Public Utilities

A guide to what utilities actually look like.

By Tom Crawford

With acknowledgement to Kevin Hurley for his input and help in keeping me honest on the electrical stuff.

This presentation is about what real utilities look like.

When people model power poles, or what they call “telephone poles” this is what they usually model. What we have here is a dying breed – the old individual wire communication system used by the railroads. If you are modeling the 60s or earlier and are only concerned with railroad communications, this would be fine. If you are trying to model modern utility poles, your aren’t even on the same planet.

Although most of what you see regarding utilities are above ground, since I was a pipeline person, I thought I’d start this with some slides of what you might see on the ground about pipelines.

Most people envision pipelines as something that runs through the rural areas. This is a pipe we had to expose near Hwy 680 to repair a leak.

This line feeds the bay area from the east coming down into Fremont along 680.

Okay, I had to get in the picture too. Notice the clean shirt and jeans. Well, at least they let me get my boots dirty. Anyway, this is what people think of when the think of big pipelines (This one is 24 inches in diameter. No where near the largest I was responsible for, but a decent sized one.

Here is a picture of a 30 inch line valve. Looks like the valve in the previous picture, doesn’t it. But lets look at where it is.

Underneath Winton Avenue in Hayward. Puts a slightly different perspective on it.

This is the new valve set we replaced that old valve set with.

Here is a vault you would see on the street. But if you opened the vault, what you would see is

A crossover valve.

Or the topworks to a 30 inch valve.

This is a valve frame and cover. The actual valve is 4 feet below ground. All we have sticking up is an operating stem that we get to by removing the circular cover, and attaching an operator to it. So where do these lines go?

Underground Service Alert (USA)

System for marking and locating Utilities to avoid hitting them.

- Mark where you want to dig
- Call before you dig

The Utilities have the USA system. If you call for a USA, they will mark their lines, and even standby, at no expense to you , to make sure you don't hit their pipes or electrical lines.

Request Marks

First you submit a USA tag, and then mark where you want them to check.

This is a typical request mark. It denotes one edge of the area to be worked on

Here’s another

This means that the area to be marked goes 25 feet onto the property.

Response Marks

Then all the utilities, provide markings to show where their lines are.

Pass out USA cards.

We have some water, a storm sewer, and some cable or fiber optics. Oh, and some gas

This mark means that the gas line is one foot off of the mark

When we are not on pavement, we use flags.

Pass around flags.

Above Ground Markers

Used to show locations of

- High Pressure Gas Lines
- Volatile Liquid Lines
- Other High Risk Lines
- Or sometimes, special lines they don’t want anyone to cut, like major fiber optic trunks.

We also put markers on our high pressure lines

If it is major, they put the big markers up.

This is a marker used for some areas where they don’t want the marker to be too obnoxious.

On city streets we have little yellow markers.

Pass around markers.

See the yellow mark. I bet this guy has no idea there is a 30 inch line at 500 psig going right through his back yard.

If we had to get to this pipe to do a repair, guess how wide the trench would be.

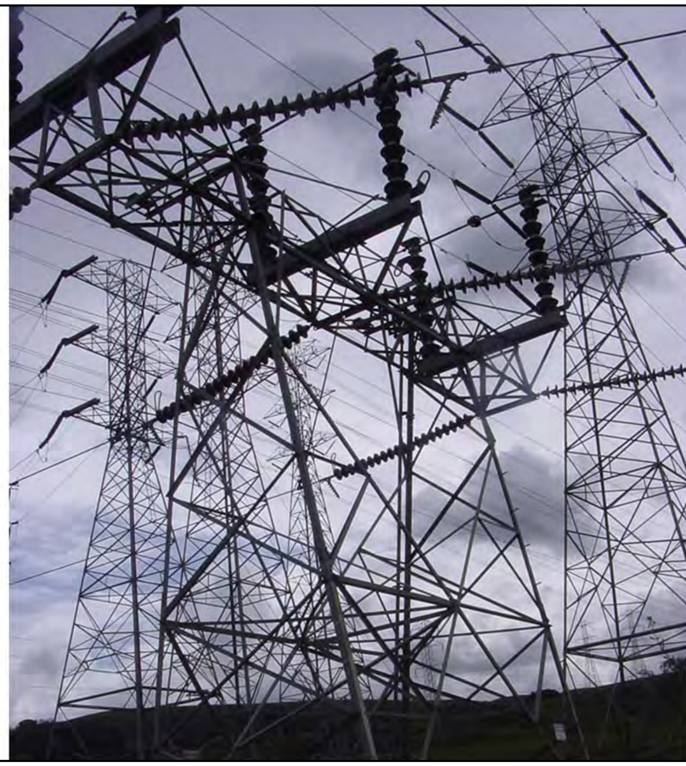
Electric Power Transmission Lines

- High Voltages

  60KV (60,000 volts) to 500KV (500,000 volts)
- Mainly Steel Towers

(There are some 60 KV lines on wood poles)
- High EMF
- Steel Towers are not at ground potential

Okay, enough of what you didn't come to hear about. Lets talk poles. First lets look at big transmission towers.



Now, to me, this is what electric transmission looks like. But there really is a method to the madness.

Okay, this is what they really look like.

They come in all sizes. Notice the differences. We have 125 KV and 250 KV represented here. The thing to notice is the droop of the wires.

The higher the voltage, the less current is needed to conduct the same amount of power, and all of you know that the higher the current through a fixed resistance (the wires) the higher the power loss, and also the higher the voltage loss. So, Higher voltage, less losses.

BTW, this photo was taken looking across Grimmer in Fremont, a couple of blocks off of Auto Mall.

These are 500KV lines

Distribution Lines

Three types

- Power Poles
- Communication poles
- Joint Poles

Okay, les talk about the poles around the neighborhood, and around the towns you usually model. There are three types.

This is your standard utility pole. It is called joint pole because it has electricity, cable and telephone on it – joint usage. Starting at the top is what we call the “primary” line. It carries the power from the substations, where electricity is dropped from transmission 60 KV and above, to distribution. The primary distribution lines are usually at 12KV, although newer systems use 20.8 KV and older systems use 4KV. Notice that the voltages are going up, thus reducing the voltage loss. The next wires down are the secondary lines. These carry the 120/240 volts that goes to your house. Since the voltage is so low, there is a lot of voltage loss, so these lines are kept short, usually 3 or four poles at most. The cans in between the primary and secondary are the transformers that drop the voltage from 12KV to 240 volts. There is only one transformer to go to single phase, which is what most houses are. There are either two or three transformers to go to three phase for big motors. Grossly simplified, two transformers are used for open delta configurations, and three transformers are used for Wye configurations. This is way too much information, so don’t ask unless you want me to get way too complicated here. The important thing to know is that for single phase there are two primary wires and three secondary wires. For 3 phase there are three primary wires (sometimes with a neutral as a fourth) and four secondary wires.

This is a power pole. Notice that it has only a primary wire and the some cut-outs going to and underground run. Cut-outs, also called disconnects, are switches. The little bars can be pulled out just like a fuse, thus disconnecting the circuit.

Another Power pole

Connected to a joint pole

This a a 60 KV transmission line. Notice the spacers to keep the lines from banging into each other. Notice also the line droop. If you model it with straight lines, its not real. Lines droop.

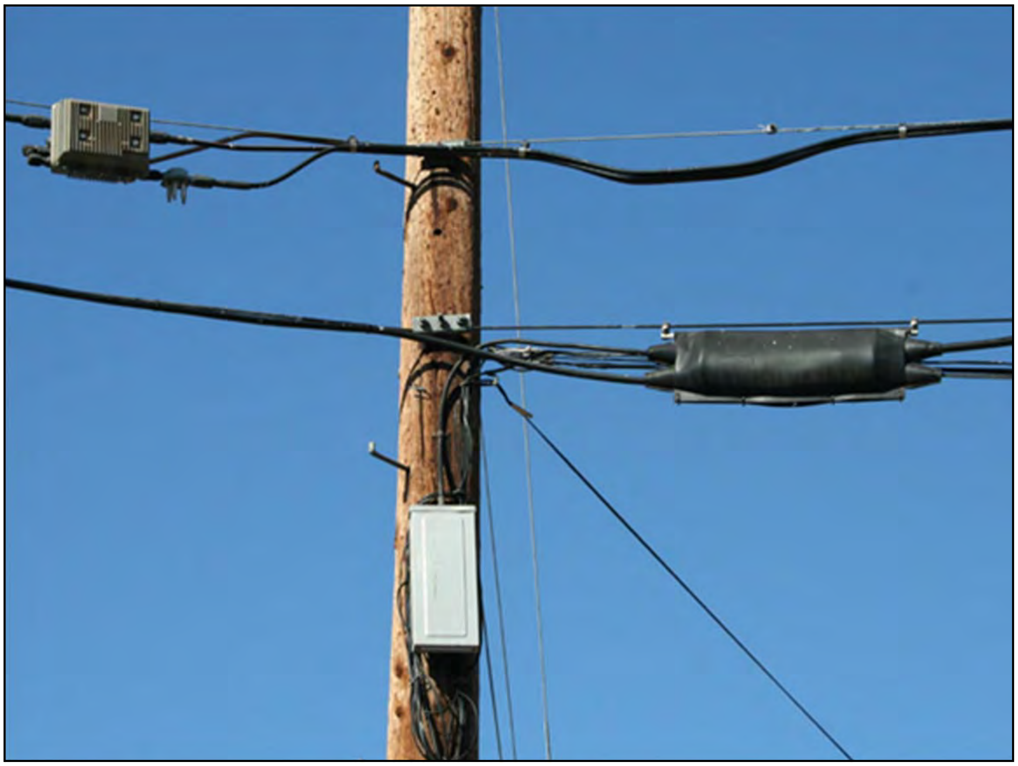
Here is another power pole on that 60 KV line, this one turning corner. Notice all the anchor lines. Whenever a line turns a corner, it needs an anchor to prevent the weight of the wires from tipping the pole over.

Here is a communication line. Notice the phone on the bottom and the cable on the top. Actually I am amazed that they have cable out on Marsh Creek road, so maybe this is something else. That phone line is the largest above ground cable I have ever seen. Maybe its two phone cables.

One wonders why this communication line is not on a joint pole with the power. Notice that the power pole has a three wire distribution in one direction and a two wire in the other two directions.

Now this is kind of interesting. It has a 60 KV transmission line on top, a primary line below that, a transformer, and then a secondary distribution line. The distribution line is interesting because the wires are stacked vertically instead of horizontally on crossbars. The reason to do this is so that when the wires swing in the wind, they can't hit each other. So why do we not do this very often? Basically, we don't like picking up dead birds who stand on the lower wire and hit their heads on a higher wire. Notice also that there are only two secondary wires. That is because these lines only feed street lights, which don't need 240 volts.

Here is your typical city street joint pole. Notice the primary on top, the secondary, the cable TV, and then the telephone.



If you look closer at the cable TV line, you can see the little box with the individual connections for houses. This particular one is empty. The “bag on the right is a telephone box, which takes individual wires out of the bundle and routes them to each house. Notice all the little wires. Those are individual house feeds.

Sometimes it gets crazy.

Sometimes they have to do apparently silly things. This is right at a corner. So the pole had to be set back. So they built this arrangement to control the wires. Notice that the cable guys just went straight through.

Notice how the primary lines between these two poles have a lot of sag. There is a lot of weight there. Also, if you look real closely, you will see that there are no anchors on the left pole.

The result was predictable.

Notice the anchors. This is a properly anchored pole. To properly model a change in direction, you have to have anchors

We saw this one before, but it shows the other thing you need to properly model. Notice how , in addition to the anchors, the cross-arms change directions. This is called a cross-buck. Name sound familiar. I wonder ywho copied who.

This is a shot from atop my shop in my backyard. Notice several things. First, look at the droop in the lines, both primary and secondary. This is very typical. Also, we have no 3 phase on our neighborhood, so there are only two primary wires. There are three secondary wires, one on the left and two on the right. If you look real close, you will see that there is a black “pipe” under the secondary cross-arm. That is how the wires get from one side to the other.

The other thing to notice is that my camera is about 15 feet off the ground, and the cable and phone lines are below me. Similarly the secondary lines are not that far above me.

On my model you will notice that the phone line crosses 17 feet above the street. Believe it or not, that is not unusual

This is a close up of how the cable and phone lines travel to get to the houses. The taught one is phone. The one of questionable neatness is the cable.

The diorama shows transmission lines that are properly run. Notice the sag. Although these towers are a little low, the sag is just about right for a hot summer day.

These lines were made with plain old sewing thread.

The top lines on these distribution lines are too tight. I tried using a new (to me) material called E-Z line. This stuff stretches easily. After having done the work, I concluded that this is not the stuff to use. After I finished installing the lines, they looked perfect, and I thought the stuff was better than thread because it was thinner and had no thread twining. Unfortunately, when I came back the next day, it was bowstring tight. You will notice that the bottom line, which is the phone line, was done using thread, and it actually slackened even more because the poles got pulled in.

If you are going to use EZ Line, I would lay it out along the pole line, hanging from the poles for about two or three days after you pull it off the spool to let it fully shrink to its true size. Use ACC to glue it up. As you can probably tell from the mess, I tried to fix this thing three times, and was never satisfied.

It does physically look better than thread.

Here is a trick if you want to use thread. Dampen it, hang it from with a weight, and let it dry. Then use it immediately without bending it. It will then form a nice smooth arc when you use it.

Remember that picture in the beginning showing actual multi-wire train control signal wires? This is two poles later.

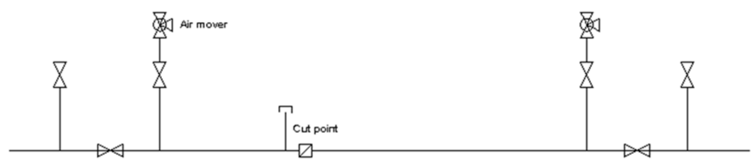
Oh, on last thing. When you go to take pictures, you gotta have an assistant.

If people are interested, I have another 20 slides that show how the cut open these big pipelines without blowing up the world.

How We Cut Into Lines

I threw this in just to show you how we actually cut into big transmission lines safely.

Operating Map



This is a simplified operating map. There are two isolation Valves, with blow off valves.

We are first going lower the pressure in the line as low as we can by closing the upstream valve and then drawing down the line pressure to the minimum the downstream load can take before the alternate source is affected. We have some other tricks, like cross compression to lower it even further, but I'll not discuss them here.

We then close the isolation valve downstream and then open up the vent valves to drop the pressure to near zero.

This is the crew waiting for the line pressure to get down to where it needs to be. They take the pressure down to just a few inches of water column, about the same as what you see in your house.

First they cut a small hole in the pipe. Notice the flames. We do this work with a small positive pressure in the pipe. The flame assures us that gas is flowing out, and air is not flowing into the pipe.

Then they weld on the control pipe.

The guy standing on the left with the red rag is controlling the gas pressure using the wet red rag as a “valve.”

You will notice the yellow rectangular marking on the top of the pipe in the center. This is the section we will cut out, called the “window.” The reason we cut a window is so that when we go to purge the line, we get lots of air flow to do it right.

The initial cut is made.

They are now cutting the window, and the guys on the left are putting mud in the cut joint to stop the gas flow so that the gas pressure stays up enough so that we have a positive gas flow.

Notice the guys with the water bucket ready to douse if needed.

Its starting to look a little tense, but you can see that the mudders are working the joints.

You can clearly see the effects of the mud now.

They have moved a chain binder to the center so that the gas pressure does not blow off the lid. In addition to the dangerousness of a flying lid, it would be impossible to control the gas pressure and maintain positive pressure if the lid rose up.

Almost done.

They bring the cut to leave about 1/8 inch uncut.

Now they cool it all down with water and a piece of canvas.

They wrap the canvas with tape (so it doesn't slide off) and keep it soaked until it totally cools down to the touch..

They then open up the can.

Notice the disks on the left.

As soon as the window is open air movers are started at both the upstream and downstream isolation valves, they suck the gas from the pipe.

One disk is inserted into the pipe to create a wall. The lime green strips indicate that there is air flow. The disk ensures that the air flowing down the pipe comes from outside the window, and not just from the other end of the pipe.

When the air at the air movers is gas free, they can now work on the line safely. They will keep the air movers working the entire time the are working on the pipe.