

A NATURAL HISTORY OF THE WOODEN UTILITY POLE



California Public Utilities Commission

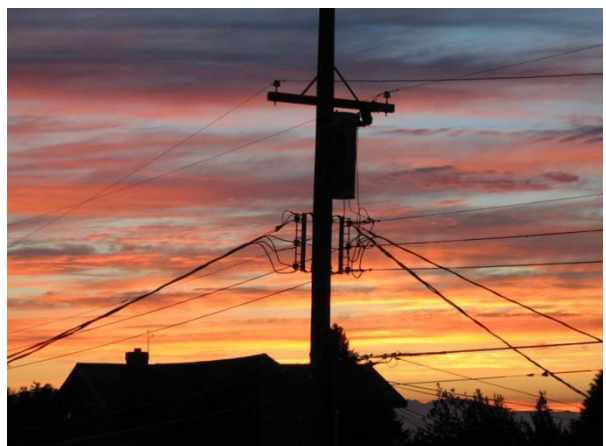
July 2017

**April Mulqueen
Policy and Planning Division
California Public Utilities Commission
San Francisco**



**...Yet they are ours. We made them.
See here, where the cleats of linemen
Have roughened a second bark
Onto the bald trunk. And these spikes
Have been driven sideways at intervals handy for human legs.
The Nature of our construction is in every way
A better fit than the Nature it displaces
What other tree can you climb where the birds' twitter,
Unscrambled, is English? True, their thin shade is negligible,
But then again there is not that tragic autumnal
Casting-off of leaves to outface annually.
These giants are more constant than evergreens
By being never green.**

----- Excerpt from "Telephone Poles" by John Updike, 1963



1. Early Communications: Eyes, Wings, and Feet

Before the modern communications era, it was very difficult to communicate over a distance.

Clockwise from upper left: beacon towers along the Great Wall of China used fire and smoke to warn of approaching armies; Phidippides ran 26 miles to deliver the news of the Greek victory at the battle of Marathon, and died from the effort; carrier pigeons have been used to carry brief (and lightweight) messages for thousands of years; and in 1775, lanterns in a window at Boston's Old North Church signaled the direction of the British Army's march towards Lexington and Concord, Massachusetts: "one if by land, two if by sea!"



Figure 1



Figure 2

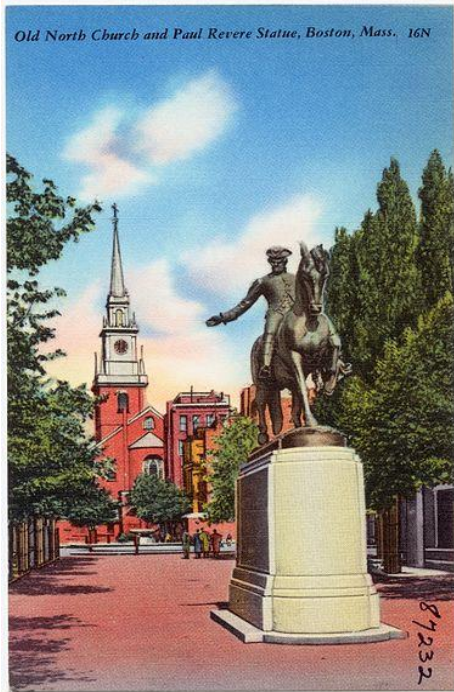


Figure 4



Figure 3

More complicated messages had to be written down and carried, and delivery over a distance could be quite slow. For example, in 1841, it took 110 days for news of President William Henry Harrison's death to reach Los Angeles.¹ 110 days is more than three times as long as William Henry Harrison served as President. 110 days is also the gestational period of a lion. While 110 days might be the right length of time to wait for a lion cub to be born, it is a long time to wait for important news.



Figure 5

2. The Telegraph: Forty Miles, and a Mistake

In 1843, the United States Congress gave Samuel Morse \$30,000 for a demonstration project to prove he could send messages over a distance more quickly and efficiently than the means available at the time. Morse and his partners began laying underground telegraph wires between the Capitol Building in Washington, D.C., and a railroad station in Baltimore, a distance of forty miles.

Unfortunately, the wires were defective, and Morse and his partners were running out of time and money. One of Morse's partners suggested that the quickest way to complete the project would be to string telegraph wires overhead on trees and wooden poles.

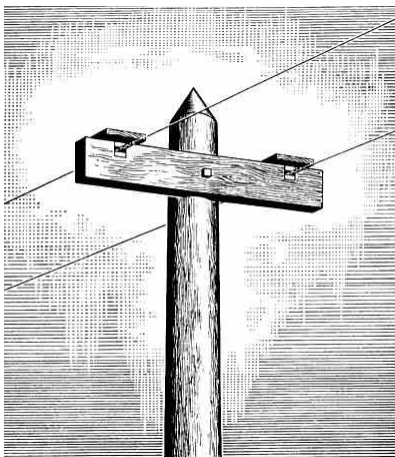


FIG. 2 MORSE'S FIRST TELEGRAPH LINE—1844

Figure 6

¹ Global Connections: Volume 2, Since 1500: Politics, Exchange, and Social Life in World History By John H. Coatsworth, Charles Tilly, Juan Cole, Louise A. Tilly, Michael P. Hanagan, and Peter C. Perdue, Cambridge University Press, March 2015, at 247.

The wooden utility pole was born, albeit as a mistake.

On May 24, 1844, thanks to telegraph wires hastily strung on hundreds of wooden utility poles, the phrase “What Hath God Wrought” was successfully telegraphed via Morse code from D.C. to Baltimore and back.



Figure 7

Although the first wooden utility poles were the result of a mistake, they caught on quickly; aside from the Plains, the United States is richly forested, and the raw material for wooden utility poles was readily available. Soon there were thousands of wooden utility poles carrying telegraph signals around the eastern and the western portions of the United States, although the eastern and western networks were not yet connected.

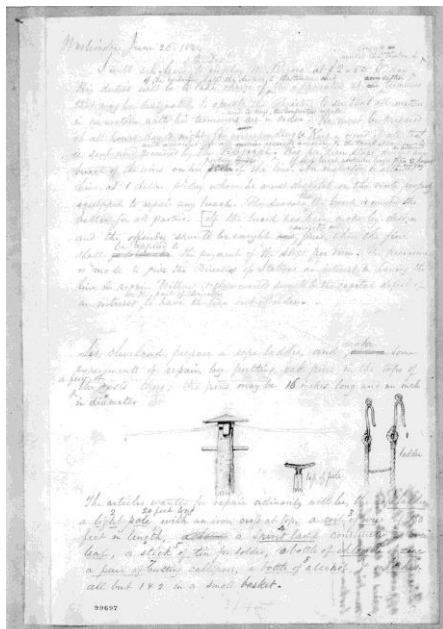


Figure 8

3. Coast to Coast: The Pony Express and the Transcontinental Telegraph

The California Gold Rush created a need for swift communications between the Atlantic and Pacific coasts. Standard overland mail took weeks or months to travel from New York to San Francisco, and the eastern and western telegraph networks were not connected. Beginning in 1860, the Pony Express used teams of riders on horseback to deliver letters from New York to San Francisco in a remarkably swift ten days. News intended for a wider audience could be carried by a combination of telegraph and Pony Express; in November 1860, the Pony Express riders bridged the gap between the eastern and western telegraph networks to bring news of Abraham Lincoln's election as President to California in eight days.

PONY EXPRESS!

CHANGE OF TIME!  REDUCED RATES!

10 Days to San Francisco!

LETTERS

WILL BE RECEIVED AT THE

OFFICE, 84 BROADWAY,

NEW YORK,

Up to 4 P. M. every TUESDAY.

AND

Up to 2½ P. M. every SATURDAY.

Which will be forwarded to connect with the PONY EXPRESS leaving ST. JOSEPH, Missouri,

Every WEDNESDAY and SATURDAY at 11 P. M.

TELEGRAMS

Sent to Fort Kearney on the mornings of MONDAY and FRIDAY, will connect with PONY leaving St. Joseph, WEDNESDAYS and SATURDAYS.

EXPRESS CHARGES.

LETTERS weighing half ounce or under..... \$1 00
For every additional half ounce or fraction of an ounce 1 00
In all cases to be enclosed in 10 cent Government Stamped Envelopes,
And all Express CHARGES Pre-paid.

☞ PONY EXPRESS ENVELOPES For Sale at our Office.

WELLS, FARGO & CO., Ag'ts.

New York, July 1, 1861.

SLATER & JAMES, SEVIENBERGERS AND PRINTERS, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, NASSAU STREET, NEW YORK

Figure 9

Almost as swiftly as the Pony Express carried mail to California, however, the Pony Express itself was swiftly overtaken by technology. In October 1861, thanks to tens of thousands of wooden utility poles installed across the Plains to connect telegraph networks in the eastern and western portions of the United States, the transcontinental telegraph was born. With the east and west coasts able to communicate instantaneously by telegraph, there was no more need for teams of riders on mustangs to gallop across the American Plains, and the Pony Express was disbanded.

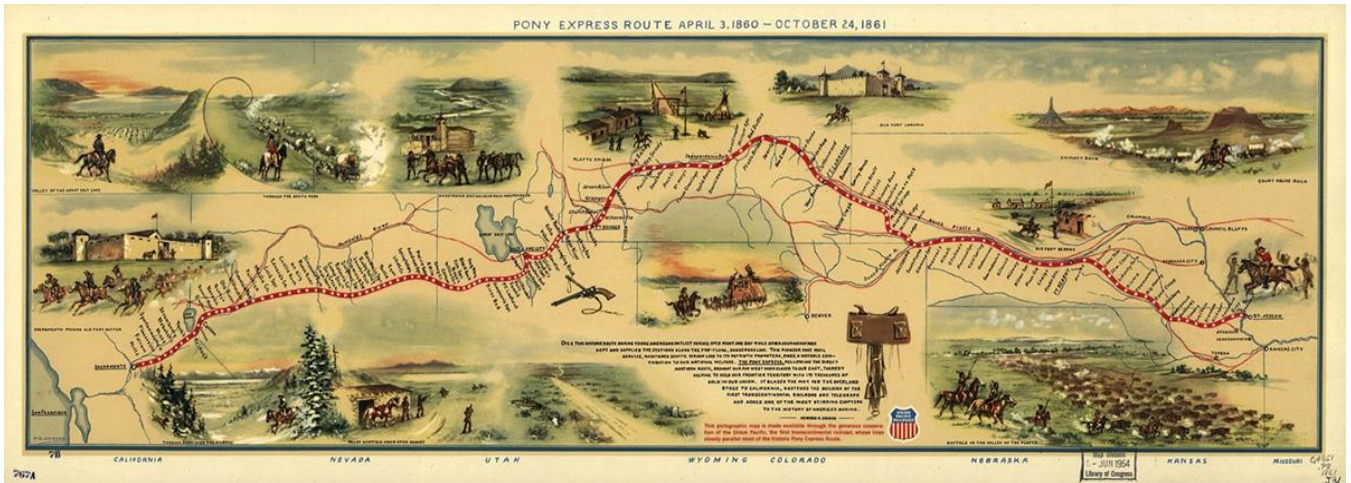


Figure 10



Figure 11

In 1860, it took eight days for news of Abraham Lincoln's election as President to reach California through a combination of telegraph and Pony Express. In 1865, thanks to tens of thousands of wooden utility poles carrying the transcontinental telegraph, the sad news of President Lincoln's assassination reached California instantly.

4. From the Telegraph to Telephones and Electric Lights

By the early 20th Century, wooden poles were carrying telephone lines and electrical lines as well as telegraph lines. Between electrification and the rapid adoption of telephony, wooden poles grew larger and more heavily burdened with utility lines to an extent that is unimaginable today.



Figure 12



Figure 13

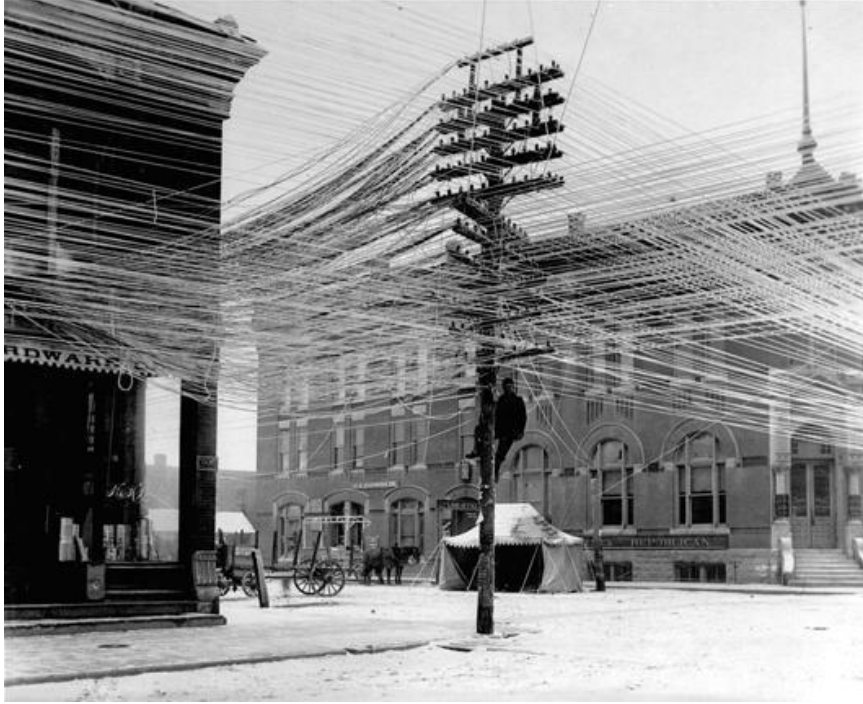


Figure 14

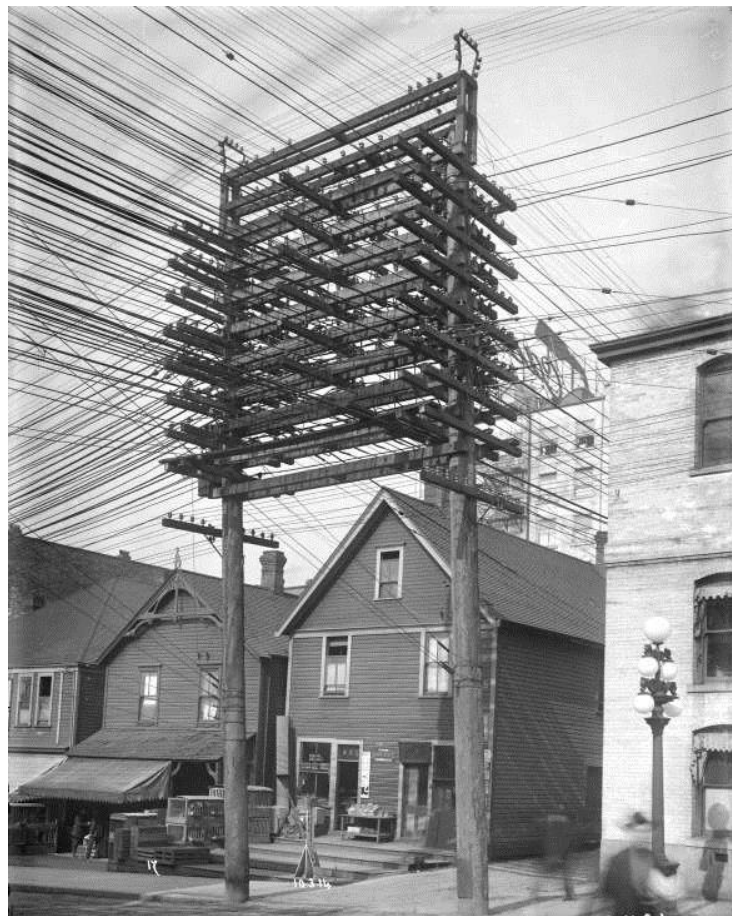


Figure 15

5. Technological Change and Competition

Although many Americans continue to use the term “telephone pole” to refer to utility poles, wooden utility poles now carry infrastructure necessary for such services as wireline and wireless voice communications, electricity, communications facilities for electric smart meter backhaul, video service, internet, communications lines for municipalities and water companies, and sometimes streetlights.

Southern California Edison provides this overview of the elements of a modern wooden utility pole carrying electric and communications lines:

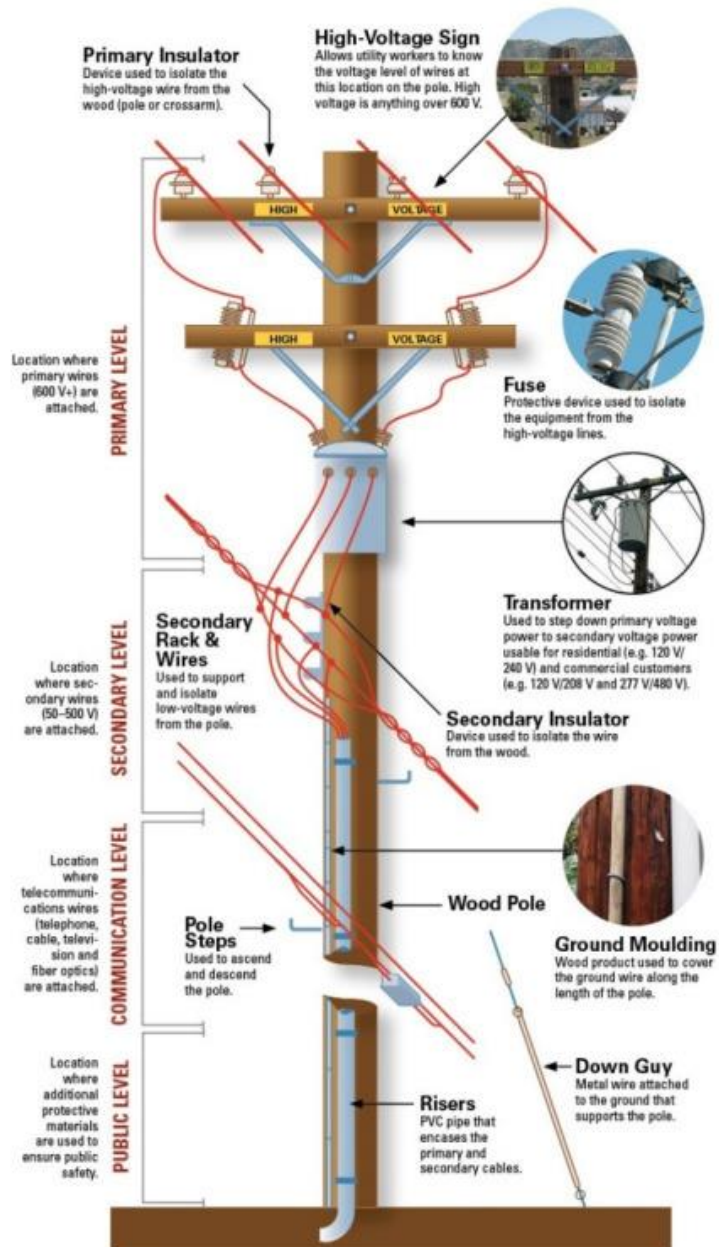


Figure 16

The following diagram, from Clay Electric Cooperative in Flora, Illinois, describes the basic electrical infrastructure on a utility pole:

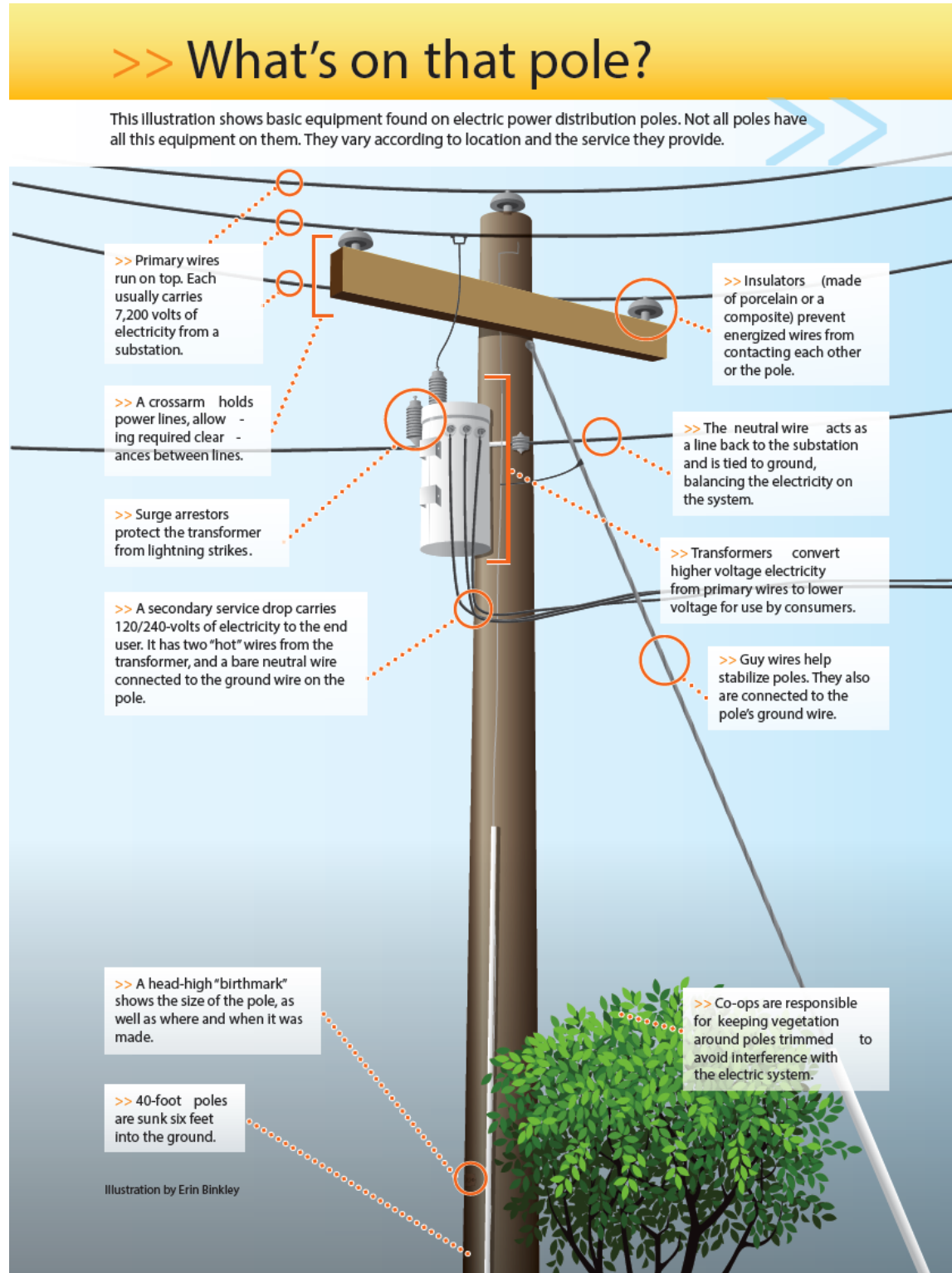


Figure 17

Of course, utility poles in the field rarely appear as neat and tidy as the utility poles in the diagrams above. The utility pole below was photographed in San Francisco in 2008:



Figure 18

The image below, from the San Francisco Planning Department, shows a potential arrangement of electric lines, communications attachments, and a streetlight.

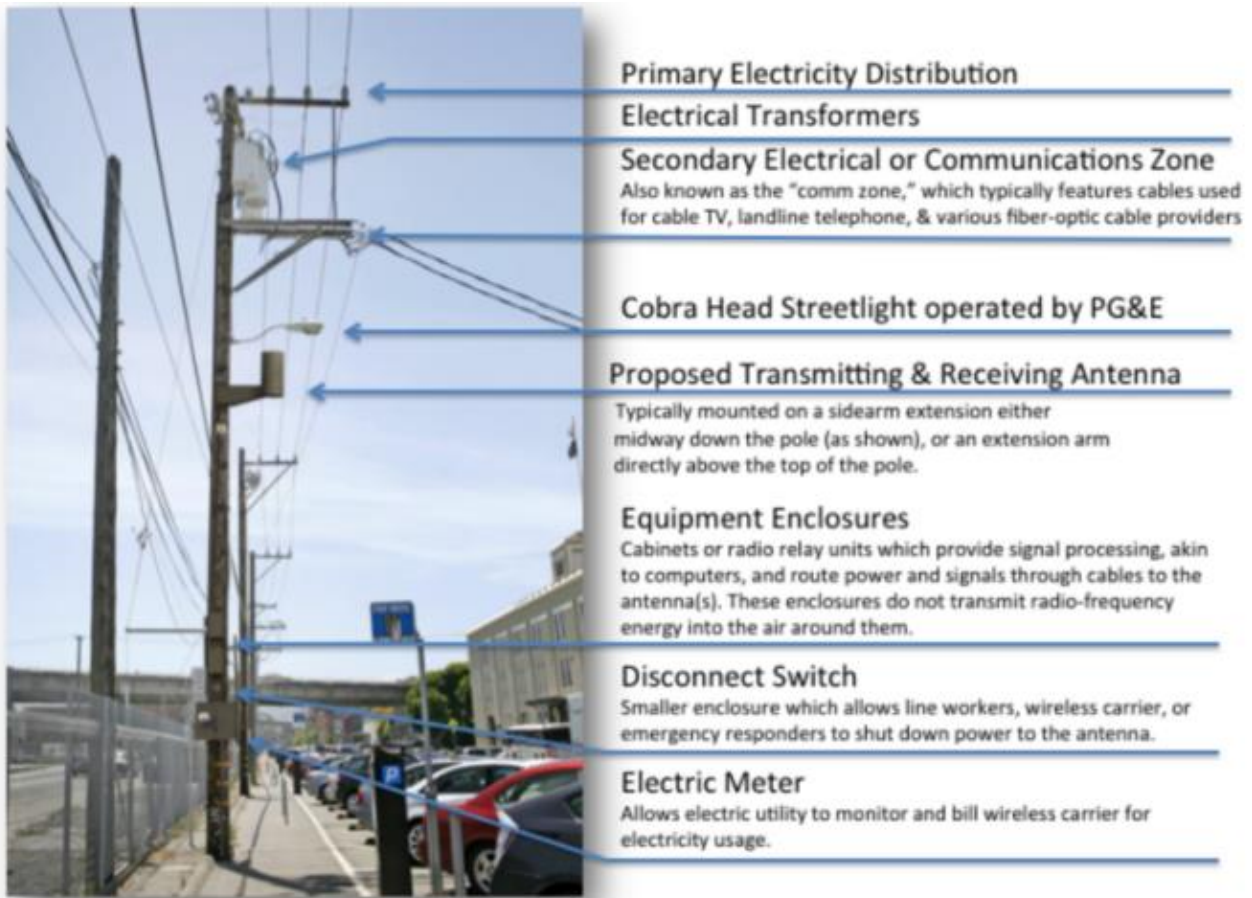


Figure 19

With all the different types of services competing for space on the pole, and the different providers competing with each other to offer those services, managing their shared use of the pole can be very complicated.

State and federal regulators enforce some rules regarding utility poles. For example, the California Public Utilities Commission has rules governing the operation and maintenance of utility poles and attachments. These rules, contained in General Order 95, consist of highly detailed engineering requirements designed to protect safety.

The Commission updates General Order 95 in response to changes in technology, engineering, or markets; for example, the Commission recently updated General Order 95 to ensure the safety of wireless attachments. The three slides below, from a 2016 Commission staff presentation, describe some of the changes:



GO 95 Safety Amendments (page 1 of 3)

- Prohibit antenna installations that obstruct pole climbing space or interfere with fall-protection gear.



4



Figure 20



GO 95 Safety Amendments (page 2 of 3)

- Require pole-overturning calculations for new pole-top antenna attachments.



5



Figure 21



GO 95 Safety Amendments (page 3 of 3)

- Generally prohibit antennas on guard arms.
- Clarify requirements for signs regarding radio-frequency radiation of antennas.
- Clarify protocols for de-energizing antennas.
- Only qualified workers may work on wireless facilities installed above supply lines.



6

Figure 22

Double poles are another challenge arising from joint use. When a utility pole is replaced, all the joint users must transfer their attachments from the old pole to the new pole. Some joint users fail to transfer their attachments in a timely manner, creating unsightly double poles, such as those below, that last for months or years longer than is safe or necessary.



Figure 23

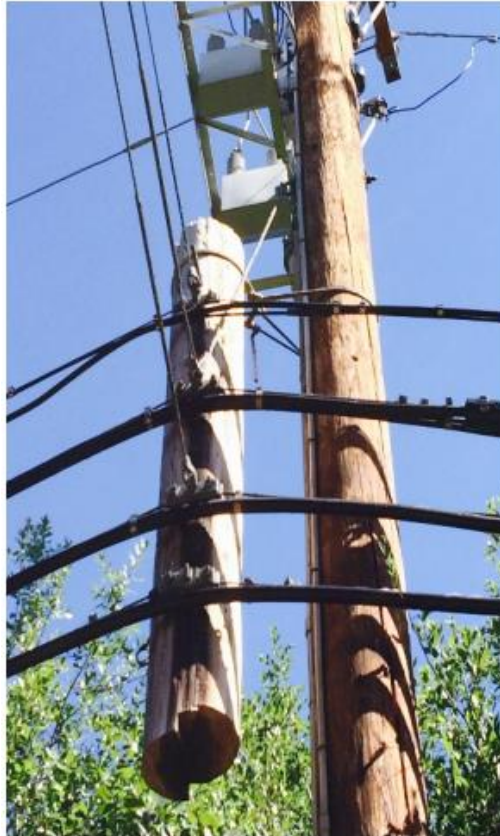


Figure 24



Figure 25

Another complication of joint use concerns abandoned or unused equipment on a pole. For example, loops of spare communications lines not being used to serve customers can frequently be seen attached to utility poles.



Figure 26

State and federal rules do not cover every possible question that might arise when sharing space on a utility pole. For example, if a company wants to rent space on a utility pole, or even become a joint owner of a utility pole, who do they call? What is the process?

Given the frequency of joint pole ownership (Southern California Edison has stated that 70% of the poles in its service area are jointly owned) and the number of companies, services, and technologies involved, reliability and safety could suffer if joint pole ownership is not carefully managed.

To handle aspects of their shared use of a utility pole not covered by state and federal law, some companies have formed voluntary organizations to manage joint pole ownership. In California, there are two such joint pole organizations.



The Northern California Joint Pole Association and the Southern California Joint Pole Committee handle many aspects of joint pole ownership, including: billing; joint pole planning process; pole abandonment and removal; and identifying poles and attachments for record-keeping purposes.

An example of the territory covered by the Northern California Joint Pole Association:



Figure 27

And an example of the territory covered by the Southern California Joint Pole Committee:



Figure 28

6. Safety

In October 2007, strong Santa Ana winds swept across Southern California and caused dozens of wildfires. Several of the worst wildfires were reportedly ignited by power lines. These included the Grass Valley Fire (1,247 acres); the Malibu Canyon Fire (4,521 acres); the Rice Fire (9,472 acres); the Sedgewick Fire (710 acres); and the Witch Fire (197,990 acres). The total area burned by these five power line fires was more than 334 square miles. During the Fire Siege, transportation was disrupted, and portions of the electric network, communications network, and community water sources were destroyed.

One of the fires, the Malibu Canyon Fire, started when three wooden utility poles came down in a windstorm and the downed power lines sparked a vegetation fire. A California Public Utilities Commission staff report determined that the three utility poles were not in compliance with the safety and engineering rules in General Order 95, and that they would have been able to withstand the wind gusts if they had been in compliance.

The California Public Utilities Commission ultimately approved settlement agreements between all the joint owners involved. Among the admissions made as part of the settlement agreement, one party admitted having placed attachments on a pole despite having been informed that the attachments would overload the pole, i.e. cause it to become too heavy, in violation of General Order 95.

The pictures below illustrate what can happen when companies do not follow utility pole safety rules:



Figure 29

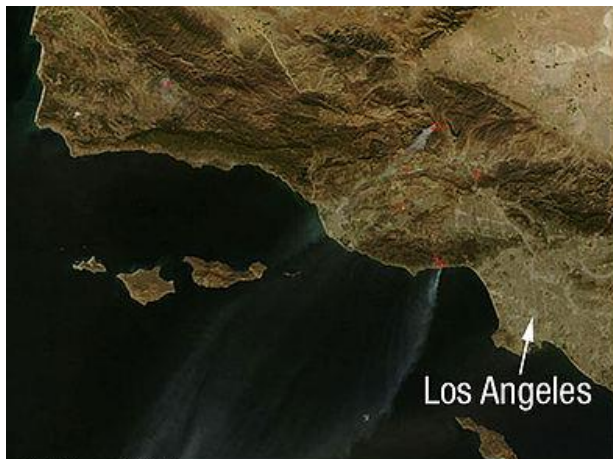


Figure 30

The pictures below were taken by NASA three hours apart on the first day of the Fire Siege. Although not every fire was caused by downed utility poles and electric lines, the pictures demonstrate how quickly fires can spread in California's dry, rugged terrain. According to NASA:

This pair of images, depicting the area around Los Angeles on October 21, 2007, shows just how quickly the fires grew.

The left image, captured by NASA's Terra satellite at 11:35 a.m. local time, shows several fires giving off small plumes of smoke. Just over 3 hours later, at 2:50 p.m. when NASA's Aqua satellite passed overhead, large amounts of smoke were pouring from blazes northwest of Los Angeles. Actively burning fires are outlined in red.



11:35 am (PDT)

Figure 31



2:50 pm (PDT)

7. Vegetation Management

Utility pole safety does not stop with engineering and maintenance of the poles and attachments and coordination between the joint owners. Vegetation management is an important component in maintaining the safety of the poles for utility employees and the general public, and for ensuring the reliability of the services carried on the poles.

The following two pictures show a utility pole in Walnut Creek, California, that is surrounded by vegetation. There is no safe climbing space for utility workers, and branches appear to be in contact with the communications lines. If the tree falls, either during a storm or because it is weakened by drought, it could conceivably take down the utility pole.



Figure 32



Figure 33

Fortunately, a rigorous vegetation management program at the utility company can prune back surrounding vegetation before it threatens service reliability, or the safety of utility employees or the general public.

Vegetation management at San Diego Gas & Electric...



Figure 34

...and at Pacific Gas & Electric



Figure 35

Customers have an important role to play in vegetation management. Customers may create threats to utility safety and reliability if they plant the wrong tree in the wrong place, where it can come into contact with utility lines. Fortunately, California's three large electric companies make information available to their customers concerning vegetation management and its role in safety.

San Diego Gas & Electric provides a recommended tree planting list with detailed tree characteristics, as well as a customer brochure on vegetation management, explaining why trees must be pruned in a way that prioritizes safety over aesthetics.²

Southern California Edison's consumer information page, "Let's Keep Trees Away From Power Lines," also provides information on what to plant, where to plant it, power line safety, and even how to use shade trees to lower energy costs.



Figure 36

Pacific Gas & Electric's information on Power Lines and Trees provides links to brochures on tree planting and management, including a tree selection guide managed by California Polytechnic State University.



Figure 37

² https://www.sdge.com/sites/default/files/documents/594331938/Tree_Planting_List.pdf?nid=19891;
<https://www.sdge.com/sites/default/files/documents/808851578/pruningTrees.pdf>

According to Pacific Gas & Electric, palm trees near utility poles create special challenges, because they cannot be pruned to grow away from the utility pole and any associated electric and communications lines. Pacific Gas & Electric recommends that palm trees be planted at least 50 feet away from utility poles to reduce the risk of contact from wind-blown palm fronds.

8. Animal Management

Utility poles are outside, so in addition to vegetation management, animal management is also necessary.

Bears

Bears rub, claw, and bite trees to communicate with other bears via scent, and to find food.

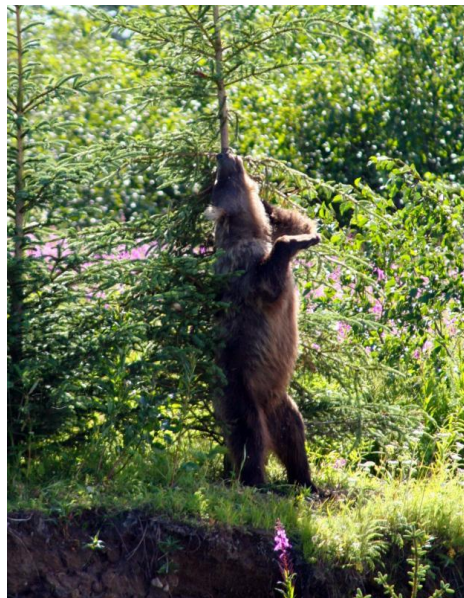


Figure 38



Figure 39

Unfortunately, bears are very bad at distinguishing living trees from utility poles. The utility poles below in West Virginia have been clawed and bitten nearly in half by bears. Appalachian Power utility workers began bear-proofing their wooden utility poles by swaddling the poles with layers of plastic pipe, which has proven to be an effective deterrent. Other utilities in the area are reportedly having luck installing a new utility pole next to the damaged utility pole, finding that the bears will continue to scratch the old pole and leave the new pole undisturbed.



Figure 40



Figure 41

Some bear incursions on utility poles are more adorable than others.

A customer in West Virginia called Mon Power to report a bear cub on top of a 40 foot wooden utility pole. Two linemen were able to de-energize the utility pole and rescue the cub, with the assistance of a state game commissioner who stood lookout for the bear cub's mother.



Figure 42

Southern California Edison shared this photograph of a bear with impressive climbing skills. No word on how the bear got down. The bear was doubtless disappointed by the lack of acorns on utility poles, although information shared at the California Public Utilities Commission’s Utility Pole Safety En Banc in 2016 suggests that there is an ingredient in insulation materials that bears find irresistibly tasty.



Figure 43

Woodpeckers



Figure 44

Woodpeckers also treat wooden utility poles like trees, and peck holes in the wooden poles to store nuts. This damage can be quite extensive, and will weaken the pole by removing wood and exposing remaining wood to water and insects. Woodpeckers are impervious to topical chemical deterrents, sounds, and fake owls, although covering the pole with wire mesh may aid in deterrence.³

Birds and Electrocutation

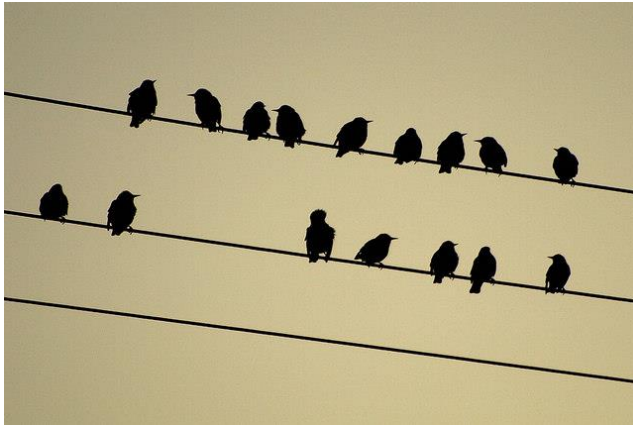


Figure 45

Have you ever looked at birds sitting on power lines and wondered why they aren't electrocuted?

It isn't because the power lines are shielded (they aren't), or because the birds are not good conductors of electricity (they are).

So why aren't the birds electrocuted?

The birds are not electrocuted because electrons are lazy. Electrical current travels along the path of least resistance; if the bird is only touching one power line, there is not a significant difference in electrical potential between the bird's feet and the power line sufficient to cause the electrons to deviate from their path, so the electrons will not leave the power line to travel through the bird's body.⁴

However, if the bird touches two power lines at the same time, especially if the power lines have different voltages, the bird will become a conductor between the different electrical potentials and the bird will be electrocuted.

Similarly, if the bird touches an electrical line and the wooden utility pole at the same time, the bird's body will provide the electrons with a path to ground through the utility pole and the bird will be electrocuted.

³ Woodpeckers and Utility Pole Damage, Richard E. Harness and Dr. Eric L. Walters, 2004, IEEE
<http://www.ericwalters.org/harnesswalters2004.pdf>

⁴ <https://engineering.mit.edu/engage/ask-an-engineer/how-do-birds-sit-on-high-voltage-power-lines-without-getting-electrocuted/>

The larger the bird's wingspan, the greater the risk that it will touch two energized lines at the same time, or an energized line and a grounded part of the pole, and be electrocuted. Because birds' contact with power lines endangers the integrity of the electrical line and public safety (an electrocuted bird started a 1.5 acre brushfire in Novato in 2012⁵), the Avian Power Line Action Committee⁶ recommends specific clearances between energized lines to prevent electrocution, and deterrent measures to prevent birds from nesting on utility poles.



Figure 46

9. The Future

A member of the public who is handed a paper on utility poles might be forgiven if they exclaimed: "Utility poles? Who cares about utility poles? I'm walking around downtown and I don't see a single utility pole, everything is underground."

It is true that new developments in many parts of the country tend to favor (and sometimes require) that utility facilities be placed underground rather than aboveground on utility poles. The California Public Utilities Commission mandated, in General Order 128, that residential subdivisions built after 1970 locate their electrical distribution lines underground.

Despite the fact that new residential and commercial construction projects underground their utility infrastructure, California still has more than 4 million utility poles, most of which are wood. Although

⁵ <https://patch.com/california/sanrafael/electrocuted-bird-sparks-fire-near-skywalker-ranch>

⁶ <http://www.aplic.org/index.php>

some utilities and municipalities are replacing wood utility poles with utility poles made of concrete, metal, or fiberglass composite, all of which are bear and woodpecker resistant, the North American Wood Pole Council estimates that there are 130 million wooden utility poles across North America.⁷

Although a wooden utility pole will never be as flashy as this metal Mickey Mouse-inspired utility pole outside of Disney World, the wooden utility pole has been an important part of our communications history since 1844 and will likely be with us for years to come.



Figure 47

⁷ <http://woodpoles.org/WhyWoodPoles/HowPolesAreMade.aspx>

10. In Case of Emergency

The California Public Utilities Commission puts safety first and offers the following tips on the importance of staying safe around overhead and underground power lines.⁸

What if I spot a downed wire?

Incidents related to accidents, severe weather, trees, etc., can cause a power line to fall to the ground. If you see a downed power wire, stay clear of it and call 9-1-1 immediately to report an electrical emergency. All lines down should be treated as dangerous. Never touch a downed power line or go near one. Always call 9-1-1 immediately.

What should I do if I see a person, animal, or object that is in contact with a downed power line?

Do not touch the person, animal, or object because the power line may still be energized. Call 9-1-1 immediately.

What if I need to do outside work near an overhead power line?

If your outside work requires you to be near an overhead power line, always remember to keep everything – and everybody – at least 10 feet away from the power line. If you have any questions or concerns, contact your local utility company before starting any work.

What if a power line falls on and/or comes into contact with my vehicle while I am still in it?

Remain calm and stay in your car, as the ground around your car may be energized. Call 9-1-1 on your cell phone or tell someone to call for you. Tell everyone to stay clear and do not touch the vehicle. If there is a fire and you have to exit your vehicle that has come in contact with a downed power line, remove loose items of clothing, keep your hands at your sides, and jump clear of the vehicle, so you are not touching the vehicle when your feet hit the ground. Keep both feet close together and shuffle away from the vehicle without picking up your feet.

A power line carries electricity, which can be dangerous and cause serious injury or even death if you come into contact with it. The California Public Utilities Commission wants you to stay informed and alert to stay safe.

11. Contact the Commission

If you ever see a downed power line, call 9-1-1 immediately. However, if you live in California, don't forget that you can also file utility pole complaints with the California Public Utilities Commission. You may file a complaint with the Commission after calling 9-1-1 to report an immediate threat, but you may

⁸ The Buzz About Power Line Safety, July 2016,

http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/News_Room/Fact_Sheets/English/PowerLineSafety.pdf

also contact the Commission about utility poles that appear unsafe or dangerous even if they do not present the immediate and obvious safety risk of a downed power line.

To file a public safety complaint with the California Public Utilities Commission:

The fastest way to file a complaint is using the [online complaint form](https://appsssl.cpuc.ca.gov/cpucapplication/), available at <https://appsssl.cpuc.ca.gov/cpucapplication/>

Please be aware that the CPUC cannot help you resolve issues with:

- Publicly owned or municipal utilities, such as SMUD or the Los Angeles Department of Water and Power
- Federal, city, or county taxes and surcharges on your bills
- Long-distance telephone, cable TV, cellular phone rates, paging, or Internet rates and services

The CPUC also cannot award claims for damages, or help you determine a utility's alleged negligence or liability. If you cannot resolve this type of problem with the utility directly, you can file a claim in civil court.

If you do not want to file your complaint online, you can send us a written complaint letter. Be sure to include:

- Your name
- The name the account is billed under (if it is different than your name)
- Your mailing address
- The service address (if it is different than your mailing address)
- The name of the utility or company
- The name of the utility or company's representative you contacted (if applicable)
- A brief description of the problem (no more than two pages)
- Daytime phone number where you can be reached
- The phone number or account number of the service (if applicable)

You can mail your written complaint to:

CPUC Utilities Safety Branch
505 Van Ness Avenue
San Francisco, CA 94102-3298

If you have any questions about mobile home park safety, you can call us at 1-415-703-1126. For all other public safety complaints, you can call us at 1-800-755-1447.

References:

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Front cover: National Archives, circa 1862-1863, NWDNS-77-F-194(6)(62), available at <https://catalog.archives.gov/id/519420>

Back cover: Utility pole in Walnut Creek, California. Photo by April Mulqueen.

Page 3: Top: View west down the Carlin Canyon from the hill above the Carlin Tunnel in Elko County, Nevada, with an old telephone pole in the foreground, April 19, 2015, by Famartin
https://commons.wikimedia.org/wiki/File:2015-04-19_16_05_45_View_west_down_the_Carlin_Canyon_from_the_hill_above_the_Carlin_Tunnel_in_Elko_County,_Nevada,_with_an_old_telephone_pole_in_the_foreground.jpg

Bottom: Telephone pole sunset, July 23, 2005, by Chas Redmond from Seattle, WA,
https://commons.wikimedia.org/wiki/File:Telephone_Pole_Sunset.jpg

Figure 1: Great Wall of China near Simatai, May 29, 2009, photo by Jakub Halun;
https://commons.wikimedia.org/wiki/File:20090529_Great_Wall_Simatai_8350.jpg

Figure 2: Statue of Phidippides, who ran 26 miles to deliver the news of the Greek victory at the battle of Marathon; posted by Hammer of the Gods 27, June 1, 2003,
https://commons.wikimedia.org/wiki/File:Statue_of_Pheidippides_along_the_Marathon_Road.jpg

Figure 3: Young Lady in Oriental Clothing with a Homing Pigeon, unknown, 19th Century
https://commons.wikimedia.org/wiki/File:Junge_Frau_mit_Taubenpost.jpg

Figure 4: Postcard depicting Paul Revere and Boston's Old North Church from The Tichnor Brothers Collection, Boston Public Library; <http://ark.digitalcommonwealth.org/ark:/50959/wh246s22h>

Figure 5: Lioness and Cub, Otjiwarongo, Namibia by Greg Willis. October 13, 2006,
<https://www.flickr.com/photos/gregw66/3685503278/>

Figure 6: Morse's First Telegraph Line - 1844, by Bill Meier,
<http://www.insulators.info/pictures/?id=145113243>

Figure 7: Historical marker of first telegram, https://en.wikipedia.org/wiki/Baltimore-Washington_telegraph_line#/media/File:MD_Historical_Marker_First_Telegram.jpg

Figure 8: Early Drawing of Telegraph Poles, June 25, 1844. Library of Congress, Samuel Finley Breese Morse papers, <http://hdl.loc.gov/loc.mss/mmorse.018001>

Figure 9: Smithsonian Institution Poster Museum, https://arago.si.edu/record_219560_img_1.html

Figure 10: Pony Express Route April 3, 1860 – October 24, 1861. William Henry Jackson, creator; Library of Congress, Geography and Map Division, <https://www.loc.gov/item/2004629249/>

Figure 11: Pony Express rider and the advancing telegraph. Original sketch in Oregon Trail Museum. https://www.nps.gov/parkhistory/online_books/hh/28/hh28o.htm

Figure 12: Etching of Overhead Telephone and Telegraph Wires in Broadway, 1890, https://commons.wikimedia.org/wiki/File:New_York_utility_lines_in_1890.jpg

Figure 13: Streetscape with wooden utility poles, Allentown PA, 1891, https://commons.wikimedia.org/wiki/File:600_Block_Hamilton_Street_Allentown_PA_1891.jpg

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Figure 16: <http://sce.tumblr.com/post/59329041377/the-anatomy-of-a-distribution-pole-this>

Figure 17: <http://www.ceci.coop/blog?page=7>

Figure 18: A Utility Pole in South San Francisco, California, March 22, 2008, © BrokenSphere / Wikimedia Commons https://commons.wikimedia.org/wiki/File:SSF_utility_pole_1_front.JPG

Figure 19: San Francisco Planning Department, http://www.sf-planning.org/ftp/files/currentplanning/wireless/FAQ_Wireless_Facilities_on_Poles.pdf

Figures 20, 21, 22: <http://slideplayer.com/slide/10268094/>

Figures 23, 24, 25: Presentation on Utility Pole Safety to Commission by Fadi Daye, PE, from SED, May 12, 2016, http://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Safety/Presentations_for_Commission_Meeting/SED%20Utility%20Pole%20Safety.pdf

Figure 26: Unused communications drops on a utility pole, <http://info.aldensys.com/joint-use/managing-joint-use-utility-poles-attachments-overloading>

Figure 27: Fog Over Potrero Hill, Lynn Friedman, <https://www.flickr.com/photos/lynnfriedman/7800224336>

Figure 28: Los Angeles Plaza Church circa 1905, USC Libraries Special Collections, [https://commons.wikimedia.org/wiki/File:Los_Angeles_Plaza_Church_\(CHS-545\).jpg](https://commons.wikimedia.org/wiki/File:Los_Angeles_Plaza_Church_(CHS-545).jpg)

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[https://commons.wikimedia.org/wiki/File:Malibu_Fire_October_2007_\(2\).jpg](https://commons.wikimedia.org/wiki/File:Malibu_Fire_October_2007_(2).jpg)

Figure 30: The 2007 Malibu fire. (Los Angeles Times) <http://articles.latimes.com/2013/may/20/local/la-me-ln-edison-admits-errors-in-malibu-fire-settles-now-top-60-million-20130520>

Figure 31: NASA/MODIS Rapid Response. Story credit: Laura Spector, NASA Goddard Space Flight Center. https://commons.wikimedia.org/wiki/File:Nasa_satellite_photo_side_by_side_2007-10-22.jpg

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Figure 36: https://www.sce.com/wps/portal/home/safety/power-lines/!ut/p/b1/hc_NCoJAFAXgZ2nh1jklmrWbwnQkKjFIZxMaNgrqiFq-fIO0Efq5u3P5DtxLOikIr5N7IZK-kHVSPjO3zlPbpR4LwfZrbwM2xyyglj-DCwViBfBfBKP71T4SPieuyFGyFxdHcWgZgvsHCheP5ewWOgQFmBNiFICpgvcGPG3zCRSnT1z8xrVPDFoS32TVrs1a_tWqd933TLTVoGIZBF1KKMtMvstLwqZLLrifRWJKmilAcqpPd0ckDe5hC-w!!/dl4/d5/L2dBISEvZ0FBIS9nQSEh/?from=powerlines

Figure 37: https://www.pge.com/en_US/safety/yard-safety/powerlines-and-trees/right-tree-right-place/right-tree-right-place.page

Figure 38: National Park Service Photo / K. Jalone, <https://www.nps.gov/akr/photosmultimedia/photogallery.htm?id=43AA5C46-1DD8-B71C-07974EB8392075C1>

Figure 39: Grizzly bear rubbing on a tree, Northern Divide Grizzly Bear Project, by GlacierNPS, USGS photo. [https://commons.wikimedia.org/wiki/File:Grizzly_bear_rubbing_on_a_tree_\(Northern_Divide_Grizzly_Bear_Project\)_4428171412.jpg](https://commons.wikimedia.org/wiki/File:Grizzly_bear_rubbing_on_a_tree_(Northern_Divide_Grizzly_Bear_Project)_4428171412.jpg)

Figures 40, 41: Photos courtesy of Appalachian Power. http://www.roanoke.com/news/appalachian-power-workers-find-solutions-to-bear-damaged-power-poles/article_520c7594-e544-5c1b-adaa-af8a810edcc0.html

Figure 42: Mon Power Lineman Rescue Bear Cub, FirstEnergy Corp, <https://www.flickr.com/photos/firstenergycorp/17208905806>

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<https://www.flickr.com/photos/teddyllovet/3327247005>

Figure 45: Birds on Far Bank's Power Line, Hedon, East Riding of Yorkshire, England, by Andy Beecroft.
From geography.org.uk, October 16, 2008.
https://commons.wikimedia.org/wiki/File:Birds_on_Far_Bank%27s_Power_Line_-_geograph.org.uk_-_1008653.jpg

Figure 46: Red-tailed Hawk by Rennett Stowe, January 4, 2011,
<https://www.flickr.com/photos/tomsaint/5327481818>

Figure 47: A Mickey Mouse-shaped utility pole near Disney World, by akampfer, March 20, 2013,
https://commons.wikimedia.org/wiki/File:Electrical_Transmission_Tower_at_Walt_Disney_World.jpeg

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