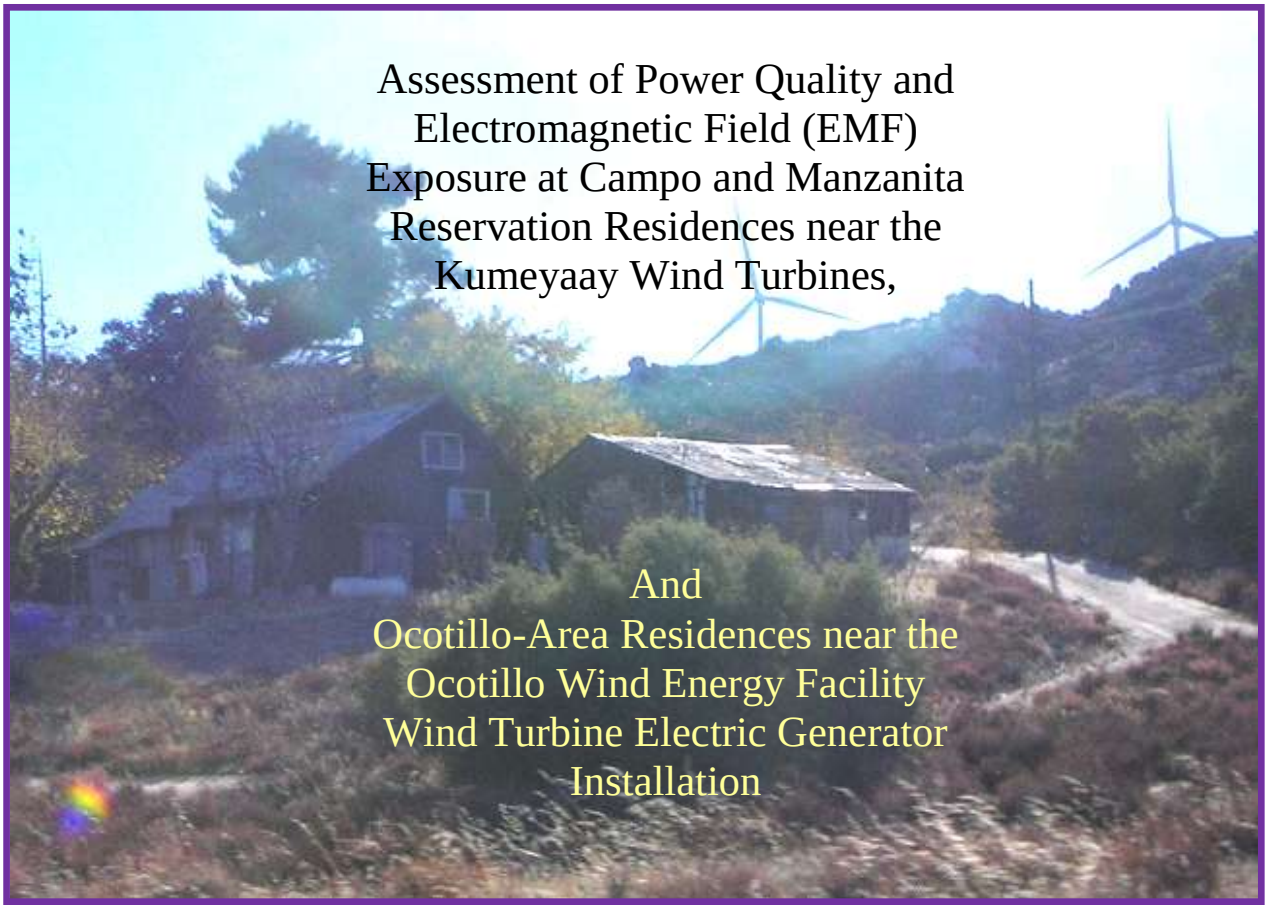

Assessment of Power Quality and Electromagnetic Field (EMF) Exposure at Campo and Manzanita Reservation Residences near the Kumeyaay Wind Turbines,

And

Ocotillo-Area Residences near the Ocotillo Wind Energy Facility Wind Turbine Electric Generator Installation

Prepared For

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Testing Conducted On
November 18-20, 2012

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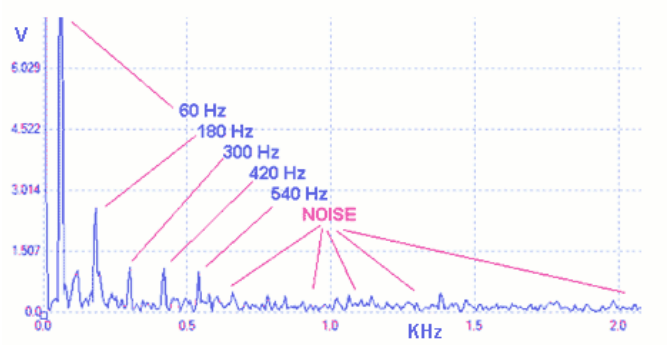
Disclaimer

This report is limited to electric fundamentals: Electric and Magnetic fields, Power Frequency Harmonics, and Transients, the latter two categories falling into what some define as electrical "pollution," and does not address any physical noise, infrasound, or other form of emissions that may be generated by industrial wind turbines.

This report is also preliminary and cooperation is needed from the turbine owners, SDGE, and the CPUC for more tests with the turbines and power off and on in order to clearly identify and eliminate the source of the electrical anomalies, and to ensure the safe and reliable delivery of electricity.

Executive Summary

The author was retained by the Protect Our Communities Foundation to visit the Campo and Manzanita Indian Reservations to: (1) test Power Quality and Electromagnetic Field (EMF) exposure at a variety of residential and comparison locations from the operation of 25 Gamesa 2-MW G-87 wind turbine electric generators at the Kumeyaay Wind Facility, and (2) measure the EMF exposure of two Ocotillo-area private residences and one open-desert comparison location prior to the operational commencement of 112 Siemens 2.3-MW wind turbines that have now been mostly installed as part of Pattern Energy Group LP's Ocotillo Wind Energy Facility.[1]



Testing was conducted with the permission of individual Manzanita and Campo tribal home owners, as arranged and witnessed by Manzanita tribal member Rowena Elliott. Owing to the author's distance from the investigation sites, Environmental Testing and Technology (**ET&T**) from the San Diego area, assisted in the investigation with the intent of possibly providing follow-up testing. During the days of testing near operating turbines, the wind was weak, late in the day, and few turbines operating. Because the cooperation of Infigen Energy (Kumeyaay Wind owner based in Australia), or San Diego Gas and Electric Company (SDG&E) could not be obtained prior to the testing, it was not possible to make EMF measurements during a fuller range of operational conditions.

Despite the involuntary constraints on testing, the measurements obtained were of high quality and were sufficient to identify numerous facets of the conventional residential electric supply near the Kumeyaay turbines that are anything but conventional – namely, inordinately high electric field strengths and substantial Electromagnetic Interference (EMI). The findings suggest that the high levels of EMF exposure at the tested residences are exacerbated if not primarily caused by (1) the expansion of the electric system web around the area's residents, including the Kumeyaay wind turbines and other electric generators and their interconnections, (2) the operation of and intermittent electrical generation from the Kumeyaay wind turbines, an (3) the immediate proximity of power lines to residences. As discussed herein, it is well demonstrated that utility-scale wind turbines, with their associated transmission and substation facilities, can and do cause the type of EMF exposure shown by our testing.

Because of the documented potential for significant adverse health and other effects from high levels of EMF exposure, as discussed further in this report, the author concludes this report with a discussion of some of the measures available to mitigate these harms.

Findings

Except for Mr. Ewing's Ocotillo residence, all other residences are modest dwellings of about 1000 square feet, ranch-style construction, with no basement. The Ewing residence consists of a separate home and garage, with the home larger than the others. The Ocotillo homes are built on what can be considered open desert, with the tribal homes built on rugged high desert land terrain.

[1] A separate Health Impact Assessment is being conducted with the Manzanita Band of Kumeyaay Nation through the National Latino Research Center at California State University, San Marcos, to determine disproportionate health impacts on low-income and ethnic minority population.

Except for Mr. Ewing's, all residences have an attached breaker panel mounted on a structural wall with outdoor access and are limited to 100 Amps. The Ewing residence had larger electric controls detached from the house.

All residences investigated employ NM / Romex indoor power distribution. This type of wiring allows the voltage resident on the conductors to produce an Alternating Electric Field through the insulating jacket. This is because the wires' insulating jacket (made of plasticizer-softened PVC), as well as Gypsum wallboard and most other structural components are transparent to the voltage-produced Electric Fields. These continuously pervade the living space, because all installed wiring is always energized, even if not in use.

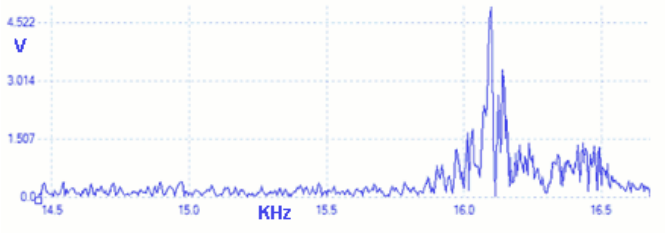
All residences investigated employ the common North American split-phase 120/240 V electric supply.

All residences investigated are interconnected to an aerial WYE electrical system. In this system there is a physical hard connection between the 7200 Volt Primary Neutral/Ground, and the 120/240 Volt Secondary Neutral/ground. In this respect, if there are abnormal electrical characteristics associated with the Primary Neutral they will be conveyed to the Secondary Neutral, and the residents served by them, without reduction.

Except for Site G, all residences had the 7200 V Primary distant from the structure and were at the end of a distribution circuit, or one of its branches. The Site G residence was constructed directly under the aerial Primary.

All residences displayed electrical characteristics within their electrical systems that are foreign to their electrical devices and related consumption characteristics. That is, these characteristics were detectable even with no power in use within the residences investigated (main breaker open/off). By virtue of the Electric field availability from installed wiring, all of these uncommon electrical characteristics (whether with power on or off) became a component of chronic personal exposure.

Some residents noted experiencing damaging interference with their electrical / electronic equipment. One individual remarked having to replace a well pump several times. High frequency harmonics or other frequencies using the electric system as a carrier were detected at this site.[2] High frequencies perform no useful work, other than perhaps heating (*precipitating equipment burnout*), when they are conveyed to a device engineered for 60 Hz exclusively. Another noted repeated EMI to television reception. Again, a high frequency presence was identified at this site on the electric system, and due to the type of electrical connection, external EMI is brought indoors without reduction. Some tribal members described the onset of various health issues that seemed to coincide closely with a certain time lag from the installation of the turbines, such as numerous cancers including stomach, kidney and brain.



However, formally ascertaining the cause-and-effect relationships between these maladies, and the presence of EMI and wind turbine operations is beyond the scope of our testing and this report.

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[2] **Harmonics in your electrical system -** *What they are, how they can be harmful, and what to do about them* – Eaton Corporation, undated - http://www.newark.com/pdfs/techarticles/eaton/Eaton_Technical_Articles/UPS_Training/Powerware_Training/HarmonicsInYourElecSystem.pdf
Hazards of Harmonics and Neutral Overload - *a Schneider Electric White Paper*, 2011 - http://www.apcmedia.com/salestools/SADE-5TNQZ5_R1_EN.pdf

Although the scope of testing was limited, preventing us from conclusively determining the ultimate source(s) and propagation pathway(s) of the measured EMI, the most likely sources appear to be the Kumeyaay wind turbines and associated electrical substation and power distribution facilities. The most likely pathways are through ground currents, via the aerial distribution primary, and through the air when in closest proximity to the turbines. This may be considered pollution in an otherwise 60-Hz-only environment where it may interfere with various forms of sensitive electronics, or life forms whose sensitivity is heightened for whatever reason.

Discussion

The authors documented Alternating Magnetic and Electric Field backgrounds, Radio Frequency (**RF**) background, Neutral-to-Earth Voltage (for the system Neutral), and Wide-band Emission character of each field, where possible.

The most notable finding is that all residences at which measurements were taken displayed substantial Electromagnetic Interference (EMI) within their electrical systems that were foreign to their electrical devices and related consumption characteristics.[3] The Electric fields were also inordinately strong, even reaching extreme levels in certain locations like Site G (~700 V/m) due to the presence of the 7200-V aerial distribution primary.[4] RF was relatively high, considering the rural character of the community. While Magnetic fields were minuscule, they were also dynamic in character and wideband, i.e. varying constantly and spanning a significant portion of the frequency spectrum.

All fields were below officially recommended exposure guidelines that are based on Thermal considerations or short-term (acute) effects, yet by virtue of the electric field availability from the installed wiring, all of these uncommon electrical characteristics (whether with power on or off) enter the living space and become a component of chronic personal exposure for the residents.

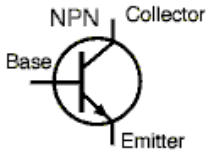
The EMI encountered may be associated with the Ground / Grounding current as described in Appendix D [3, 4] where current is flowing between grounding points of different voltage levels, and may be cause for current to flow from the ground wire into the soil, or from the soil into the ground wire, solely dependent on the instantaneous value of the grounding point voltage relative to the soil. The EMI encountered may also be carted about by the Electric Primary 7200-V power distribution system, which serves as a convenient antenna, to acquire it at one location and redistribute it to others. This EMI can thus migrate into homes and other occupied structures through power distribution lines, ground currents, and through the air, when in closest proximity to the source(s).

The most powerful sources of EMI in the area are suspected to be the Wind Turbines, by the means they produce power.

A brief Internet search on December 16, 2012, for a Gamesa 2.0 MW turbine disclosed the following:
Gamesa 2.0 MW catalog - October 2012[5]
*Control system: Maximum output under Any wind condition. Dual powered generator, speed and power controlled by **IGBT** converters and electronic **PWM** control (Pulse Width Modulation).*

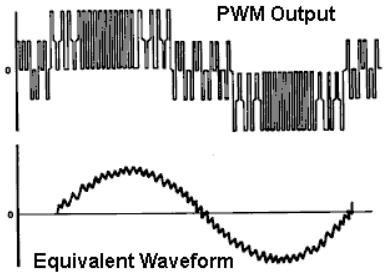
[3] We confirmed the foreign origin of the EMI when we repeated our measurements with the power to the residences turned off (main breaker open/off) and still detected EMI.
[4] Because the distribution primary is solidly referenced to ground, it can spread electric fields more than 300 feet radially from the power line in the absence of tree buffer, which attracts the electric field lines and shunts them into the ground due to the intimate root-soil contact.
[5] http://www.gamesacorp.com/recursos/doc/productos-servicios/aerogeneradores/catalogo-g9x-20-mw-eng.pdf

An **IGBT** is a Field-effect Transistor. In the world of electronics there are two types of transistors, Point-contact as shown to the right, and Field-effect.



The Point-contact type is known as a **Bipolar Transistor** or **BT**. BTs have a limiting power rating.[6]

The Field-effect type known as an **Insulated Gate Bipolar Transistor** or **IGBT** for short, function by electrostatic action and are essentially a switch that is either on or off, and is shown schematically and pictured below. The thermal limitations of the Point-contact device are not present.[7] However, to properly employ the features of an IGBT, any desired analog output waveform has to be synthesized from digital means. In order to produce a smooth-appearing output waveform, filtering is used to smoothen an otherwise very erratic output, as shown to the right, also on page two of Appendix B, and commonly known as **Pulse Width Modulation** or **PWM** for short.



The IGBT to the left is limited to 30 Amps and 900 Volts, or 27,000 Watts of throughput! *Source: Wikipedia* Perhaps not unlike what may be used in the wind turbine generator exciters.

A typical switching frequency for an IGBT is 30,000 Hz. This is equivalent to turning a switch on and off 30,000 times per second. A dimmer switch, in contrast, turns power on and off to its controlled device(s) at a frequency of 120 Hz. A faster switching frequency requires a steeper waveform. The steeper the waveform, the greater the number of Harmonics required to produce it. Some of the peculiar side effects of the associated components of this PWM are: 1) a spread of the harmonics across the Radio Frequency (RF) spectrum, as easily detectable with an AM radio, or suitable spectrum analyzer, and 2) induced voltages and currents onto anything electrically conductive within reach of the incident field. The latter, as described in the Aegis literature referenced,[8] involves a process whereby the induced voltages and currents cause **Electric Discharge Machining** (**EDM**, a process with much similarity to welding) of the generator bearings and the races they fit into (apparently due to inadequate filtering), truly an Achilles' heel. To prolong the life of a generator with PWM input, a shaft collar with conductive nanotubes (to increase the contact surface area) was developed by Aegis to short these induction effects to ground. Aegis' testing, indicates the harmonics span to several MHz. The uncontrolled presence of these harmonics across the spectrum constitutes Electromagnetic Interference (EMI) with anything using that portion of the spectrum intentionally or under license to do so.

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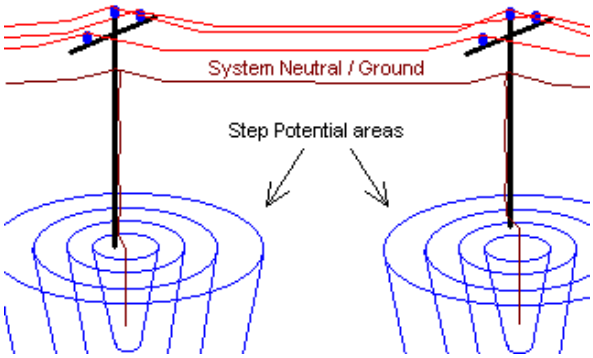
[6] Wattage = Voltage across the device x the Current through the device, or W = V x C. So when a BT has 20 volts across it and 2 amps through it, it is instantaneously dissipating 40 Watts of power, and requires a substantial heat sink to prevent immediate failure. Common heat sinks can be found at the rear of many audio amplifiers, as solid metal fins that get warm during use, because the output power BTs require adequate cooling.

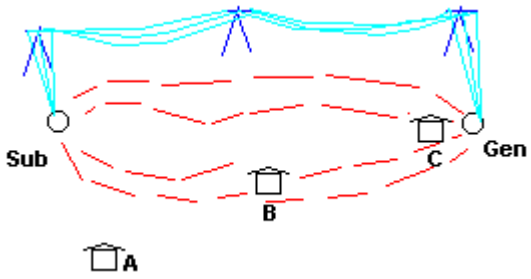
[7] When considering the relationship of W = V x C, during IGBT operation, the Voltage is zero (fully on, and maximum current) rendering zero power dissipation across the transistor, or the Current is zero (fully off, and maximum voltage) rendering zero power dissipation across the transistor.

[8] **Aegis - Preventing Generator Shaft Current Damage** - William Oh - Electro Static Technology, 9-2006 - http://est-aegis.com/TechPaper.pdf

Considering a typical .5% of the generator output being required at the exciter to provide stable operation would imply .5% of 2,000,000 Watts (2 MW), or 10,000 Watts (10 KW) of PWM power being fed to the exciter. All harmonics associated with this IGBT-fed exciter, at each generator, would need to be filtered, and induction effects shorted to ground. When anything electrical is shorted to ground, there is a cone of influence, much like an inverted ice cream cone, around the point of contact that expands with decreasing strength as one moves away from the point of contact horizontally, as well as vertically downward. When there is a nearby point (within a mile or so) that has a ground contact with dissimilar voltage (*due to the intrinsic resistance of wiring and the current flow through it*), current flows between the two as a Ground Current of definite but erratic and unpredictable path. When someone is within or near the cone of influence above the soil, it is easy to measure the voltage differences with earth contacts, or detect free-space magnetic fields that mimic the flow of current in the soil when sufficiently away from the aerial power line's influence.



When these large power generators, be they wind or solar, are built close to residences, the impact can vary greatly depending on the proximity to the residences. As shown in the oversimplified sketch, the house at location "A" is distant from the intended route between the generator and substation. House "B" is distant from the intended route, but is encroached upon by the unintended route via the ground current, the dashed route. House "C" is encroached upon by both the intended route, and the unintended route. The author is keenly aware that since economics drives all facets of such installations, the least-cost route will be chosen. So some thought may be given to exposure concerns to house "C" because it is obvious, but no concern will be given to study possible ground current effects, so house "B" may be impacted, despite the best-intended efforts at being "community-conscious" by considering the effects for house "C."



<u>The Kumeyaay Wind Facility Is Likely a Primary Source of the Measured EMI in Tribal Homes</u>

The EMI measured in the Campo and Manzanita tribal residences is likely produced primarily by the Kumeyaay wind turbines and associated facilities. While, as discussed, it is beyond the limited scope of our testing and this report to conclusively determine the ultimate source(s) of the measured EMI, the available evidence points strongly towards the wind turbine facilities as the primary source for at least three reasons.

First, as discussed above, wind turbines exciters produce substantial induced voltages, currents and broad spectrum harmonics that frequently manifest as EMI in the electrical systems of nearby residences and other receptors. And as explained, these electrical irregularities often stem from the use of

IGBTs and pulse width modulation (PWM). Those same mechanisms are used here, probably with the same effect. According to Gamesa's own literature, "speed and power" of its 2.0-MW turbines are "controlled by IGBT converters and electronic PWM control (Pulse Width Modulation)"[9] (p. 16).

Second, the WYE power distribution design of the measured tribal residences (whereby there is a hard-and-fast connection between each home's supply transformer primary and secondary) is such that any voltage irregularity produce by the Kumeyaay turbines and present or induced in the long-distance route of the circuit will be brought directly into each home without reduction.

Third, there appear to be no other nearby sources capable of producing the magnitude of EMI measured at the tribal homes. According to knowledgeable area residents, there are no other energy-intensive industrial or commercial uses nearby that could have produced the EMI. The one possible exception is the Golden Acorn Casino. But the casino is operating under minimum occupancy and correspondingly minimal electrical load, and it is thus unlikely that it contributed much if at all to the measured EMI.

It is also unlikely that the residents themselves contributed more than minimally to the measured EMI. We confirmed the foreign origin of the EMI when we repeated our measurements with the power to the residences turned off (main breaker open/off) and still detected the EMI.

Due to the current transformation between any transformer's secondary (120/240) and the primary (7200), even 60 amps generated at the customer's premises translates to only one amp on the primary side. And because, like the residents at the sites investigated, the majority of tribal residents live in modest homes, it is unlikely that they would even generate the typical residential load of 7 amps per phase. This indicates that their contribution to primary load and subsequent N-E voltage would be minimal, strongly suggesting that the major, and possibly only, source of EMI would be industrial and/or energy-intensive commercial uses, with the Kumeyaay wind turbines and associated facilities being the most likely candidates.

Given these three factors, it is not surprising that the characteristic electrical irregularities produced by wind turbines closely resemble the EMI measured at the tribal homes.

The production of electromagnetic interference (EMI) can be propagated by way of **Conduction** (where the EMI travels within or along the surface of a conductor) or by **Radiation** (whereby the energy frequency content is fast enough for it to travel in free space). Whether by Conduction or Radiation, the infrastructure is present to support both. Additionally, there is a region in space whose dimensions are dictated by wavelength, which is designated as the "**Near Field**," whereby even without radiation, energy is transferred from source to victim receiver by immediate proximity to the source field. The wavelength of the frequencies detected varied from about 3100 miles for 60 Hz to about 180 feet at 5 MHz, placing all conductive structures within the near field of the turbines except for the highest frequencies detected. The nacelles being located high aloft places them at ideal position to convey EMI onto the surrounding countryside, and use the distribution lines as convenient antennas that will pick a portion of the radiated energy and redistribute it far from the sources. The grounding necessary to protect the generator bearings, introduces unusual ground current characteristics whose paths we could not adequately map or quantify, due to time and location constraints, providing for conduction propagation via every grounded electrical device in the surrounding area to act as a party to the conveyance between grounding points.

[9] http://www.gamesacorp.com/recursos/doc/productos-servicios/aerogeneradores/catalogo-g9x-20-mw-eng.pdf

As time passes new technologies are introduced whose utility is embraced without concern for possible consequences, until . . . someone realizes a connection with the new technology and disease, and questions are raised. In 2001 one such connection was published between childhood Leukemia for ages 2-4 and electrification. Electrification was introduced in North America around the late 1920s. The connection was realized some 80 years later, via historical data.[10] Along the course of this discovery, when evidence was sought, it was sometimes suppressed, or destroyed.[11] The study's authors implicated alternating Magnetic fields based on their understanding. The author of the present document would like to suggest that during early stages of electrification magnetic fields were minuscule, but electric fields were at maximum value, the same as they are today. The incubation period for the disease trigger mechanism to develop can then be less than two years, for susceptible individuals. In 1996 a study was published of research among electric utility workers whereby over 30,000 workers were tracked for over 15 years as to their occupational electrical exposure and occurrence of disease. The clear connection emerged between exposure and various forms of Leukemia, showing a dose-response for increasing exposure to Electric fields. While the authors stated that "the analysis have to be interpreted with caution," they also stated that due to the peculiarities of Electric field measurement the "association in practice may even be stronger than that reported."[12] The incubation period for the disease trigger mechanism for adults in the general population is unknown due to many variables. Both studies noted are suggestive of Electric Field interactions.

Clearly, we would want to have absolute certainty before making rash actions that could curtail commerce and put people out of work. So application of a **Precautionary Principle** is appropriate, albeit conservatively. However, "its potential impact on trade means that its application can have global repercussions. One early application in Europe was by Dr. John Snow, who in 1854 recommended removing the handle from the Broad Street water pump in an attempt to stop the cholera epidemic that was then ravaging central London. Some evidence for a correlation between the polluted water and cholera had been published five years earlier by Snow himself (Snow, 1849). This evidence was not 'proof beyond reasonable doubt'. However, it was proof enough for Snow to recommend the necessary public health action, where the likely costs of inaction would have been far greater than the possible costs of action."[13] - Absolute certainty, however, is clearly impossible in some cases.

The Magnetic and Electric field exposure limits criteria might infer that we can sit inside an operating transformer and remain healthy, as:
"Maximum exposure limits are based on avoidance of the following short-term reactions:
a) Aversive or painful stimulation of sensory or motor neurons,
b) Muscle excitation that may lead to injury while performing potentially hazardous activities,
c) Excitation of neurons or direct alteration of synaptic activity within the brain,
d) Cardiac excitation,
e) Adverse effects associated with induced potentials or forces on rapidly moving charges within the body, such as in blood flow."[14]

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[10] Historical Evidence that Residential Electrification Caused the Emergence of the Childhood Leukemia Peak - S. Milham, E. M. Ossiander – 2001 - http://d1fj3024k72gdx.cloudfront.net/historical_leukemia.pdf
[11] Dirty Electricity – Sam Milham, MD, PHD - Publisher: iUniverse, 2010 ISBN 978-1-4502-3821-2
[12] Leukemia following Occupational Exposure to 60-Hz Electric and Magnetic Fields among Ontario Electric Utility Workers Anthony B. Miller et.at. January 1996 - Evaluation of the combined effect of electric and magnetic fields for leukemia showed significant elevations of risk for high exposure to both, with a dose-response relation for increasing exposure to electric fields and an inconsistent effect for magnetic fields. http://www.ncbi.nlm.nih.gov/pubmed/8678046
[13] Late Lessons From Early Warnings - The Precautionary Principle 1896–2000 – European Environment Agency - ISBN 92-9167-323-4 © EEA, Copenhagen, 2001
[14] C95-6 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0–3 kHz

Ironically, exposure to any alternating field will cause the very thing happening within a transformer, for all individuals exposed. When an electrically conductive structure (which includes humans) is exposed to a field of any kind with **relative motion** to the structure, what occurs is **Transformer Action / Action at a distance / Induction**, which causes internal and external currents and voltages to the structure. When the source is not physically moving but the components (voltage, current) are changing, and their reach extends onto a conductive structure, the relative motion criteria is satisfied. With humans, this will be voltages and currents produced internally and externally to the body. While most individuals do not directly feel these currents and voltages, they nonetheless produce effects which may be immediately unpleasant, and whose end-result is interference with ongoing chemical and electrical processes within each individual. Any interference with normal processes has the potential to bring about errors in process that as an aggregate constitutes disease. And most unfortunately, while the "safety" standards provide some protection from imminent danger, they do not address chronic or cumulative exposure resulting from an ever-increasing invasion of our residential, workplace, and remaining natural environments. In the minds of the IEEE, that is because:

a) There is not sufficient, reliable evidence to conclude that long-term exposures to electric and magnetic fields at levels found in communities or occupational environments are adverse to human health or cause a disease, including cancer.

b) *There is no confirmed mechanism that would provide a firm basis to predict adverse effects from low-level, long-term exposure."*[15]

However, *"The lack of a reasonable explanation is not a trivial distinction, since there is great reluctance to accept observational evidence, regardless of replications and the number of supportive reports, without a reasonable biomolecular basis."*[16] Further, *"Ion cyclotron resonance (ICR) as it applies to biological systems was first discovered to be a critical underlying factor in connection with previously observed electromagnetically-induced changes in free calcium in brain tissue (Ca-efflux experiments)."*[17] And *"Because these ICR effects appeared to violate simplistic analysis involving magnetic induction at first they evoked much suspicion in the scientific community. Many subsequent confirmations, however, performed on different model systems in diverse experimental situations , . . . , proved that these weak low-frequency effects are indeed real."*[18] *"One explanation is that this effect likely reflects the endogenous nature of bioresonance, wherein multiple ion resonances are occurring simultaneously giving rise to a balanced physiologic outcome."*[19]

"The description ***non-inductive non-thermal*** *helps emphasize that the effects obtained by applying low intensity low-frequency electromagnetic fields to biological systems are not the result of either inductive emf generation or the delivery of thermal energies through Joule heating. By contrast, a number of clinical devices that make use of Faraday induction or Joule heating are recognized by the medical community not only because they are effective, but also because the applied voltages, currents or heat are fully consistent with what is expected biochemically. In sharp contrast, the non-inductive non-thermal category includes clinical applications where this is not true, that is, where the electromagnetic variables that are part of the therapy fall outside those permitted by the current medical paradigm."*[20]

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[15] C95-6 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0–3 kHz

[16] **Electromagnetic Medicine Non-Inductive Non-Thermal Modalities** (Supplement 2012), Abraham R. Liboff, PhD, Professor Emeritus Department of Physics Oakland University Rochester Hills, Michigan USA - Prepared for the BioInitiative Working Group September 2012 (Bioinitiative Report 2012, p.1112) http://www.bioinitiative.org/

[17] Ibid, p.1113

[18] Ibid, p. 1114

[19] Ibid, p. 1115

[20] Ibid, p.1111)

Notably, even from the briefest excerpts quoted from the IEEE C95-6 standard, all exposure standards are based on induced emf (voltage and / or current) and thermal (heating) effects. These predecessors to these exposure standards were devised in the middle of the 20th century to protect personnel who were displaying symptoms after acute exposures. Since trying to produce guidelines for long-term effects was not within these agencies' capabilities, short-term limits were set exclusively, with erroneous assumptions for long-term exposure effects, which are now becoming obvious.

There is a community at large, working to eliminate "dirty" energy generated by fossil fuel power plants and the related air pollution. Not that electricity can be dirty in the sense that one can easily clean it up, but rather that it has some quality that was not originally intended. And, expectedly, there are some hucksters trying to make a quick profit with the lore of a clean and green "solution." Yet, as complex as the electrical "dirt" may be, so is the "solution," which brings on additional complex technical problems. The real "dirt" in electricity is non-linearity in the waveform, in that the end-result of some usage causes deformation of the original waveform provided by the utility (in North America a continuously alternating voltage at 60Hz), as well as additional frequency components which are required to produce that deformation. The more radical the deformation, the more frequency components are required. As an example, a simple charger for a personal computer can produce additional frequency components (or harmonics of the power frequency provided to it) that span the entire range from 60 Hz to the MHz range. That is, from 60 cycles per second to well over 1,000,000 cycles per second. All of the exposure guidelines do not take into account the presence of harmonics from a biological exposure perspective.

Some of the sites visited allowed both the test group and homeowners to clearly hear the motors used to rotate the blade direction to optimize output, as well as being in the electrical near-field, as referred to on page 9 of this document. Such close proximity to residents cannot be implied as being anywhere close to "clean and green," as it may be for individuals living 10 to 20 miles distant, where the ground currents and induction effects from the generators get lost in the urban electrical noise background. Testing was performed solely during daylight hours, but it is obvious that if the wind is blowing during nighttime the same physical noises heard during daylight will also be present during time when individuals try to sleep. Sleep disruption is one of the worst possible effects, because when an individual fails to achieve restful sleep, their daytime functioning may be impaired. While Solar Power projects have the promise of eliminating the physical noise component to some extent (except possibly Aeolian vibration as the wind passes the various structures), electrically they may be as problematic as wind turbines, because the output of solar panels is direct current, and the transformation to alternating current for long distance cartage is an electronic synthesis, perhaps not much different than the wind turbines'. While the author cannot delineate a distance that is comfortably "safer," it is clear that placing industrial-scale wind and solar projects at least a few miles distant from all neighbors would eliminate the most significant electrical near-field effects, reduce or eliminate physical sound perception (partly based on topography, as sound produced in a valley can echo to all distant sides), and reduce or eliminate ground current contributions to residents.

What should be apparent from the material above by Professor Liboff is that the human metabolism is far from the simplistic machine of interconnected parts as commonly considered by many branches of medical practice. The human metabolism is a design, elegant beyond description, of many subsystems (some of which have been deemed by some "scientists" as "vestigial," or useless) which function separately, but in concert, to produce what we know as "life." When we consider that life to be a concert of many interrelated bioresonances due to the varied chemical compositions of our many subsystems, it begins to make sense why the amount of electrical "dirt" can be so irritating and potentially harmful, as

appears to be the case in the sites investigated relative to this document. Resonance interactions can occur at signal levels that are quantum leaps lower than brute-force exposure levels, such as those required for thermal effects. The copious availability of many simultaneous frequencies introduced into our systems from without are chaotic at best, with amplitudes that shift regularly owing to how many devices are involved in producing them, confounding the "dirt" with accompanying modulation by other frequencies. And because of our slightly different chemical makeup, the reactions will vary slightly among individuals.

One of the possible end-results of exposure to the various EMFs is Leukemia, if one were to believe the growing body of independent credible research on a global scale, giving the naysayers no valid excuse. The rate of leukemia is about 10 per 100,000,[21] and while it is a rare disease, it is nonetheless devastating. It is a fundamental attack at one or more of our core systems, so various other ailments will most likely precede its occurrence. Yet those succumbing to the illness are often considered "anecdotal" because "scientists" do not understand or have confirmed the mechanism of their demise, when environmental exposures such as EMF may contribute risk. Yet with abundant and credible scientific research having taken place to prove cause and effect, when there is even an inkling of increased risk due to some exposure, and avenues to reduce that exposure are available at no or low cost, they should be implemented. Doing otherwise is nothing short of idiotic. It was not long ago in the historical past that various cultures sacrificed their children to various gods. Although we claim to be "civilized," "moral," and "technically advanced," we may be no different than our predecessors, when we accept the sacrifice of children to an electrical god, when simple precautions globally employed would reduce that risk to zero.

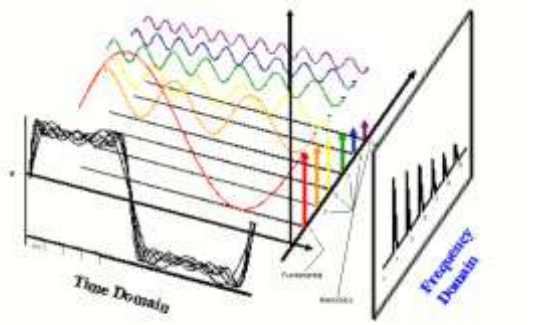
It is in the best interest of anyone subjected to Alternating fields of any level and frequency to reduce them to the greatest extent possible following the **ALARA** principle (As Low As Reasonably Achievable), because the available research strongly suggests that there is no safe minimum exposure.

Electric Field reduction indoors can be achieved inexpensively by removing energized devices from the bedside (lamps, alarm clocks, radios, etc.), and using day lighting as much as possible during waking hours. **Electric Field reduction outdoors** is greatly aided by tree plantings, as they are in intimate contact with moist soil (grounded), are conductive, and shunt the electric field from a source on one side, preventing a field presence on the other side. This is especially effective when the trees are planted between a house and a nearby power line. This is an electrostatic effect and does not increase ground current. **Magnetic Field reduction from ground current** is difficult to accomplish at the individual level owing to the many sources interconnected to the soil, and Neutral Isolation from the supply transformer will greatly help to reroute long-distance cartage of ground current to/from sources, and especially away from residences. **Magnetic Field reduction from wiring errors,** which are common indoors, is easily accomplished per the protocol included at the end of Appendix B. **Wideband Emissions reduction** is at the core of the biological exposure due to many frequencies involved that are also themselves changing amplitude dynamically depending on what device(s) is(are) energized at any moment in time. Thus Neutral Isolation will help in part from a communal level, regardless of the source, and individual measures as described below will help at the individual level.

Testing was performed with expediency and with the intent of acquiring meaningful data with minimum testing. This prevented a full spectrum of all tests performed equally at all sites, even given their differences that prevented some testing from being performed in the first place.

[21] Leukemia and Lymphoma Society – http://www.lls.org/diseaseinformation/getinformationsupport/factsstatistics/leukemia/

Conclusion and Recommendations



Comparison of signal analysis between time domain and frequency domain

Modified from:

The authors employed magnitude, waveform, and frequency spectrum capturing equipment to document the presence of an extensive span of power-frequency harmonics, as well as other frequencies that are not associated with residential electric usage of any form. Some frequencies detected appear to be associated with electrical motor brushes as used in turbine exciters.[22] A few of these may even be produced by individual residential users and minimally shared among them[23] by the power distribution system as built, while testing with user power turned off identified that in most instances the electric non-linearity being brought in was still present and much greater in frequency span than that being locally produced by the owners at the premises investigated. Some of these components cause ambient multi-frequency EMF exposure even distant from any electric infrastructure.[24] While both authors collaborated to eke out meaningful data in an EMF-hostile environment, the opinions expressed herein are those of the principal author.

Alternating Electric fields abounded outdoors, in several cases at extreme levels, as well as indoors. The RF background was considerably high for a rural environment, and no directionality was acquired. While ET&T remarked that the levels were low, the author has on regular occasions detected RF levels decades lower in intensity. So it remains that RF levels were present from some undetermined source(s).

The author hypothesizes that many of the Magnetic, as well as Electric, interactions are frequency-dominated effects, especially where levels are high, as for Electric fields that were quite strong at most sites. When one considers that most of the common power frequency harmonics are within the human hearing range, it is not very speculative to realize that exposure to these fields can elicit auditory nerve response, such that individuals may "hear" sounds brought about by the field character, quite like air pressure variations, which is the more customary expression of sound.

Although the authors worked under restrictive guidelines, with a far-from-complete assessment, even the limited results and the ubiquity of the EMI seems to implicate the turbines, in that whether due to ground current, or induction in nearby power lines, the electrical components are carried to nearby and distant residences.

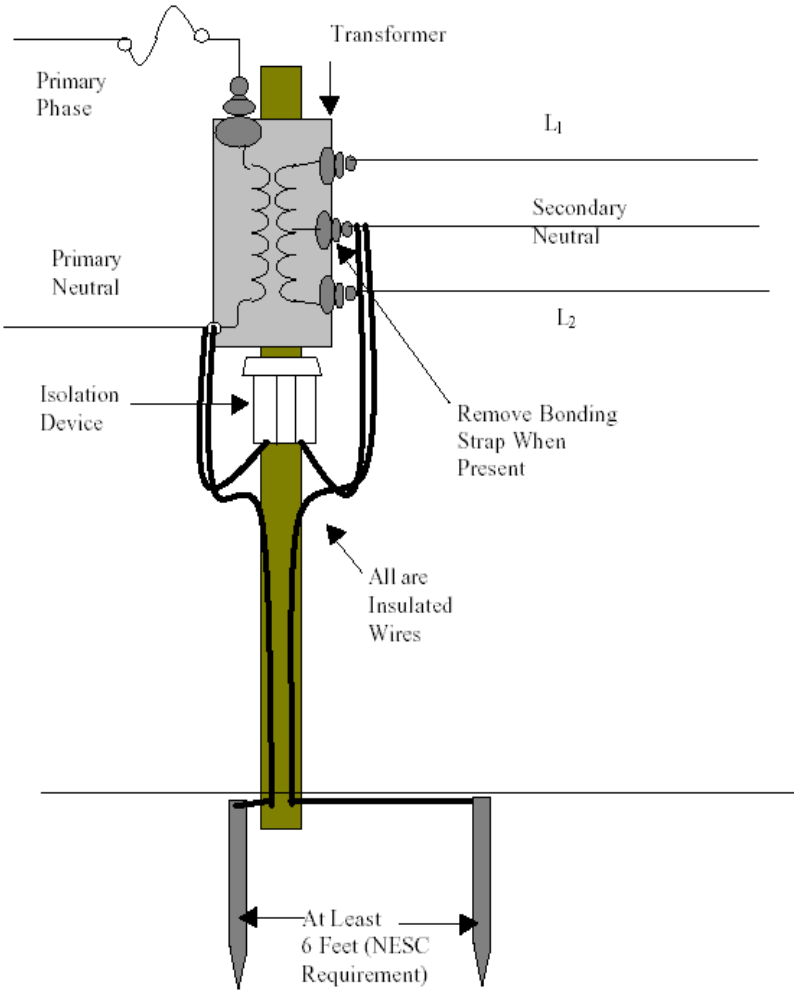
Because of the numerous demonstrated links between irregular electromagnetic field exposure and leukemia and other maladies, combined with the likelihood that many more health impacts from EMF exposure have yet to be discovered, the author recommends the implementation of the following mitigation measures to reduce wind turbine-generated EMF and the negative health impacts thereof, both here, with regard to the Kumeyaay Wind Facility and the Ocotillo Wind Energy Facility, and in future projects. Most suggestions offered herein are low cost, and easily implemented, with the general intent to reduce / eliminate: 1) the Electric field exposure, and 2) the wide-band content and exposure.

[22] Uptower Testing of AEGIS WTG™ Wind Turbine Bearing Protection Ring - AEGIS_WTG_Test_Report-4-Dec-2007.pdf – and Appendix B
[23] Appendix C
[24] Appendix D

Action Items for the Electric Utility:

- Verify the integrity of the secondary neutral at the transformer for each residence.

- To separate the electrical phenomena produced exterior to the residences, all services in the areas investigated should be provided with Neutral isolation, accomplished by separate Primary and Secondary grounding at the transformer, with a secondary class surge arrester joining the two when surges are present, as sketched to the right. (source: Stray Voltages - Concerns, Analysis and Mitigation FINAL DRAFT - NEETRAC Project Number: 00-092 September 2001)



- If the isolation is insufficient to eliminate the EMI, then each transformer shall be replaced with an internally shielded design to further reduce EMI.

- Site G sits immediately below the 7200 V Primary. Whether out of ignorance, or other cause, this little detail presents an ongoing imminent danger that should be immediately rectified, as any form of accident that could cause the Primary to drop and make contact with the structure would immediately initiate a fire, and in case of personal contact, death.
- Site G should have the 7200 Volt Primary relocated beyond the perimeter of the house, at least 50 feet from any edge of the house, or where people traffic areas and children play areas exist. *

- Where the power line is located in roadways adjacent to the house, such as at Site F, relocate the line to allow enough space for a row of tree plantings between the primary and the residence. *

- If power lines are located adjacent to turbines, transpose the phase and ground wires 90 degrees per span, where single phase, or all wires, if three-phase, to provide a repeating change of orientation to induced EMI from turbine sources.

Action items for the Turbine Generator operators and their required interconnection:

- Measure Ground Current contribution for each Turbine to develop an expectable profile in Magnitude, Waveform, and Spectrum. Identify any significant deviations from the norm and troubleshoot and correct same.

- Employ monitoring equipment at each turbine, to identify if any uncontrolled ground current becomes excessive, and alert personnel to quickly correct the situation.

- Employ improved harmonic filtering or Active Power Factor correction at each turbine's exciter to eliminate the introduction of non-linear current into the soil.

- Identify sources of outgoing EMI and reduce or eliminate same.

- Employ wired real-time telemetering rather than wireless. This can be easily accomplished with Power Line Carrier since the turbines' power output does not go directly to any customer (or it should not), and is less subject to EMI effects than wireless.

Action items for the individuals:

- Remove all energized fixtures by the bedside. Namely all light fixtures, any alarm clocks, any radios etc. *They produce an impact regardless of whether the appliance is on or not, because the cord is still energized.*

- Replace all Fluorescent lighting of any form, where practical, with incandescent lighting. *An alternative is a Quartz-Halogen lamp, which has a dual glass envelope, is more efficient than a standard incandescent lamp, and is readily available.*

- Replace any structurally installed dimmer switches with conventional on/off switches.

- Employ an electrician to test for, and pursue correction of indoor wiring errors were found, per the protocol included at the end of Appendix B.

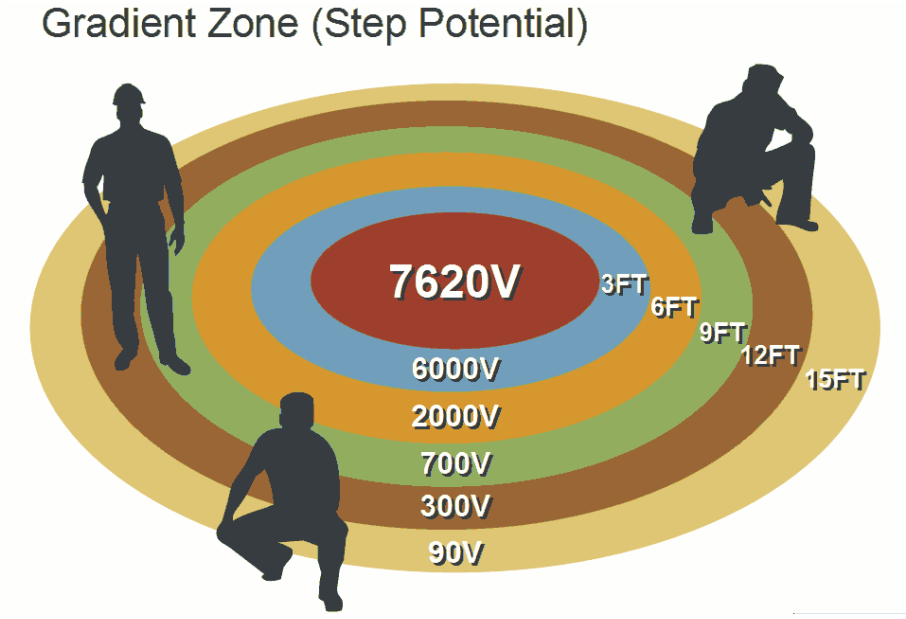
- Employ an electrician to verify the integrity of all accessible Neutral connections, including the one(s) behind the meter. *Repeat this verification on a ten year cycle, owing to an expected failure rate of once in 20 years, as highlighted within the referenced resource material.*

- Be continually vigilant for a condition known as bright-and-dim lights occurring simultaneously. *This is an indication of an impending Neutral failure (and a fire hazard), and the immediate action is to turn off / open the main breaker and call an electrician to investigate. This may occur at any time, even before the suggested neutral isolation at the transformer is accomplished.*

- If within your means consider planting trees between the aerial electric primary and the house. *A blockage of 50-70% should be sufficient to absorb and block all electric fields from reaching the house. The trees will attract the fields and shunt them to ground, without increasing ground current, as this is primarily an electrostatic effect.*

- Consider using small electronics' chargers that are labeled as accepting 90 -250 V as the input (as stated on individual labels on each charging device) only during daytime hours. *These are non-linear switch-mode power supplies that produce many harmonics, and having them plugged in only during daylight hours, removes their contribution from night time when most people sleep. Common transformers are labeled as only accepting 120 V. The difference is immediately obvious, even if the label cannot be read, by using an AM radio in close proximity to the device. A common transformer will be quiet, while a switch-mode power supply will blanket all frequencies within the reception range with electrical static (power frequency harmonics spanning into the MHz range)*

* Even without direct physical contact a downed power line can be fatal. Stepping across areas of more than a couple of hundred volts has the capability to arc right through shoes.



Instrumentation and Methodology

Alternating Current Electromagnetic Fields (EMF) - (a.k.a. Alternating Magnetic Fields)

A *Gigahertz HF3851A* alternating current (AC) magnetic field meter was used by the author to measure the magnetic flux density present at the survey properties. The instrument is a single axis "Gauss" meter, Gauss being a measure of Magnetic Field. Its usable frequency range is 5 Hz to 100 KHz. Its displayed unit of measurement is in nanoTesla (a European equivalent), 100 nT equals 1 milliGauss (mG). Its lower detection limit is 0.1 nT or 0.001 mG. Measurement was conducted at ground level for recording, and at waist level to get directionality of fields. It provides a single number as an aggregate level of all frequencies within its range. The purpose of the assessment was to ascertain what magnetic fields there were outdoors, their strength, direction, and character. As a point of reference the Earth's naturally occurring field is about 500 mG in most location on the planet.

A *Teslatronics Model 710* alternating current (AC) magnetic field meter was used by ET&T to measure the magnetic flux density present within the survey properties. The instrument is a tri-axial Gaussmeter. The frequency range for this instrument is 30 Hz to 2000 Hz. It provides a single number as an aggregate level of all frequencies within its range. The lower detection limit of the instrument is 0.1 mG. Measurements were conducted at about 4 feet above ground level. The purpose of the assessment was to ascertain exterior EMF or wiring influences and therefore do not reflect EMF levels present at interior point sources such as refrigerators, televisions or air condition units.

Alternating Electric Fields

The author used a plastic conductive bag, approximately 12" by 12" by 12" on a fiberglass pole whose capacitively-coupled voltage pickup was referenced to ground and fed to a PicoScope 2203 PC-driven Oscilloscope. When compared to the HF3851A Voltage sensing capability, a voltage of 500-600 mV on the conductive bag equated to about 200 V/m on the HF3851A. The free-form probe was more sensitive than the HF3851A, and was not limited by electronics' frequency limitations as in the HF3851A. The purpose of the assessment was to ascertain exterior contributions of multi-frequency emissions. When compared to indoor quantities, it was noted that housing structures provide a reduction factor of about 10. As a point of reference the Earth's field is about 100 Volts/meter between the ground surface and the ionosphere. This field changes dramatically with weather phenomena, primarily from changes in Relative Humidity (RH) where a high RH will cause low field detection.

PC-driven Oscilloscope

The author used a PicoScope 2203 to acquire waveform and spectral data from the HF3851A, the conductive bag on a fiberglass pole via capacitive coupling, or by direct lead contact with a source. The PicoScope 2203 is usable from 0 Hz (DC) to 5 MHz, with a sensitivity of less than 1 mV. The capacitive coupling method was also applied to measuring buss voltage within a breaker panel, where possible.

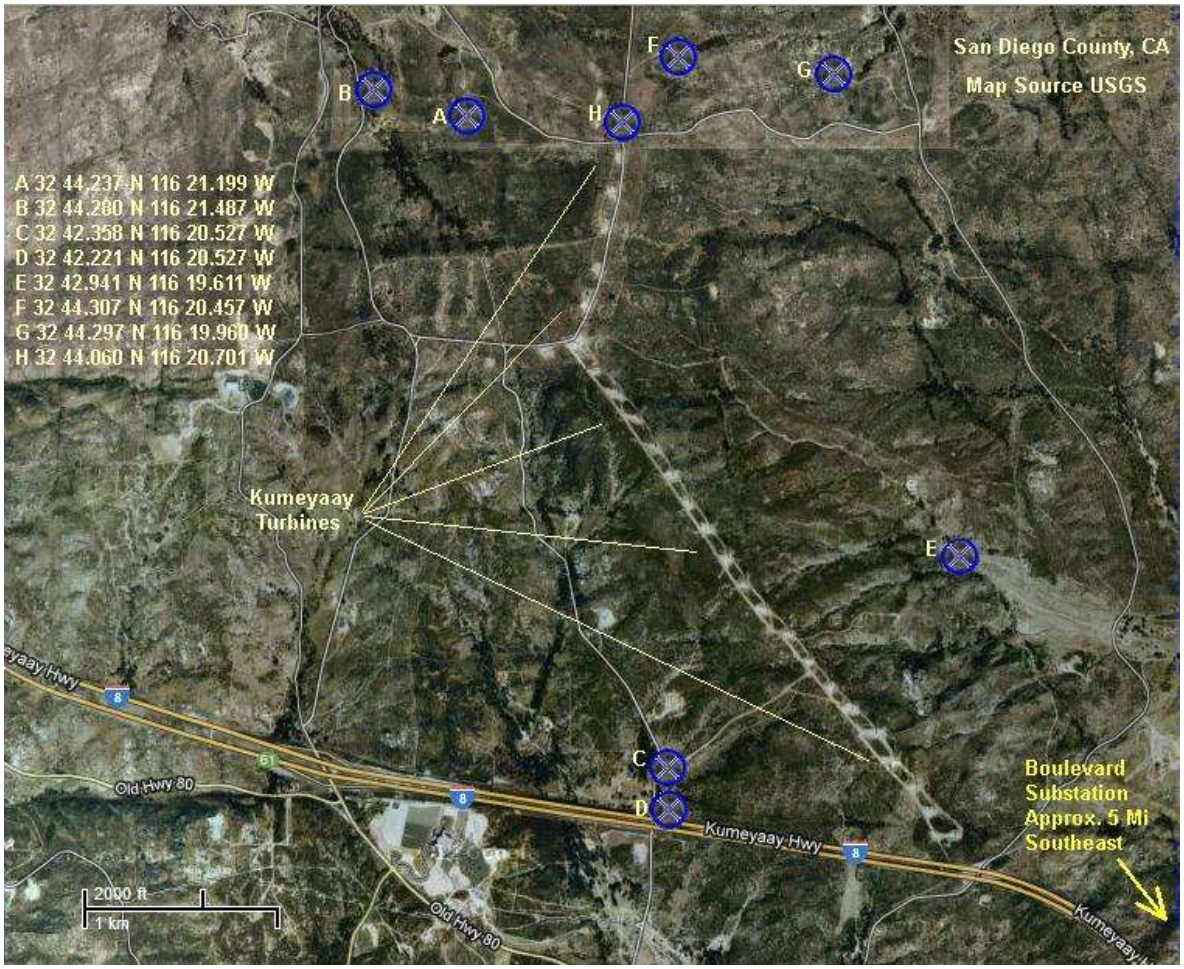
Radio Frequency (RF) and Microwave Survey

A *Wavecontrol SMP* portable electromagnetic field monitoring system with a *WPF8* probe was used by ET&T to obtain measurements of the power density (RF level) at the different survey locations. The *WPF8* probe has a frequency range from 100 kHz to 8 GHz. It provides a single number as an aggregate level of all frequencies within its range. The unit was used in a data logging mode and RF levels were recorded for at least 10 minutes. The measurement results are displayed and reported in Volts per meter (V/m). The lower detection limit of the instrument is 0.3 V/m. The instrument was calibrated according to manufacturer's specifications and instructions. The instrument was placed at 20 to 30' distance from the building on subject property. Measurements were recorded approximately 6 feet above the floor level. *Although levels may have been detected lower than 0.3 V/m, this instrument is not calibrated below 0.3 V/m, so ET&T decided to report data conservatively and note levels lower than 0.3 V/m as simply <0.3 V/m (less than 0.3 V/m) without giving the actual level.*

Measurement Locations

ID	Location	Latitude	Longitude	Site Description
A	Ginger Thompson	N 32° 44.237'	W 116° 21.199'	Residential property
B	Rowena Elliott	N 32° 44.280'	W 116° 21.487'	Residential property
C	Kumeyaay Wind Substation	N 32° 42.358'	W 116° 20.527'	Electrical substation on open property, next residential building approximately 500 yards away
D	Home owner name withheld by request	N 32° 42.221'	W 116° 20.527'	Residential property
E	David Elliott, Jr.	N 32° 42.941'	W 116° 19.611'	Residential property
F	Home owner name withheld by request	N 32° 44.307'	W 116° 20.457'	Residential property
G	Lance Conway	N 32° 44.297'	W 116° 19.960'	Residential property
H	By Turbine	N 32° 44.060'	W 116° 20.701'	Near operational turbine
I	SDG&E's Boulevard Substation	N 32° 39.709'	W 116° 16.424'	Electrical substation on open property, next residential building approximately 100 yards away
J	Jim Pelley	N 32° 45.131'	W 116° 00.133'	Residential property
K	Parke Ewing	N 32° 44.928'	W 116° 00.616'	Residential property
L	Open Desert	N 32° 45.060'	W 116° 00.580'	Open desert approximately 500 feet north from Ewing property border

Measurement Locations – North is at top



Magnetic Field and RF Survey Results

The following table summarizes the measurements results for the different type of measurements and evaluations performed during the survey.

ID	Location	M Field Inside	M Field Outside	RF Power Density	Comments
A	Ginger Thompson	< 0.1 mG	< 0.1 mG	< 0.3 V/m	
B	Rowena Elliott	< 0.1 mG	< 0.1 mG	< 0.3 V/m	
C	Kumeyaay Wind Substation	NA	10-16 mG	0.35 V/m	Background levels at about 150 feet distance
D	Home owner name withheld by request	0.1-0.2 mG	0.1-0.2 mG	0.3 V/m	
E	David Elliott, Jr.	< 0.1 mG	< 0.1 mG	0.4-0.6 V/m	
F	Home owner name withheld by request	0.1-0.4 mG	No Access	0.3 V/m	
G	Lance Conway	0.1-0.3 mG	0.2-0.3 mG	0.5-0.6 V/m	Distribution Primary over residence, E field 300-500 V/m outside and 30-50 V/m inside
H	By Turbine	NM	NM	NM	
I	SDG&E's Boulevard Substation	NA	0.9-6.1 mG	NM	Background levels at about 150 feet distance
J	Jim Pelley	< 0.1 mG	< 0.1 mG	0.6 V/m	
K	Parke Ewing	< 0.1 mG	< 0.1 mG	0.6 V/m	
L	Open Desert	NA	< 0.1 mG	NM	North of Ewing property

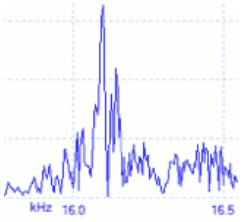
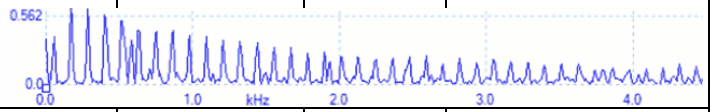
NA = Not applicable, NM = Not measured, 1 mG = 100 nT

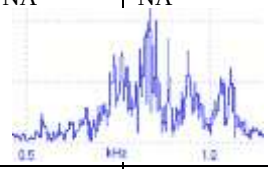
· The **AC magnetic field** levels detected during the survey were very low and within a normal range of residential buildings in Southern California. Magnetic field levels are dependent on current flow. With increasing load conditions the field levels may increase in buildings were distribution lines are in proximity.

· The **RF levels** detected were low and well below levels commonly encountered in metropolitan areas in San Diego County. 0.3 V/m equals 0.02μW/cm^2 0.6 V/m equals 0.09μW/cm^2

Waveform and Spectral Content Survey Results – *all measurements taken outdoors*

All pertinent graphics located in Appendix A

ID	Location	N-E V	Harmonics	M Field	Harmonics	E Field	Harmonics
A	Ginger Thompson ~ 3000' to nearest turbine, ~ 2 miles to Kumeyaay Sub, and ~ 7 miles to Boulevard Substation	~ 200 mV, Irregular with Power ON, ~ 200-300 mV 3-phase with Power OFF	3, 7, 9, 11, 13, 115, 17 with power OFF Note absence of 5th Harmonic	1-3 nT, 0.01-0.03 mG. 500-900 KHz EMI inducted into meter leads between gaussmeter and analyzer	3, 5, 7, 9 Persistent Background Electrical "noise" (EMI)	~ 30 V/m EMI, most pronounced at 16-16.5 KHz, and 3.5-4.8 MHz No Tree Buffer	3, 5, 7, 9 Persistent Background Electrical "noise" (EMI) 
B	Rowena Elliott ~ 4000' to nearest turbine, ~ 2 miles to Kumeyaay Sub, and ~ 7 miles to Boulevard Substation	~ 25 mV, many power frequency harmonics, and discrete EMI peaks with power off	3, a faint 5th, 7, 9, 11, 13, 15, and 17th Harmonics, but many other peaks, and pervasive EMI	1-2.5 nT / 0.01-0.025 mG. EMI, most pronounced at 3-4.5 MHz 	TNTC	Mostly obscured by Tree Buffer	EMI
C	Kumeyaay Wind Substation	NA	NA	~ 100 nT / 1 mG Vertical @ 60 Hz (from Substation equipment)	All very faint (2, 3, 5, 9), except the Fundamental (60 Hz) in Vertical field. Horizontal field (Ground Current) rich in Harmonics.	> ~ 200' from sources, ~ 10 V/m	NA
D	Home owner name withheld by request ~ 3000' to nearest turbine, ~ 1000' to Kumeyaay Sub	NA	NA	12 nT / 0.12 mG Vertical. 6 nT / 0.06 mG Horizontal	Both Vertical and Horizontal fields rich in harmonics and EMI, the one alternately obscuring the other.	~ 200' from sources, ~ 10 V/m, except where obscured by Tree Buffer	NA
E	David Elliott, Jr. ~ 3000' to nearest turbine, ~ 2 miles to Kumeyaay Sub, and ~ 7 miles to Boulevard Substation	350 mV power on, 250 mV power off	Odd Harmonics to 1 KHz. With power off, 60 Hz reduced, but harmonics increased size	EMI	EMI	3-8 mV depending on tree buffer	with much EMI between 60 Hz to 400 KHz

ID	Location	N-E V	Harmonics	M Field	Harmonics	E Field	Harmonics
F	Home owner name withheld by request ~ 2000' to nearest turbine, ~ 2 miles to Kumeyaay Sub, and ~ 7 miles to Boulevard Substation	NM	NM	~ 2 nT, 0.02 mG	3, 5, 7, 9, 11, EMI – most pronounced between 550 KHz and 1 MHz	~ 250 V/m	Discrete EMI peaks
G	Lance Conway ~ 4000' to nearest turbine, ~ 2 miles to Kumeyaay Sub, and ~ 7 miles to Boulevard Substation	NM	NM	20 nT, 0.2 mG	3, 5, 7. Distinct group of EMI at 27.5 KHz, 16 KHz	~ 700 V/m	NM
H	By Turbine	NA	NA 	< 1 nT	Insufficient field strength, possibly due to being away from ground current route	< 3V/m	Pervasive EMI, most pronounced at 550-1200 Hz, 50, 55, and 60 KHz, 95 KHz, 115, 120, 130, and 140 KHz
I	SDG&E's Boulevard Substation	NA	NA	23 nT, 0.23 mG	3, 5, 9, Three-phase grounding current, EMI most pronounced between 500 KHz and 1 MHz	~ 30 V/m	NM
J	Jim Pelley Ocotillo area	370 mV	Wide-band EMI, most pronounced between 800 KHz to 2 MHz, and then low-level electrical noise to 3.5 MHz	15 nT, 0.15 mG – little difference between power on and power off	3, 5, 7, 9, 11– little difference between power on and power off	~ 70 V/m	Wide-band EMI 0.8 to 1.8 MHz, too many discrete peaks to be AM stations
K	Parke Ewing Ocotillo area	~ 1 V	3, 5, 7	~ 1 nT, 0.01 mG	Insufficient field strength to quantify	~ 15 V/m	NM
L	Open Desert Ocotillo area	NA	NA	1 nT, 0.01 mG There should have been	North to South orientation There should have been none	> 200' from sources, < 3 V/m	NM

				none			

N-E V = Neutral-Earth Voltage, **M** = Magnetic, 1 mG = 100 nT, **E** = Electric, **NM** = Not Measured, **NA** = Not Applicable, **TNTC** = Too Numerous To Count, **EMI** = Electromagnetic Interference - Electrical noise-compromised data

All harmonics are whole-number multiples of 60 Hz, so harmonics # 1, 2, and 3 would equate to the presence of 60 Hz (the Fundamental), 120 Hz, and 180 Hz. In most cases with irregular wave shapes only the ODD harmonics are present.

When the authors attempted Ground Current measurement North of the Ewing reference, in open desert, rods were stuck in the soil in an East-West direction, and nothing was detected. One rod was relocated so that the detection arrangement was North-South, and a tell-tale 60 Hz and harmonic signature emerged (*When placing metal rods in the soil such that they "straddle" any possible flow of current, their electric potential will be the same and no voltage will be detected. When placing metal rods in the soil such that they are parallel with the flow of current, they may divulge a 60 Hz and harmonic signature, because of the soil's electrical resistance between the rods. This is complicated by the ground current flowing through layers of soil whose depth below the surface is uncertain, and whose eventual route is also uncertain due to the non-homogeneity of the soil*.). Using the HF3851A Gaussmeter verified the presence and direction of the ground current, as it lined up with the flow corresponding to a North-South direction, and whose strength was about 1 nT, or about 0.01 mG. The reading should have been zero.

North is at top

Resources, not ordered

All documents listed are on the supplied disk, but addresses are valid as of time of retrieval, 12-2012

1) **Electrosmog in the environment** - Swiss Agency for the Environment, Forests and Landscape – SAEFL – June 2005 http://www.bafu.admin.ch/publikationen/publikation/00686/index.html?lang=en (PDF link on the page)

2) **Electric and Magnetic Fields Associated with the Use of Electric Power** – Prepared by the National Institute of Environmental Health Sciences - National Institutes of Health, sponsored by the NIEHS / DOE **EMF RAPID** Program – June 2002 http://www.niehs.nih.gov/health/assets/docs_p_z/results_of_emf_research_emf_questions_answers_booklet.pdf

3) **Why Ground Currents** – 2001 Dahlberg 2001 http://www.mikeholt.com/mojonewsarchive/SV-HTML/HTML/WhyGroundCurrents~20020921.htm

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Limited Glossary

In any discussion of energy, frequencies, and Electromagnetic Fields (EMF) there is a need for **Scientific Notation**, to make sense of very large or very small numbers.

The most common multipliers used are:

Pico (p) = x0.000,000,000,001 (or $x10^{-12}$) Nano (n) = x0.000,000,001 (or $x10^{-9}$)

Micro (u) = x0.000,001 (or $x10^{-6}$) Milli (m) = x0.001

Kilo (K) = x1000 (or $x10^{3}$) Mega (M) = x1000,000 (or $x10^{6}$)

Giga (G) = x1000,000,000 (or $x10^{9}$)

Some of the more common foundational units are:

Cycles per second (cps) or Hertz (Hz),

Gauss (G) a unit of magnetic field,

Tesla (T) – the European unit of magnetic field, 100 nT = 1 mG

Volts (V) – a unit representing electric potential, 1 V = 1000 mV

Amperes or Amps (A) – a unit of current flow. 1 A = 1000 mA

Radio Frequency is generally considered to begin around 30,000,000 Hertz or 30 MHz, although the AM Broadcast bands in the 540 KHz to 1.6 MHz are also designated as "Radio"

Units of **Magnetic field** are generally expressed in milliGauss (mG) or nanoTesla (nT).

Units of **Electric field** are generally expressed in Volts / meter. As an example, for a 7200 V electric primary suspended 30 feet in the air (a typical height), the electric field directly below would be Volts divided by the height. Since 30 feet (30') is approximately 10 meters (10 m), the relationship becomes 7200 V / 10 m, or 720 V/m or about 700 V/m.

When an electrically conductive structure (which includes humans) is exposed to a field of any kind with **relative motion** to the structure, what occurs is **Transformer Action / Action at a distance / Induction**, which causes internal and external currents and voltages to the structure. When the source is not physically moving but the components (voltage, current) are changing, and their reach extends onto a conductive structure, the relative motion criteria is satisfied. Although the discussion is centered on power lines, inside an automobile similar events occur, in that the alternator produces an Alternating (changing with respect to time) Magnetic field, in the process of generating power. This magnetic field in most cases extends into the passenger compartment.

Harmonics are produced by non-smooth electrical phenomena, some of which are repetitive and described within this document. **Transient** phenomena, such as lightning, also produce a wide-band presence of harmonics, even though they are not repetitive. The firing of spark plugs produces the same effect on a smaller scale. Turning a light switch on or off, produces the same effect on a much smaller scale.

Discussion of EMF also inevitably involves **Wavelength**. Since EMF travel at the speed of light or about 186,000 miles/second, the wavelength is 186,000/frequency. For 60 Hz it is about 3100 mi. The term **Microwaves** then pertains to frequencies whose wavelength is small, such as faster than 1 GHz. A microwave oven for instance, using about 2.45 GHz would have a wavelength of about 4 inches.

Author Bios in Brief

Sal La Duca, Principal - Environmental Assay Inc. / Indoor Environmental Consultant / www.emfrelief.com

Sal is an Environmental Consultant specializing in the built environment, with over 30 years' experience in instrumentation and controls. After receiving two years training in the physical sciences, Sal performed as a Nuclear Reactor Operator / Reactor Technician (Instrumentation and Control Technician - Nuclear) on the USS Mississippi, CGN40, and participated in initial construction, initial criticality, Commissioning (1978), and shakedown operations. During this time he also acquired a First Class FCC License with Radar Endorsement. He was then offered employment by Jersey Central Power and Light to help build a Radiological Survey instrument repair facility at the Oyster Creek Nuclear Plant in Forked River, NJ. After having done so, and trained sufficient employees to man the facility, he migrated to the Communications department, where he performed installation, calibration, and repairs of various generations of remote-control supervisory equipment for power system control, as well as work on fixed and mobile Radio Frequency equipment. After three years of this work he migrated to the Dispatch Center and performed as a Power System Load Dispatcher for six years, performing all operations of system control, maintenance, and restoration. He then had an opportunity to return to the Communications department where he performed as an Instrumentation and Control Technician.

In 1994 Sal incorporated and began offering Electromagnetic Field services. In 1999 he sought and acquired certification as a Building Biology Environmental Consultant with the Institute of Building Biology and Ecology, Clearwater, FL, and expanded service offerings to include Indoor Air Quality. In 2003 he sought and acquired Indoor Environmental Consultant status with the Indoor Air Quality Association. He holds a Bachelor of Science from the University of Phoenix, AZ.

Peter Sierck, Principal - Environmental Testing and Technology / Industrial Hygienist, REA / www.etandt.com

Peter is an Industrial Hygienist with over 25 years of experience performing professional low and high frequency electromagnetic field measurements, designing EMF and RF mitigation plans and developing management plans. His technical experience includes alternating current (AC) electric and magnetic fields, direct current (DC) electric and magnetic fields, high radio frequency and microwave radiation surveys. He has conducted surveys for commercial, institutional and residential buildings, performing RF measurements for cell sites, computer interference investigations, performing EMF studies for developers and providing EMF management plans for numerous school districts and acted as a liaison with utility companies on magnetic field reduction methods.

Peter Sierck is a Registered Environmental Assessor (REA) with the State of California, a Certified Indoor Environmental Consultant (CIEC) with the American Council of Accredited certifications (ACAC) and a charter member of the National Electromagnetic Field Testing Association (NEFTA) founded in 1991. Peter started his environmental education in Germany. Mr. Sierck has studied industrial hygiene, environmental testing methods and engineering controls at the Engineering School in Hamburg, University of California San Diego, University of California Berkeley, and the MidAtlantic Environmental Hygiene Resource Center (MEHRC) in Philadelphia. Mr. Sierck was designated by the Honorable Judge Lawrence Sterling of the San Diego Superior Court as an Expert Witness in March of 1999 in accordance with the California Evidence Code Section 720.