**Arizona Public Service**

**Merrill to Coolidge 69kV Transmission Line Project**

**FREQUENTLY ASKED QUESTIONS**

March 2023; rev’d September 2023

The following is a list of questions and answers to address the following topics:

* Project Specifics.
* Electricity.
* Understanding Easements and Rights-of-Way.
* Siting and Permitting.
* Land Acquisition.
* Safety Around Transmission Lines.
* Underground Versus Overhead.

# PROJECT SPECIFIC

Q. Why is Arizona Public Service (APS) building a 69kV transmission line connection between the Merrill Substation and Coolidge Substation?

**A.** The existing system may experience low voltage at the Merrill and Valley Farms substations, which serve surrounding communities, if there is an outage of the Coolidge to Valley Farms 115kV transmission line. Low voltage limits the ability of the transmission system to support existing and forecasted electrical demands from APS customers.

Also, electrical service into the Merrill Substation is supplied by a single source of power flowing in one direction. If there is an outage on the system, APS has limited capacity to redirect the power flows into the area. That could interrupt our ability to provide power to customers in the area.

This new 69kV line will connect the Merrill Substation to the Coolidge Substation to create a redundant power source to the Merrill Substation, also called a “looped system,” which will increase the system’s capacity for electricity in Pinal County.

Deferring this project increases the risk of APS being unable to serve the area reliably.

Q. What will the Merrill to Coolidge 69kV transmission line look like?

**A.** The proposed transmission line will be supported on steel monopoles, approximately 75 feet tall, with 250- to 350-foot spans between the monopoles. The monopoles will be constructed to support two 69kV circuits (referred to as a “double-circuit”) and a 12kV distribution line underbuild. One 69kV circuit will be installed initially. The second 69kV circuit and the 12kV distribution line will be installed in the future when additional electric capacity is needed. There are three conductors, or wires, per circuit, and there will be one or two smaller wires at the top of the poles providing ground or system communications.

**Q. What is the process for routing the new transmission line?**

**A.** APS is conducting a study to identify a suitable route for the transmission line. The study examines and evaluates alternative routes to identify a viable transmission line route that best meets engineering and safety standards while minimizing impacts on the community, land uses and the environment.

Q. When will construction start and end?

**A.** Construction is planned to begin in Q4 2026 with the transmission line in service Q1 2027.

Q. Will there be power outages while the line is being built?

**A.** APS will work to avoid outages while the transmission line is being built.

Q. What is the cost of construction, and will it affect my energy bill?

**A.** The cost of the new transmission line and future maintenance expenses have already been factored into APS’s planning budget. Therefore, you should not see an increase in rates.

# ABOUT ELECTRIC TRANSMISSION

Q. How does electricity get to my house from where it is made?

A. Electricity is produced in many different ways, from large-scale remote power plants, all the way to local small-scale renewable energy sources. However, the bulk of electricity, no matter where it is generated, travels over distances through a system of transmission and distribution lines, which carry the electricity to where it is needed, and substations convert the voltage to an amount usable by a specific customer.

Q. What is a transmission line?

**A.** Transmission lines are high-voltage conductors (wires)supported by various types of structures that carry electricity from generation plants to substations, or from substation to substation.

Q. What is electrical transmission?

**A.** Transmission lines are a vital link used to deliver bulk electricity over long distances from power sources (generation) to transmission substations closer to homes and businesses. A strong transmission system helps ensure reliable electricity. Transmission-level electricity is transformed (or stepped down) to lower voltages to distribute electricity to consumers. These interconnected systems form regional grids allow power to flow from one area to another, ensuring reliable and efficient delivery to customers, even during emergencies.

Q. What determines the need for a new or upgraded transmission line?

**A**. In determining the need for a new or upgraded power line, utilities evaluate several factors. The primary factors are: (1) system capability to maintain adequate service, (2) system ability to serve projected load (demand) and (3) system transfer capability to deliver new resources or provide emergency assistance to adjacent power systems. The system’s capability to maintain adequate service is affected by the age of the transmission lines and by growth in the area that the system serves. Sometimes new lines are necessary to maintain current levels of service to customers as infrastructure ages. Additionally, projected changes to system capacity or the addition of new sources must be planned for years in advance due to the length of time needed for siting, permitting, engineering and materials acquisition.

Q. What is considered in siting a transmission line or substation?

**A.** Once the need for a facility has been established, several considerations determine where the transmission line is located and how long planning and construction will take. These considerations include existing system facilities, current and future land uses, negotiation with landowners, terrain, environmental effects, economics and public comments.

Q. What determines the cost of a transmission line?

**A.** A combination of factors determines the cost of constructing a new or upgraded transmission line. First is the length of the line and the terrain and environment it crosses. While a straight-line path for a transmission line may be desirable, routing a transmission line requires evaluation of a number of factors such as existing and planned land use, existing facilities and infrastructure, environmentally sensitive areas, terrain and other factors that affect locating the transmission line route. Would the transmission line be a compatible use with these factors or are the factors constraints to routing the transmission line? Should the constraining factors be avoided by the transmission line route or can the effects be mitigated? The outcome of this evaluation process and the cost of materials, right-of-way acquisition and construction all contribute to the cost of a project.

**Q. I live in an established neighborhood. Why are new transmission lines needed in my area?**

**A.** There are multiple reasons why new transmission lines may be needed in an existing area.

One common possibility is due to nearby growth. APS’s system is set up as a grid. This means that through an interconnected set of substations and power lines, power is delivered from the bulk source to the customer. In most cases, there are redundant paths for the power to make it to the customer. However, as the system is a grid, this may mean that an additional power line is needed in an already connected area to bolster the already existing system and accommodate nearby growth.

In some cases, a neighborhood may be served by a radial (single) line, and APS may be adding a line to provide a second source into the area to improve reliability.

Our customers are also using more energy than ever before, even in established areas.

**Q. What is the noise I hear from transmission lines?**

**A.** Transmission line noise can be described as humming or crackling. Audible noise from the power lines is created by:
• Corona discharge along the line.
• Frequency and voltage level of the line.

Corona is defined as the breakdown of air into charged electrical particles. The amount of corona for a transmission line is a function of several things, including:
• Engineering design.
• Voltage.
• Phase spacing and geometry.
• Weather conditions.

Effects of corona can include:
• Audible noise.
• Radio and TV interference.

Suggested noise levels:
• Electric Power Research Institute (EPRI) studies show that customer complaints are registered at 52.5 decibels, A-weighted (dB(A)).
• The Environmental Protection Agency (EPA) has concluded that day/night (Ldn) sound levels below 55.0 dB(A) will not cause interference or annoyance with outdoor activities.

Noise levels on a typical extra-high voltage transmission line are expected to be less than the suggested levels.

# UNDERSTANDING EASEMENTS AND RIGHTS-OF-WAY

Q. What is an easement?

**A.** An easement is a permanent right authorizing a person or party to use the land or property of another person or party for a particular purpose. In the case of 69kV and higher voltages, APS will acquire an exclusive easement for the line. APS acquires certain rights to build and maintain a transmission line on the property of the landowner. An easement agreement is the legal document that is signed by the landowner. which grants APS the right to use the property for placement of the transmission line and is often recorded at the county records office similar to other property deeds. If the line parallels a roadway, we may use the roadway right-of-way to overhang our lines and do maintenance on that side of the pole. The poles would be in an easement. The reason for this is that, due to our franchise agreements, we are required to relocate our facilities at our expense in road right-of-way if the road is widened or water/sewer lines require more room. Easements are common on private property, including streets, cable TV, telephone, gas and electric uses.

Q. What is a right-of-way?

**A**. A right-of-way is the land area and any associated access and/or maintenance rights acquired for a specific purpose, such as a transmission line, roadway or other infrastructure.

Q. What is the difference between an easement and a right-of-way?

**A.** An easement is a land right document, and a right-of-way is the physical land and area upon which the facilities (transmission line, roadway, etc.) are located.

Q. How long does an easement last?

**A.** Terms of the easement are written in the easement agreement. Most of APS’s easements are perpetual and not subject to termination or expiration. Once an easement is signed, it becomes part of the property record. APS, the landowner who signed the easement, and all future property owners, are bound by the agreement terms. If APS removes the transmission line and abandons the right-of-way, it can release the easement rights.

Q. How are landowners paid for an easement?

**A.** Landowners typically are given a one-time payment based on fair market value for easement rights to their land, traditionally based on the appraised land value. The majority of land is still usable for the same purpose it had been used for, particularly in agricultural settings.

Q. Who pays property taxes for the right-of-way on which the transmission line is constructed?

**A.** The landowner continues to pay property taxes on the property in which a r/w or easement is acquired.

Q. What easement rights will be needed for the construction of a transmission line?

**A.** Easements will be needed that allow for the construction, operation and maintenance of a transmission line across a defined right-of-way located on the landowner’s property. These easements will include the right to clear, trim and remove vegetation and trees from within the right-of-way, as well as tall and dangerously leaning trees adjacent to the right-of-way that may threaten the line if they fall. Easements for electric transmission lines generally restrict the placement of permanent structures within the right-of-way.

# SITING AND PERMITTING

**Q. Doesn’t APS need to get permission from the state, county or city to build new transmission lines?**

A. For transmission lines 115kV or greater, APS is required to obtain a [Certificate of Environmental Compatibility](https://www.aps.com/en/About/Construction-and-Power-Line-Siting/Power-Line-Siting/CEC-Process) (CEC) from the Arizona Corporation Commission (ACC).

Siting for lower voltage lines does not require approval by the State of Arizona, nor by individual communities; however, in most cases, APS follows a similar [public siting process](https://www.aps.com/en/About/Construction-and-Power-Line-Siting/Power-Line-Siting/Siting-Process) to determine where 69kV lines will be located.

Q. What is a siting study?

**A.** A siting study is a comprehensive and systematic process of sequential steps that consider technical criteria from APS’s system planners and engineers, environmental and site-specific data analyses, along with agency and community input. This process reveals constraints and opportunities for routing a transmission line and helps us identify and evaluate alternative routes. Route alternatives are evaluated in detail and compared to identify a preferred, viable route for the transmission line. A preferred route is generally a starting point from which minor route adjustments (micro-siting) may be made as APS collaborates with landowners along this route.

Q. Will any new routes be added or are these all the routes considered?

**A.** The siting study being conducted by APS will result in multiple route alternatives for the proposed transmission line. As the alternatives are reviewed in detail and comments are received from landowners, other local stakeholders and local government officials, there may be adjustments made to the preliminary alternative routes and/or new alternatives evaluated.

Q. Can APS put the lines over existing underground oil/gas transmission lines?

**A.** Yes. If it is an underground oil or gas pipeline, the power line can cross over the pipeline. If the pipeline and transmission line are parallel, that is feasible as well, but there has to be some additional engineering to make sure that there is no conflict between the transmission line and the underground pipelines. However, it is common for those facilities to overlap rights-of-way and be next to each other.

**LAND ACQUISITION**

Q. How will land be acquired?

**A.** A real estate representative will negotiate with property owners based on the fair market value of the easement area.

Easement rights may include:

* The length and width of the right-of-way.
* The number of and placement of pole structures .
* Right-of-way clearing and construction practice.
* Access for construction and post-construction maintenance.

# SAFETY AROUND TRANSMISSION LINES

Your safety is first and foremost. We design, construct, operate and maintain transmission lines and substation facilities to meet or exceed the requirements of the National Electric Safety Code, United States Department of Labor occupational safety and health standards and our own power system safety standards. We provide a maximum degree of safety and protection for the landowner and landowner’s property, the public and our own employees.

Most activities can continue as before, including agriculture and ranching. The main restrictions in the right-of-way include limiting tall-growth trees that could contact the power line causing damage and limiting permanent structures in the right-of-way.

## Machinery and Vehicle Guidelines

One of the most important rules to follow when working around transmission lines with tall equipment is simple. LOOK UP. Know where the transmission lines are and stay away from them.

Q. How can farm equipment and other machinery be safely operated near transmission lines?

**A.** If you are considering operating a vehicle with a height greater than 14 feet, always remember:

* Physical contact with transmission lines is extremely hazardous and can cause a lethal shock. Equipment SHOULD NOT be operated under a transmission line in a manner that causes contact or near contact with the wires.
* DO NOT lift, elevate or pass under a transmission line any object, tool or vehicle that could make contact or near contact with the wires.
* To help prevent arc flashing or an explosion, it is recommended that equipment, antennas and people stay at least 14 feet away from any energized transmission line.

**Q. Can machinery be fueled safely near a transmission line?**

**A.** Fueling vehicles or equipment under transmission lines is not recommended. If you must fuel a vehicle or equipment under a transmission line, use a non-metallic (plastic) container. The vehicle also should be grounded to eliminate any source of sparks.

Q: Is the transmission line going to interfere with the GPS for the farming equipment?

**A:** No. The GPS [global positioning system] functions are on a different wavelength than the electrical fields on a transmission line.

## Building or Planting Guidelines

The North American Electric Reliability Corporation (NERC) requires electric utilities to meet stringent requirements designed to keep our electric system safe and reliable, including standards for maintaining proper clearances. APS works to maintain a certain amount of distance around transmission lines that is clear of anything that may make contact or near contact with a conductor wire or potentially cause damage to the poles. This includes buildings and vegetation.

Trees or other vegetation that could grow into or fall across the conductors may have to be trimmed, topped or removed. You must call APS before planting any trees or shrubs or building any structures in power-line right-of-way areas to help avoid problems in the future.

**Q.** Can anything be planted in the right-of-way area?

**A.** For your benefit, DO NOT plant any trees or shrubs in the right-of-way area before talking to an APS representative first. As a landowner, even with an easement granted, most property rights remain with the landowner, but utilities must remove tall trees that grow in the right-of-way area. Activities in the easement area that do not interfere with the safe construction, operation and maintenance of the power line, including most agriculture, are permitted.

Q. Can buildings or other structures be constructed beneath a transmission line?

**A.** Not without written approval from APS. Buildings and other structures generally are not permitted on rights-of-way. It is important that you discuss projects with APS to avoid creating situations that could become unsafe to the landowner and/or utility workers.

## Fence Guidelines

Fence wires mounted on metal fence posts can build up an electrical charge near transmission lines. Important factors are:

* Length of fence paralleling the transmission line.
* Distance between the transmission line and the fence.
* Amount of moisture in the fence posts and the ground.
* Presence of grounding devices such as metal fence posts or weeds growing next to the fence.

Q. What do I need to know about non-electric fences?

**A.** Non-electric fences made of barbed wire or similar materials directly attached to and near a transmission line, use at least one steel post every 150 to 200 feet to ground the fence.

## Irrigation and Watering Guidelines

The potential for water and metal to conduct electricity makes it important to take safety precautions when irrigating near transmission lines. Additionally, fertilizers and pesticides tend to increase conductivity of water, making extra precautions necessary. Watering the lawn at a home or business is not problematic; however, you still must prevent a direct, solid stream of water from contacting the transmission line.

**Q. Can I irrigate near transmission lines?**

**A.** Yes, if you take these precautions:

* Prevent a solid stream of water from hitting the wires. Equipment with nozzles that are small in diameter or spray a fine mist typically is not problematic because the solid part of the water stream will not reach the transmission line wires. Also, an intermittent spray of water will not conduct significant amounts of electricity. Even large-diameter nozzles operating at their normal spray angle typically will not reach the wires with a solid stream. However, at no time should the solid part of a water steam touch transmission line wires. Should that happen, turn the water off by switching the pump off before trying to correct the problem.
* Make sure the irrigation system is well grounded. If you have questions as to whether your irrigation system is adequately grounded, call APS.
* Check with APS before installing a new irrigation system in the vicinity of a transmission line. Each system should be reviewed on a case-by-case basis; questions about the installation and operations of an irrigation system adjacent to or under a power line should be directed to APS.
* DO NOT install long lengths of pipe parallel and adjacent to transmission lines. They should be laid out at right angles to transmission lines, if possible, to reduce the risk of pipes building up an induced charge.
* Be careful when moving the pipelines. When loading irrigation pipelines, stay at least 50 feet from transmission lines to avoid any chance of raising them too close to the wires.

## Safe Construction and Maintenance Practices

Q. How do I know transmission lines are safe?

**A.** Transmission lines are built and maintained to meet or exceed safety standards specified by the National Electric Safety Code and the North American reliability Corporation. Every effort is made to ensure safety in construction, operation, and maintenance of transmission lines. For information on safe distances for specific activities near power line infrastructure, contact APS. Transmission lines and line infrastructure are designed to withstand extreme weather conditions. Protective devices at transmission line terminals stop the electricity flow under abnormal operating circumstances.

Q. How do you monitor the safety of the transmission line?

**A.** APS follows strict transmission-line maintenance standards. Transmission lines are inspected regularly and by air to look for the following:

* Non-compatible vegetation and hazards within the right-of-way.
* Equipment needing repair or replacement.
* Right-of-way encroachments, which can be hazardous to safety and reliable operations.
* Anything that might jeopardize safe, reliable operation of the power line.

APS must visit the right-of-way for these inspections, but visits may be minimal, and landowners will be contacted prior to inspections or maintenance. However, in cases of emergency, advance contact may not be possible.

## Birds and Transmission Lines

APS uses several strategies to reduce the number of birds that are injured or killed when they contact transmission lines or electrical equipment. The strategies are:

* Preventive – conducting risk assessments and using avian-safe standards where possible.
* Proactive – educating employees and being involved in organizations that conduct avian interaction research.
* Reactive – documenting mortalities, notifying resource agencies and applying remedial measures where appropriate.

For additional information regarding birds and transmission lines, visit the Avian Power Line Interaction Committee website at [www.aplic.org](http://www.aplic.org/).

Q. What measures are taken to manage roosting and nesting?

**A.** Transmission-line structures and equipment can be attractive to birds for roosting and building nests. APS tries to minimize the risk of electrocution or injury to birds, of damage to electrical equipment and outages to customers that may result when birds come in contact with transmission lines and structures. Perch discouragers are used to try to keep birds from perching or roosting on utility equipment. Nest management programs include installing nest boxes or platforms in safe areas on or near structures, where warranted. Additionally, APS personnel are educated on nest reporting, nest removal and platform construction**.**

Q. What measures are taken to avoid bird electrocution?

**A.** Problems that do arise can be corrected in two primary ways:

* Isolation – moving the components farther apart to achieve the necessary clearance.
* Insulation – using covers on various electrical components to prevent contact with the component that would cause the electrocution.

APS complies with Avian Power Line Interaction Committee (APLIC) guidelines.

Q. What measures are taken to minimize bird collisions with transmission lines?

**A.** There are measures that can be taken before construction and after construction.

## Pre-Construction Efforts

* Use vegetation, topography, or man-made structures to shield lines.
* Cluster lines together.
* Site lines away from obvious flyways if possible.

## Post-construction efforts

* Modify habitats.
* Create habitats on the same side of the power line to minimize crossings.
* Minimize human activities/disturbances near the line (educational process).

## Marking Lines

Marking lines with various types of markers can decrease but not eliminate bird collisions. The different types of markers vary in effectiveness. Devices include bird flight diverters and clamp-on markers.

# OVERHEAD VS. UNDERGROUND

**Q. Why doesn’t APS place all electric transmission lines underground?**

**A**. Placing transmission lines underground is significantly more expensive than placing transmission lines overhead. This is due to more intensive construction activity plus the use of special materials and conductors required for underground use. In particular, trenching or boring for the entire length of the transmission line can be difficult as well as expensive. Depending on the voltage and the location of the transmission line and considering the inability to be cooled by the ambient (surrounding) air as in an overhead configuration, underground transmission lines may require special technology to keep the wires cool. This technology may include oil or gas filled pipe type conductors, forced and refrigerated oil-cooled piping and forced airflow.

Buried power lines also can extend power outages, as it may take additional time to locate a specific power issue and take more time to access the fault and repair it. Additionally, underground systems can be prone to flooding in certain conditions.

Typically, lower-voltage (distribution) lines are buried with new developments, as the additional cost to place the lines underground is passed onto home buyers or business owners by the developer through impact fees.

**Q. Why do some areas have underground transmission lines and others do not?**

A. To help keep prices lower for all customers and provide efficient access to our systems, our standard practice is overhead construction for transmission lines. However, there may be instances where underground installation takes place, such as through development agreements or where individual customers have paid for the lines to be placed underground through a utility facilities improvement district that is established by municipal and/or county authorities. The local municipal authority may establish an improvement district if approved by a majority of affected property owners. A district is a taxing authority, taxing affected property owners in order to raise funds for the additional cost of placing cables underground.

***Other General Information Regarding Undergrounding***

Overhead, transmission lines are a reliable, low-cost, easily maintained and established method to transport bulk electricity. Unlike lower-voltage distribution lines, which deliver electricity to homes and businesses, transmission lines are not frequently installed underground because of several factors, including cost. Underground transmission lines require insulated underground cables and a concrete trench with truck-size manholes along the length of an underground line, increasing building costs 10 times or more. Burying transmission lines results in more impacts on the environment than placing them overhead. The benefits and costs of undergrounding are important issues since the benefit gained from undergrounding the line may be limited while the cost is shared. While underground transmission lines are expected to have fewer weather-related outages, underground lines can still fail. And when outages occur, it takes an average of 8 to 10 extra days to repair an underground line than an overhead line. Also, the lifespan of underground lines is estimated to be about half that of overhead lines. [With a few notable exceptions, our nation’s utilities have found that building cross-country transmission lines underground is cost-prohibitive.]

Q. Why not bury transmission lines?

**A.** Electric utilities consider the following factors when deciding whether to construct transmission facilities above ground or bury them:

* **Power** Restoration – Damage to underground transmission lines is difficult to pinpoint and repairs may take a few weeks to several months. Damage to overhead lines is easy to locate and typically takes several hours or days to repair.
* **Capacity Requirements** – Many cables are often required to match the capacity of the overhead circuit. Additional components increase the underground cost as a duct bank, vaults, splices and terminations are required that also can reduce overall system reliability.
* **Line-length Challenges** – High-voltage underground lines may require additional equipment to ensure proper electrical performance along the distance of the transmission line. The additional equipment translates to a higher overall cost, limits the length of the underground line installation and increases the likelihood of failure because of additional components. A system study would be required to determine if this additional equipment would be required.
* **Multiple Cables and Cooling Options –** Overhead lines are air-cooled and widely spaced for safety. Underground cables are installed in concrete-encased PVC duct banks. Heat generated by the cables is dissipated into the earth.
* **Construction Impacts** – Burying transmission lines results in more environmental impacts than placing them overhead. An overhead line typically requires erecting structures and placing foundations every 500 to 1,000 feet. Typical structures can be up to 120 feet tall, while the diameter of the foundation ranges from 5 to 8 feet. Burying transmission lines often requires a continuous trench several feet wide and deep. Considerable clearing and grading would be necessary; dust and noise from construction would last longer than it would for overhead construction. Large concrete splice vaults or access structures are needed periodically along the trench. Permanent access to the vaults is required to make repairs when needed.
* **Easement and Land Purchase Requirement** – An overhead line typically has a wider easement footprint than an underground line.
* **Life Expectancy** – Underground high-voltage transmission lines have a life expectancy of 40 or more years, while overhead lines have a life expectancy of more than 80 years.
* **Costs** – An underground line costs 10 to 15 times more than an overhead line due to time, materials, processes, the need to include transition substations and the use of specialized labor. Part of the added cost to bury lines may include routing and boring to avoid other underground installations, such as water, natural gas and sewer lines. An overhead line often can be routed around or over these difficult areas.
* **Electric and Magnetic Fields** – Electric and magnetic fields generally are greater directly over an underground installation (the earth does not provide shielding) and directly under an overhead installation.
* **Noise and Lighting** – High voltage overhead high-voltage lines can emit hissing or humming noises. Underground lines are silent except in the immediate area near the transition substations.
* **Transition Stations** – High-voltage underground transmission lines require small transition stations wherever the underground cable connects to overhead transmission. Transition stations require grading, access roads, stormwater management facilities and fencing in some cases.
* **Site Restoration** – Site restoration for underground construction is a much larger endeavor than it is for overhead construction because soil is disturbed along the entire route. Topsoils must be restored and returned to vegetated areas, and all hard surface areas must be re-established to meet local codes. Vegetated areas may require up to two years to return to pre-construction conditions. Trees and large shrubs would not be allowed above the underground line due to potential problems with roots. In farmland or natural areas, some herbaceous vegetation and agricultural crops may be allowed to return to the right-of-way.

# ELECTRIC AND MAGNETIC FIELDS

**Q. What are electric and magnetic fields?**

**A.** 60 Hertz (Hz) electric and magnetic fields (known as “EMF”) are produced by all devices which use, carry or produce electricity, including household appliances, office equipment, power lines and wiring in buildings. These are actually two separate fields; the electric field is caused by the voltage on a conductor, while the magnetic field is caused by the current flowing in a conductor.

For transmission lines, this means that the electric field is relatively constant (since the voltage of a transmission line does not fluctuate), while the magnetic field varies throughout time depending on the current flowing in the transmission line (this is a function of how much electricity our customers are using at any given time). The strength of both fields decreases as distance from the source increases. In addition, the electric field is easily shielded by solid objects such as buildings or trees, while the magnetic field is generally not shielded by these objects.

Due to these factors, and the fact that high-voltage transmission lines are placed on poles high in the air, the field strengths at ground level near high-voltage transmission lines, particularly the magnetic field strengths, are often similar to those encountered in proximity to common household, school and office electrical appliances.

There have been scientific studies on the potential health effects of EMF for more than 25 years. For a more thorough understanding of this research, we recommend reviewing websites of organizations such as the [National Institute of Environmental Health Sciences](https://www.niehs.nih.gov/health/topics/agents/emf/) and the [World Health Organization (WHO)](https://www.who.int/peh-emf/en/). The WHO website, as of March 2017, states, “Extensive research has been conducted into possible health effects of exposure to many parts of the frequency spectrum. All reviews conducted so far have indicated that exposures below the limits recommended in the ICNIRP (1998) EMF guidelines, covering the full frequency range from 0-300 GHz, do not produce any known adverse health effect.”

APS recognizes that research into potential health effects from exposure to EMF is ongoing and we try to respond appropriately. We follow this research closely, and over the years we have helped to fund and participate in some of this research. We also include EMF considerations in the design and siting of new power lines or structures. In addition, we can provide educational materials and field-strength information on existing and proposed transmission lines as necessary. All of our construction standards and practices meet or exceed the nationally accepted standards of the National Electrical Safety Code.

Refer to APS EMF fact sheet.

***Other General Information Regarding EMF***

***PLEASE NOTE: While the following responses to questions frequently asked by the public have been prepared from credible sources of information (e.g., World Health Organization, American Cancer Society, United States National Cancer Institute,*** [***National Institute of Environmental Health Sciences***](https://www.niehs.nih.gov/health/topics/agents/emf/)***), it is preferred to provide explanation from the text above or refer inquiries to the APS EMF fact sheet or APS EMF Expert.***

**Q. What are electric and magnetic fields?**

**A.** Electric fields are created by voltage—the higher the voltage, the stronger the field. Anytime an electric appliance is plugged in, even if it is not on, an electric field is created in its vicinity. The farther away you move from the source of the electric field, the weaker it becomes. Moving even a few feet away from an appliance makes a difference in the strength of the field that you’re exposed to.

Magnetic fields, measured in milliGauss (mG), are produced by electric current and only exist when electricity is flowing through a wire or an appliance is turned on—the higher the current, the greater the magnetic field. As with electric fields, the strength of a magnetic field dissipates rapidly as you move away from its source.

Q. Why are you calling them electric and magnetic fields instead of electromagnetic fields? Is there a difference?

**A.** These terms are often used interchangeably, and both electric and magnetic fields from transmission lines and electromagnetic fields may be abbreviated as EMF. However, there are differences between low-frequency transmission line EMF and higher frequency radio waves.

The frequency (i.e., the rate of time variation) of fields produced by the generation, transmission and use of electricity – typical of most household and office appliances and transmission lines – are low, and electric and magnetic fields exist separately. At higher frequencies, such as with radio or TV signals, the fields are interrelated and are more accurately described by the term “electromagnetic.” Radio and TV electromagnetic waves are meant to transmit away from the antenna and carry radio frequency energy to the receiver. The EMF from transmission lines is too low in frequency to carry any significant energy away, and the electric power stays on the utility lines.

It is important to recognize that transmission line EMF and radio frequency electromagnetic waves should not be confused with ionizing radiation such as X-rays. Because of its dramatically higher frequency, ionizing radiation (like X-rays) has enough energy to alter chemical bonds and damage biological molecules, something that lower frequencies in the electromagnetic spectrum (transmission lines, radio, TV and infrared) cannot do.

Q. Do EMFs interfere with pacemakers or other medical devices?

**A.** High levels of transmission-line EMF can interfere with a pacemaker’s ability to sense normal electrical activity in the heart. Most often, the electric circuitry in a pacemaker might detect the interference of an external field and direct the pacemaker to fire in a regular, life-preserving mode. This isn’t considered hazardous and is a life-preserving default feature. There have been cases with dual-chamber pacemakers triggering inappropriate pacing before the life-preserving mode takes over. Newer pacemakers have been designed to be less susceptible to this type of interference.

The American Conference of Governmental Industrial Hygienists issued guidelines for EMF exposure for workers with pacemakers or implantable defibrillators. Maximum safe exposure for workers with these medical devices at 60 hertz (the frequency of most transmission lines) is 1.0 G (1,000 mG) for magnetic fields and 1.0 kilovolt per meter for electric fields. Non-electronic metallic implants (artificial limbs, screws, pins, etc.) can be affected by high magnetic fields like those produced by MRI devices but are generally unaffected by the lower magnetic fields produced by most other sources.

Q. Do EMFs from transmission lines pose health hazards?

**A.** The issue has been studied for more than 40 years by government and scientific organizations around the world. The balance of scientific evidence indicates exposure to electric and magnetic fields cannot conclusively be linked to the cause of disease. Organizations include the World Health Organization and the United States National Cancer Institute and others.

Q. Is there a line between EMF exposure and childhood leukemia, brain cancer or other forms of cancer in children or cancer in adults?

Results of more than 40 years of studies by government and scientific organizations around the world indicate exposure to electric and magnetic fields does not cause disease. Organizations include the World Health Organization and the United States National Cancer Institute.

Q. Are there medical studies on EMF that APS can provide?

**A.** The following are links to more information and studies on EMF:

World Health Organization “Electromagnetic fields and public health,” World Health Organization fact sheet, [Radiation: Electromagnetic fields (who.int)](https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields)

Environmental Health Criteria 238, Extremely Low Frequency Fields, [Extremely Low Frequency Fields (who.int)](https://www.who.int/publications/i/item/9789241572385)

American Cancer Society: Power Lines, Electrical Devices and Extremely Low Frequency Radiation, [Power Lines, Electrical Devices, and Extremely Low Frequency Radiation | American Cancer Society](https://www.cancer.org/cancer/risk-prevention/radiation-exposure/extremely-low-frequency-radiation.html)

United States National Cancer Institute: Electromagnetic Fields and Cancer, [Common Cancer Myths and Misconceptions - NCI](https://www.cancer.gov/about-cancer/causes-prevention/risk/myths)

Health Canada: Electric and Magnetic Fields from Power Lines and Electrical Appliances, [Power lines and electrical products: Extremely low frequency electric and magnetic fields - Canada.ca](https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/power-lines-electrical-appliances.html)