4.2.1 OVERHEAD LINE ROUTE SELECTION

A. GENERAL

Route selection is an important factor in establishing the cost, the acceptance and the continuing usefulness of a distribution line.

In some cases, the route for a new overhead line extension is obvious. An example of this would be a group of new houses built adjacent to a three phase line with rear lot lines perpendicular to the existing three phase line. FPL practice is to serve overhead customers from the front lot line, keeping FPL's facilities accessible.

If a group of houses is located in a new area, remote from existing distribution lines, route selection would be one of the decisions the field engineer would have to make. Check with the Area Planning department to coordinate the extension with future feeder possibilities.

B. CONSIDERATIONS IN ROUTE SELECTION

1. Safety

Overhead lines built in accordance with FPL's overhead distribution standards and maintained in accordance with standard maintenance practices will be safe, both for Company personnel and the public. Even so, it is good practice to consider the exposure of lines to accidental damage as one item in the route selection process.

In serving rock pits or similar operations, avoid building overhead lines on routes where cranes and other tall equipment will likely pass under the line. At boat yards or boat launching sites, avoid areas which may be used to move tall masted boats into and out of the water, or from the launching site to a parking lot. Avoid expressway or railroad crossings where feasible. Even though the pole height required to make an acceptable crossing may not be excessive, construction and maintenance problems are usually more difficult.

Where possible, avoid building a line crossing over or along a property line of a school yard, athletic field or park where it is customary for groups of children to congregate or play.

2. Economics

The shortest route would normally be the obvious choice. At first glance, it might appear that the shorter the line, the lower the construction costs and the line losses. Sometimes the shortest route will involve numerous corners and anchors. Longer straight runs with fewer anchors might make the overall cost lower, even though the line is longer.

Terrain and landscape features must be considered in the economic evaluation. Avoidance of unstable, mucky or boggy areas can save considerable money in line construction. Heavy tree trimming is expensive (and may meet customer resistance) which may justify choosing a "tree-free" route, even if longer.

Building a new line for joint use with the Telephone Company reduces the cost to both utilities. Before deciding upon a route, it is wise to confer with Telephone Company engineers. If a route is found which is suitable for their use, they will generally agree to set the poles to maintain equal ownership of joint use poles.

When considering the installation of new poles, concrete poles are preferred in the case where replacement costs would be extremely high (i.e. Duct system riser pole, corner poles with multiple circuits, etc.). No differential is charged for poles in this case.

Joint construction on existing or proposed transmission pole lines must be examined from an economic viewpoint. Get an estimate from the Transmission Section of General Engineering as to the additional cost to accommodate distribution before deciding to route your line over the transmission line. It may be cheaper to find another route for the distribution line.

Look at the situation as though you were going to build the line to FPL standards, but had to pay for it with your money; what route would you choose?

3. Public Acceptance

The public attitude toward new power and telephone lines in urban areas is generally that no line at all is preferable to the most attractive (least offensive) line we can build. Accepting this attitude as a fact of life, one of our considerations in choosing a route is to pick one which will cause as little notice as possible, and one we can defend.

Single-phase laterals are usually in easements and are the lighter type of construction. They usually provide service to the customers whose land they pass over. They raise the least controversy and are the easiest to defend. Three phase lines are usually on through roads around the perimeter of the subdivision. If the subdivision is extensive, three phase mains will be necessary on one or more through streets dividing the subdivision into smaller segments.

Sometimes subdivisions are developed by segments, and these through routes can be obtained by building the line at a time when it is on the perimeter of the section being developed. In this way, the line is already existing when the next section is developed, and no one can complain later that "I wasn't told you were going to build a line there".

A study of the complete development must be made, to decide where three phase lines will be needed. Then the needed sections can be built as suggested above, and construction of unnecessary mains will be avoided.

In deciding on the necessity of mains through a subdivision, include a consideration of how adjacent undeveloped land can be fed. If it must be fed from the system you are designing, be sure you include capacity to take care of it. Once the subdivision you are now working on is finished, it will be very difficult to add three phase mains on pole-free, landscaped streets to serve load in someone else's subdivision.

When the first section of a large land development begins, plans must be made to serve the first houses, which typically are the models.

The first inclination, in line with paragraph B2 above, would be to come from the nearest source. If an adequate source is available at the edge of an adjacent developed area, this is fine. New construction will all be on the property being currently developed, and can be justified as necessary to serve the first houses. Even this first section should be built to fit in with the ultimate system, if it is believed the development will be completed as planned.

If the use of the nearest adequate source would require a three phase main to be extended through a completed development, you must judge the reaction from the customers in that development and how it will affect the Company's public relations. It may be that coming from a source further removed from the new houses, but over a route which is in the same subdivision will be more acceptable. The route of the line should be laid out to fit in with future development of the subdivision.

4. Usefulness

a. Undeveloped Land

If there is undeveloped, unplatted land between a new subdivision and a source which must be used, it is quite likely that any easement through the undeveloped land that can be obtained at this time will contain a relocation clause. This can be very expensive if a heavy three-phase line has to be relocated at a later date.

If this is true, consider building the minimum capacity line which you estimate will be able to serve the new development until a good easement, or public right-of-way (R/W) can be had to build the line ultimately needed. Keep in mind that other developments in the area might make sources available which you can tap without crossing undeveloped land. For these reasons, the first line built might well be a single phase, long span line.

b. Along Highways and Roads

Our franchises allow us to build on public R/W, though we may have to obtain permits before we can do this. DOT permits are required on state highways and city and county permits are required in many locations.

Even though we have a permit to occupy public R/W, we must usually absorb the relocation costs if the road is widened such that our poles must be moved if the permitter makes the request. In general, if any authority other than that which granted the permit (the permitter) requests relocation of FPL facilities, it reimburses FPL. An example would be a pole line on a city street permitted by the City. The street is later made a county road and the County asks FPL to relocate for widening. The County pays the costs. In any event, read the Franchise Agreement (they differ). See also Sections 1.6 and 1.8 of this manual.

When confronted with a highway improvement project and the relocation of a concrete or wood pole line becomes necessary, the existing type pole line should be used as a guide for replacements. There is no additional charge for concrete poles if the existing poles being relocated are concrete (like for like relocation). If the customer requests an "upgrade" to concrete poles, a differential is charged. When adding or replacing more than 10 poles, contact Storm Secure to ensure compliance with Hardening pole guidelines.

If our line is on a private easement, and must be relocated, the authority requesting us to relocate must pay the relocation costs. Therefore, when lines are to be built on state or county roads, get an easement to set the poles one foot inside private property, so they will be just off the road R/W.

It is important to consider the zoning and the character of the neighborhood through which a line may be built. In areas which are, or may be, developed for heavy commercial or industrial use, it may be possible for multi-story structures to be built at or near the property lines. In such a case, a line properly built in a street or alley or in a side - property easement may have to be relocated, due to the impossibility of maintaining code clearances from proposed buildings.

c. Crossing Multi-Lane Limited Access Highways

In the event that a new overhead line route will cross a multi-lane limited access highway, it is important to be aware of certain design considerations. Installation of a new crossing, regardless of whether it is a single, two, or three phase, needs to be made underground and it should be designed in such a fashion that it can accommodate three phase feeder size cable. However, in the event that an underground crossing is not possible, concrete poles need to be utilized and disconnect switches installed on both sides of the crossing. Storm guys should be installed on the crossing poles whenever possible.

d. Existing Areas Needing Additional Power Supply

In growing urban, suburban or industrial areas, the capacity of existing feeders may be approached or equaled by the area load.

Division Planning personnel have responsibility for monitoring load growth and planning ahead for feeder changes as needed.

The solution to the problem of supplying more source capacity may be to bring in one or more new feeders.

Unless the area is fairly new, many of the three phase main line sections or even feeders may be found to be of something smaller than what we now consider feeder sized conductors, such as #1/0 copper or #3/0 aluminum.

In picking a route for the new feeders, the easy way sometimes taken is simply to reconductor existing smaller 3 phase lines. The line sections are then rearranged to create the new feeders, sometimes with a small amount of new line construction near the substation. In some cases a cable pull-off can be installed at the substation and no new line construction is required.

This practice may be justified in cases where possible routes are extremely limited, or where it is management's opinion that additional three phase main feeder lines are unacceptable.

Where this is not the case, it may be to better advantage to install the new feeders on new routes, leaving the smaller three phase lines to serve as feeder ties and branches.

Rebuilding and reconductoring an old line "hot" can sometimes cost more than building a new line "cold" on a new route. In addition, if this procedure is followed, the #1/0 and #3/0 lines will be left to serve out their useful lives, rather than being retired from plant prematurely.

If a pole line is to be extended, the existing pole type should be used as a guide for the new poles. If concrete poles are requested by the customer (or are required as a condition of the permit if the poles are located in the R/W), the customer will pay the differential charge for concrete poles. However, when replacing pole(s) and anchor(s) with larger self supporting concrete poles, caution should be used, as the property owners in the vicinity of the facility will not perceive it as a better choice.

5. Accessibility for Operation and Maintenance

a. Operation

The route chosen for a line often affects the efficiency of operating procedures which are necessary for good service to customers fed by the line.

1) Disconnect Switches

Disconnect switches must be operated fairly often for transferring load as well as for sectionalizing around trouble locations. Therefore, it is essential that they be accessible. The speed of switching and restoration is greatly improved when switches can be reached with aerial equipment. Additionally, disconnect switches should not be installed on poles taller than 50 feet.

If disconnect switches are used in a three phase line located in a rear lot line easement, put them at the end of the block, where they can be seen and approached from the street. This will avoid disturbing the customer for switching operations where his service is not directly involved. If this is unavoidable, any switches installed in rear easements must be framed crossarm.

Disconnect switches should be installed on both sides of a limited access R/W crossing.

2) Fuse switches

Lateral fuse switches are usually located on the main line pole where the lateral originates. For efficient operation, this pole should be readily accessible from the entrance road to the area. An example might be a main line and a canal paralleling the access road. There are many laterals at right angles to the line, but only one bridge over the canal at the far end. There is parallel dirt road on the other side of the canal. If the main line is along the access road, with laterals crossing the canal, the fuse switches are accessible from the main line. However, to patrol the lateral before re-fusing, the troubleman would have to ride up to the bridge, cross over to the dirt road, ride back to the lateral in trouble, patrol and locate the trouble. After repairing or finding no trouble, he would have to repeat his travels in reverse to re-fuse the switch. Moving the line location across the canal to the dirt road would require more travel to get to the fuse switch but once there, he would save time in patrolling and re-fusing. There are many variations of this problem, and the answer is seldom clear cut. You must use your best judgement and consult with your operating people to get the optimum solution.

In urban residential areas, the main line is usually on the street with laterals branching off at right angles down rear easements. Lateral fuse switches are located on the main line where accessible from the road. If the lateral runs in both directions and is fairly long, it should have an individual fuse for each direction, even though the load may not be enough to justify having two fuses on the basis of connected transformer kVA. This will decrease the patrolling time and the number of customers suffering an interruption when a fuse blows.

If the rear lot line lateral is long and second stage fusing is used, the second stage fuse switch should be located on a pole at a street crossing so that it will be more accessible.

3) Transformers

Transformer fuses must be at the transformer, so we have little control over them. However, as far as possible, install the transformer on a pole which is free from shrubbery and trees. Junctions of walls or chain link fences at a transformer pole slow the troubleman in his work and delay service restoration.

From an operating standpoint, transformers located on the street and feeding secondary each way into the easement would be good in that they would be accessible for re-fusing and replacing without working on customer property. This is not possible in many cases. Loads and lengths of secondaries vary; block lengths are not all equal. This is an item which might be considered for limited application. The one drawback is that the transformer is more visible to the public.

4) Poles

When selecting an overhead line route there are some important design issues to bear in mind when choosing a new pole location, considerations that impact the overall operation and maintenance of the facilities. Every attempt should be made to place new or replacement poles in private easements or as close to the right of way line as practical. Similarly, overhead pole lines should be placed in front lot lines or accessible locations were feasible, and replacement poles should be set as close as possible to the existing pole to avoid the creation of a new pole location. Finally, poles are not to be placed in medians, and concrete poles, in particular, are not to be placed in inaccessible locations or locations that could potentially become inaccessible.

b. Maintenance

Maintenance of pole lines and equipment must be considered in choosing the route of a line. In rural areas, pole lines along county roads are easier to maintain than those which run for long distances through forest areas, inaccessible by road. It is usually better to follow close to a road, although the distance may be somewhat greater. Where there is no road, it is usually better to go around boggy areas or swamps than through them. Patrol and maintenance are very difficult and expensive in swamps.

Along interstate highways and some toll-ways, maintenance from the highway R/W is not permitted. If a pole line is located on the road R/W, provision must be made to service the line from service roads or private property. Sometimes, fences may be diverted to make this possible.

If there is a parallel service road or secondary road, it is usually better, from a maintenance standpoint to build there rather than on the expressway. On some of the older highways the pavement has been widened until there is little room left for a pole line. Traffic would endanger poles, and lines would be better built elsewhere.

Regulations as to safety warning signs and cones required when a crew is working on a line from a state road make it increasingly difficult to maintain lines from primary state roads.

Lines in severe salt spray areas deteriorate because of the corrosive action of damp salt, even though our construction is modified to be corrosion resistant. The life of the line and equipment can be lengthened if the route chosen is back from the oceanfront as far as possible, and shielded as much as possible by buildings and trees. Transformers, switches, and cable risers should be located, if possible, where they are shielded by buildings from direct exposure to wind from the ocean.

This section offers only a partial list of thoughts to consider, since the General Office cannot presume to know local situations. The bottom line is: plan ahead; build the line where the public won't notice it, but where the troubleman can service it easily; and use good judgement.

Section 4.2.2, (the tables on pp. 39 and 40) were updated on December 8, 2006. Tables G & H were updated on June 15, 2007

4.2.2 POLES-STRUCTURES-GUYING

A. POLES, GENERAL INFORMATION

1. Pole Brands

All FPL poles are marked with a brand to indicate manufacturer, month and year of manufacture, class or type and length. For wood and concrete poles the brand is located 15' from the butt.

2. Design Specifications

It is impossible to discuss poles and guys completely separately, since the two act together. In many of our calculations, it will be seen that the effects of line and guy tensions upon pole loading must be considered at the same time as the effects of wind loading. As far as possible, however, poles and guys will be dealt with separately in this section.

The National Electrical Safety Code (NESC) provides basic standards intended for safeguarding the installation, operation and maintenance of electrical supply, communication lines and equipment. NESC, also known as "The Code", is applicable to diverse work rules and regulations in the utility industry.

Rules 240 through 264 illustrate the application of grade of construction to electrical and communication lines and the appropriate requirements. Grade of construction is a classification resulting from the application of a safety factor to the various supporting items on our overhead distribution lines. A particular grade is determined in accordance with the wind pressure characteristics of a specific location. These wind pressures determine the necessary safety of the electrical supply lines in each area. FPL boundaries incorporate regions which vary in wind pressure; thus allowing for two different grades of construction to be applicable, Grade B and Grade C construction. In reference to electric supply, the restrictions for supply lines exceeding 750V to ground fall into the category for Grade B or C construction.

As previously stated, a grade of construction results from the application of a multiplier or safety factor. Grade B is designated by a safety factor of 4 and Grade C by 2.67 (NESC Tables 261-1 & 261-3A). Using the formula for wind pressure on cylindrical surfaces,

$$V = \sqrt{\frac{P}{.00256}}$$

the calculated wind velocity for Grade B is 118.6 mph and 96.9 mph for Grade C.

Referencing to figure 1 below (Figure 250-2, Basic Wind Speed) of the 1997 edition of the NESC book, the State of Florida can experience basic wind speeds between 90 and 110 mph.

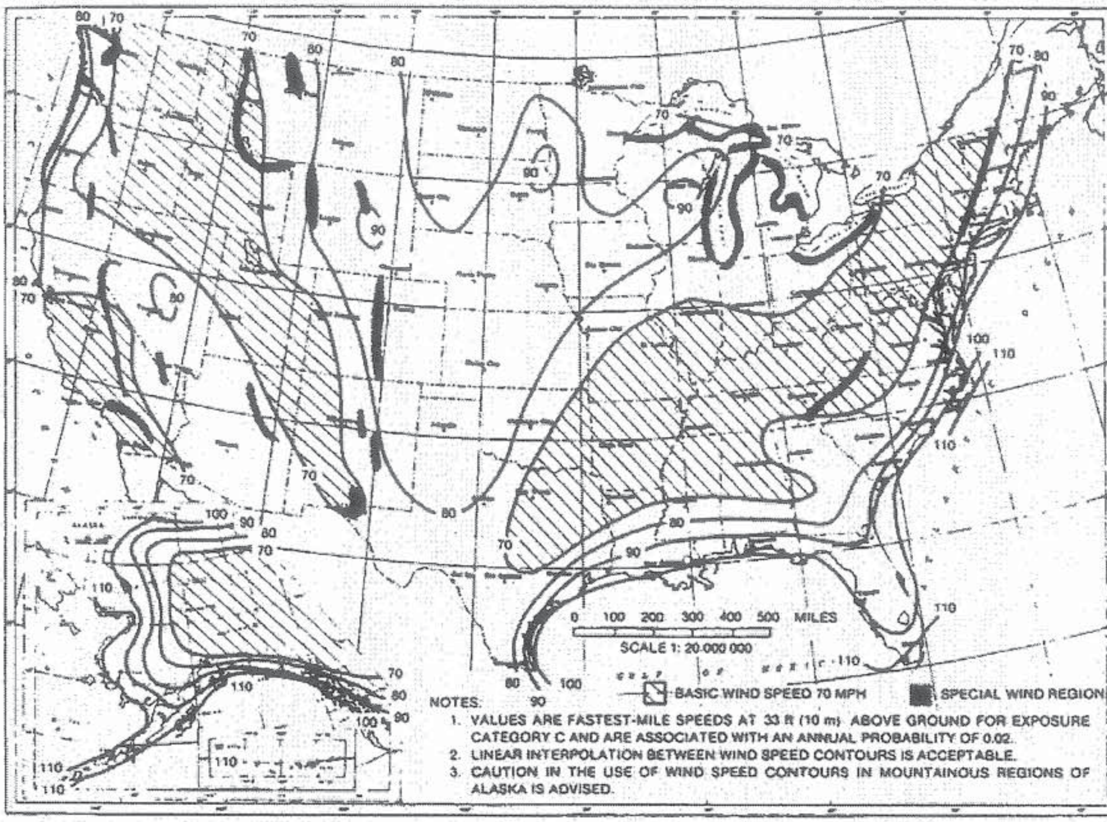


FIGURE 1
(NESC FIGURE 250-2 BASIC WIND SPEED – MILES PER HOUR

Grade B and C construction are applicable in our service territory as shown in the figure on the following page. This means that for wood and concrete poles the minimum strength is calculated using 9 lb.-per-square-foot wind multiplying by the appropriate safety factor required by the NESC (see tables on page 4).

Figure 2 (continued from previous page)

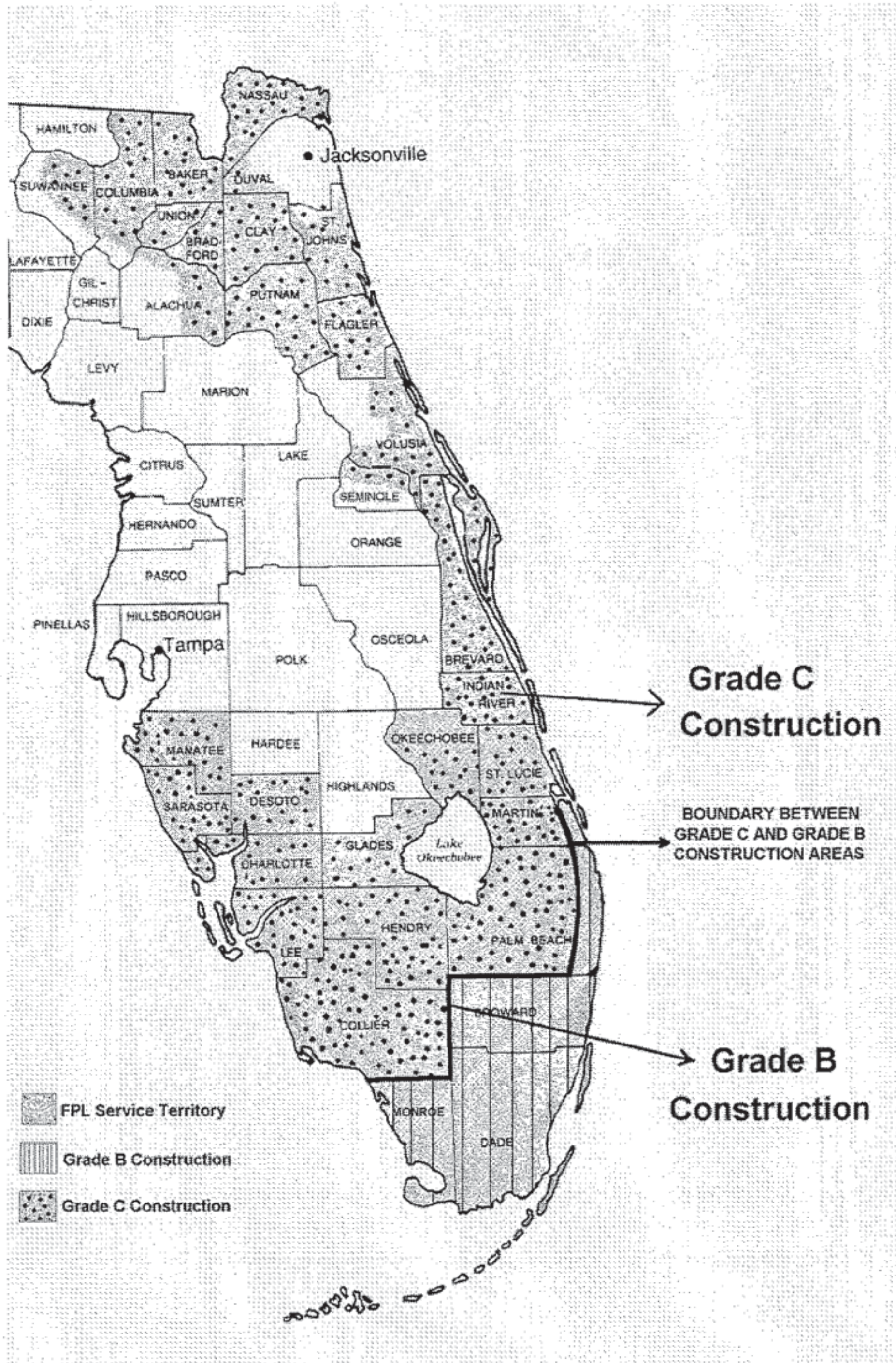


FIGURE 2
(See Boundaries on following pages.)

Grade B Construction Boundaries For West Area and East Area

- West Palm Beach county area: east of Florida Turnpike.
- Martin county area: east of Florida Turnpike.

OVERLOAD FACTORS FOR CALCULATIONS ON WOOD POLES

Item	Grade B Construction Overload Factor	Grade C Construction Overload Factor
Pole, transverse (Wind load)	4.0	2.67
Pole, vertical (Axial load)	2.2	2.2
Equipment (Wind load)	4.0	2.67
TANGENT conductors, cable, or other attachments (Wind load)	4.0	2.67
ANGLE conductors or cable attachments	2.0	1.33
DEADEND conductors or cable attachments	2.0	1.33

OVERLOAD FACTORS FOR CALCULATIONS ON CONCRETE POLES

Item	Grade B Construction Overload Factor	Grade C Construction Overload Factor
Pole, transverse (Wind load)	2.5	2.2
Pole, vertical (Axial load)	1.5	1.5
Equipment (Wind load)	2.5	2.2
TANGENT conductors, cable, or other attachments (Wind load)	2.5	2.2
ANGLE conductors or cable attachments	1.65	1.10
DEADEND conductors or cable attachments	1.65	1.10

Note: Values listed are from NESC Table 253-1 and Table 253-2

3. Wood Poles

a. Wood Treatment

FPL presently purchases two types of pressure treated wood poles; Chromated Copper Arsenate (CCA) and creosoted (CYP) poles. Distribution poles are CCA treated. However, Transmission purchases some creosoted poles. If necessary, these creosoted poles can be used for Distribution as well. Occasionally Douglas fir may be substituted for SYP in these larger sizes. Since Douglas fir does not accept CCA treatment as well as SYP, they are treated with creosote. CCA poles are treated to a retention of .6 lbs./cu. ft. by assay.

b. Strength

The strength of wood poles is based upon ASA minimum dimensions for Southern Yellow Pine with an ultimate fiber stress of 8000 psi and a bowing fiber stress of 1000 psi. To say it another way: for any circumference of pole there is a moment, expressed in foot-pounds, which will create a fiber stress of 1000 psi; this moment will cause the pole to begin to bow. There is another moment - 8 times as large - which will create a fiber stress of 8000 psi; at this point the pole should fail.

An industry-accepted simplified formula for calculating these moments is:

$$M_r = .000264\ fC^3$$

Where M_r = moment (ultimate or long term bowing) in foot-pounds.

F = fiber stress (8000 or 1000 psi for Southern Yellow Pine).

C = circumference, in inches, of pole at the point where the moment acts. For a pole set in earth, this point is the "fixity point", or fulcrum point, which is 1/3 of the setting depth below the ground line. The distance from pole top to fixity point is the pole length minus 2/3 of the setting depth. See Figure 3, page 9, this section. See TABLE G, page 68 of this section, for circumferences.

The reason for identifying a fixity point (See Fig. 6) is that the earth is not perfectly solid at or near the surface, but will yield slightly in response to pole bending or bowing. At one-third of the setting depth, the earth is generally considered to be a firm, immovable support. If the pole were set in a large volume of concrete, or even in a poured concrete sidewalk, the fixity point should be considered to be at the ground line.

Note that there is no safety factor built into this formula.

Example: *Find the initial strength of a 45'/2 pole set 7' deep. Distance from top to fixity point = 45' - (2/3 x 7') = 45' -4.67' = 40.33'. From TABLE G, the circumference of a 45'/2 pole 40.33' from the top is 41.0".*

$$M_r = .000264 \times 8000 \times (41.0)^3 = 145{,}561 \text{ ft.-lbs.}$$

A pole may have a continuous stress (i.e., a stress other than wind loading) imposed on it. If the resulting moment is above the maximum allowable long term bowing moment, the pole will, in time, become permanently deformed. Therefore, when your design places continuous stresses on a pole, check to see that you have not exceeded the permissible long term bowing moment. If this moment is exceeded, guy the pole or redesign your installation. While a safety factor of at least 4 (Grade B construction) or 2.67 (Grade C construction) is required when working with ultimate, no safety factor is required with "long term bowing", it is a self-imposed guideline.

4. Concrete Poles

All FPL concrete poles are prestressed. Concrete pole strengths are specified by FPL. These strengths were originally obtained from empirical data. The controlling factor in concrete pole strength is the closure of cracks on the tension side of a pole after repetitive loadings.

If these cracks do not close after a temporary load (wind) is removed, the exposed pre-stressing steel will deteriorate and the pole will eventually fail. Similarly, if the pole is continuously loaded beyond the point where cracks open, the pole will deteriorate as above. Therefore, like wood poles, concrete poles have a continuous and a temporary rating. The temporary rating is the maximum load that can repetitively be placed on a concrete pole with crack closure upon unloading. The continuous load rating is the maximum continuous load that can be placed on a concrete pole without opening cracks after repetitive loading to the maximum temporary load rating.

The tabulated ratings are for loads placed two feet from the top of the pole with the fulcrum placed six feet from the butt for Type III, III-G and III-H. Type "O", "S", and "SU" are loaded at one foot from the top of the pole and held at five feet from the butt.

Pole Type	Temporary Rating	Continuous Rating
"O"	850#	255#
"S" & "SU"	900#	300#
III	1300#	560#
III-A	1300#	600#
*III-G	2400#	900#
III-H	4200#	1200#
12KIP	8400#	2400#

*Type III-G concrete poles are identical to Type III poles except they have galvanized pre-stressing strands. Because the strands are galvanized some cracks on the tension side are permitted to remain open, thus increasing both strength ratings.

In view of the above facts, then, the strength (M_r) of a concrete pole is calculated as follows:

For Type "O", "S", and "SU" poles, M_r = Design Load x (Pole Length - 6 ft.)

For Type III, IIIG, and IIIH poles, M_r = Design Load x (Pole Length - 8 ft.)

The Design Load is the Temporary Rating when calculating ultimate strength; it is the continuous rating when considering continuous stresses, such as conductor loads due to angles in the pole line.

Example: Find the ultimate strength of a 45' IIIH pole.

M_r = Design Load x (Pole Length - 8 ft.)

= 4200# x (45 - 8) ft. = 155,400 ft.-lbs.

Note When calculating maximum moments for various situations all safety factors specified on TABLE A must be applied and the wind loads on the pole itself must be subtracted. (See tables beginning on page 36, this section.)

B. POLE OWNERSHIP AND CLASSIFICATION

1. FPL vs. The Telephone Company

Wherever a joint use agreement with the telephone company exists, there is always a decision to be made as to which company will set proposed poles. In the case of new construction, this must be determined by local policy and by negotiation with telephone company engineers, in accordance with the Joint Use Agreements in force.

Where existing poles must be replaced or relocated, it is vital that their ownership be correctly identified. The surest way to identify the owner is to check the pole brand. In the event that there is no legible pole brand, the adjacent poles should be checked.

Another means of identification is the top of the poles. The top of most FPL poles have a peaked top while the top of most telephone company poles have a sloped flat top. Also, FPL's standard pole treatment is CCA, a green color.

Most concrete poles with FPL facilities attached are owned by FPL and have an FPL brand on them. There are, however, city and county owned traffic and street light poles.

FPL wood and concrete poles are generally branded 15 feet from the butt.

2. Transmission vs. Distribution

Any pole or guy stub to which transmission facilities are attached shall be classified as a transmission pole. For further information refer to Section 4.5 and 4.2.3, Part H of this manual.

If a transmission pole or stub must be replaced to accommodate distribution facilities, it should be done on a Transmission Work Order (TWO). If a distribution pole is replaced with a transmission pole or stub, the distribution pole should be retired on an System Improvement and transmission pole or stub installed on a TWO.

When the classification of a pole is changed without replacing the pole, the department originating the Work Order that caused the change in classification shall request classification of the pole by entry on the job face.

When a transmission pole is replaced on a TWO, the underbuilt distribution facilities are to be transferred on the TWO with the charges going to distribution maintenance.

For further information on this subject, refer to Sections 4.5 and 4.2.3, part H, this manual.

C. SELECTION OF POLE TYPE AND CLASS

1. Wood Vs. Concrete Pole

Concrete poles are considerably more expensive than wood poles; consequently, their use should be limited to situations where their extra cost can be justified. They should be used in areas where specified by management, preferably where the chance of future relocation is slight. They may also be used where future wood pole replacement costs would be extremely high, e.g., duct system riser poles, three phase deadends or corner poles.

2. Torsional Loading

In designing deadend or corner poles using crossarms, it is important to balance tensions or provide arm guys so that the pole is not subjected to torsional loads. Concrete poles do not resist torsion very well, especially at the top of a pole; therefore such loads can cause failure. Wood poles, though tolerant of temporary torsional loads, will over a period of time become permanently deformed.

To provide adequate strength to resist sudden and/or accidental torsional loading of concrete poles, a class 3H pole should be used at all new two or three phase deadends using a crossarm regardless of conductor size. Two and three phase crossarm lateral pulloff deadends do not require a 3H pole because of the added strength at the buck level due to increased pole cross-section area and reinforcing.

3. Wind Loading

Wind loading is applied at right angles to the pole line. It consists of the moment due to the pressure of the wind upon the pole itself, plus the moment due to wind acting upon the conductors (one-half span in each direction from the pole), plus any moment due to wind acting upon transformers or capacitor banks installed on the pole.

a. Wind Loading Upon Pole

The wind forces upon a pole are considered to be directed against the "projected area" of the pole. This is a trapezoid whose area is

$$A = H_1\left(\frac{a+b}{2}\right)\left(\frac{1}{12"}\right)$$

	A	=	projected area above grade in sq. ft.
	H_1	=	the pole's height above the ground line in feet.
For a wood pole,	a	=	diameter at pole top in inches.
	b	=	diameter at ground line in inches.

For a concrete pole, a and b are the widths of one face at top and ground line respectively.

Wind speed in miles per hour is converted to wind loading (pressure in lbs. per square foot) according to National Electrical Safety Code Rule 250B and Figure 250-1; typical values are tabulated in NESC Table 250-2. The total wind force upon the pole is the loading per square foot, times the area in square feet, times a "shape factor" as defined in NESC Rules 250C and 252B2. For a cylindrical pole such as our wood poles, the shape factor is 1.0; for a square pole such as our concrete poles, the shape factor is 1.6.

In calculating the wind-loading moment, we must identify a point at which the wind force may be considered to be concentrated. This point is the center of area, or the "center of gravity" of the trapezoidal projected area. Its location is calculated according to the formula:

$$H_{CA} = \frac{H_1(b+2a)}{3(b+a)}$$

where H_{CA} is the height above ground line of the center of area, the other letters having the same meanings as above. As an approximation, for wood distribution poles, $H_{CA} = 0.46 \times H_1$. For square concrete distribution poles, $H_{CA} = 0.45 \times H_1$.

The moment arm through which the wind-loading moment acts is the distance from the center of area to the fixity point, or $H_{CA} + D_F$, as shown in Figure 3. (See Page 5 for an explanation of the fixity point.)

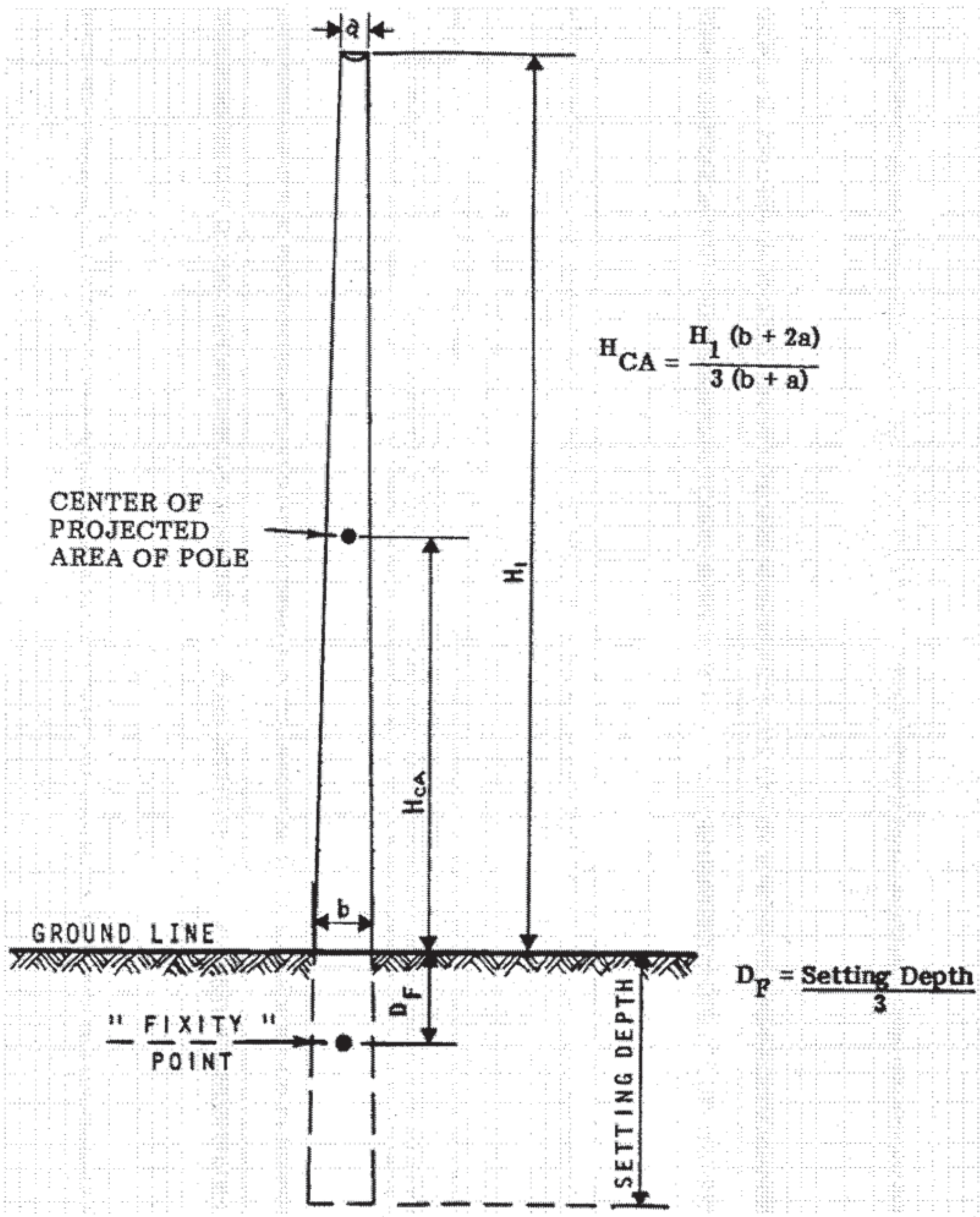


Figure 3
DIMENSIONS USED IN CALCULATING WIND LOAD ON POLE

Example of Calculation for Wood Pole: Calculate the wind load on a 45'/2 pole set 7 ft. deep.

$$Projected\ Area.\ A = H_1(ft.) x \frac{1\ ft}{12\ inc.} x \left[\frac{a+b(inches)}{2}\right]$$

$$From\ Table\ G,\ Page\ 71,\ the\ circumference\ at\ the\ top\ of\ a\ 45'/2\ pole\ is\ 25",\ a = \frac{25"}{\pi} = 7.96"$$

$$The\ circumference\ at\ 38\ ft.\ below\ the\ pole\ top\ 40.1",\ b = \frac{40.5"}{\pi} = 12.89"$$

$$So\ A = \frac{38}{12} x \left[\frac{7.96+12.89}{2}\right] = 33.01\ sq.\ ft.$$

$$Height\ of\ center\ of\ area,\ H_{CA} = \frac{H_1(b+2a)}{3(b+a)} = \frac{38(12.89+15.92)}{3(12.89+7.96)}$$

$$Moment\ Arm = H_{CA} + D_F = 17.50 + \frac{7}{3} = 19.83\ ft.$$

$H_{CA} = 17.50\ ft.\ above\ ground$

Wind Load M_P = Wind Pressure x Overload Factor x Projected Area x Moment Arm.

M_P = 9 p.s.f. x 4 (Grade B Construction) x 33.01 sq. ft. x 19.83 ft. + 23,565 ft. lbs.

The strength of this pole, as calculated on Page 5, is 145,561 ft.-lbs. Subtracting the wind load from this leaves

145,561 – 23,565 = 121,996 ft.-lbs.

Dividing this by a overload factor of 4 (Grade B construction), we have 30499 ft.-lbs. As the initial allowable moment available for conductors and other attachments.

The NESC permits the overload factor to be reduced from 4 to 2.67 (Grade B construction) for existing installations when the pole is nearing replacement age (see NESC Table 253-2). However, this does not take into account the reduced strength of the pole due to deterioration.

Example of Calculation for Concrete Pole: Calculate the wind load on a 45" 111H pole.

$$Area\ of\ pole\ face = A = H_1\ x \frac{1}{12} x \left[\frac{a+b}{2}\right] = 3'8\ x \frac{1}{12} x \left[\frac{9.0+15.33}{2}\right]$$

$$A = \frac{38}{12} x \frac{24.33}{2} = 38.52\ sq.\ ft.$$

$$Height\ of\ Center\ of\ Area\ H_{CA} = \frac{H\ 1(b+2a)}{3\ (b+a)} = \frac{38\ x\ 33.33}{3\ x\ 24.33} = 17.35\ ft.$$

$$Moment\ arm = H_{CA} + D_F - 17.35' + \frac{7}{3} = 19.69\ ft.$$

Wind Load M_P = Wind Pressure x Area x Moment Arm x Shape Factor x Overload Factor

= 9 p.s.f. x 38.52 sq. ft. x 19.69 ft. x 1.6. x 2.5 (Grade B construction)

= 27,304 ft.-lbs.

The ultimate strength of this pole was previously clculated to be 155,400 ft.-lbs. Subtracting the wind load and dividing the result by a safety factor of 2.5 we have $\frac{155{,}400-27{,}304}{2.5}$ =5,238 ft.-lb. as the allowable moment available for conductors and other attachments.

b. Wind Loading Upon Conductors and Other Pole Attachments

The wind-load moment of each conductor is calculated in the following steps:

1) Obtain from TABLE A-1 the wind force on the conductor per foot of span. (Tables begin at page 32, this section.)

2) Multiply by span length (one-half span in each direction from pole).

3) Multiply by the conductor attachment height above the fixity point.

Or, Mc = (Wind force per foot) x (span length) x (attachment height + 1/3 setting depth)

This calculation is repeated for each FPL, telephone, and CATV conductor or cable to be attached.

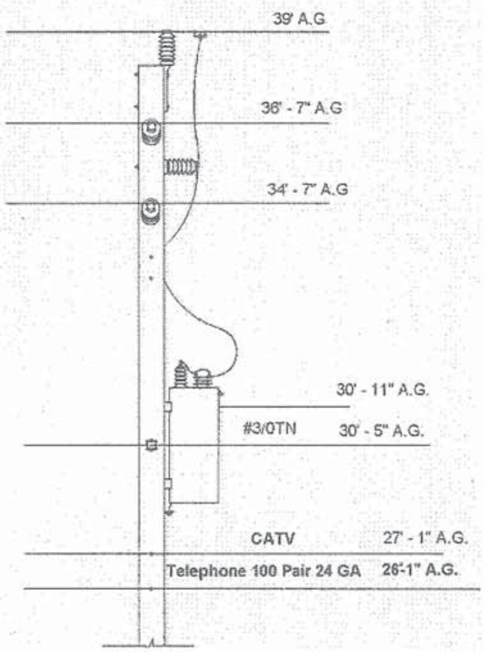
The moment for each item of equipment is then calculated, using the appropriate resisting force from TABLE A-2, multiplied by its attachment height above the fixity point.

All conductor and equipment moments are added together, and the total is compared with the available moments for each height and class of pole from TABLE A-3 and A-4. Note that no overload factor need be considered in the conductor and equipment calculations, since the appropriate overload factors have already been factored into TABLE A-3 and A-4.

The tables and information shown on TABLES A-1, A-2, A-3, A-4 and B may be used to determine the class or type of pole required for any proposed installation. Some additional factors which should be considered, however, are:

- Where a guyed lateral pulls off another line, the pole is, in effect, storm guyed and one class lighter pole may be used.
- Calculated transverse loads (except when crossing over a railroad or a major communication facility) shall be based on the average span length of a uniform section of line, providing the average span length used is not less than 75% of actual average of the two spans adjacent to the pole being considered.
- A pole not individually meeting the transverse strength requirements will be permitted when reinforced by a stronger pole on each side, provided the average strength for the three poles meets the transverse requirement and the weak pole has not less than 75% of the requirement.
- A dead-end pole has only half the transverse load that it would have if the line continued on.
- Intermediate poles set in line may be lighter than the existing poles if no conductors are added.

Following are examples of typical wind-loading calculations. These calculations were done assuming Grade B construction.



WIND LOADING CALCULATIONS: EXAMPLE A

Determine class of 45' pole required for:
3 - #568 ACAR primary
1 #3/0 AAAC neutral,
1 - CATV feeder cable
1 - 100 pair 24 ga. BKMS telephone cable.
1 - 50kVA transformer

Proposed average span length is 200 ft. Calculate moment for each conductor and for transformer. Total all moments.

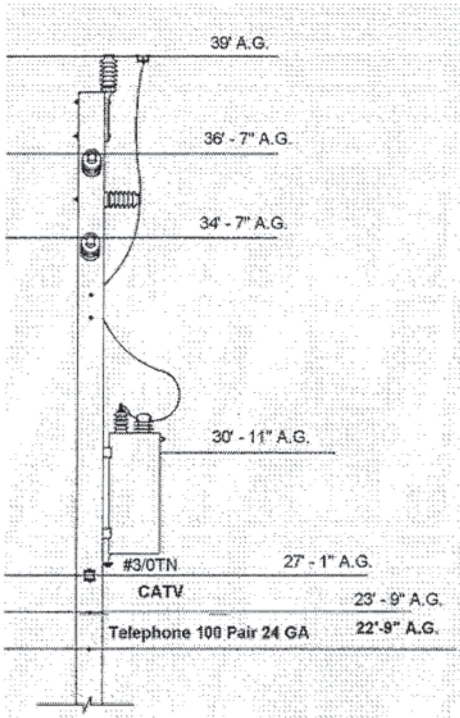
Conductors:

# of Conductors	x	Wind Load Per Foot (Table A-1)	x	Span Length (ft.)	x	$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$	=	Units (ft.-lb.)
1	x	.659	x	200	x	$(39'+2.33')$	=	5,448
1	x	.659	x	200	x	$(36.62'+2.33')$	=	5,134
1	x	.659	x	200	x	$(34.62'+2.33')$	=	4,870
1	x	.377	x	200	x	$(30.42'+2.33')$	=	2,470
1	x	.56	x	200	x	$(27.08'+2.33')$	=	3,294
1	x	.84	x	200	x	$(26.08'+2.33')$	=	4,773

Transformer:

Wind Load from Table A-2	x	$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$		
49	x	(30.9'2 + 2.3'3)	=	1,629 ft.-lb.
		Total of Moments	=	27,619 ft.-lb.

From TABLE A-3, the initial allowable moment of a 45'/2 pole is 30,585 ft.-lbs. The 45'/2 pole is adequate for this application.



WIND LOADING CALCULATIONS: EXAMPLE B

Determine maximum average span for a 45' class 2 wood pole with 3-568 kcmil ACAR primary.

1 #3/0 AAAC neutral, 50 kVA transformer, 1 - CATV feeder cable, 1 - 100 pair 24 ga. BKMS telephone cable

Conductors:

# of Conductors	x	Wind Load Per Foot (Table A-1)	x	$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$	=	Units (ft.-lb. per foot of span)
1	x	.659	x	$(39' + 2.33')$	=	27.24
1	x	.659	x	$(36.62' + 2.33')$	=	25.67
1	x	.659	x	$(34.62' + 2.33')$	=	24.35
1	x	.377	x	$(27.08' + 2.33')$	=	11.09
1	x	.56	x	$(23.75' + 2.33')$	=	14.61
1	x	.84	x	$(22.75' + 2.33')$	=	21.07
				Total conductor moment per foot of span	=	124.038 ft.-lbs.

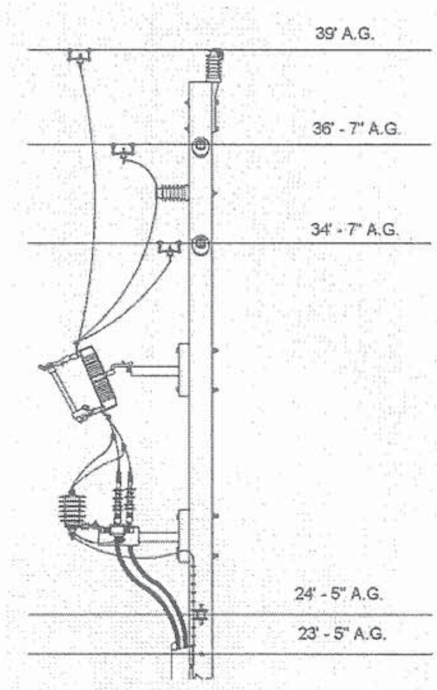
Transformer:

Wind Load from Table A-2	x	$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$	=	
49	x	$(30.9'2 + 2.3'3)$	=	1,629 ft.-lb.

Subtract the transformer wind load from the initial allowable moment of a 45'/2 pole (from TABLE A-3), which is 30,585.

30,585 – 1,629 = 28,956-lbs., permissible conductor moment

$$\textit{Maximum average span} = \frac{28{,}956}{124} = 233\ ft.$$



WIND LOADING CALCULATIONS: EXAMPLE C

Determine class of 45' pole required for 3-568 kcmil ACAR primary, 1 #3/0 AAAC neutral, and a 4" riser shield.

Proposed average span is 200'.

Calculate moment for each conductor and for riser shield. Total all moments.

Conductors:

# of Conductors	x	Wind Load Per Foot (Table A-1)	x	Span Length (ft.)	x	$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$	=	Units (ft.-lb.)
1	x	.659	x	200	x	$(39' + 2.33')$	=	5,477.30
1	x	.659	x	200	x	$(36.62' + 2.33')$	=	5,133.61
1	x	.659	x	200	x	$(34.62' + 2.33')$	=	4,870.01
1	x	.377	x	200	x	$(24.50' + 2.33')$	=	2,023.00

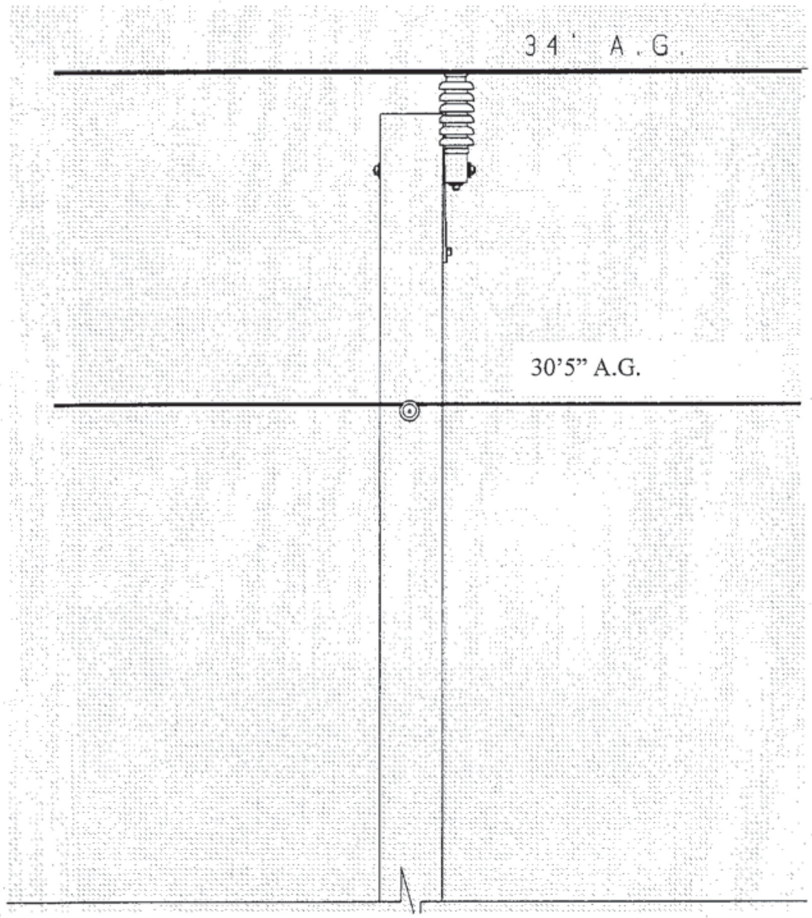
4" Riser:

Riser Wind Load from Table A-2 x $\left(\frac{\text{Riser Height Above Ground}}{2} + \frac{\text{Setting Depth}}{3}\right)$ =

$$3.2 \times \left(\frac{23.42'}{2} + 2.3'3\right) = 1{,}052 \text{ ft.-lbs.}$$

Total of all Moments = 18,797.43 ft.-lbs.

From TABLE A-3, the initial allowable moment of a 45'/3 pole is 23,535 ft.-lbs.



WIND LOADING CALCULATIONS: EXAMPLE D

Determine maximum average span for a 40' class 4 wood pole with 3-568 kcmil ACAR primary and #3/0 AAAC neutral using crossarm construction.

<u>Conductors</u>:

No. of Conduc.		Wind Load Per Foot (Table A-1)		$\left(\text{Height Above Ground} + \frac{\text{Setting Depth}}{3}\right)$		
3	x	.659	x	(34.0' + 2.16')	=	72 ft.-lb. Per foot of span
1	x	.377	x	(30.42' + 2.16')	=	12 ft.-lb. Per foot of span
				Total conductor moment per foot of span	=	84 ft.-lb. Per foot of span

From TABLE A-3 the initial allowable moment of 40/4' pole is 17,115.

$$\frac{17{,}115}{84} = \underline{\underline{203\ ft.}}$$

4. Columnar (Axial) Loading On Wood Poles

a. General

At corners and deadends, poles are down-guyed to hold conductor tension. The vertical component of the tension in the guy wire places an axial compressive force on the pole. The pole is a column, and excessive axial compressive load will cause it to bow. The critical buckling load has been reached when bowing starts. At this point, if the loading is reduced, the pole will straighten out. If loading is increased, the bowing will increase, and failure by buckling will eventually result if the loading is increased enough.

Where a combination of vertical, transverse or longitudinal loads may occur simultaneously, the structure shall be designed to withstand the simultaneous application of these loads.

b. Longitudinal Strength at Deadends

NESC Rule 261A states that the strength requirements for supporting structures may be met by the structures alone or with the aid of guys or braces or both. This rule further states that structures shall be designed to withstand the appropriated loads multiplied by the overload factors in Section 25 without exceeding the permitted load for metal, prestressed and reinforced concrete structures or the permitted fiber stress of wood poles. The permitted load or fiber stress is multiplied by the appropriate strength factors in Section 26.

For guyed poles, this fiber stress or permitted load is measured at point of attachment of the guy. FPL practice is to attach guys at or very near the point of application of conductor tension, so that this requirement is seldom a problem for standard guyed deadend poles. Where extreme wind loading conditions are used, (see NESC Rules 250C and 260B).

c. Columnar (Axial) Loading

Guyed poles must be designed as columns resisting the vertical component of guy tension, plus any other vertical loads. A guyed deadend pole may be considered as a column fixed in place at the "fixity" point, defined as 0.33 of the setting depth below the ground line. At the top, it is fixed in position in one plane (the longitudinal) only and free to bow in either plane. Lateral movement of the pole top will be resisted by a slight increase in conductor tension.

d. Corner or Junction Poles

A corner pole or a junction pole can be considered to have the same restrictions at the bottom as a deadend pole. At the top, however, it is fixed in position in each plane.

At a junction pole, the guy would stress the pole in the same manner as at a deadend pole. At a 90° corner, there would be two guys, each exerting a downward force on the pole. However, the direction of the wind cannot be perpendicular to both conductors. A wind direction should be assumed which will give the maximum resultant load. Proper reduction should be made in loading to account for the reduced wind pressure on the wires resulting from the angularity of the application of the wind to the wires.

e. Calculating Allowable Axial Loading

If we assume, as an approximation, that the bottom of the pole is fixed and that the top is held in place as though pinned on a ball joint, Euler's modified formula with an end condition factor of 0.8 may be used. However, to be more conservative, we used a factor of 1.0 to obtain the recommended allowable loadings shown in TABLE C. This table may be modified if new data, specifically applicable to guyed distribution poles, is obtained.

$$P = \frac{\pi^3 \, x \, E \, x \, d^4}{64 \, x \, 1 \, x \, SF \, x \, (12H)^2} = \frac{\pi^3 1.76 \, x 10^5}{64 \, x \, 1 \, x \, 1 \, x \, 144} \, x \, \frac{d^4}{H^2} = 5921 \frac{d^2}{H^2}$$

(Euler's Formula, Southern Yellow Pine, with effective column length equal to actual column length)

where P = Allowable downward force on the pole, in pounds.

E = Modulus of elasticity, 1.76 x 10^6 psi for southern yellow pine.

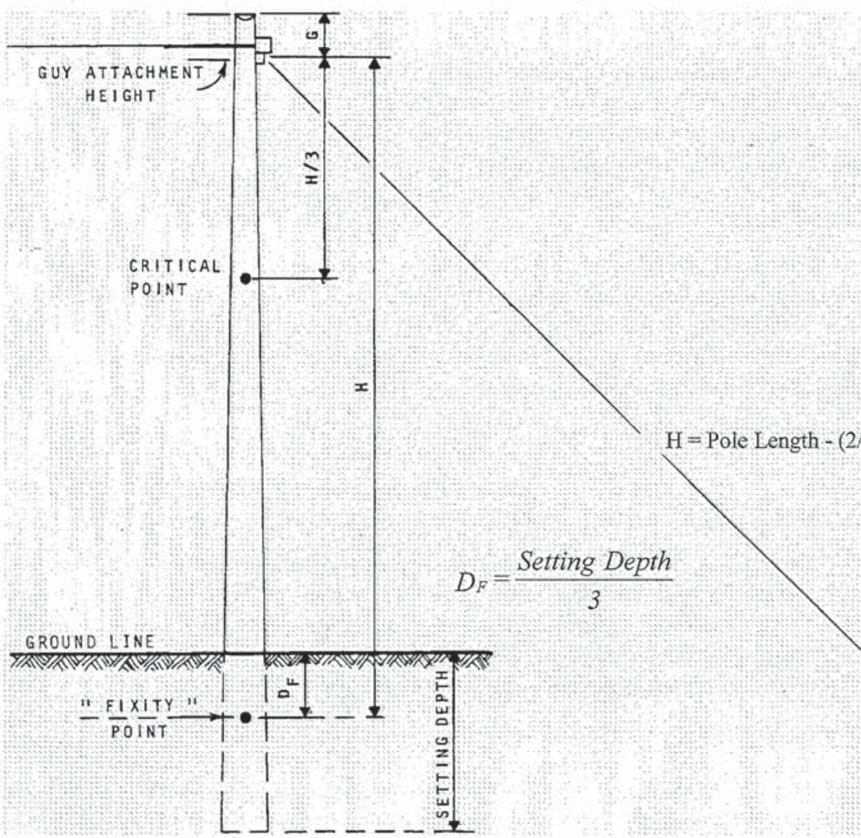
H = Distance in feet from point of guy attachment to fixity point.

SF = Safety Factor. We justify using 1.0 on basis that maximum loading is based on wind loading, an infrequent, short-time load, and that Euler's formula is conservative for distribution length poles. In addition, minimum diameters for pole class were used.

d = Diameter, in inches at critical point, (1/3 H feet down from guy attachment).

Note: E = Modulus of Elasticity, 3.75 x 10^6 psi for III-H and III-G concrete poles. Use given width of concrete pole for d dimension.

See Figure 4 below for dimensions used in calculating axial load on pole

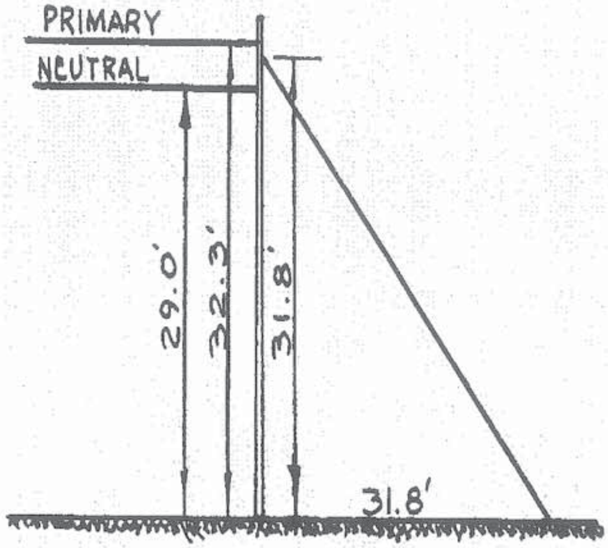


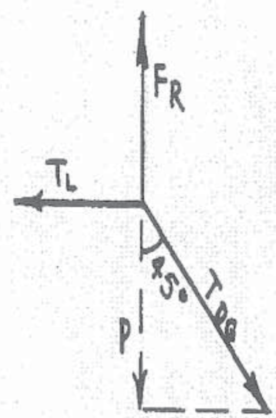
With pole framed per DCS E-11.0.0, Fig. 1, on concrete pole, dimension G = 11". With pole framed per DCS E-11.0.0 Fig. 3, Sect. C-C on wood pole, dimension G = 21".

FIGURE 4

f. Examples

Example #1. Three phases of #3/0 AAAC and 1 #1/0 AAAC neutral are to be deadended on a 40 ft. pole as per DCS E-11.0.0, Fig. 3, with neutral 40" below the primary. Anchor lead is equal to attachment height. Is a class 5 pole adequate?





Primary: 3 #3/0 @ 2870# = 8610#;
Neutral: 1 #1/0= 1890#

Moment = 8610 x 32.3 = 278,103 ft.-lb.
Moment = 1890 x 29.0 = 54,810 ft.-lb.
Total Moment = 332,913 ft.-lb.

Guy is attached at 31.8'; Horizontal component of guy tension

$$T_L = \frac{332{,}913}{31.8} = 10{,}469\ LB.$$

$P = T_L$ = 10,469 lb. vertical force

T_L is the summation of the moments due to the conductors, all referred to the point where the down guy is attached.

In this case, since the guy is at an angle of 45° to the pole, the axial load on the pole (the vertical component of the guy tension) is equal to the horizontal component T_L.

Referring to TABLE C, the maximum allowable axial loading for a 40' class 5 pole is 15,500 lbs. Therefore, the class 5 pole is adequate.

For the vector diagram to be technically correct, the force F_R must be shown. F_R represents the resisting force with which the pole must push upward to counteract the downward pull of the guy. Thus, T_L, F_R, and T_{DG} are in equilibrium, all acting at the point of guy attachment on the pole.

At this point, we may as well proceed to calculate the guy tension and select the guy wire size.

With the 45° guy angle, $T_{DG} = \frac{10469}{COS_{45°}} = 14{,}808\,lb.$

Or, it may be calculated this way: $T_{DG} = \sqrt{(10{,}469)^2 + (10{,}469)^2} = 14{,}805\,lb.$ (more accurate)

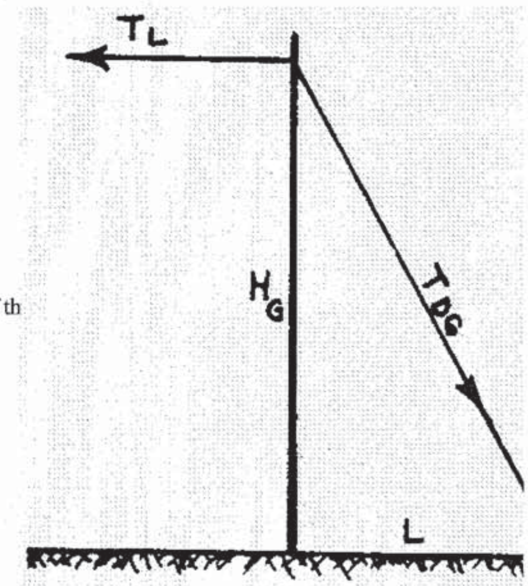
Referring to DCS D-5.0.0, Table II, we find that a 9/16" EHS galvanized guy wire, with allowable deadend tension of 18,380 lbs. will be required (Grade B construction).

If the guy is not attached at the optimum 45° angle, the calculation may be done as follows:

$$T_{DG} = \frac{T_L}{L} X \sqrt{H_G^2 + L^2}$$

$$P = \frac{T_L}{HG} X \sqrt{H_G^2 + L^2}$$

Where H_G is the height above ground of th guy attachment, and L is the guy lead.



Having determined the pole class and the required guying, it is desirable to check to be sure that the simultaneous application of axial loading (caused by the deadend guying) and transverse wind loading does not overstress the pole fibers. The common practice in doing this is to consider that the greatest fiber stress is experienced at the "critical point" (see Fig. 2), which is defined as follows.

If poles were not tapered, axial loads would cause them to bow in the middle - that is, halfway between the fixity point and the point where the load is applied. Fiber stress due to bending moments from transverse loading would be uniform up and down the pole. However, since each pole is tapered, the point of maximum fiber stress is shifted upward. Looking again at Fig. 4, the critical point, or point of greatest fiber stress, is generally accepted to be at H/3, measured down from

(1) the pole top, when considering wind loading on the pole;
(2) the point of conductor attachment, when considering wind load upon conductors;
(3) the point of guy attachment, for axial loads.

Since points 1, 2, and 3 are usually only a few inches apart, it is sufficiently accurate for our purposes to assume one point, such as point 2, from which to measure to locate the critical point.

Having done this, it is common practice to add the "per-unit" of allowable axial loading and the per-unit of transverse loading at the critical point, and be sure that the sum of the two "per-units" is not greater than 1.0. In other words,

$$\frac{P}{P_{ALLOWABLE}} + \frac{M}{M_{ALLOWABLE}} = 1.0$$

From our previous calculations, the axial loading P in this example is 10,469 lbs. P allowable from TABLE C is 15,500 lbs.

To locate the critical point, we can measure from the primary attachment height.

Dimension
H = 40' - 2/3 setting depth - distance from primary to pole top

H = 40' - 4.33' - 1.17' = 34.5'
H/3 = 34.5/3 or 11.5' (down from a point 1.17' below pole top)

Critical point is 12.67' below pole top. We can round this to 12.5'.

In calculating the transverse load due to the pole itself, we consider only the part of the pole above the critical point. The projected area of this portion equals the average diameter times its length. Diameters can be obtained from TABLE G.

$$\text{Projected Area } A_P = \frac{d_1 + d_2}{2 \times 12} \times 12.5' = \frac{6.05'' + 7.45''}{2 \times 12} \times 12.5' = 7.03 \text{ sq. ft.}$$

The transverse load due to the pole is 9 lbs.-per-sq.-ft. x 7.06 sq. ft. = 63.56 lb.

Since this load can be considered to be concentrated at the center of the area, the moment can be computed as .46 x 12.5 ft. x 63.27 lbs. = 363.8 ft.-lbs.

The transverse load due to the conductors, from TABLE A-1.

$$3\# \tfrac{3}{0} : 3 \times .377 = 1.131$$

$$1\# \tfrac{1}{0} : 1 \times .299 = .299$$

$$\text{Total} = 1.43 \text{ lbs / ft}$$

Assuming a 250' span (125' half-span), the transverse load is = 125 x 1.43 = 178.8 lbs.

The moment, then, is 178.8 lb. x 11.5 ft. = 2056 ft.-lbs.

Total moment at critical point = 2056 + 363.8 = 2,419.8 ft.-lbs = 29,038 in.-lbs.

$$M(\text{Fiber Stress}) = \frac{\text{Moment}}{\text{Section Modulus}} = \frac{29{,}038}{\pi \times D^3/32}$$

$$= \frac{29{,}038}{\pi \times (7.51)^3/32} = 715 \; p.s.i$$

$$\text{The final check is: } \frac{P}{P_{allowable}} + \frac{M}{M_{allowable}}$$

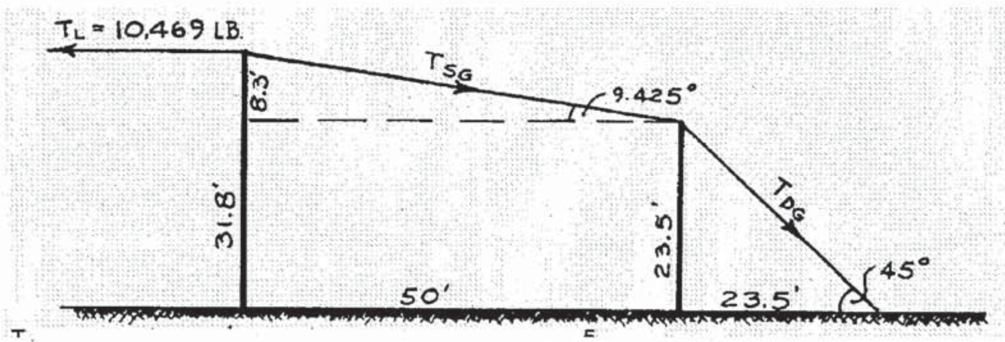
$$= \frac{10469}{15500} + \frac{715}{8000} \leq 1.0?$$

$$.6754 + .0894 = .7648 <= 1.0$$

The combined loading is acceptable.

It is not suggested that this involved calculation need be done for every proposed deadend pole. However, it should be done for several commonly seen combinations of pole, conductor size and span lengths. This will give an understanding of the process, and a file of solutions which will cover many situations.

Example #2. In Example 1, suppose it was not possible to get an adequate lead for a down guy. Design a span guy and guyed stub to hold this deadend. The stub would be 50 ft. from the deadend.



T_L/T_{SG} = COS ($\tan^{-1}$ 8.3/50) = COS 9.425° = 0.9865

$T_{SG} = T_L/0.9865$ = 10,469/0.9865 = 10,612 lb.

Axial load on DE pole due to $T_{SG} = T_{SG}$ x Sin 9.425° = 1,738 lb.

T_L/T_{DG} = COS 45° = 0.707; $T_{DG} = T_L/0.707$ = 10,469/0.707 = 14,808 lb.

Axial load on guy stub = Downward Component T_{DG} - Upward Component T_{SG}

Axial load on stub = T_{DG} (sin 45°) - 1738 = 10,469 - 1738 = 8,731 lb.

The axial load on stub is within allowable limits for a 30 ft. class 5 pole (TABLE C); 7/16 EHS guy wire will be required for the span guy and 9/16 EHS for the down guy.

Solution: Use 30 ft. class 5 stub, with 1:1 anchor lead, 7/16 EHS guy wire for the span guy and 9/16 EHS for down guy.

Choose an anchor from DCS D-4.0.1 and D-4.0.2 which will not exceed the allowable tension when holding 14,808 lb. Check to see that

P/Pa + M/Ma = 1 for the stub. In this case, we are well on the safe side.

D. SELECTING POLE HEIGHTS

Where joint use is anticipated, our standard height poles have been 45' on streets or alleys, 40' in rear easements, and 30' for most guy stubs and service poles. However, there are many factors and conditions which may require extra height, such as vertical-framed primary plus telephone and CATV attachments.

Other factors which should be considered before specifying pole height include the following:

1. Will the pole have a primary tap or crossover requiring extra height.
2. Will extra pole height be required to accommodate a transformer installation, or cable riser?
3. Will additional height be needed to cross a railroad, canal, telephone circuit, traffic signal facility, sign or other obstacle?
4. Is it likely that a street light will be installed on the pole and if so, what mounting height will be required? The larger mercury vapor and sodium vapor lights require mounting heights in excess of 30'.
5. To control the conductor elevation in a flying tap, will the pole need to be set at a non-standard depth?
6. Will the pole height need to be restricted because the line passes under a transmission line or is near an airport?
7. Will the pole chosen create a change in grade for the conductors of no more than 5' in 100'?
8. Will the pole height be adequate to accommodate planned future facilities? One phase now--three phase in the future!

9. Is the soil condition unstable so that the pole may have to be set deeper?

E. POLE PLACEMENT

1. Residential Areas

a. Rear distribution poles generally should be set 12" to 18" from the property line. This will ensure that our facilities do not interfere with present or future surveys. Particular attention should be paid to proper staking when lines cross from one block to another to ensure the line remains in the easement.

b. For front distribution, easements should be obtained, and poles set one foot inside the property. If this is impractical, front distribution poles generally should be in the road right-of-way (R/W), set with the field face at the R/W line. Poles should be not less than one foot from the street side of the curb where there is a curb. See also DCS B-3.0.2, Note 11.

2. Primary and Secondary Roads

Sidewalk widths vary somewhat, but the five-foot sidewalk with six-inch curb is most prevalent. The practice of leaving a grass strip between the sidewalk and the curb has essentially been abandoned. As a consequence, any new pole line located on a six-foot offset from the R/W line is a candidate for future relocation.

It is therefore recommended that an attempt to be made to locate all new pole lines on private property with the road face of the pole at the R/W line. With vertical construction, this will eliminate conductor encroachment over private property. Setback regulations for building will ordinarily eliminate any interference but easements for the poles will, in all cases, be required.

In areas where apartment or other buildings preclude this location due to inadequate clearances, the proposed pole line should be staked with street face three inches back of a future curb. If the future curb location cannot be ascertained, assume a five-foot sidewalk with abutting curb or street face of pole to be 4.75 feet from the R/W line into the street.

3. DOT Requirement

On all Federal, State and County maintained roads, all new pole lines should be installed at the R/W line, regardless of the distance from the through travel lanes.

4. Guidelines for Pole Placement in Right of Ways

These guidelines are to be used for all new installations, extensions, and relocations of pole lines in Road Rights of Way. All new installations of poles in Road Rights of Way should be at or as close as practical to the right of way line, when placement one foot (1 ft.) into easement on private property is impractical. Placement of poles in other than these locations, due to sidewalks, NESC code clearance requirements or other physical obstructions, should be handled on an individual basis as.

Modified vertical construction, which allows the field side of the pole to be placed at the right of way line with no aerial encroachment on private property, should be used for all new pole lines on road rights of way. If any portion of FPL facilities overhang onto private property, then an easement must be obtained.

The Florida Department of Transportation's Utility Accommodation Manual (UAM) should be used when determining the location of poles within the Right of Way (R/W). This document must be used in all DOT roadways and many counties and municipalities have adopted this as a standard. Listed below are some of the more common locations as to where not to place a pole (Control Zones). To view the UAM, you can go into DCP's Permitting website: INFPL=> Business Units => Power Systems => Distribution => Construction Processes => Processes => Permitting => FDOT's UAM => Exhibit H.

a. Intersecting Streets

Place poles outside the point of curvature away from the intersection. Flying taps should be used at intersections to eliminate the need for junction poles.

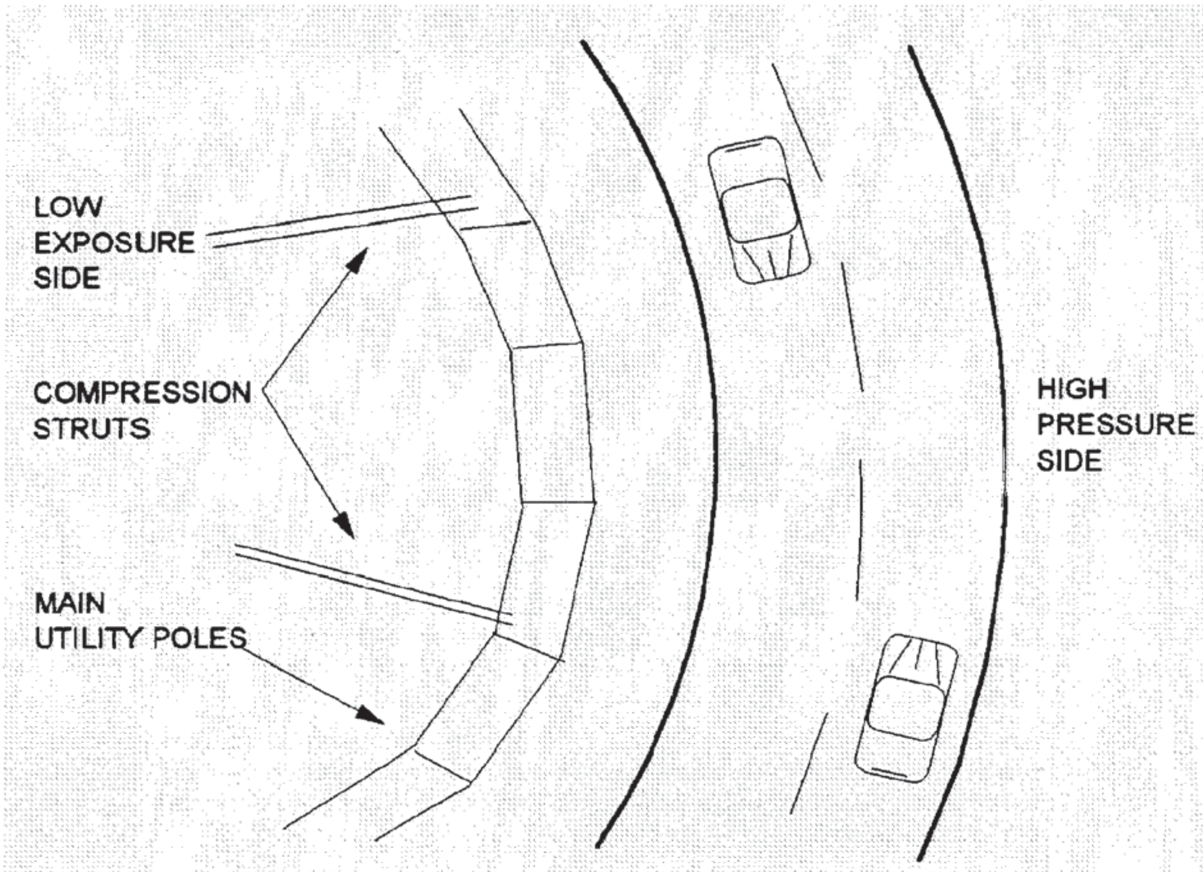

LOW
EXPOSURE
SIDE
COMPRESSION
STRUTS
MAIN
UTILITY POLES
HIGH
PRESSURE
SIDE

FIGURE 5

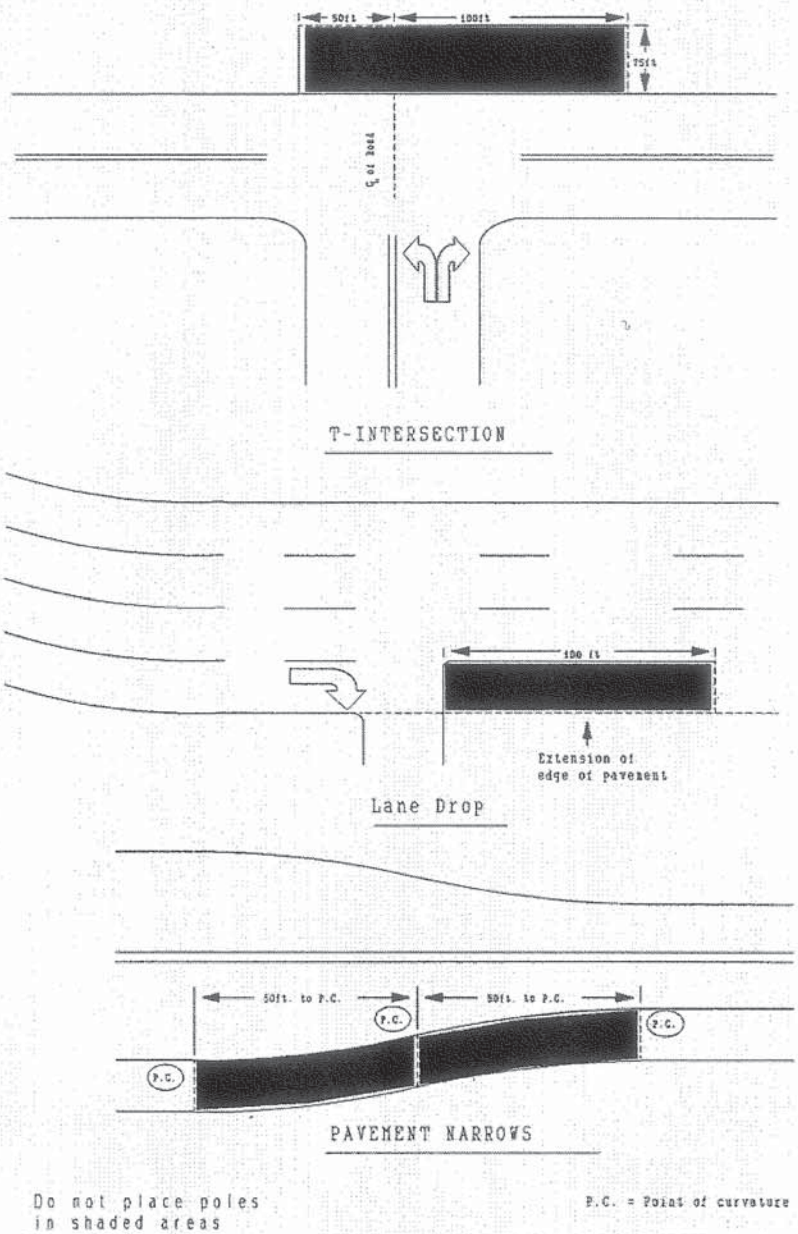

50ft
100ft
75ft
T-INTERSECTION
100 ft
Extension of edge of pavement
Lane Drop
50ft. to P.C.
50ft. to P.C.
P.C.
P.C.
P.C.
PAVEMENT NARROWS
Do not place poles in shaded areas
P.C. = Point of curvature

FIGURE 6

Topic No.: 710-020-001-d
Utility Accommodation Manual

January 1999
Office: Utilities

Control Zones

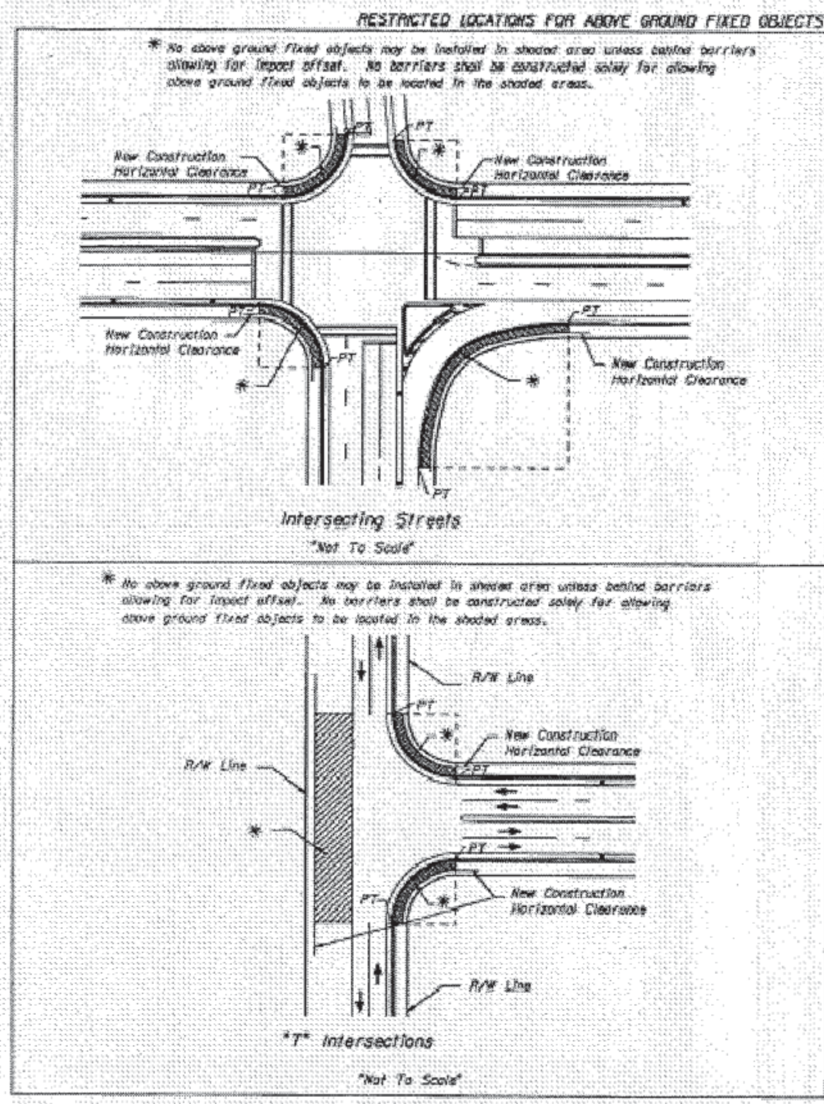


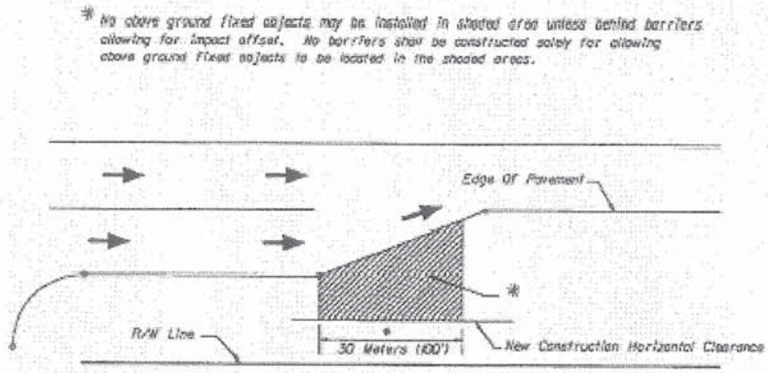
Exhibit H
Control Zones

Page 1 of 5

SFHHA 010187
FPL RC-16

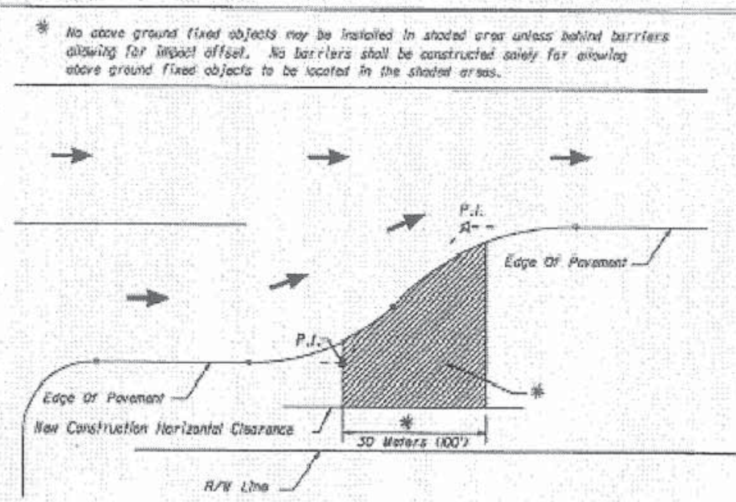
Control Zones

RESTRICTED LOCATIONS FOR ABOVE GROUND FIXED OBJECTS



Lane Termination Using A Skewed Merge Section

'Not To Scale'



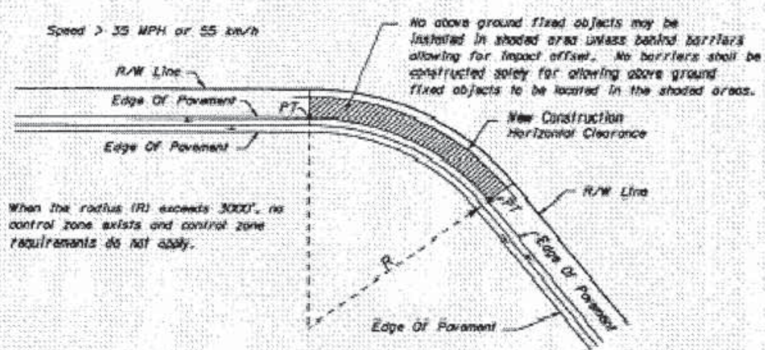
Lane Termination Using A Reverse Curve

'Not To Scale'

Control Zones

RESTRICTED LOCATIONS FOR ABOVE GROUND FIXED OBJECTS

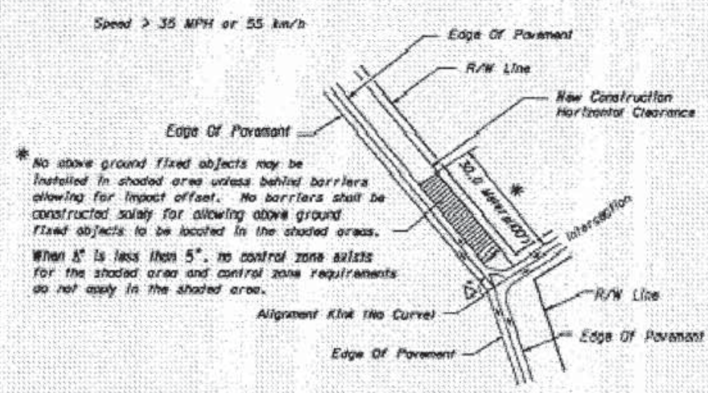
Existing Curb And Gutter Or Rural Typical Section With
No Change In Edge Of Pavement Or Existing Curb Location



Typical Curve

"Not To Scale"

Existing Curb And Gutter Or Rural Typical Section With
No Change In Edge Of Pavement Or Existing Curb Location



Typical Kink In Alignment

"Not To Scale"

SFHHA 010189
FPL RC-16

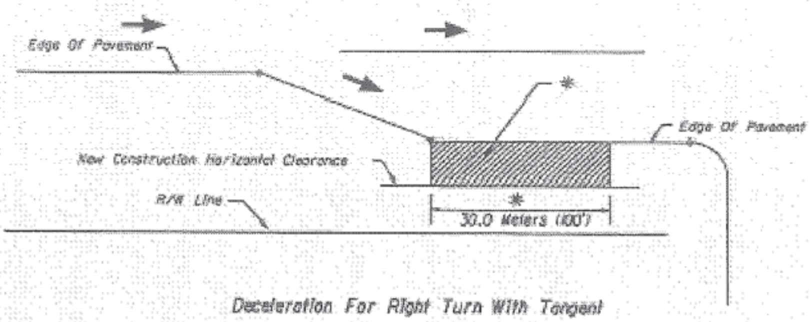
Topic No.: 710-020-001-d
Utility Accommodation Manual

January 1999
Office: Utilities

Control Zones

RESTRICTED LOCATIONS FOR ABOVE GROUND FIXED OBJECTS

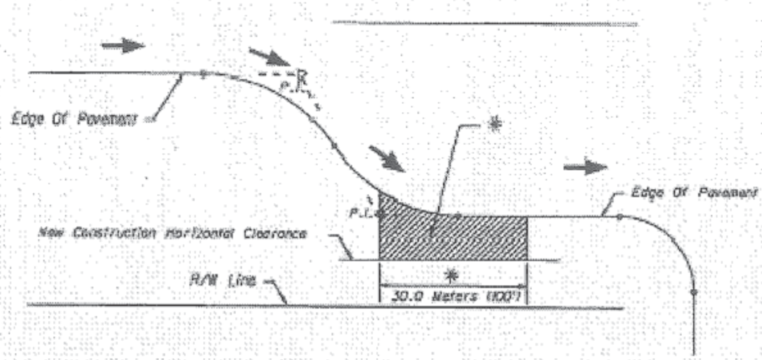
* No above ground fixed objects may be installed in shaded area unless behind barriers allowing for impact offset. No barriers shall be constructed solely for allowing above ground fixed objects to be located in the shaded areas.



Deceleration For Right Turn With Tangent

"Not To Scale"

* No above ground fixed objects may be installed in shaded area unless behind barriers allowing for impact offset. No barriers shall be constructed solely for allowing above ground fixed objects to be located in the shaded areas.



Deceleration For Right Turn With Reverse Curves

"Not To Scale"

SFHHA 010190
FPL RC-16

Topic No.: 710-020-001-d
Utility Accommodation Manual

January 1999
Office: Utilities

Control Zones

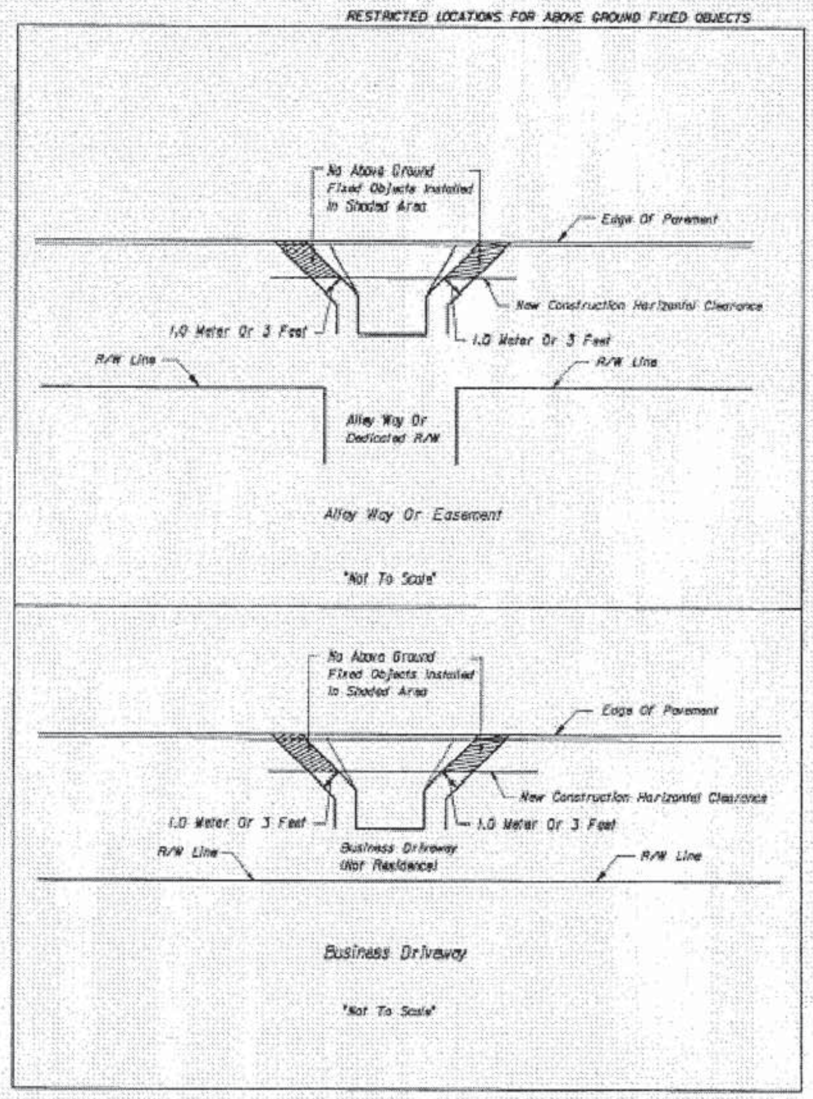


Exhibit H
Control Zones

Page 5 of 5

SFHHA 010191
FPL RC-16

b. T-Intersections

If poles are on the opposite side of the intersection, they should be placed outside an area defined as shown in the figure.

c. Lane Termination

Poles should not be placed in the area of the transition.

d. Curve

For roads with a posted speed greater than 35 mph, poles should be placed on the inside rather than the outside curvature of the roadway.

e. Kink in alignment

Poles should not be placed within 100 feet of the point of curvature in the R/W adjacent to the flow of traffic as shown in the figure.

f. Deceleration for right turn

Poles should not be placed along the tangent portion of the deceleration lane as shown in the figure.

g. Alley Way and Business Driveway

Poles should not be placed in the area of transition from the alleyway or driveway to the roadway.

h. Median and Traffic Islands

Placement of any new poles should be avoided on medians or traffic islands.

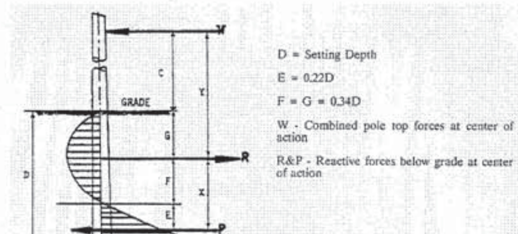
i. Poles in Sidewalk

Care must be taken when placing poles in sidewalks. The Americans with Disabilities Act (ADA) Accessibility Guidelines requires a minimum clear width for single wheelchair passage of 32 inches.

F. UNGUYED POLES

1. Limitations

Where guy installation is impractical it may be possible to install an unguyed pole. All safety factors and pole strength limits discussed in the Pole General Section must be applied as well as below grade upset limitations. (By "upset" we mean the pole leaning due to movement of the earth.) Upset limitations can be calculated in the following manner:



Soil pressure diagram - Parabola

The figure shows the principal forces acting on a pole set in compressible soil and subjected to a horizontal load at a certain distance above the ground line. The pressures developed are considered as the ordinates to a parabola located such that the pressure area on one side of the pole bears the same relation to that on the other side as R does to P, these being the butt reactions. By the principle of moments,

$$P_p = W\frac{Y}{X} \text{ and } R = P + W$$

Maximum soil pressures developed are calculated by the formula:

$$p_s \text{ (tons per square foot)} = \frac{0.003\,R}{D \times d}$$

Where D = setting depth in feet and d = butt diameter in feet. From the Figure: E = 0.22D and F = G = 0.34D

2. Lateral Bearing Strength of Soil

The following discussion uses values of soil strengths that are somewhat conservative. Therefore, calculations for pole upset should be limited to cases where poor soil strength conditions exist or where in good soils, poles not listed on TABLE A (i.e. transmission guy stubs) are used unguyed.

The lateral bearing strength of various soils cannot be listed precisely and completely because soils do not behave in this manner. Soils that look similar may have different values of bearing strengths, and soils may completely change characteristics as depth increases. The only sure method of finding these values is an actual test of the individual soils, procured from the depth in question. This test can be performed by a testing laboratory.

An approximate value can however be used if sufficient safety factors and good judgement are applied. A value of 1500 psf/ft. of depth can be applied to most cohesive Florida soils. Generally if the sides of an augured hole do not collapse, the stated value of 1500 psf/ft. can be used for upset calculations (this includes no Safety Factor). Some other values of lateral bearing strength to be used as a guide for estimating soil strengths are: rock 4000 psf/ft. and dry sand 500 psf/ft. Using these 3 figures and judgement, an approximate value for all soils can be arrived at. Remember to apply safety factors discussed on TABLE A to your calculations for pole strengths.

Applying the above to an example of an unguyed pole:

Example for soil bearing calculations:

40 ft. class 2 pole set at 6 ft. in soil judged to be approximately 800 lbs. per sq. ft./ft. of depth in lateral bearing strength. A force of 700 lbs. is acting at 33' above ground level.

Using tables for pole circumference d = 1.08'

W = 700 lbs; C = 33'; D = 6'

F = G = .34D = 2.04'; E = .22D = 1.32'

X = E + F = 3.36'

Y = G + C = 35'

$$P_P = W\left(\frac{Y}{X}\right) = 700\left(\frac{35}{3.36}\right) = 7291.67 = 7292$$

R = P + W = 7992

$$P_S = \frac{0.003R}{D x d} = \frac{0.003\,(7992)}{6 x 1.08} = \frac{23.98}{6.48} = 3.7 \quad ton\ psf$$

at 6' of depth this soil's value of lateral bearing strength = 6 x 800/2000 = 2.4 tons psf.

Since the strain on the pole produces a load on the soil that exceeds its ultimate this pole should: (1) be guyed, (2) have a slug of concrete poured around it, (3) be set at a greater than standard depth. The slug size will be determined by the above method using the dimensions of the slug instead of the pole butt. In the example above very little concrete would be required since the values of load versus capacity of the soil are close.

Using the following formulas from $p_s = \frac{.003\,R}{D\,x\,d}$

$$d = \frac{.003\,R}{p_s\,x\,D}$$

$$D = \frac{.003\,R}{p_s\,x\,d}$$

The size of the slug or the increased depth can be calculated.

$$d = \frac{.003 \quad R}{p \ x \ D}$$

$$d = \frac{.003R(7992)}{2.4x6} = \frac{23.98}{14.4} = 1.67\ ft.\ dia.$$

$$D = \frac{.003\,R}{2.4\,x\,1.08} = \frac{23.98}{2.59} = 9.26\,ft.\,depth$$

G. GUY STRENGTH - SEE DCS D-5.0.0

1. Design Criteria

FPL uses the load requirements of Table 253.1 of the NESC as the design criteria for guys. For Grade B construction, this requires that we load deadend guys to only 54.5% of their ultimate strength and side or transverse guys to 36%. For Grade C construction, this requires that we load deadend guys to only 81.8% of their ultimate strength and side or transverse guys to 40.9%. The conductor deadend tensions used to determine guy size and number are located in DCS D-5.0.0. These tensions are the sum of conductor stringing tension and a 9 pound per square foot wind load on the conductor, per NESC. For examples of guying calculations, see this section of the DERM.

2. Guy Material

FPL currently uses galvanized guys in all areas. The galvanized guy is used because it is both economical and durable. Some copperweld guys do exist because at one time that was the only type FPL installed. It should be noted that if the copper coating of copperweld is nicked, exposing the underlying steel layer, the steel will sacrifice to the copper. The copper coating is left intact but the steel will corrode away. This will reduce the holding strength of the guy even though most of the guy wire appears to be in good shape.

3. Fiberglass Guy Strain Insulators

Guy insulators are used to increase BIL on wood poles in non-salt spray areas whenever a guy is installed above the neutral for 13 kV and above. Insulators are not installed where arresters are on the pole. Guy strain insulators are not to be installed in salt areas or on concrete poles, since all wood pole hardware is bonded to ground, and concrete pole hardware is effectively grounded. Their use would not increase BIL. Occasionally, there is an exception to this rule. When a galvanized screw anchor or a galvanized anchor rod is buried in moist earth saturated with salt or other electrolyte near buried copper or copperweld electrodes, excessive corrosion of the galvanized member may occur. When this condition is discovered, installing a guy strain insulator will break the path of galvanic current and reduce further corrosion.

A downguy shall be bonded (and no guy insulator used) if it is installed adjacent to conductors, regardless of other equipment on the pole or the type of pole. For example, on a pole where the primary deadends and is downguyed, but the secondary continues (tangent), the downguy shall be bonded and no guy strain insulator would be installed. Surge arrestor(s) would be installed (where required) per DCS E-5.9.0.

H. GENERAL INFORMATION -ANCHORS

1. Anchor Types

FPL uses three types of anchors: the screw anchor, the concrete slug and the rock anchor. (See DCS D-4.0.1 for M&S numbers, strength and holding abilities of these anchors.) The screw anchor is preferred over the others, because it is the most economical and quickest to install. Concrete slug anchors are used in poor soil conditions or where space will not permit screw anchor installations. The rock anchor is used where rock conditions make it impossible to install a screw anchor, but are favorable for cementing in the rod of a rock anchor.

2. Anchor Rod Identification

The type of an existing anchor can be determined by checking the anchor rod. A concrete anchor will have an anchor rod having a diameter that is either 3/4" or 1" with a twin eye, or 1-1/4" with a triple eye for attaching guys. A screw anchor rod will be either 1" or 1-1/4" in diameter with a triple eye.

3. Anchor Installation

Anchors shall be installed at least 5' from the base of the pole. In addition, when more than one anchor is being installed, a minimum of 5' shall be maintained between them.

4. Multi-Helix Screw Anchors

Should be used on feeder size conductor deadends where possible and any other instances where their holding strength is needed.

5. Anchor Locations

Use caution in anchor placement. Anchors are usually more objectionable to the customer than a pole. Stay clear of driveways and walkways. Try to anchor along fence or hedge lines. This will hide the down guy and also eliminate yard maintenance problems. Follow fence lines in acreage also. Cattlemen and horsemen object to anchors and guys in pastures.

6. Easements For Anchors

An easement should be secured for each anchor placed on private property. If the hole to place a concrete anchor will encroach on private property, then either an easement or permission should be secured before an attempt is made to place the anchor.