

AMERICAN IRON AND STEEL INSTITUTE

Steel Distribution Poles:

What Every Lineman Should Know

Student Manual



**American
Iron and Steel
Institute**

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STEEL DISTRIBUTION POLES:

What Every Lineman Should Know

INTRODUCTION



Steel poles are becoming increasingly popular among utility companies for building new distribution lines and for replacing old wood poles in existing distribution lines. Today, over 600 utilities in the U.S. have steel distribution poles on their systems. There are even a number of utilities who are in the process of converting their entire distribution systems to steel poles. There are many reasons for the switch to steel and a major reason is the favorable recommendations that have been given by linemen who have worked with both wood and steel. Once educated about steel poles, linemen find that they have many advantages.

This course is designed to help Operations and Line Personnel learn about steel poles. It will cover all the aspects of steel poles that are important to you utility line professionals. Most importantly, it is an opportunity for you to ask questions and exchange ideas.

Following is the course outline that will be used to cover the different aspects of steel pole usage:

- Introduction
- Applications
- Handling
- Coatings
- Field Construction
- Line Operations

STEEL POLE APPLICATIONS

What is a Steel Pole?



Linemen often ask: “*Wood poles have been around for a long, long time, have done their job well, are easy to climb and work with, so why do we need steel poles?*” It is true that linemen most everywhere were trained on wood poles, and have become very familiar with how to handle and work off of them and thus have become comfortable with them. So, why would a lineman want something different? There is no one thing about steel poles that will make linemen want to have steel poles on their system, but there are many things that collectively will provide that answer. However, it is only through the linemen’s willingness to try something new and experience the many benefits that steel poles have to offer that will make a believer out of them. So, let’s explore benefits of steel distribution poles:

1. Within a pole class, **steel poles don’t vary in dimension**. They are manufactured to a tight tolerance and so their diameters are consistent pole to pole. This makes hardware selection easy. As a lineman, you will no longer need to carry an assortment of fastener lengths to accommodate a range of pole diameters.
2. Steel poles are approximately **30% lighter than a wood pole of similar strength**. This makes them easier to lift, load, haul and just plain handle in general.
3. The **strengths of steel poles have low variability**. And, because the definition of failure for steel poles is the point at which the steel begins to yield, most pole have considerable reserve strength before they would no longer be able to carry their load. A steel pole doesn’t break like a wood pole, they merely bend, which means they have a much better chance to keep the wires in the air than wood poles when Mother Nature exacts her wrath in the form of heavy ice or high winds.
4. There have been a lot of innovations made in the manufacture of steel poles over the years. This has resulted in the cost of steel poles coming down to a point where they are quite **cost competitive with wood**. The protective coating systems have also been improved, which has reduced the maintenance needed and improved their life expectancy.
5. Unlike wood, where Mother Nature limits the sizes of wood poles that are available, steel poles can be made to **handle virtually any load and in any length** and can also be made as single piece poles or in sections if that would help handling them in the field.
6. Lastly, steel is one of the most **recyclable** materials around. There is never any concern over disposing steel should there be a need to do so.



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To summarize, steel poles are a manufactured product. Their dimensional and strength properties are tightly controlled, which greatly simplifies hardware selection and makes them very dependable in their ability to keep the wires in the air. Most distribution poles are 55 feet or less in length. Thus, they can be made as single piece poles or, if needed, they can also be made as multi-piece poles to make their storage, transport or erection simpler. Steel poles can also be treated in various ways to protect them

from corrosion, some of which allows them to be any color desired. And, the steel that goes into the making of poles is typically made of at least 25 percent recycled material, so they are environmentally friendly.



Where Can Steel Poles be Used?

Most distribution poles are used in tangent applications, where there is no change of direction in the line. In such cases, steel poles are used in much the same way as wood poles. They are normally direct embedded to the same depth and are framed very similarly. Typically, they are no larger than the wood poles they replace and thus can be easily fit into tight spaces such as narrow corridors between curbs and sidewalks.

Steel poles have become especially popular in deadend situations. These applications can be met with either a guyed pole, such as is normally used in wood construction, or with a freestanding pole when guys are impractical to use. As a guyed pole, steel poles are often stronger than their wood pole counterparts.



Another feature of steel poles that is often overlooked is that even though they are hollow and lighter than the wood poles they replace, they are stiffer. That is, they will not deflect as much when they are subjected to wind or ice loading.

HANDLING STEEL POLES

Shipping

Poles up to 70 ft in length (which encompasses almost all distribution poles) are usually shipped by truck. Because they are lighter than wood poles, more steel poles are able to be loaded on a trailer making their transport a little more efficient.



When you need poles longer than 70 ft they can be shipped either by rail or using trucks with escorts.

In order to protect their finish from damage, cribbing is used to separate the poles on the load and minimize pole-to-pole contact. You can then use this same cribbing to store the poles and again to haul the poles to the pole sites.

Hauling



Steel poles can be hauled to the site very much like wood poles. And, because they are lighter than wood, you can often load more poles onto the trailer making for fewer round trips between the storage yard and the line site. Twenty to forty poles, depending on their size, can usually be loaded onto a pole trailer.

Handling



The steel pole's light weight also makes its handling that much easier. They can be lifted using a single-point pick up and because they are lighter, the boom can be further out which can be advantageous in situations where the truck has to be away from the foundation hole. Steel poles should be handled with nylon straps or rope as opposed to chain or steel cable. Doing so will help protect the finish from damage.

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Where a pole site cannot be accessed by truck, a steel pole can actually be hand-carried into the site. Again, their lighter weight (400-500 lbs for a typical 40 or 45 ft pole) gives steel poles an edge over wood.

Storage



Utilities usually purchase their distribution poles in lots and tag and store them as a commodity item. Many utilities will keep at least 2-3 months' of supply on hand, sometimes more.

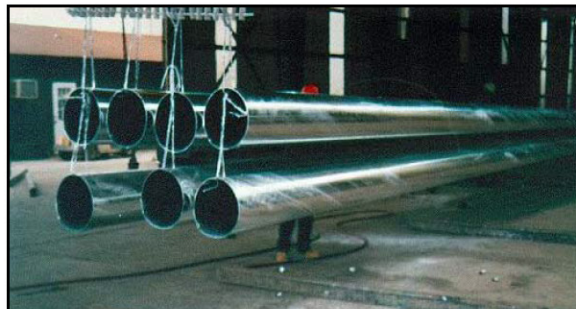
Storing steel poles is simple and easy. Cribbing is used to store the poles off of the ground and to maintain spacing so that they are not touching. Galvanized poles should be stored so that air can circulate all around them to prevent wet storage stains ("white rust") from forming. This is particularly important for poles stored in damp environments (rain or high humidity) when

the poles are being stored for more than a couple of weeks.

Best practices for wood poles recommends stored poles be rotated periodically to keep the preservative treatment well distributed about the poles circumference. In particular, with oil-borne preservatives (e.g. Penta and Creosote) gravity will cause the preservative to migrate to the bottom side of the pole. With steel poles, there is no need to rotate poles in storage.

PROTECTIVE COATINGS

To prevent corrosion, steel needs to be protected both above and below ground. There are numerous types of protection systems that can be used and the utility company is generally the one that decides which system to employ. Let's look at the different systems that might be used and learn why there is no one system that works best in all situations:



1. **Hot-dipped Galvanizing** – Galvanizing is probably the most popular of all the systems used. It provides cathodic protection to the steel, which means that the zinc coating acts as a sacrificial barrier to protect the steel. In the galvanizing process, the pole is full submerged in various baths to clean, prepare and coat the pole with pure zinc. When immersed in the molten zinc bath, the steel reacts with the zinc to create a chemical bond between the two metals, making the coating virtually one with the steel. Because the poles are open-ended, zinc is deposited on both the inner and outer surfaces of the pole wall. The zinc coating is relatively hard and will stand up to normal handling without being damaged. It is also durable and will last for many years before any recoating is required. Forty years or more is not an uncommon life expectancy for a galvanized coating.
2. **Zinc Silicate** – This coating is similar to galvanizing in that pure zinc is applied to the pole to provide cathodic protection to the steel. The zinc is encased in a silicate binder, which is sprayed onto the pole and bonds to the steel mechanically. When a zinc silicate coating is used, the pole would typically be sealed so that only its outer surface would need to be coated.
3. **Metalizing** – This coating is also similar to galvanizing wherein pure zinc is applied to the pole to provide cathodic protection to the steel. However, in this case the zinc is melted and then sprayed onto the pole, bonding with the steel mechanically rather than chemically. Like with zinc silicates, the pole is typically sealed and only its outer surface is coated.
4. **Paints** – There are a variety of paint systems that can be used on steel poles. Most are multi-coat systems using a zinc-rich primer and a barrier topcoat. Paint systems are more commonly used on transmission poles than distribution poles and are generally chosen to provide a choice of color.
5. **Weathering Steel** – Behind galvanizing, weathering steel is probably the most popular choice for corrosion protection. Weathering steel is not so much a coating as it is a chemistry. Weathering steels are formulated, using alloying metals such as nickel, copper, molybdenum, etc. to create a steel that will oxidize and create its own barrier coating. Unlike regular carbon steels that can rust and flake away until nothing is left, weathering steels rust to a point and stop. Simply stated, the oxide that is formed by the rusting process adheres tightly to the underlying steel, forming a patina, and essentially seals itself against further moisture penetration that can cause further rusting.



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Except for weathering steel, all these systems use zinc in some form to provide cathodic protection. Zinc by itself, however, does not always provide the necessary protection. In harsh environments where there is a lot of moisture mixed with pollutants such as salts, the zinc can be consumed quickly leaving the steel unprotected. In these situations, some type of barrier coating applied over the zinc is needed. Weathering steel is not a use-anywhere type of coating either. It should not be used in places that would keep the steel continuously wet or where there are a lot of pollutants like salts. Neither should it be buried in soil without some type of barrier coating.

Galvanized vs. Weathering Steel

Galvanized poles are gray in color. They usually start out being very shiny and will dull with age. In some instances, a utility will ask that the poles be “dulled” before they are delivered so that they don’t stand out so much after they are installed. Weathering steel poles start out looking just like you’d expect bare steel to look. But as they oxidize they progress to a “orange” and eventually to “chocolate brown”. The time it takes for this color transition is dependent on the climate where they are installed. In warm, humid climates the process may take a year or less, but in cold, dry climates it may take many years. In either case, the weathering steel is performing as intended.

As mentioned before, galvanized poles are vented (i.e. open top and bottom) to allow the molten zinc to flow freely across all surfaces inside and out. You cannot galvanize a sealed pole because the intense heat of the galvanizing kettle (850°F+) would likely cause the pole to explode, creating a very dangerous situation. Weathering steel poles, on the other hand, are often sealed to minimize moisture from collecting inside. However, some weathering steel poles have been vented similar to galvanized poles, but attention was paid to making sure that whatever moisture gets in the pole can freely exit.



Below-Ground Coatings

Soils can be very corrosive and the below ground area is often the harshest environment for any type of pole. Over the years, several different coatings have been used to protect steel that is direct embedded. In some situations the cathodic protection of galvanizing by itself has proven sufficient. However, it has been more common to apply some type of barrier coating to the embedded portion of the pole, even if it is over galvanizing.

Direct-embedded steel poles have been used for over 40 years and steel tanks and pipelines even longer.

Today, the most popular below grade coatings are urethanes. These materials are extremely tough, very durable and are not prone to UV degradation. When properly applied, they stand up very well to all types of abuse seen during handling, installation and backfilling/tamping. Virtually all the pole manufacturer’s today have adopted this type of coating as their recommended standard for below-grade protection of the poles they make.

FIELD CONSTRUCTION

For linemen, the most important information that you need to know is about working with steel poles. That is, how similar or different are they from wood poles in the way you have to drill them, frame them, climb them, etc. And, what special tools will you need to do these jobs.

Framing

There are some distinct differences between wood and steel poles:

- Wood poles are solid and steel poles are hollow,
- Steel poles have very consistent dimensions while wood poles can vary in diameter considerably, and
- A steel pole's geometry will not vary with the seasons, while wood poles will shrink and expand, twist and check as the climate changes. Such movement can often cause hardware on wood poles to loosen, creating the need to retighten the hardware periodically, but such is not the case for steel poles.



Some differences are not quite so distinct. For instance, it is quite common to frame steel poles using the same type of hardware as would be used on wood poles, but with one exception: the cleated grid gains typically used for wood framing are replaced with smooth gain plates.



As for bolt tightening, a common practice with wood poles is to tighten the bolts until the pole "bleeds". With steel poles it is often sufficient to tighten the nuts just beyond snug tight. Sometimes a manufacturer will provide recommendations for bolt torquing. The only problem with this is that line trucks are seldom equipped with torque wrenches. Nevertheless, torques can usually be estimated accurately enough knowing that a little over-tightening of the bolts will not cause damage to the pole. If while tightening the bolts the pole section starts to ovalize, it should be assumed that too much torque has been applied and some backing off of the nuts should be done to allow the pole to return to its original shape. In most cases it is sufficient to tighten the nuts just beyond snug tight.

Hole Drilling

Steel poles are often purchased with factory-drilled holes for use in framing and climbing. There will be times, however, when holes will need to be drilled in the field. The field-drilling of holes is relatively easy if you have the right tools. Holes in thinner steel (i.e. steel thickness ~ 3/16-in. or less) can be drilled in 30 seconds or less with a hand-held, battery-powered drill using a stepped or "Christmas tree" bit. To drill through holes in poles with thicker walls, you can use a magnetic drill with a hole saw to make the job easier.



Where attachments are going to be made with through bolts, two holes will need to be drilled 180-degrees apart. Occasionally both holes can be drilled from one side of the pole using a

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long bit extension; however, it is more common to drill each hole individually. Locating the position of the second hole is easily done using a string to wrap the circumference and then using its center point to mark the opposing hole location.

Assembly and Erection



It is no more difficult and sometimes easier to frame a steel pole than a wood pole.

Most distribution poles are under 60-ft in length and are typically furnished as single piece poles unless multi-piece poles are desired.

In the case of multi-piece poles, slip joints are the most common means of fitting the sections together.

A slip joint is a simple friction fit connection where the top section is slipped over the bottom section until they have a tight fit and minimum lap is achieved with no significant gaps between the sections.

The pole manufacturer will often recommend a minimum axial force to be used for putting the sections together to help ensure that the connection will be sound.

Occasionally, bolted flange joints might be used to join multi-section poles. Such joints are often the better choice for poles used in H-frames where the pole may be subjected to uplift or in guyed poles where the guys can put a lot of compression load into the pole. Also, in situations where tight tolerance is needed on a pole's total length, flange joints will provide this.



Foundations



You can direct embed steel poles the same as you can wood poles. A steel pole's diameter is usually very similar to the minimum ANSI-specified diameter for a wood pole used in the same situation and the hole depth used would typically be the same. The advantage that steel poles provide is their dimensional consistency, which allows for you to select an auger size without needing to account for any butt oversize that is common with wood poles. This minimizes the amount of backfilling and tamping that you will need to do.



You can use the same type of backfill material (e.g. native soil, crushed rock, etc.) on steel poles as you do with wood and its placement is no different. The backfill is placed around the pole and compacted in lifts. Tamping is important to ensure the soil is compacted well, with some care taken to avoid damaging the protective coating.

There is another option for setting steel poles as well. Where direct embedment is not practical, base plates can be welded to the bottom of steel poles so that can be mounted on anchor bolts that are either set into concrete foundations or grouted directly into rock.

Arms and Hardware



Just like wood poles, steel poles will accept all types of arms (steel, fiberglass (FRP) or wood) and these arms are often attached to the pole in the same manner. FRP arms are becoming increasingly popular because of their light weight and non-conductive properties, which helps minimize some of the dangers to wildlife. FRP arms also tend to outlast wood arms.

You can attach most hardware using through bolts and oversized washers that are either flat or curved depending on the shape of the pole. You can also use steel banding to attach hardware. Banding is sometimes more convenient and, because a steel pole's dimensions do not fluctuate with time and weather, the banding remains tight and seldom requires adjustment. Welded attachments are also an option for steel poles. Welded attachments are not necessarily commonplace on steel distribution poles, but they may be useful should you need to make repairs to a steel pole.

LINE OPERATIONS

Thus far, we have discussed many of the things that you will be doing to prepare a pole for service. Now we need to discuss those things that you need to know to work the pole safely after it is in service.

BIL

A Basic Impulse Level (BIL), also referred to as Basic Insulation Level, for line construction is not something that the Safety Code prescribes but 300kV is a level that many utilities consider minimum. If you are not sure what BIL is, it is the measure of a structure's insulation ability to withstand a voltage spike, such as from a lightning strike.



There are many types of pole top arrangements used on distribution poles. In order to help determine what is effective, the American Iron and Steel Institute sponsored an extensive study at NEETRAC electrical lab in Georgia. Following are some recommendations that came out of that study for use with 15kV and 25kV insulation levels:

- For single-phase construction, use 13- or 14-in. fiberglass pole top pins.
- For three-phase construction, either use 13- or 14-in. pole top pins for the center phase and position the outer phases at the ends of an 8-ft crossarm; or use a 10-ft crossarm and position the center phase a minimum of 31 in. from the pole's centerline with the outer phase on the opposite side of the pole positioned a minimum of 37 in. from centerline.

A steel pole's conductivity is sometimes thought to be a negative thing. However, there are some very positive aspects to having a conductive pole material, such as:

- Every pole becomes a ground for lightning strikes and other faults.
- There is no need to run a copper ground wire from the top to bottom on the pole, which not only saves time and money, but it also eliminates the temptation to vandals to steal the copper wires.
- There is little chance that there will be a break in the ground.
- Grounding is a matter of utility preference. The quality of a ground is a function of the soil characteristics.

Grounding

Good grounding is essential to system reliability and safety. As just discussed, steel pole's are an excellent conductor and can easily provide a good ground at very pole, if desired. Steel poles can provide grounding in several ways, including:

- Threaded inserts or grounding nuts can be attached to the pole anywhere on the pole where bonding attachments need to be made.



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- Where the embedded portion of the pole has a barrier coating on it, it is electrically insulated from the soil. In such cases, a galvanized ground rod can be driven in undisturbed soil and a short lead used between the pole and the rod. (Note, if copper rods are used they should be positioned a minimum of 3 to 4 feet away from the pole to minimize the potential for any cathodic reaction between it and the pole.
- Leaving a portion of the embedded section bare of any insular coating is another method that has been used to ground steel poles. However, caution must be exercised when doing this. Depending on the characteristics of the soil, the unprotected zinc coating on the pole may be subject to quick consumption which would then leave the steel pole itself unprotected against corrosion.

Working Around Energized Lines



Understanding touch-and-step potential is important to understanding what you need to do to work safely. At the higher voltage levels used in many of today's distribution circuits, no material provides the same protection it did when voltages were only, four, eight or perhaps 12 kV. When a live 35kV conductor contacts a wood pole, a significant voltage gradient along the pole can occur creating a potential difference between a lineman's hands and feet. The advantage of steel being a good conductor is that it greatly minimizes the risk of any sizable voltage gradients being created.

Whether working to set a steel pole or working off it, the procedures used are essentially the same as those you have used when working with wood poles. When working around live lines, all materials need to be treated as if they are conductive and the standard approved work practices of the utility need to

be followed. Such procedures almost always include:

- Set and tag reclosers in the non-reclose position
- Use a dedicated observer and signal person
- Cover live conductors
- Use cover-ups or guards on the pole

Pole Replacements

Steel poles are widely used for all types of new construction, but some utilities have been reluctant to use them as replacement structures in existing lines because they would need to be installed in close proximity to energized wires. The concern is that because steel is a conductive material, this type of operation would be dangerous. The fact of the matter is that work practices require wood poles to be handled as if they are conductive as well, which means the work procedures for handling steel poles should be no different than those for wood poles. Those utilities that are using steel poles in such situations have reported that their line crews are working more cautiously around energized lines as required, and are thus are actually working safer.



Climbing

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While most line work today is done using bucket trucks, linemen still have occasion to climb poles and thus, during training one of the things a lineman is taught is how to climb a wood pole. However, little, if anything is taught about climbing a steel pole and one of the biggest differences between steel poles and wood poles is the way you climb them. Nevertheless, the training you have been given will serve you well when learning to climb steel; you just get to leave the gaffs behind.

Most utilities have adopted some type of step (or ladder) system for use on their steel poles and removable steps seem to be the most common. Most removable steps are designed to fit into a hole or slot put in the pole and the step can usually be put in and secured within seconds. While there are several styles of removable steps, the climbing of each is pretty much the same. Most of the time steps are spaced approximately 15 in. apart on alternating sides of the pole for the lower reaches of the pole. Then, in the upper portions of the poles where you will need to stand to work, steps are often positioned on both sides so that you can stand level-footed and work comfortably.



Other types of climbing apparatus are also available, including removable ladders, which have been popular on the larger transmission structures. These ladders generally span five feet of pole length and have four steps on them spaced at 15-in. intervals. These ladders are designed to fit into channel-shaped clips that have been welded to and run up one face of the pole. Ladders also come in a “working” style that provides eight steps per ladder or two steps at each elevation so that you can stand level-footed while working.

Work Platforms

There are times when working off of steps or ladders may be awkward. A few utilities have addressed this problem by designing a simple work platform that can be easily placed at most any location along the pole. A lineman can then place the platform at a position that best suits the work that needs to be done.



GLOSSARY OF TERMS

Base Plate – a flat plate welded to the bottom of the steel pole, which has holes in it for fitting onto an anchor bolt type foundation.

Basic Impulse Level (BIL) – also called Basic Insulation Level, the measure of a structure's insulation ability to withstand a voltage spike, such as from a lightning strike.

Deadend Structure – a structure having strain or deadend insulators.

Fiber-reinforced Polymer (FRP) or Fiber-reinforced Composite (FRC) – a product that is manufactured from a combination of fiberglass and resin (often referred to as simply “fiberglass”).

Hot-dipped Galvanizing – a coating of pure zinc that is applied to steel products (simply referred to as “galvanizing”). The process involves dipping the product in acid and flux baths to clean and prepare the surface and then dipping it in a bath of molten zinc.

Metalizing – a coating of pure zinc that is melted and sprayed onto the exterior surface of the product.

Slip Joint – a telescoping-type friction connection used to join two tapered pole sections together.

Snug-tight – the tightness obtained by manually turning a nut onto a bolt until it is fully seated.

Steel Distribution Pole – these poles are typically 60-ft or less in length and are made from steel that is between 1/8 and 5/16-inch in thickness.

Tangent Structure – a structure where no directional change in the line is made.

Touch and Step Potential – the potential difference in voltage (voltage gradient) between a lineman's hands and feet when working near an energized line.

White Rust – a powdery, grayish white buildup of zinc oxide on the galvanized surface (sometimes referred to as wet storage stain).

Work Platform – a device that can be mounted at an elevated position on the pole from which a lineman can stand and work.

Weathering Steel – a special chemistry steel that enables it to form its own protective coating, which significantly slows the corrosion process.

Zinc Silicate – a specially formulated coating that combines zinc with a silicate binder, which can be sprayed onto the surface of a steel product.

IN SUMMARY

Steel distribution poles continue to grow in popularity, first because they are both reliable and durable, but also because Operations and Line Personnel are finding them as easy or easier to use and work from as the wood poles they are most familiar with. The American Iron and Steel Institute represents a number of steel pole manufacturers and would be most interested in hearing from you with any questions, comments or suggestions that you have regarding their product. Please feel free to contact us:



**American
Iron and Steel
Institute**

1140 Connecticut Ave NW, Suite 705
Washington, DC 20036
(202) 452-7100

Email: ti@steel.org
Web: lineman.steel.org

PARTICIPANT'S QUIZ

The following questions are being asked to help you discover how much you learned by participating in this workshop. Please take a few minutes to read and answer them, then we will discuss each question and answer.

- 1) Which of the following applications are suitable for steel pole usage? *(circle all that apply)*
 - a. Tangent structure
 - b. Deadend/Angle structure
 - c. Guyed structure
 - d. H-Frame structure

- 2) What percentage of a steel pole can be recycled at the end of its service life?
 - a. Cannot be recycled
 - b. 25%
 - c. 50%
 - d. 100%

- 3) True – or – False *(circle one)*: When used as an angle or corner structure, a steel pole always needs to be guyed, as does a wood pole.

- 4) What is the most popular protective coating system for steel distribution poles?
 - a. Hot-dipped galvanizing
 - b. Zinc silicate
 - c. Metalizing
 - d. Paint
 - e. Self-weathering steel

- 5) Galvanized poles are typically furnished as single piece poles, with a maximum length of...
 - a. 35-ft
 - b. 45-ft
 - c. 55-ft
 - d. 70-ft

- 6) While in storage, how often do steel poles need to be rotated?
 - a. Monthly
 - b. Every three months
 - c. Every six months
 - d. Rotating is not required

- 7) True – or – False *(circle one)*: If a pole is galvanized, no additional coating is ever needed on the embedded portion of the pole.

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8) Name the two basic types of field joints that are used to connect the sections of a multi-piece pole:

9) Name the three primary ways of making attachments to a steel pole:

10) Holes should only be made in a steel pole using which of the following

- a. Stepped or "Christmas tree" bit
- b. Twist bit
- c. Hole Saw
- d. Any of the above

11) Which of the following crossarms is best suited for steel pole construction?

- a. Wood
- b. Steel
- c. Fiberglass
- d. Any of the above

12) According to a study by NEETRAC, in single-phase construction, a fiberglass poletop pin of what length should be used?

- a. 9"-10"
- b. 13"-14"
- c. 18"-20"
- d. A fiberglass spin should not be used

13) What is the most common means for climbing a steel pole?

- a. Removable ladders
- b. Permanent ladders
- c. Step bolts
- d. Removable steps

14) List three things about steel poles you see as the primary advantages over wood poles.

15) What is the biggest disadvantage you see you see in using steel poles vs. wood poles?
