December 12th, 2012

Subject: AC ELF EMF EMC Magnetic Field Testing for a Sauna Heater

Electromagnetics was commissioned by the Saunamates Company to perform comprehensive AC ELF EMF EMC (electromagnetic compatibility) testing for a provided sauna heater, Operated the heater under normal electrical load and its regular "ON/OFF" settings to identify the peak magnetic field emission level emitted from the heater per full-compliance testing. In addition to the normal magnetic field testing at the common power frequency of 60 Hz, Measured the AC ELF magnetic field emanating from the sauna panel heater from 12 Hz to 50 kHz as spot readings to ensure low-level magnetic flux density levels at the harmonic frequencies as well. The site survey was performed from 12:30pm to 3:00pm on Monday, December 10th, 2012 and from 10:30am to 12:00pm on Wednesday, December 12th, 2012 by EMF Technician.

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, Bpeak-to-peak (p-p) and Bpeak (p) according to Equation 1 below:

$$\text{Equation 1:}\quad Brms = \frac{Bp - p}{2\sqrt{2}} = \frac{Bp}{\sqrt{2}}$$

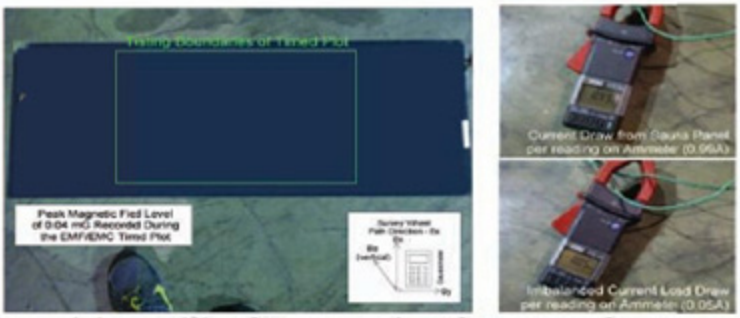
The objective of the AC ELF EMF testing services performed for the sauna panel heater was to identify the peak magnetic flux density levels emanating from the device under load and compare the recorded magnetic field data with both current federal/state/industry standards and Electromagnetics' recommendation 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, RMS (BRMS, Bx, By, Bz).

AC ELF Magnetic Flux Density Site Assessments & Conclusions

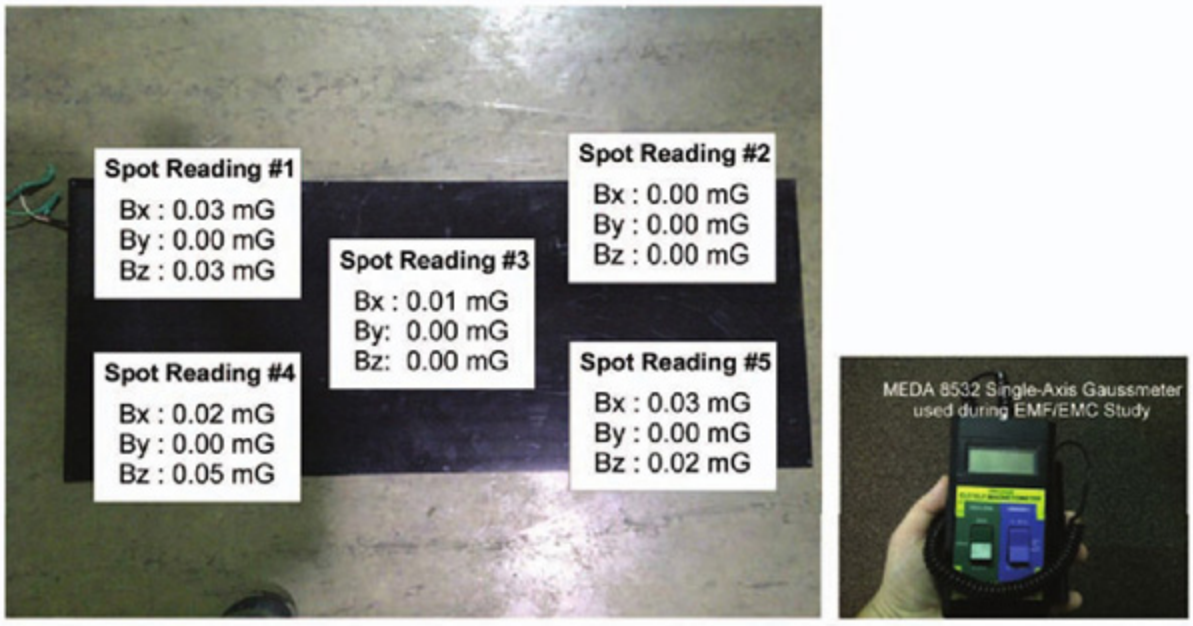
Recorded timed, mapped, and spot-reading AC ELF magnetic flux density levels as a set of data plots to ascertain the magnetic field emission profile of the provided Sauna Panel Heater from the Saunamates Company. It should be noted that the sauna panel leads were fitted to a 220-240VAC power system with care taken to minimize the distortions in the electrical system (power) as much as possible. It should also be noted that due to the nature of the testing, a push-button was used to record spot-reading measurements with the FieldStar1000 gaussmeter at a frequency of 60 Hz to gather the most pertinent data possible. The single-axis MEDA 8532 gaussmeter, used to collect spot-reading data from 12 Hz to 50 kHz, utilizes a proprietary probe which is situated for Bx-Horizontal, By-Horizontal and Bz-Vertical measurements. Lastly, it should also be noted that all AC magnetic flux density levels were recorded in units of milligauss RMS (root-means-square), and it is important to distinguish between the resultant magnetic field measurements recorded by the FieldStar 1000 three-axis gaussmeter and the directional-component magnetic field measurements recorded by the MEDA 8532 single-axis gaussmeter. A detailed assessment of the recorded magnetic flux density data is presented as a series of graphics, Figure #1 through Figure #3, and within the body of this report below.

Figure #1, Sauna Heater AC ELF Data, presents the magnetic flux density levels recorded directly atop the sauna heater panel as a timed plot during typical operation (panel leads affixed to time-varying power source). This plot was recorded to identify/measure the peak magnetic field levels from the center of the heater panel and to identify potential EMI hot-spots on the device. As shown by Figure #1, the peak magnetic flux density level recorded atop the energized sauna heater panel was 0.04 mG, which was recorded in the center of the heater panel at three separate instances. It should be noted that 0.04 mG is extremely low, and serves as the resolution for the meter used during the study.



Due to the complex wiring utilized to energize the sauna heater panel, an ammeter was used to record the current draw and imbalance during the assessment. As shown by the pictures above and indexed on Figure #1, a current draw reading of 0.99 amps was made by the ammeter during testing with a 0.05 amp imbalance listed on the meter.

Figure #1A, Sauna Heater AC ELF Data, presents the magnetic flux density levels recorded above the sauna heater panel as a series of spot-reading wideband measurements with the MEDA-8532 gaussmeter. The single-axis gaussmeter used during this portion of the analysis records magnetic flux density levels from 12 Hz to 50 kHz with a 0.01 mG resolution, and can easily detect magnetic flux density levels present on the harmonic frequencies when the FieldStar 1000 gaussmeter cannot. It should be noted that this analysis was performed with the sauna heater panel turned ON, and the ambient environment before testing was recorded at 0.0 mG (zero).



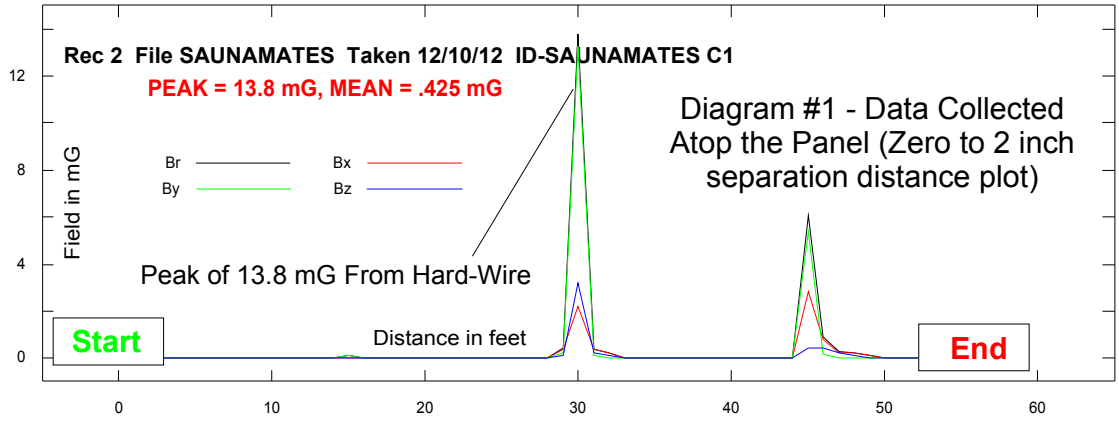
As shown by the picture above and the data indexed on Figure #1A, the 12 Hz to 50 kHz magnetic flux density data for the tested heater panel is excellent, with

component magnetic field levels measured at 0.05 mG and less on all axes. As the recommended magnetic field level for human health exposure is 10 mG, the tested heater panel to be compliant at all magnetic field frequencies.

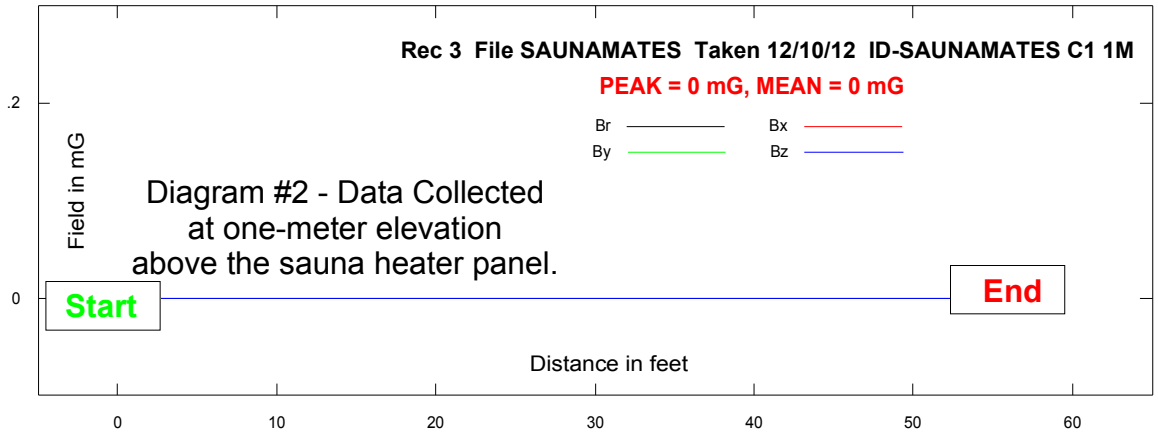
Spot Reading Location	Bx Component in mG, RMS	By Component in mG, RMS	Bz Component in mG, RMS	Calculated Br Resultant, mG RMS
Location #1	0.03 mG	0.00 mG	0.03 mG	0.04 mG
Location #2	0.00 mG	0.00 mG	0.00 mG	0.00 mG
Location #3	0.01 mG	0.00 mG	0.00 mG	0.01 mG
Location #4	0.02 mG	0.00 mG	0.05 mG	0.06 mG
Location #5	0.03 mG	0.00 mG	0.02 mG	0.04 mG
Peak Field in mG	0.03 mG	0.00 mG	0.05 mG	0.06 mG

Table #1 – 12 Hz – 50 kHz Magnetic Flux Density Levels recorded as Spot Readings

Figure #2, Sauna Heater AC ELF Data, presents the magnetic flux density levels recorded above the sauna heater panel as a pair of contour magnetic field plots. This pair of analyses was recorded to measure the magnetic field from all areas of the panel (including the elevated magnetic fields emanating from the hard-wired connection to the panel itself) at elevations of one-inch and one-meter to ascertain both the peak emission levels and magnetic field decay rate of the panel.



Per the associated contour plot presented on Figure #2, Diagram #1 shows the recorded magnetic flux density data which was collected directly atop the panel (between zero and 2 inches of separation distance, with measurements made as close to the panel as possible without touching). A peak magnetic field of 13.8 mG was recorded (from the hard-wired connection to the panel) with an average of 0.43 mG. As shown on the contour plot, most of the sauna heater panel is at 0.0 mG with the large deviation in the average magnetic field stemming from the elevated magnetic field from the connection itself. Under the testing operational mode, 95% of the panel was at 0.1 mG and less.



Per the associated contour plot presented on Figure #2, Diagram #2 shows the recorded magnetic flux density data which was collected at one-meter elevation above the panel. This plot was recorded to identify the decay rate of the device and confirm that the magnetic field emissions recorded on the panel properly decay to a level of 0.0 mG at a distance of 1-meter. As shown by Diagram #2, the entire contour plot assessment at this elevation recorded zero milligauss (0.0 mG).

Figure #3, Sauna Heater AC ELF Data, presents the magnetic flux density levels recorded above the heater panel as a series of vertical plots from three panel locations (left end, center, right end) to complete the emission profile of the source and the relative magnetic field decay rate. Similar to the contour plots, these plots were recorded to identify/measure the peak magnetic field levels from the entire heater panel under typical operation.

As shown by Figure #3, the three lateral/vertical plots recorded a magnetic field level of 0.0 mG throughout the assessment, confirming the extremely low magnetic field emission profile of the heater panel provided for testing.

Conclusions

The peak magnetic flux density level recorded during the AC ELF EMF testing was 13.8 mG, which was collected during a contour plot measurement conducted at ~zero separation distance away from the heater (as noted above, this measurement was recorded from the hard-wired electrical connection to the sauna heater panel).

The peak magnetic flux density level recorded from the center of the Saunamates sauna heater panel itself during the AC ELF EMF testing was 0.06 mG (during the single-axis spot measurements), which easily complies with the long-term human health exposure threshold/recommendation of 10 mG.

As the magnetic field decay rate away from the sauna panel heater is also excellent, based on the data collected during the time of the site survey, Asserts that the sauna heater panel tested produces little to no electromagnetic interference. In

instances where an individual is concerned with excessive electromagnetic field exposure a panel of the model tested would be an acceptable sauna device with regard to our typical human health exposure recommendations.

AC ELF Test Instruments

MEDA 8532 Single-Axis Gaussmeter

Recorded the AC LF-ELF magnetic flux density data using a single-axis gaussmeter oriented in each axis. The MEDA 8532 gaussmeter has a resolution of 0.01 mG and a frequency response of 12 Hz to 50 kHz. After collection of the 12 Hz to 50 kHz magnetic field data, the measurements were then converted to true RMS magnetic flux density (milligauss) readings of each axis (Bx, By, Bz) and then to the resultant *Rrms* (root-means-square) vector according to the following formula:

$$R_{rms} = \sqrt{Bx^2 + By^2 + Bz^2}$$

FieldStar 1000 Gaussmeter - AC ELF Magnetic Flux Density

Recorded the AC ELF magnetic flux density data using a FieldStar 1000 gaussmeter with a NIST traceable calibration certificate manufactured by Dexsil Corporation. The FieldStar 1000 has a resolution of 0.04 mG in the 0 - 10 mG range, 1% full-scale accuracy to 1000 mG and a frequency response of 60 Hz (55 - 65 Hz @ 3dB). Three orthogonal powdered-iron core coils are oriented to reduce interference to less than 0.25% over the full dynamic range. The three coils are arranged inside the unit holding horizontal with the display forward: Bx horizontal coil points forward, By horizontal coil points to the right side, and Bz vertical coil points upward. The microprocessor instantly converts the magnetic field to true RMS magnetic flux density (milligauss) readings of each axis (Bx, By, Bz) and simultaneously calculates the resultant R_{rms} (root-means-square) vector according to the following formula:

$$R_{rms} = \sqrt{Bx^2 + By^2 + Bz^2}$$

When collecting contour path data, a nonmetallic survey wheel is attached to the FieldStar 1000 gaussmeter and the unit is programmed to record mapped magnetic flux density data at selected (1-ft., 5-ft., 10-ft. etc.) intervals. The FieldStar 1000 is exactly 39.37 inches (1 meter) above the ground with the survey wheel attached. Along each path the distance is logged by the survey wheel and the relative direction (turns) entered on the keyboard. Up to 22,000 spot, mapped and timed data points can be stored, each containing three components (Bx, By & Bz), event markers and turn information. After completing the path surveys, magnetic flux density data is uploaded and processed. All plots display a title, time/date stamp, ID path number, and the following statistical data (in milligauss) defined below:

Peak - maximum magnetic field (flux) value measured in group.
Mean - arithmetic average of all magnetic field (flux) values collected.

The following is a quick description of the Hatch, Profile and 3-D Contour plots presented in the figures of this report:

> **Hatch Plot** - data is represented by four difference hatch marks (1 mG, 5 mG, 10 mG and 25 mG thresholds) based on width and color as a function of distance along the survey path that shows 90 and 45 degree turns. Note: the site drawing and all Hatch Plots were scaled in feet to verify actual recorded distances and correct survey locations.
>
> **Profile Plot** - data shows each recorded component (Bx, By, Bz) axis and the resultant (Br) levels as a function of distance: Bx (red) is the horizontal component parallel to the survey path, By (green) is the horizontal component normal (perpendicular) to the survey path, and Bz (blue) is the vertical component with the computed Br resultant RMS (root-means-square) summation of the three components.

AC ELF EMF Health Issues

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/m^2 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 10 mG (1 µT) recommended long-term human exposure limit are discussed in the next section.

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 affects 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.***

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.

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.

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 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.*

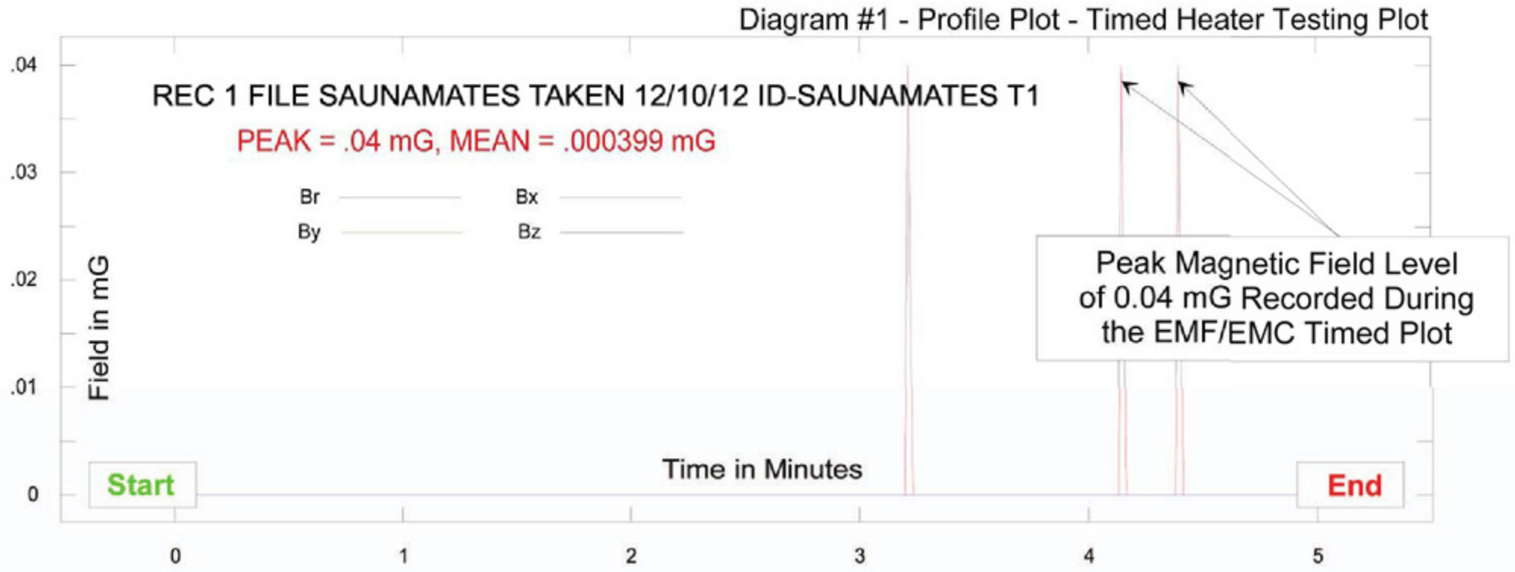
This completes the *Saunamates sauna heater ELF EMF EMC Testing Assessment*

The contents of this report are intended for the exclusive use of the Saunamates company and their subsidiaries.

Best regards,

EMF Technician/Project Manager/Simulation Programmer
Electromagnetics

Enclosures: Figures #1 - #3 (total of four graphics)



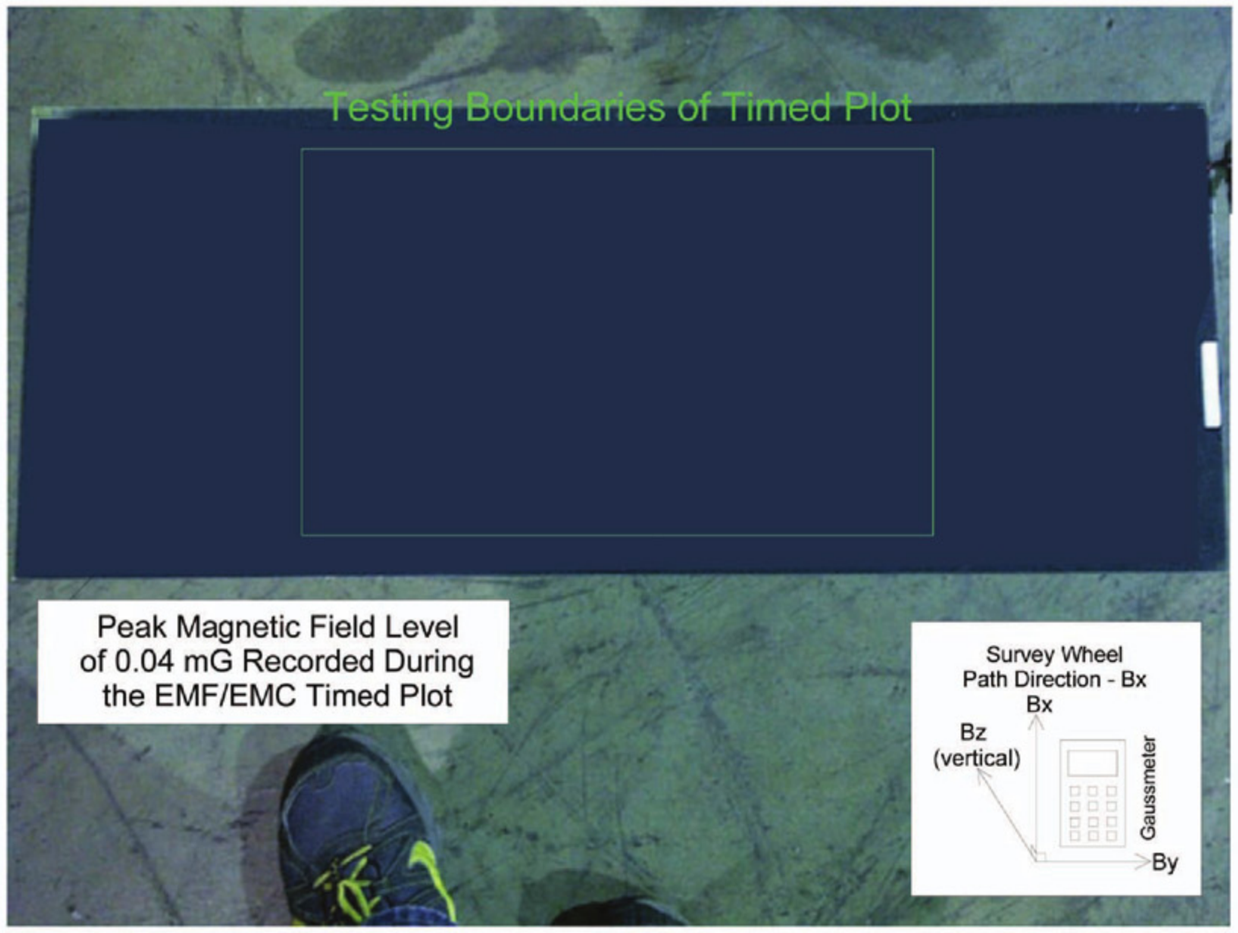
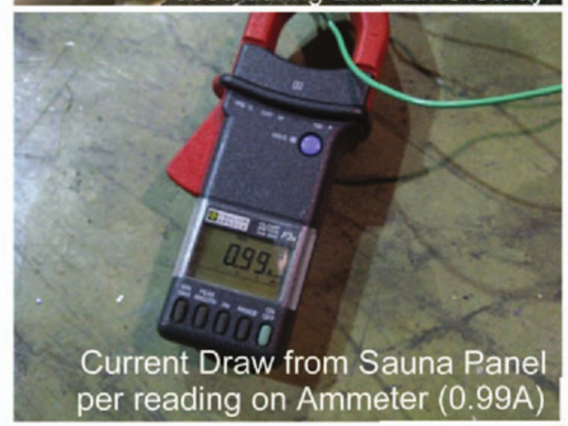


Figure #1, Sauna Heater AC ELF Data
EMF/EMC Magnetic Field Testing
Magnetic Flux Density Levels
Recorded as a Timed Plot



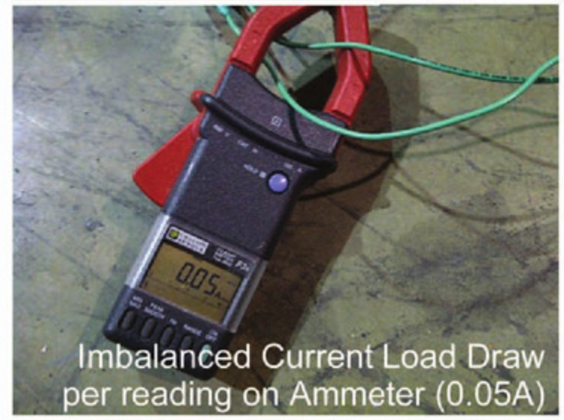
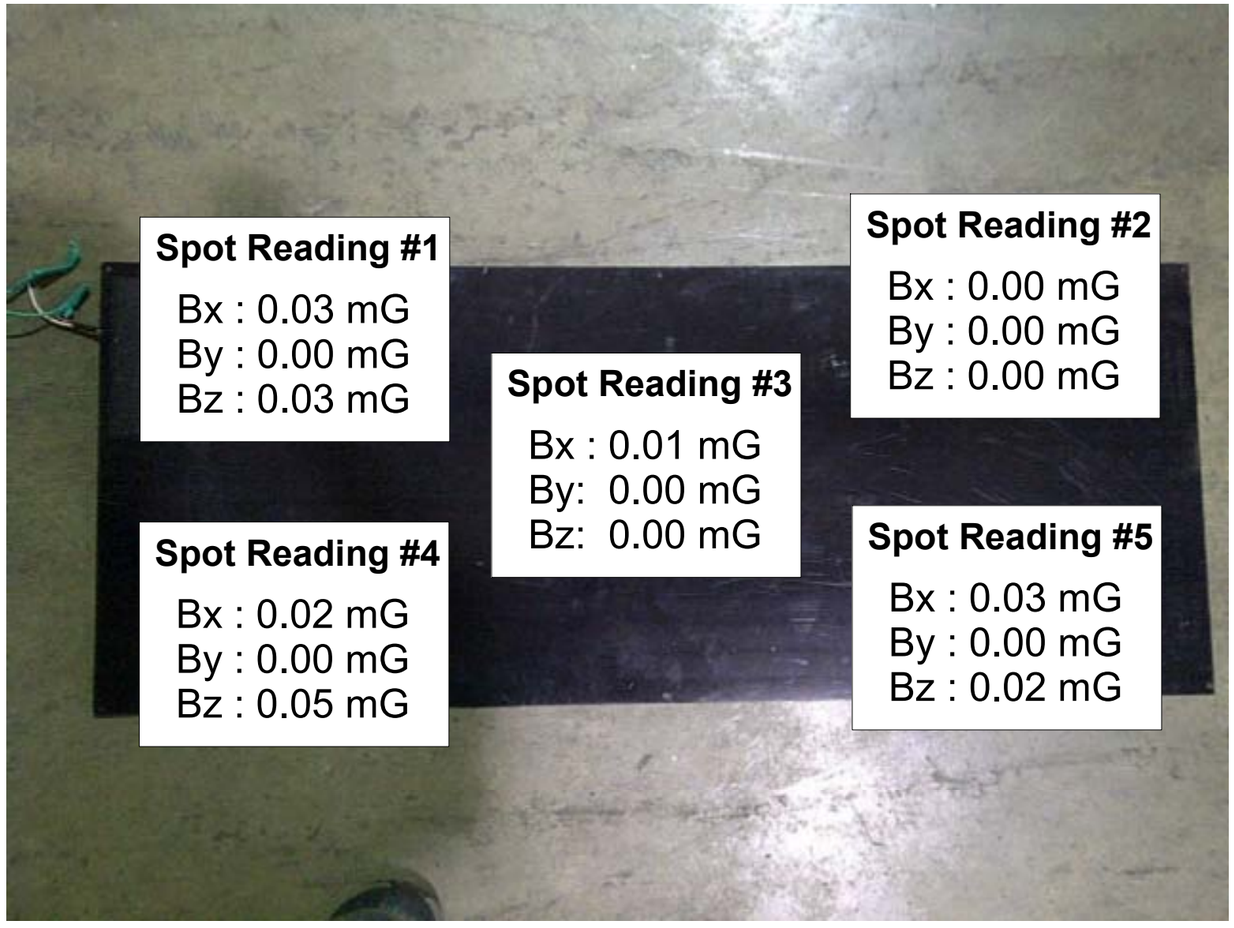


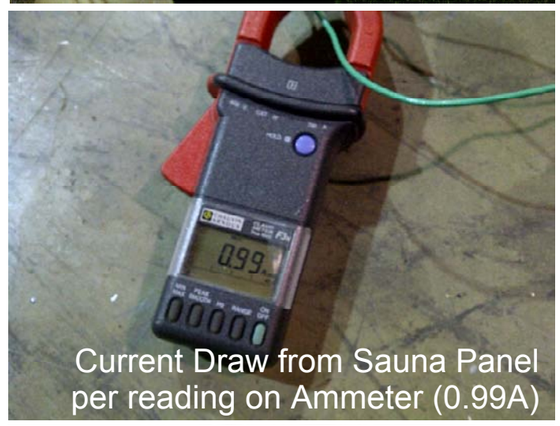
Figure #1A, Sauna Heater AC ELF Data
EMF/EMC Magnetic Field Testing
Magnetic Flux Density Levels
Recorded as a Timed Plot

Diagram #1 - Spot Testing Drawing - Sauna Heater

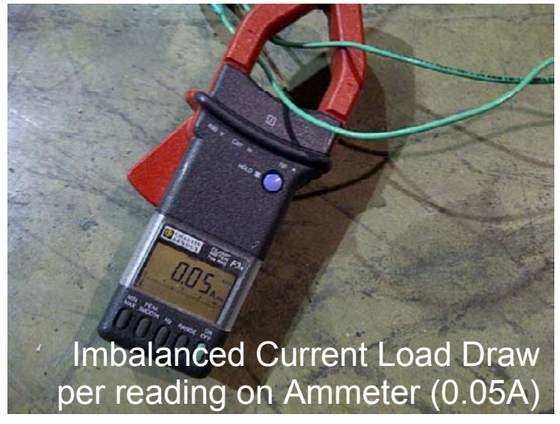


Data recorded in units of milligauss, RMS using a single-axis MEDA 8532 gaussmeter.

MEDA 8532 Single-Axis Gaussmeter used during EMF/EMC Study



Current Draw from Sauna Panel per reading on Ammeter (0.99A)

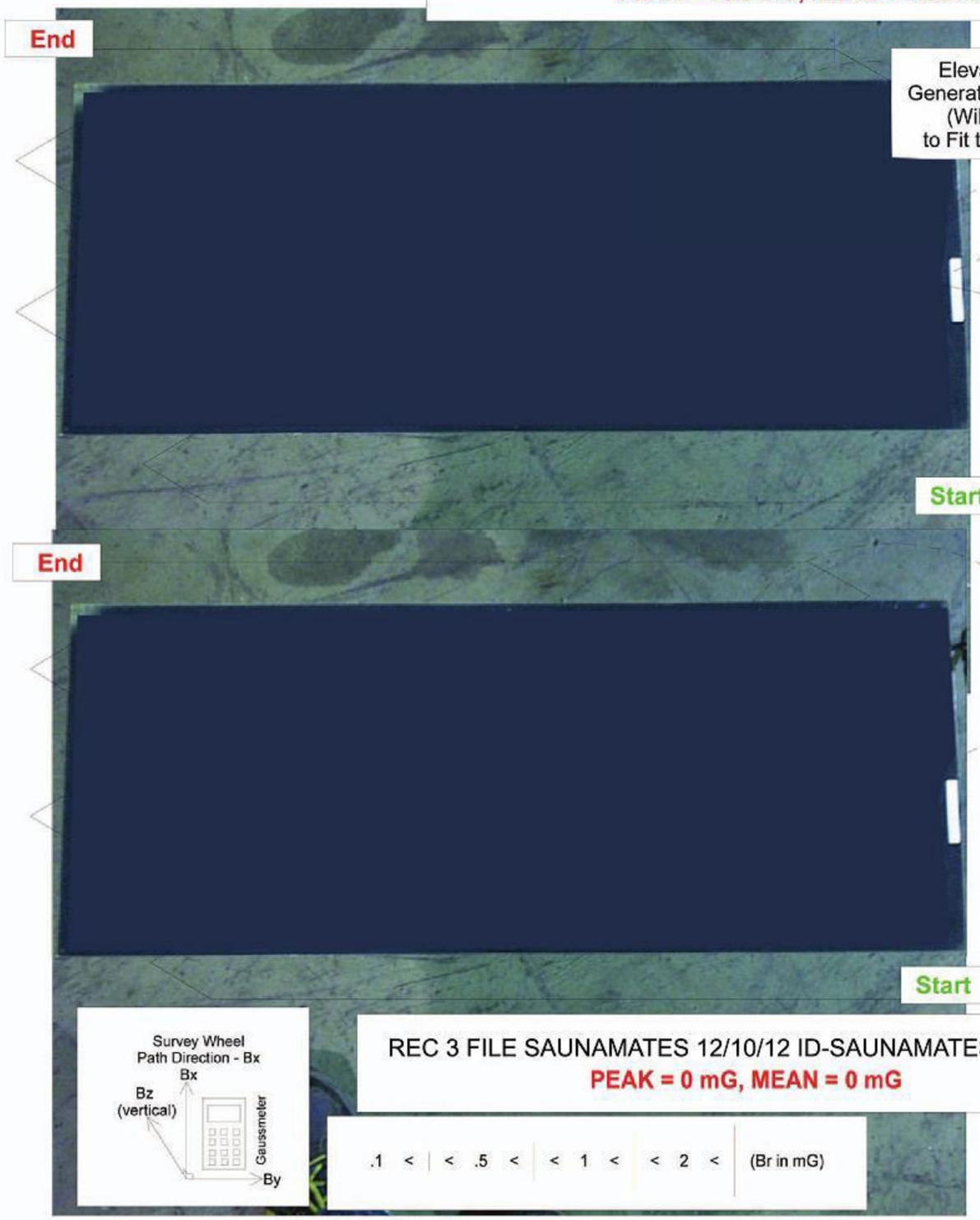


Imbalanced Current Load Draw per reading on Ammeter (0.05A)

Figure #2, Sauna Heater AC ELF Data
EMF/EMC Magnetic Field Testing
Magnetic Flux Density Levels Recorded as Contour Plots

REC 2 FILE SAUNAMATES TAKEN 12/10/12 ID SAUNAMATES C1

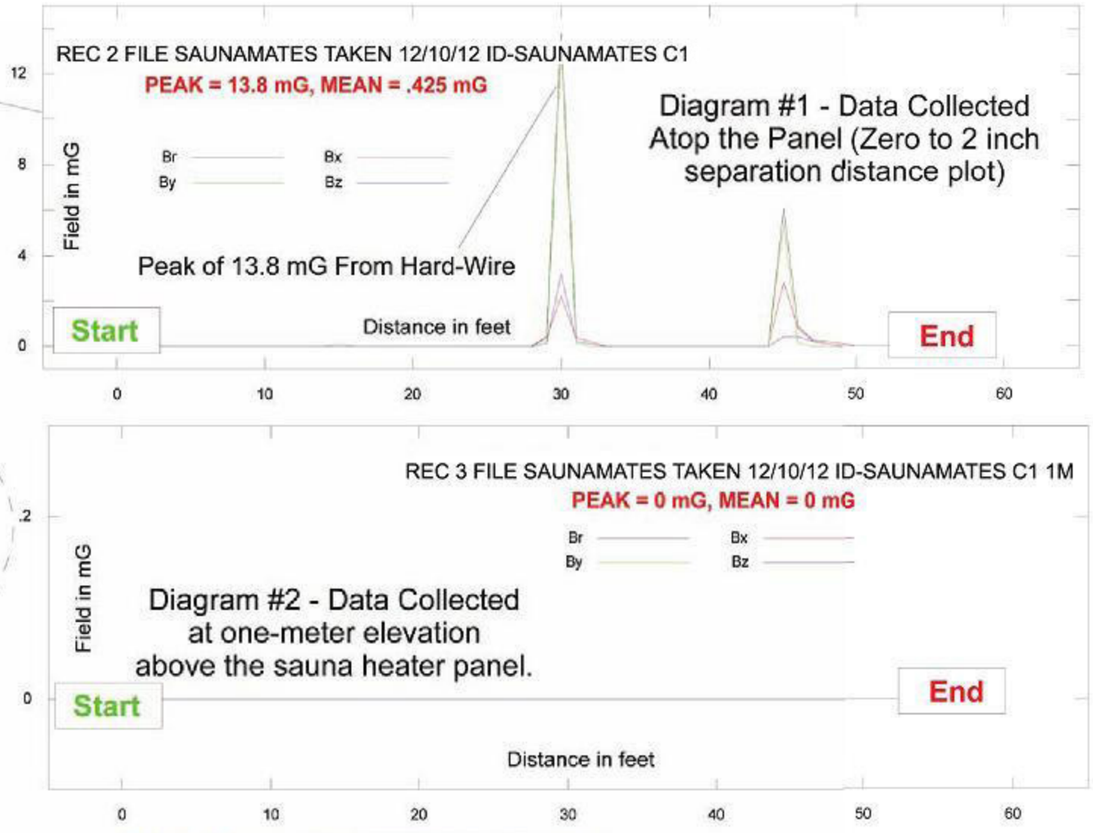
PEAK = 13.8 mG, MEAN = .432 mG



REC 3 FILE SAUNAMATES 12/10/12 ID-SAUNAMATES C1 1M

PEAK = 0 mG, MEAN = 0 mG

.1 < | < .5 < < 1 < < 2 < (Br in mG)



REC 4 FILE SAUNAMATES TAKEN 12/10/12 ID-SAUNAMATES V1

PEAK = 0 mG, MEAN = 0 mG

REC 5 FILE SAUNAMATES TAKEN 12/10/12 ID-SAUNAMATES V2

PEAK = 0 mG, MEAN = 0 mG

REC 6 FILE SAUNAMATES TAKEN 12/10/12 ID-SAUNAMATES V3

PEAK = 0 mG, MEAN = 0 mG

End **End** **End**

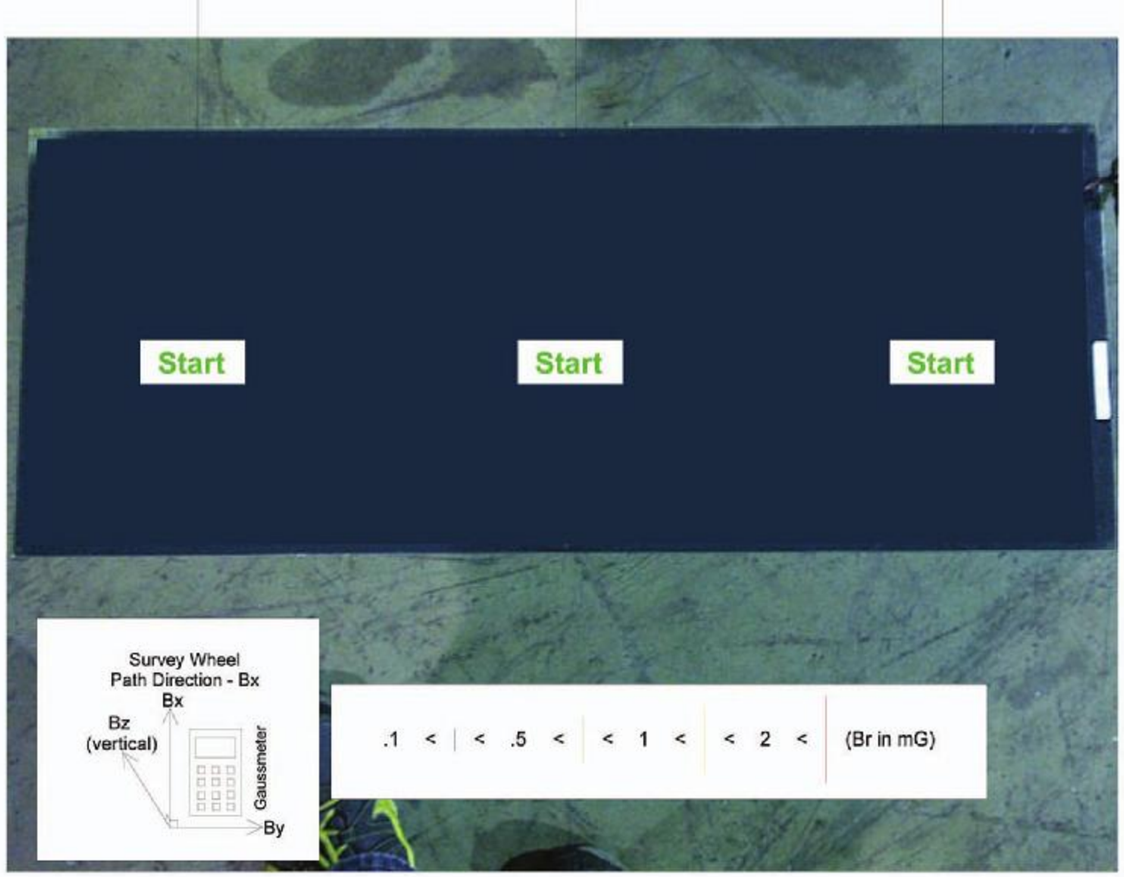


Figure #3, Sauna Heater AC ELF Data
EMF/EMC Magnetic Field Testing
Magnetic Flux Density Levels
Recorded as Vertical Plots