the panel at the time.

Figure #3 - AC ELF Magnetic Flux Density Levels at 3 Ft Elevation

Figure #3 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 3 feet above ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+ x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health

threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #4 - AC ELF Magnetic Flux Density Levels at 1m Elevation

Figure #4 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 1 meter above ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #5 - AC ELF Magnetic Flux Density Levels at 4 Ft Elevation

Figure #5 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 4 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the emission profile of the electrical panel here extends much further away than the background measurement. No EMI threats were found.

Figure #6 - AC ELF Magnetic Flux Density Levels at 5 Ft Elevation

Figure #6 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 5 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the emission profile of the electrical panel here extends much further away than the background measurement. No EMI threats were found.

Figure #7 - AC ELF Magnetic Flux Density Levels at 6 Ft Elevation

Figure #7 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 6 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #8 - AC ELF Magnetic Flux Density Levels at 7 Ft Elevation

Figure #8 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 7 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #9 - AC ELF Magnetic Flux Density Levels at 8 Ft Elevation

Figure #9 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 8 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the emission profile of the electrical panel here extends much further away than the background measurement. No EMI threats were found.

Figure #10 - AC ELF Magnetic Flux Density Levels at 9 Ft Elevation

Figure #10 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 9 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #11 - AC ELF Magnetic Flux Density Levels at 10 Ft Elevation

Figure #7 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 6 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #12 - AC ELF Magnetic Flux Density Levels at 11 Ft Elevation

Figure #12 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 11 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #13 - AC ELF Magnetic Flux Density Levels at 12 Ft Elevation

Figure #13 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 12 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #14 - AC ELF Magnetic Flux Density Levels at 13 Ft Elevation

Figure #14 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 13 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+x direction) portion of the

contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #15 - AC ELF Magnetic Flux Density Levels at 14 Ft Elevation

Figure #15 presents the magnetic flux density levels measured as the 600 watt 240 V sauna heater is turned ON (connected) and elevated 14 feet from ground level. Data is presented as a contour map of isolines. Similar to the background emission, elevated fields are present on the right (+ x direction) portion of the contour map, primarily due to a 60 Hz electrical panel near the experimental setup. All magnetic flux density level measurements were below 0.5 mG, which is well below Vitatech's recommended human health threshold of 10 mG. Note that the magnetic flux density levels within close proximity to the sauna heater are little to none. No EMI threats were found.

Figure #16 - Baseline Electric Field Spot Measurement

Figure #16 presents the background electric field levels of the testing environment recorded with a MEDA ARA Electromagnetic Analyzer PMM. The peak electric field level recorded was 3.8735 V/m at 58.6 Hz.

Figure #17 - Electric Field Spot Measurement at $Z = 1$ m and $X = 0$ m

Figure #17 presents the electric field levels recorded with a MEDA ARA Electromagnetic Analyzer PMM directly 1 m below the 600 watt 240 volt sauna heater as it is turned ON (connected). The peak electric field level recorded was 17.167 V/m at 58.6 Hz. Vitatech recommends a human health exposure limit of 4,167 V/m for 60 Hz electric field, which is compliant with the ICNIRP electric field standard for the general public. The recorded peak electric field level was well below Vitatech's recommended value.

Figure #18 - Electric Field Spot Measurement at $Z = 1$ m and $X = 1$ m

Figure #18 presents the electric field levels recorded with a MEDA ARA Electromagnetic Analyzer PMM 1 m below and 1 m in front of the 600 watt 240 volt sauna heater as it is turned ON (connected). The peak electric field level recorded was 3.8391 V/m at 58.6 Hz. Vitatech recommends a human health exposure limit of 4,167 V/m for 60 Hz electric field, which is compliant with the ICNIRP electric field standard for the general public. The recorded peak electric field level was well below Vitatech's recommended value.

Figure #19 - Electric Field Spot Measurement at $Z = 1$ m and $X = 2$ m

Figure #19 presents the electric field levels recorded with a MEDA ARA Electromagnetic Analyzer PMM 1 m below and 2 m in front of the 600 watt 240 volt sauna heater as it is turned ON (connected). The peak electric field level recorded was 4.1356 V/m at 58.6 Hz. Vitatech recommends a human health exposure limit of 4,167 V/m for 60 Hz electric field, which is compliant with the ICNIRP electric field standard for the general public. The recorded peak electric field level was well below Vitatech's recommended value.

Figure #20 - Decay Models

Figure #20 presents the magnetic flux density emission profiles along the x , y , and z axis of the sauna heater emission. Magnetic flux density levels were measured as spot readings at points along each axis using the FieldStar 1000 Triaxial Gaussmeter. Data taken along the x , y and z directions all demonstrated good fit to a power decay model. Along the x axis, the magnetic flux density levels (in mG) decays at a rate of 0.9568 with respect to separation distance (in inches); along the y axis, the magnetic flux density levels (in mG) decays at a rate of 1.3104 with respect to separation distance (in inches); and along the z axis, the magnetic flux density levels (in mG) decays at a rate of 1.3010 with respect to separation distance (in inches).

Conclusions

It was found that at a separation distance of 3-4 feet the magnetic field levels produced by the Clearlight 600 watt 240 volt sauna heater drop to 0.0 mG (below the detection resolution of the FieldStar 1000 Triaxial Gaussmeter), which fully complies with Vitatech's recommended long-term human health exposure threshold recommendation of 10 mG. In addition, the sauna heater demonstrates excellent magnetic field decay rate along the x , y , and z directions.

The electric field measurements taken with the Clearlight 600 watt 240 volt sauna heater switched ON showed peak values at 58.6 Hz. At 1 meter below the sauna heater, a peak of 17.167 V/m was found, which fully complies with the ICNIRP electric field standard for the general public.

Therefore, Vitatech concludes that the Clearlight 600 watt 240 volt sauna heater, not only complies with, but also emits magnetic and electric fields significantly lower than Vitatech's recommended long-term human health EMI exposure limits and can be considered very a low EMI noise heater.

Note: Attachment: Twenty (20) figures – Figure#1 through Figure#20.

This completes the *Clearlight Infrared Sauna Heater AC ELF EMF Testing and Mitigation Analysis Report*. Please call if you have any further questions.

Best regards,



Pengcheng Zhang
Simulation Programmer



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Figure #1 Experimental Setup



Image #1:

The sauna heater is secured to a forklift using unistrut and chains. The height of the sauna heater is adjusted by raising and lowering the fork. The sauna heater remains level throughout the experiment.



Image #2:

The FieldStar 1000 Triaxial Gaussmeter is secured to the bottom of the mapping wheel. Magnetic flux density measurements are taken every foot from the starting point in a 14' X 20' box. Note that the center point of the sauna heater is located at $X = 11' 5''$ and $Y = 3' 8''$ with respect to the starting point.



Image #3:

The fork of the forklift is raised for height adjustment of the sauna heater. The height of the sauna heater is measured prior to every measurement.