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Quick guide to living and working near electric transmission lines

ABOUT ATC

American Transmission Co. has approximately 50,000 easement agreements with property owners in our service area. These legal easements cross agricultural, commercial, industrial and residential land, including many residential neighborhoods that have been developed near our transmission lines.

ATC real estate and engineering staff are available to help landowners, farmers and workers with questions about living and conducting business near our poles, wires and substations.

For detailed information on these topics, including links to third-party resources, visit www.atc-projects.com/learning-center.

The science of moving electricity

Our experts are frequently asked if our transmission lines may affect people and animals. Here is a summary of common scientific topics associated with moving electricity.

Electric and magnetic fields, or EMFs

Any device that uses or carries electricity creates electric and magnetic fields, or EMF. Electric fields are created by voltage, and magnetic fields are created by current flow. The Electric Power Research Institute indicates that, to date, no health effects from transmission line electric fields have been conclusively found or accepted by the scientific community.

Transmission lines produce magnetic fields of varying intensity, measured in units called milligaus (mG).

Many variables affect the strength of a magnetic field around a transmission line:

- The amount of electric current flowing through the wires
- Distance from the wires
- The configuration of the wires

The intensity of a magnetic field is strongest directly under the wires and drops dramatically with distance.

Scientific research

Most of the discussion and research during the past four decades about the possible human health risks of exposure to electric and magnetic fields has focused on magnetic fields. After years of research, a direct link between magnetic fields and a higher risk of negative health effects has not been firmly established.

HOUSEHOLD MAGNETIC FIELD LEVELS

(at typical working distance)

COFFEE MAKER
.2 to 3 mG

TELEVISION
<.1 to 1.5 mG

TOASTER
10 to 60 mG

COMPUTER TABLET
.1 to .2 mG

VACUUM CLEANER
230 to 1300 mG

HAIR DRYER
3 to 1400 mG

Sources: Gauger, Jr., Household Appliance Magnetic Field Survey. IEEE transactions on power apparatus and systems. PA-104.

The intensity of a magnetic field is strongest directly under wires and drops dramatically with distance.

Voltage	Under wires	Edge of right-of-way*	100 feet away
69,000 volts	20-25 mG	5-10 mG	.5-5 mG
138,000 volts	35-40 mG	15-20 mG	.5-10 mG
345,000 volts	85-100 mG	50-60 mG	.5-15 mG

**Edge of right-of-way is typically 40 to 75 feet away from centerline on either side, depending on voltage.*

Nuisance shocks and induced voltage

Nuisance shocks are caused when someone who is electrically grounded contacts an object with induced voltage, an electrical charge buildup. Induced voltage may be present in ungrounded objects, such as vehicles or fences near high-voltage transmission lines. While not common, it is more likely that a nuisance shock may occur at higher voltages, such as 345 kilovolts. This phenomenon is not a health or safety hazard and is not the same as direct electrical contact.

Nuisance shocks can be minimized or eliminated when objects and vehicles are grounded.

The severity of these shocks depends on the same factors that impact the amount of induced voltage:

- Power line voltage
- Distance from wires
- Size or length of the object and its orientation to the line
- Object grounding

Stray voltage/electricity

Stray voltage is the general term used to describe low-level voltages that may occur between surfaces that livestock contact. On a farm, these surfaces may include stanchion pipes, water cups and feeders. Stray voltage is not generally an issue within a typical residential environment.

Causes

Stray voltage is a scientific phenomenon associated with on-farm wiring and electrical connections to utility distribution systems. Both farm systems and utility distribution systems are grounded to the earth to ensure safety and electric reliability. Inevitably, some current flows through the earth at each grounding point and some voltage develops. This voltage is called neutral-to-earth voltage, or NEV. When NEV is found at animal contact points, it is called stray voltage.

Sources of elevated stray voltage may be on-farm, off-farm or a combination of the two. In many cases, there may be more than one source.

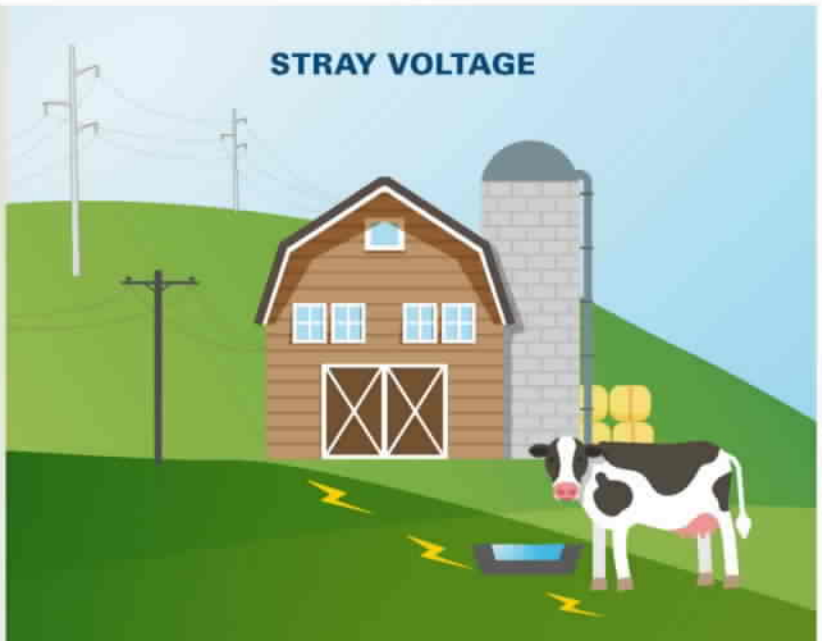
Mitigation

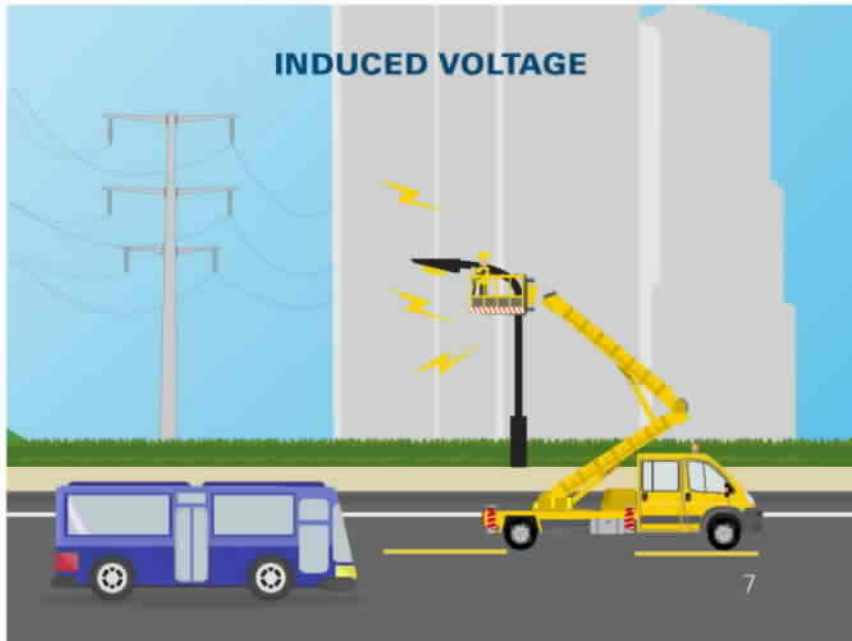
In Wisconsin, the Public Service Commission and the Wisconsin Department of Agriculture, Trade and Consumer Protection have established the Rural Electric Power Services Program to work with farmers in resolving herd health and production problems, and to provide outreach and technical assistance. Many local distribution utilities offer on-site investigations and can recommend steps to correct stray voltage. When transmission and distribution facilities are co-located, ATC works with local distribution companies to investigate and resolve stray voltage sources that may exist.

QUICK TIP: Visit http://datcp.wi.gov/index.aspx and type REPS in the search field for more information on the Rural Electric Power Services Program.

Stray voltage is most often associated with on-farm wiring.

Induced voltage may be present in ungrounded objects, such as vehicles near high-voltage transmission lines.





Living near transmission lines

Tens of thousands of people live near our facilities. Common topics of interest include:

Implantable medical devices

According to the Public Service Commission of Wisconsin, pacemakers and Implantable Cardioverter Defibrillators can be affected by electromagnetic interference, or EMI. Their literature states: "Transmission lines are only one of a number of external EMI sources. Exposure to magnetic fields produced by transmission lines generally will not affect pacemakers and implantable defibrillators." Please read the PSC's Environmental Impacts of Transmission Lines brochure, available in the library at psc.wi.gov, for more information on this and other topics. You should also discuss any concerns with your health care provider.

Ice shedding

It is possible for ice to collect on transmission lines during weather events. Ice shedding may cause ice from lines to fall to the ground.

Noise

Line noise can occur, is weather dependent, and if present, is typically noticeable at higher voltages. Decibel ratings for 345-kV transmission lines have been measured at around 50 decibels within 200 feet of the line. Noise is increased in humid weather, and newer lines become more quiet over time. A rating in the 50s is considered relatively quiet. After 200 feet, it blends in with the surroundings.

Placing structures in rights-of-way

Residences, swimming pools and structures, such as sheds, signs, deer stands and playground equipment, are not permitted in rights-of-way without prior written consent from ATC.

Property values

Home buyers consider many variables, some highly subjective, when making purchasing decisions. Generally speaking, peer-reviewed, published studies confirm that property values are derived from many factors, and that the presence of a transmission line plays a minor role in determining property values. These scientific studies and literature reviews of such studies find that transmission lines have little effect on most property values.

Radio, TV, communication interference

Transmission lines may interfere with AM receivers, TV receivers, amateur radio receivers, aircraft communications receivers and specialized devices such as radio astronomy antennas. If you experience any interference that you suspect is caused by ATC transmission facilities, please contact ATC. When feasible, we work to mitigate any interference.

Trees and landscaping

To help ensure public safety and the safe and reliable operation of the electric transmission system, ATC removes incompatible vegetation from the right-of-way. Tall-growing trees and other vegetation near power lines can be hazardous to public and worker safety. Incompatible vegetation also can threaten electric service reliability and risk damage to the electric system. Dense, incompatible vegetation also is removed because it can impede access for crews to inspect, maintain and repair lines.

Between 1996 and 2003, the number and severity of transmission grid failures increased as a result of vegetation contacts with high-voltage power lines. A widespread power outage in 2003, caused in part by a tree contacting a line, affected 50 million people in the eastern United States and Canada. The federal government responded by developing mandatory reliability standards requiring transmission utilities to establish vegetation management programs with the goal of preventing outages caused by trees and vegetation.

Planting near power lines

ATC's vegetation management program does not prohibit all plantings in the right-of-way. Transmission line corridors cultivated with low-growing vegetation are most compatible with the operation and maintenance of a high-voltage transmission line and can provide habitat for pollinators and other wildlife. Visit www.atc-GrowSmart.com to learn more and review our planting guide.

Farming near transmission lines

ATC has standards and guidance for a variety of agricultural land use topics, which are available at www.atc-projects.com/learning-center and in our Guide to Agricultural Use in American Transmission Co. Rights-of-Way brochure. Please review these resources and contact ATC if you have questions about the following topics:

- Conservation Reserve Program land
- Crops
- Electric fields, equipment and nuisance shocks
- Fences
- Fires and field burning
- GPS and communication equipment
- Irrigation systems and wells
- Livestock
- Manure pits and spreading
- Organic farming
- Property or crop damage
- Soil compaction
- Trees and landscaping

Fence construction, location

Our staff will help identify an appropriate type of fence for the location and ensure that the design complies with the terms of the easement and ATC policies.

Overhead clearance

When operating machinery that extends vertically, such as sprayers, augers, elevators and fertilizer applicators, remember that additional clearance may be needed beyond the standard 14-foot vehicle height. Maintain proper clearance from the highest point on your equipment to the wires above. Use a spotter to keep an eye on how far tall equipment is from the wires. Also avoid refueling any vehicles within the right-of-way.

Materials/equipment in rights-of-way

Do not store or pile materials or equipment within the right-of-way without prior approval from ATC.

Irrigation systems and wells

Improper irrigation installation may cause shocks. Before installing an irrigation system near an ATC transmission facility, contact ATC to discuss your plans. Also keep in mind that wells are not permitted in the right-of-way.

Nuisance shocks

Electric fields from transmission lines can cause induced voltage and current on insufficiently grounded equipment that is near 345-kV transmission lines. Induced voltage can cause nuisance shocks to people who touch the equipment while standing on the ground, but can be minimized by installing a grounding strap or chain on the equipment, or simply by parking farther away from the line.

Burning near rights-of-way

Fire under the wires or within the right-of-way can be dangerous. If you plan to burn near an ATC right-of-way, contact ATC to learn proper burning methods and to inform ATC of when the burn will take place.

GPS navigation

Major manufacturers of GPS navigation systems have not found any degradation of the GPS signal as a direct result of transmission lines.

Animal pens

ATC discourages animal pens or confinements beneath our transmission lines. ATC performs low-flying helicopter inspections each year and may use helicopters with aerial saws to manage vegetation. If areas near the transmission lines are fenced for animal confinement purposes, it is possible for animals to be startled and/or injured during helicopter inspections.

Manure pits

Due to the various access, clearance and other issues associated with manure pits, they typically are not permitted within ATC rights-of-way.

Property and crop damage payments

If ATC maintenance or construction activities cause compaction or rutting or damages drain tile or crops, ATC will pay you a reasonable amount for damages caused by ATC when activities are completed. The USDA Custom Rate Guide is used as a guideline for crop damage payments.

Stray voltage investigations

If you think stray voltage may be an issue on your property, contact your local electric utility. The local utilities and ATC work together on individual investigations to better understand the interactions between both systems where the local transmission line configuration is parallel to the distribution neutral system.

Working safely near poles, wires and substations

Clearances

The Occupational Safety and Health Administration requires minimum safe working clearances based on transmission line voltage.

If you plan to work or operate machinery under ATC transmission lines, ensure you know the required OSHA clearance, which must be maintained at all times.

The height of the wires above ground may vary depending on the voltage of the line, type of structure and span length of the line on your property.

When electric usage is high, wires can sag creating insufficient clearances. High electric usage can be related to hot weather, extreme cold weather or non-weather conditions, such as cranberry or corn harvesting season. Clearances also can fluctuate during a given day as electric usage peaks.

STAY AWAY FROM DOWNED POWER LINES

Transmission infrastructure is relatively robust, but if you encounter a downed power line here are a few safety tips:

- If you see a downed line, always assume it is live. You cannot tell if it is energized just by looking at it.
- Move away from it and anything touching it with shuffling, small steps. Keep your feet together and on the ground at all times to minimize the potential for a shock.
- Do not attempt to move a downed power line or anything else in contact with it by using an object such as a broom or stick.
- Do not touch or step in water near a downed power line.

WORKER SAFETY AT-A-GLANCE

- When operating machinery that extends vertically, remember that additional clearance is needed beyond the truck height. Maintain proper clearance from the highest point on your equipment to the transmission line above. Use a spotter to keep an eye on how far tall equipment is from the wires.
- Do not store material or equipment within the right-of-way without prior approval.
- Electric fields from transmission lines can cause induced voltage on insufficiently grounded equipment that is near 345-kV transmission lines. This is more common when larger vehicles and equipment are parked on asphalt or dry rock. People who touch equipment while standing on the ground may receive a nuisance shock until they stop touching the equipment. This can be minimized by installing a grounding strap or chain on equipment or parking away from the line.
- Avoid refueling vehicles within the right-of-way.

American Transmission Co. owns, operates, builds and maintains the high-voltage electric transmission system that helps meet the electric needs of approximately five million people in parts of Wisconsin, Michigan, Minnesota and Illinois.

We are regulated by the Federal Energy Regulatory Commission, North American Electric Reliability Corporation and the states in our service area. We also work with state natural resource and environmental quality departments, the U.S. Fish and Wildlife Service and the Army Corps of Engineers when building new projects or upgrading existing facilities. We are a member of the Midcontinent Independent System Operator regional transmission organization, which oversees the regional electric grid.

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atcllc.com

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Electrical Notes & Articles

Sharing Abstracts,Notes on various Electrical Engineering Topics.

Effects of High Voltage Transmission Lines on Humans and Plants

FEBRUARY 17, 2012 30 COMMENTS
(HTTP://ELECTRICALNOTES.WORDPRESS.COM/2012/02/17/EFFECTS-OF-HIGH-VOLTAGE-TRANSMISSION-LINES-ON-HUMANS-AND-PLANTS/#COMMENTS)

(http://electricalnotes.files.wordpress.com/2012/02/untitled.png)

Introduction:

By increasing population of the world, towns are expanding, many buildings construct near high voltage overhead power transmission lines. The increase of power demand has increased the need for transmitting huge amount of power over long distances. Large transmission lines configurations with high voltage and current levels generate large values of electric and magnetic fields stresses which affect the human being and the nearby objects located at ground surfaces. This needs to be investigating the effects of electromagnetic fields near the transmission lines on human health.

The electricity system produces extremely low frequency electromagnetic field which comes under Non ionizing radiations which can cause health effects. Apart from human effect, the electrostatic coupling & electromagnetic interference of high voltage transmission lines have impact on plants and telecommunication equipments mainly operating in frequency range below UHF.

IS Power Line EMF safe? This is the controversy Discussion directly eludes on Government Regulation policy and Power Company. There are lots of supporting documents and research paper in favor and criticize this arguments.

Witness Exhibit No. 32
Date 9-4-14 Reporter
File No. EA-2014-0207
Hamilton, MO

What is The Electric and Magnetic fields:

- Electric and magnetic fields, often referred to as electromagnetic fields or EMF, occur naturally and as a result of the Power generation, Power Transmission, Power distribution and use of electric power.

- EMF is fields of force and is created by electric voltage and current. They occur around electrical devices or whenever power lines are energized.
- **Electric fields** are due to voltage so they are present in electrical appliances and cords whenever the electric cord to an appliance is plugged into an outlet (even if the appliance is turned off).
- Electric fields (E) exist whenever a (+) or (-) electrical charge is present. They exert forces on other charges within the field. Any electrical wire that is charged will produce an electric field (i.e. Electric field produces charging of bodies, discharge currents, biological effects and sparks). This field exists even when there is no current flowing. The higher the voltage, the stronger is electric field at any given distance from the wire.
- The strength of the electric field is typically measured in volts per meter (V/m) or in kilovolts per meter (kV/m). Electric fields are weakened by objects like trees, buildings, and vehicles. Burying power lines can eliminate human exposure to electric fields from this source.
- **Magnetic fields** result from the motion of the electric charge or current, such as when there is current flowing through a power line or when an appliance is plugged in and turned on. Appliances which are plugged in but not turned on do not produce magnetic fields.
- Magnetic field lines run in circles around the conductor (i.e. produces magnetic induction on objects and induced currents inside human and animal (or any other conducting) bodies causing possible health effects and a multitude of interference problems). The higher the current, the greater the strength of the magnetic field.
- Magnetic fields are typically measured in tesla (T) or more commonly, in gauss (G) and milli gauss (mG). One tesla equals 10,000 gauss and one gauss equals 1,000 milli gauss.
- The strength of an EMF decreases significantly with increasing distance from the source.
- The Strength of an electric field is proportional to the voltage of the source. Thus, the electric fields beneath high voltage transmission lines far exceed those below the lower voltage distribution lines. The magnetic field strength, by contrast, is proportional to the current in the lines, so that a low voltage distribution line with a high current load may produce a magnetic field that is as high as those produced by some high voltage transmission lines.
- In fact, electric distribution systems account for a far higher proportion of the population's exposure to magnetic fields than the larger and more visible high voltage transmission lines.
- **Electrical field:** the part of the EMF that can easily be shielded.
- **Magnetic field:** part of the EMF that can penetrate stone, steel and human flesh. In fact, when it comes to magnetic fields, human flesh and bone has the same penetrability as air!
- **Both fields are invisible and perfectly silent:** People who live in an area with electric power, some level of artificial EMF is surrounding them.
- The magnetic field strength produced from a transmission line is proportional to: load current, phase to phase spacing, and the inverse square of the distance from the line.
- Many previous works studied the effect of different parameters on the produced magnetic field such as: the distance from the line, the conductor height, line shielding and transmission line configuration and compaction.

Electric and Magnetic Field (EMF) Effects

- Extremely high voltages in EHV lines cause electrostatic effects, where as short circuit currents & line loading currents are responsible for electromagnetic effects. The effect of these electrostatic fields is

seen prominent with living things like humans, plants, animals along with vehicles, fences & buried pipes under & close to these lines.

1) EMF Effects Human beings:

- The human body is a composed of some biological materials like blood, bone, brain, lungs, muscle, skin etc. The permeability of human body is equals to permeability of air but within a human body has different electromagnetic values at a certain frequency for different material.
- The human body contains free electric charges (largely in ion-rich fluids such as blood and lymph) that move in response to forces exerted by charges on and currents flowing in nearby power lines. The processes that produce these body currents are called **electric and magnetic induction.**
- In electric induction, charges on a power line attract or repel free charges within the body. Since body fluids are good conductors of electricity, charges in the body move to its surface under the influence of this electric force. For example, a positively charged overhead transmission line induces negative charges to flow to the surfaces on the upper part of the body. Since the charge on power lines alternates from positive to negative many times each second, the charges induced on the body surface alternate also. Negative charges induced on the upper part of the body one instant flow into the lower part of the body the next instant. Thus, **power-frequency electric fields induce currents in the body (Eddy Current) as well as charges on its surface.**
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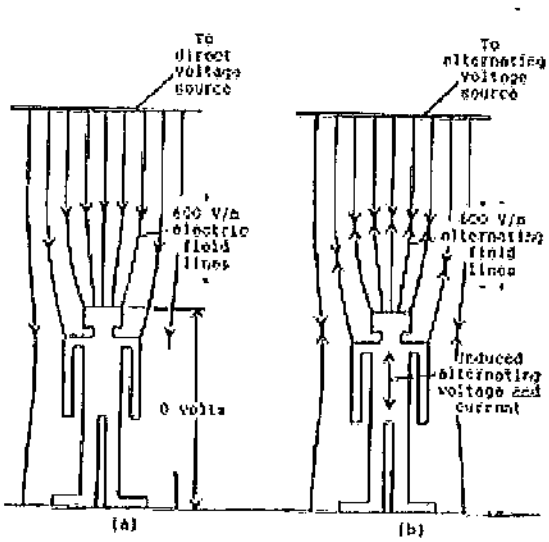

(http://electricalnotes.files.wordpress.com/2012/02/13.png)The currents induced in the body by magnetic fields are greatest near the periphery of the body and smallest at the center of the body.

- It is believed that, the magnetic field might induce a voltage in the tissue of human body which causes a current to flow through it due to its conductivity of around them.
- The magnetic field has influence on tissues in the human body. These influences may be beneficial or harmful depending upon its nature.
- The magnitude of surface charge and internal body currents that are induced by any given source of power-frequency fields depends on many factors. These include the magnitude of the charges and currents in the source, the distance of the body from the source, the presence of other objects that might

shield or concentrate the field, and body posture, shape, and orientation. **For this reason the surface charges and currents which a given field induces are very different for different Human and animals.**

- When a person who is isolated from ground by some insulating material comes in close proximity to an overhead transmission line, an electrostatic field is set in the body of human being, having a resistance of about 2000 ohms.
- When the same person touches a grounded object, it will discharge through his body causing a large amount of discharge current to flow through the body. Discharge currents from 50-60 Hz electromagnetic fields are weaker than natural currents in the body, such as those from the electrical activity of the brain and heart.
- For human beings the limit for undisturbed field is 15 kV/m, R.M.S., to experience possible shock. When designing a transmission lines this limit is not crossed, in addition to this proper care has been taken in order to keep minimum clearance between transmission lines.
- According to research and publications put out by the World Health Organization(WHO), EMF such as those from power lines, can also cause:

Short term Health Problem

1. Headaches.
2. Fatigue
3. Anxiety
4. Insomnia
5. Prickling and/or burning skin
6. Rashes
7. Muscle pain

Long term Health Problem:

- Following serious health Problems may be arise due to EMF effects on human Body.

(1) Risk of damaging DNA.

- Our body acts like an energy wave broadcaster and receiver, incorporating and responding to EMFs. In fact, scientific research has demonstrated that every cell in your body may have its own EMF, helping to regulate important functions and keep you healthy.
- Strong, artificial EMFs like those from power lines can scramble and interfere with your body's natural EMF, harming everything from your sleep cycles and stress levels to your immune response and DNA!

(2) Risk of Cancer

- After hundreds of international studies, the evidence linking EMFs to cancers and other health problems is loud and clear. High Voltage power lines are the most obvious and dangerous culprits, but

the same EMFs exist in gradually decreasing levels all along the grid, from substations to transformers to homes.

(3) Risk of Leukemia:

- Researchers found that children living within 650 feet of power lines had a 70% greater risk for leukemia than children living 2,000 feet away or more.(As per British Medical Journal, June, 2005).

(4) Risk of Neurodegenerative disease:

- "Several studies have identified occupational exposure to extremely low-frequency electromagnetic fields (EMF) as a potential risk factor for neuro degenerative disease."(As per Epidemiology, 2003 Jul; 14(4):413-9).

(5) Risk of Miscarriage:

- There is "strong prospective evidence that prenatal maximum magnetic field exposure above a certain level (possibly around 16 mG) may be associated with miscarriage risk." (As per Epidemiology, 2002 Jan; 13(1):9-20)

2) EMF Effects on Animals

- Many researchers are studying the effect of Electrostatic field on animals. In order to do so they keeps the cages of animals under high Electrostatic field of about 30 kV/m. The results of these Experiments are shocking as animals (are kept below high Electrostatic field their body acquires a charge & when they try to drink water, a spark usually jumps from their nose to the grounded Pipe) like hens are unable to pick up grain because of chattering of their beaks which also affects their growth.

3) EMF Effects on Plant Life

- Most of the areas in agricultural and forest lands where high power transmission lines pass. The voltage level of high power transmission Lines are 400KV, 230KV, 110KV, 66KV etc. The electromagnetic field from high power transmission lines affects the growth of plants.
- Gradually increases or decreases and reaches to maximum current or minimum current and thereafter it starts to fall down to lowest current or raises to maximum current or a constant current. Again the current, it evinces with little fluctuations till the next day morning.
- Current in Power transmission lines varies according to Load (it depending upon the amount of electricity consumed by the consumers). Hence the effect of EMF (due to current flowing in the power lines) upon the growth of plants under the high power transmission lines remains unaltered throughout the year.
- From various practically study it was found that the response of the crop to EMF from 110 KV and 230 KV Power lines showed variations among themselves. Based on the results the growth characteristics

like shoot length, root length, leaf area, leaf fresh weight, specific leaf weight, shoot/root ratio, total biomass content and total water content of the four crop plants were reduced significantly over the control plants.

- Similar trend were observed in the biochemical characteristics like chlorophyll.
- Reduced growth and physiological parameter was primarily due to the effect of reduced cell division and cell enlargement. Further the growth was stunted which may be due to poor action of hormones responsible for cell division and cell enlargement.
- The bio-chemical changes produced in this plant due to EMF stress quite obvious and it affects the production leading to economic loss.
- It is concluded that the reduced growth parameter shown in the crop plants would indicates that the EMF has exerted a stress on that plants and this EMF stress was quite obvious and it affects the production leading to economic loss. So further research activities are needed to safe guard plants from EMF stress.

4) EMF Effects on Vehicles parked near Line

- When a vehicle is parked under high voltage transmission line an electrostatic field is developed in it. When a person who is grounded touches it a discharge current flows through the human being. In order to avoid this parking lots are located below the transmission lines the recommended clearance is 17 m for 345 kV and 20 m for 400 kV lines.

5) EMF Effects on Pipe Line/Fence/Cables:

- A fence, irrigation pipe, pipeline, electrical distribution line forms a conducting loops when it is grounded at both ends. The earth forms the other portion of the loop. The magnetic field from a transmission line can induce a current to flow in such a loop if it is oriented parallel to the line. If only one end of the fence is grounded, then an induced voltage appears across the open end of the loop. The possibility for a shock exists if a person closes the loop at the open end by contacting both the ground and the conductor.
- For fences, buried cables, and pipe lines proper care has been taken to prevent them from charging due to Electrostatic field. When using pipelines which are more than 3 km in length & 15 cm in Diameter they must be buried at least 30 laterally from the line center.

6) EMF Effects on Maintenance Worker:

- For providing continuous and uninterrupted supply of electric power to consumers maintenance operations of power lines are often performed with systems energized or live.

- This is live line maintenance or hot line maintenance. The electric fields and magnetic fields associated with these power lines may affect the health of live line workers. Its electric field and current densities affect the health of humans and cause several diseases by affecting majority parts of the human body. These electric field and current densities affects humans of all stages and causes short term diseases in them and sometimes death also.

Contradiction of EMF Effect on Human Health:

- There are two reasons why electromagnetic fields associated with power systems could pose no threat to human health.
- First, The EMF from power lines and appliances are of extremely low frequency and low energy. They are non-ionizing and are markedly different in frequency from ionizing radiation such as X-rays and gamma rays. As a comparison, transmission lines have a low frequency of 60Hz while television transmitters have higher frequencies in the 55 to 890 MHZ range. Microwaves have even higher frequencies, 1,000 MHZ and above. Ionizing radiation, such as X-rays and gamma rays, has frequencies above 1015 Hz. The energy from higher-frequency fields is absorbed more readily by biological material. Microwaves can be absorbed by water in body tissues and cause heating which can be harmful, depending upon the degree of heating that occurs. X-rays have so much energy that they can ionize (form charged particles) and break up molecules of genetic material (DNA) and no genetic material, leading to cell death or mutation. In contrast, extremely low frequency EMF does not have enough energy to heat body tissues or cause ionization.
- Second, all cells in the body maintain large natural electric fields across their outer membranes. These naturally occurring fields are at least 100 times more intense than those that can be induced by exposure to common power-frequency fields. However, despite the low energy of power-frequency fields and the very small perturbations that they make to the natural fields within the body.
- When an external agent such as an ELF fields lightly perturbs a process in the cell, other processes may compensate for it so that there is no overall disturbance to the organism. Some perturbations may be within the ranges of disturbances that a system can experience and still function properly.
- During Research on health effects of electric and magnetic fields, it has come forward that electric field intensity exposure of about 1-10 mv/m in tissue interact with cells but not proved to be harmful. But strong fields cause harmful effects when their magnitude exceeds stimulation thresholds for neural tissues (central nervous system and brain), muscle and heart

Surface Current Density(mA/m2)	Health Effect
<1	Absence of any established effects.
1 To 10	Minor biological effects.
10 To 100	Well established effects(a) Visual effect.(b) Possible nervous system effect
100 To 1000	Changes in central nervous System
>1000	Ventricular Fibrillation (Heart Condition 0. Health hazards.

- In India it is stipulated that electric field intensity should not exceed 4.16 kV/m and magnetic field intensity should not exceed 100μT in public areas.
- Even when effect is demonstrated consistently on the cellular level in laboratory experiments, it is hard to predict whether and how they will affect the whole organism. Processes at the individual cell level are integrated through complex mechanisms in the animal.

Mitigation of EMF Effect of Transmission Line:

1) Line shielding:

- There are two basic 60-Hz magnetic field mitigation (reduction) methods: passive and active.
- Passive magnetic field mitigation includes rigid magnetic shielding with ferromagnetic and highly conductive materials, and the use of passive shield wires installed near transmission lines that generate opposing cancellation fields from electromagnetic induction.
- Active magnetic field mitigation uses electronic feedback to sense a varying 60-Hz magnetic field, then generates a proportionally opposing (nulling) cancellation field within a defined area (room or building) surrounded by cancellation coils. Ideally, when the two opposing 180-degree out- of-phase magnetic fields of equal magnitude intersect, the resultant magnetic field is completely cancelled (nullified). This technology has been successfully applied in both residential and commercial environments to mitigate magnetic fields from overhead transmission and distribution lines, and underground residential distribution (URD) lines.

2) Line Configuration and Compaction

- Line compaction means that, bringing the conductors close together keeping the minimum (safe) phase -to-phase spacing constant. Keeping all the parameters the same and the only variable is the phase-to-phase spacing. The magnetic field is proportional to the dimensions of the phase-to-phase spacing.
- Other studies showed that, increasing the distance between phases by increasing the height of the central phase conductor above the level of the other phase conductors leads to the reduction of the peak value of the magnetic field.
- Reducing the phase-to-phase distance, leads to the decrease of the magnetic field. This reduction between phases is limited by the electrical insulation level between phases.
- (A) For single circuit lines, compaction causes a great reduction to the maximum magnetic field values. This reduction of magnetic field allows for lower conductor heights above the ground. This leads to transmit the same power on shorter towers. This gives a great reduction of the tower cost.
- (B) For double circuit lines, some studies showed that, the use of optimum phase arrangement causes a drastic reduction to the maximum magnetic field values for both conventional and compact lines i.e. with vertical conductor

3) Grounding:

- Induced currents are always present in electric fields under transmission lines and will be present. However, there must be a policy to ground metal objects, such as fences, that are located on the right-of -way. The grounding eliminates these objects as sources of induced current and voltage shocks. Multiple grounding points are used to provide redundant paths for induced current flow and mitigate nuisance shocks.

4) **Providing Right of Way(R.O.W):**

- Overhead transmission systems required strips of land to be designed as right-of-ways (R.O.W.). These strips of land are usually evaluated to decrease the effects of the energized line including magnetic and electric field effects.

5) **Maintaining Proper Clearance:**

- Unlike fences or buildings, mobile objects such as vehicles and farm machinery cannot be grounded permanently. Limiting the possibility of induced currents from such objects to persons is accomplished by maintaining proper clearances for above-ground conductors tend to limit field strengths to levels that do not represent a hazard or nuisance.
- Limiting access area by increasing conductor clearances in areas where large vehicles could be present.

Conclusion:

- Based on the review and analysis and other research projects it is of the opinion that there is no conclusive and convincing evidence that exposure to extremely low frequency EMF emanated from nearby high voltage Transmission lines is causally associated with an increased incidence of cancer or other detrimental health effects in humans. Even if it is assumed that there is an increased risk of cancer as implied in some epidemiological studies, the empirical relative risk appears to be fairly small in magnitude and the observed association appears to be tenuous. Although the possibility is still remain about the verse effect on health by EMF.

References:

- SSGBCOE&T, Electronics and Communication Engineering-Girish Kulkarni1, Dr.W.Z.Gandhare
- Pharmacology, School of Medicine, Chung-Ang University, Seoul, Korea-Sung-Hyuk Yim, Ji-Hoon Jeong.
- Electrical Engineering Department, Shoubra, Benha University, Cairo, Egypt- Nagat Mohamed Kamel Abdel-Gawad.
- Madurai Kamaraj University-S. Somasekaran.
- Electrical Engineering Department at King Fahd University of Petroleum & Minerals- J. M. Bakhashwain, M. H. Shwehdi, U. M. Johar and A. A. AL-Naim.
- Dept. of Electrical Engineering. College of Engineering – University of Tikrit-Iraq- Ghanim Thiab Hasan, Kamil Jadu Ali, Mahmood Ali Ahmed.

About Jignesh.Parmar

Jignesh Parmar has completed his B.E(Electrical) from Gujarat University. He has more than 11 years experience in Power Transmission-Power Distribution-Electrical energy theft detection-Electrical Maintenance-Electrical Projects(Planning-Designing-coordination-Execution). He is Presently associate with one of the leading business group as a Assistant Manager at Ahmedabad,India. He is Freelancer Programmer of Advance Excel and design useful Excel Sheets of Electrical Engineering as per IS,NEC,IEC,IEEE codes. He is technical Author for "Electrical Mirror" and "Electrical India" Magazines. He

is Technical Blogger and Familiar with English, Hindi, Gujarati, French languages. He wants to Share his experience & knowledge and help technical enthusiasts to find suitable solutions and updating themselves on various Engineering Topics.

30 Responses to *Effects of High Voltage Transmission Lines on Humans and Plants*

moses says:
February 18, 2012 at 10:39 am
Thanks for the info, man

Reply
Mohd saood Khan says:
February 18, 2012 at 10:51 am
It needs more discussions & debates……

Reply
prakash chandra says:
February 22, 2012 at 5:15 pm
sir i am dooing my final year project on optimal location of interline power flow controller (ipfc) ,i am facing problem in design of IPFC controller in matlab simulation .if you having some idea about this topis then please help me .

Reply
theja says:
March 17, 2012 at 5:53 pm
very good article.An eye opener to everybody

Reply
Pushpinder Asthir says:
March 24, 2012 at 3:35 pm
It is an intersting article.But than we also need Transmission lines for the development and any large development that benefits mass population always effects some small portion of population.

Reply
suren says:
May 11, 2012 at 11:17 am
sir,
We are construction a g+ 3 upper floor building adjoining the 400KV NTPC line in bangalore,
Pl inform at what level we may have induction & danger to life,
what is the minimum clearence required form over head line to bulding.
answers may also be mailed to my mail is surend26@rocketmail.com

Reply
balasubramani says:
December 2, 2012 at 4:54 pm

sir i got a plot for house construction 10m from the overhead lines it will make any problem in future by legaly & safety and howmany meters clearence need from the OHLINES in india

Reply

Syed Rizwan says:
May 15, 2012 at 1:48 pm
Sir i would want to know your views on the Ultra high voltage transmission line being built by China having a length of 2,210 Km. Waiting for your blog on this topic .

Reply

Sandeep Beniwal says:
August 9, 2012 at 4:37 am
sir i would to know that when a new tower established on a field then what the payment made by power grid or the company who is establishing that tender tower. If the quality of irrigation on that area is very good. please reply me ASAP

Reply

shiraz says:
September 11, 2012 at 3:10 am
nice work
Shirazul Islam

Reply

karen says:
October 6, 2012 at 11:30 pm
Thank you for your clear, current info. we are considering a purchase of a home within 60 meters of 30 towers of hi voltage electric transmission lines. Would you live there? or want your family to live in this home?

thanks so,
karen

Reply

eli says:
October 11, 2012 at 3:33 am
I'm in a similar situation, but I want to buy the house is 350 meters from high voltage antennas, do you think that is bad for the health?

Thank you so much.

Eli

Reply

Bharat Bhushan says:
November 22, 2012 at 11:16 am
Hi , This is very good info indeed ,

I am trying to buy a home in builder society and there is high voltage line passing over it.The distance of flat I am looking is 10 mtrs away from line.Will that not effect health in any mean.

Please advise

Bharat.leo@gmail.com

Reply

hemant kharat says:
December 17, 2012 at 10:14 am
sir please tell me what are distance of electrical overhead tower line of 400 kv and living home its urgent please????

Reply

Jignesh.Parmar says:
December 17, 2012 at 6:02 pm
Refer Post of "Electrical Safety Distance Part 1 to 6" of this Blog

Reply

RAVI says:
January 14, 2013 at 4:26 am
we r planing to buy agriculture land of 20 acers. in between the high tension line and one high line pole is thare. is it safe to health for humans and plants? how much distance should maintain from the line hight and long?

Reply

mary kwan says:
January 24, 2013 at 4:52 am
Sir,
Thank you so much for yr helpful article. I am thinking about buying a flat in Hong Kong, it is 2/F on the building and the ground level is for stores and an electricity (maybe transforming) substation which seems to supply electricity for the complex. Is it safe, will there be radiation harmful for humans? Urgently needing your advice.

Reply

Guillermo Ferrando says:
March 19, 2013 at 1:05 pm
Hello: I need to find any article or reference about of the EMF effects on steel bridges. In a case, I need install a 33 KV electrical line over a steel bridge, but I think that is an dangerous situation for the people, vehicles and the steel of structure, because the electrical induced currents on the steel is (for me) of uncertain effects....Thank you. Guillermo

Reply

iman says:
March 28, 2013 at 9:45 am
al salam alaikm I'M a physics teacher, and graduate student, my thesis is about, the risk of high voltage transformers on human health, can you help me, all my thanks and God bless you. ,

Reply

shaneel says:
April 19, 2013 at 5:10 am
can any body tell me what is distance working on a live transmission lines of different voltages....

Reply

Jignesh.Parmar says:
April 20, 2013 at 5:58 pm

Review old post of this Blog

Reply

N.S.DUHAN says:

May 12, 2013 at 7:43 am

Sir, we r running a mild steel galvanized pipe mfg.co. We have a electronic weighing bridge of 80 m.t. cap. A high voltage (H.T.LINE) is going on the bridge. There is a big variation on weight. We called so many experts. But result is zero. Is it possible, that due to H.T. Line there is any effect on weighing bridge load cells.There r6 load cells in the bridge. If it is possible what r the remedies for this .Please suggest.
Thanks.

Reply

A Tierney says:

June 14, 2013 at 11:09 pm

Am I in any danger? I live in a 12 unit apt building with all the wires and boxes for cable, electricity, and phone serving it attached to my outside bedroom wall. I can sometimes hear a loud hum in the wires and have called the utility to do something about it. My neighborhood is a dense urban DC area.

My bed is within 3 feet of these wires and boxes. Is there any way to measure the strength of the electromagnetic field I am sleeping in? What distance mitigates the impact of this field?

My neighbor of 12 years, who lived below me with her bedroom in the same configuration, recently died of a lung disease. I have lived here for 9 years. I was recently diagnosed with a spot on my lung. Any advice you can offer would be appreciated.

ETN

Reply

suryabhan singh says:

August 14, 2013 at 3:27 pm

recently i purchased a house in mumbai later on i find a high tension cable over head wire passing around 80 to 90 meter away from my building is it safe pls suggest

Reply

Dr. Aung Ze Ya says:

September 5, 2013 at 8:25 am

Your document is very effective to us.
Thank you.

Reply

Charlie says:

September 15, 2013 at 2:55 pm

I have booked an apartment and yet to take possession. The distance between the flat and HT Line is 18Meters away. Is it advisable to proceed?

Reply

Bhagyaman Chettri says:

October 8, 2013 at 2:23 am

Sir Please advise me that what is that safe distance between high tension line 400kv and humam

Reply

Jignesh.Parmar says:
October 8, 2013 at 3:01 pm
Already given in the Blog

Reply

othman hasnaoui says:
November 4, 2013 at 9:05 pm
dear sir
I'm a phd student, my research is about the EMF Effects Human and plants and i want to know if there are a scientific studies who demonstrate if really there is a damage for human and plants.
Plz let me know

Reply

Peter Yougha says:
November 5, 2013 at 9:07 am
I'm a MSc GIS student, I am researching on effect on overhead power transmission lines near residential buildings in UK. I need contribution on EMF radiation from the power lines to the environment.

Reply

We oppose link J22 being used in this project. We are within the habitable structures within 500' of the transmission lines. Some of our neighbors would have pole's literally next to the houses. Our property and some of our neighbors property is home to livestock, wildlife, dogs and our family that enjoy our backyard. The health risk to our livestock, natural habitat for wildlife, dogs and family are a huge concern to us! Please consider an alternate route that does not include J22.

Request to Intervene in PUC Docket No. 55067

The following information must be submitted by the person requesting to intervene in this proceeding. This completed form will be provided to all parties in this docket. **If you DO NOT want to be an intervenor, but still want to file comments, please complete the "Comments" page.**

For USPS, send one copy to:

Public Utility Commission of Texas
Central Records
P.O. Box 13326
Austin, TX 78711-3326

For all other delivery or courier services, send one copy to:

Public Utility Commission of Texas
Central Records
1701 N. Congress Ave.
Austin, TX 78701

First Name: Stevanna Last Name: Matthews-Tyler

Phone Number: 940/735-2849 Fax Number:

Address, City, State: 11599 Olen Dr Justin TX 76247

Email Address: stetyler1@yahoo.com

I am requesting to intervene in this proceeding. As an INTERVENOR, I understand the following:

- I am a party to the case;
- I am required to respond to all discovery requests from other parties in the case;
- If I file testimony, I may be cross-examined in the hearing;
- If I file any documents in the case, I will have to provide a copy of that document to every other party in the case; and
- I acknowledge that I am bound by the Procedural Rules of the Public Utility Commission of Texas (PUC) and the State Office of Administrative Hearings (SOAH).

Please check one of the following:

☑ I own property with a habitable structure located near one or more of the utility's proposed routes for a transmission line.

☐ One or more of the utility's proposed routes would cross my property.

☐ Other. Please describe and provide comments. You may attach a separate page, if necessary.

Signature of person requesting intervention:

Stevanna Matthews-Tyler Date: 7/18/23