UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration

BULLETIN 1751F-626

SUBJECT: **Staking of Aerial Plant**

TO: All Telephone Borrowers
REA Telephone Staff

EFFECTIVE DATE: Date of Approval

EXPIRATION DATE: Seven years from effective date

OFFICE OF PRIMARY INTEREST: Outside Plant Branch, Telecommunications Standards Division

PREVIOUS INSTRUCTIONS: This bulletin replaces REA Telecommunications Engineering & Construction Manual (TE&CM) Section 626, Staking of Aerial Plant, Issue 2, dated June 1962.

FILING INSTRUCTIONS: Discard REA Telecommunications Engineering & Construction Manual (TE&CM) Section 626, Staking of Aerial Plant, Issue 2, dated June 1962, and replace it with this bulletin. File with 7 CFR 1751 and on REANET.

PURPOSE: This bulletin provides REA borrowers, consulting engineers, contractors and other interested parties with information concerning the staking of aerial plant construction projects.

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Administrator	Date

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ABBREVIATIONS

LD	Loan Design
L/H	Lead to height ratio
MGN	Multigrounded neutral
NEC	National Electrical Code
NESC	National Electrical Safety Code
NID	Network Interface Device
PM2	Pole Ground Assembly Unit
PM2-1	Auxiliary Ground Rod Assembly Unit
REA	Rural Electrification Administration
R/W	Rights-of-way
TE&CM	Telecommunications Engineering and Construction Manual

6M	6,000 pound suspension and guy strand size
10M	10,000 pound suspension and guy strand size

1. GENERAL

1.1 Staking is the process of locating proposed construction routes and preparing drawings and tabulations to show the locations and quantities of construction units required. It should be consistent with the construction proposed in the approved Loan Design (LD). It should be undertaken with the objective of constructing plant which conforms to REA standards, is free from hazards, and is economical. The information and recommendations in this bulletin are advisory.

1.2 A construction drawing is produced in the field by an engineer and depicts the proposed construction route from a topographical survey of the route showing the following:

a. Measurements along the route;

b. Above ground features such as road name or number, road width, danger trees, rights-of-way, etc.;

c. Poles, guys, anchors, etc;

d. Lakes, ponds, streams, etc; and

e. Approximate location of any obstruction that may be encountered during the actual construction of the project.

1.3 The engineer performing the staking should be familiar with and have access to the following materials:

a. The approved Loan Design (LD) (including Maps) and any revisions;

b. List of subscribers giving map locations and grades of service;

c. List of held service orders;

d. Maps showing available executed or planned rights-of-way easements;

e. Reports or maps on environmentally sensitive areas;

f. Details of joint use or joint occupancy agreements;

g. National Electrical Safety Code (NESC) (latest edition);

h. National Electrical Code (NEC) (latest edition);

i. Existing local and state electrical codes more stringent than the NESC and NEC;

j. Route and pole numbering sequences;

k. Existing as built construction drawings;

l. Station installation procedures;

m. Clearances according to NEC and NESC;

n. Association of American Railroads Crossing Standard;

o. Cable manufacturer's sag and tension data;

p. REA Form 515, Telephone System Construction Contract;

q. REA Bulletin 345-153, Specifications and Drawings for Construction of Pole Lines, Aerial Cables and Wires, Form 515f (Proposed conversion to REA Bulletin 1753F-011(515f));

r. REA Bulletin 345-6, REA Standard For Splicing Plastic Insulated Cable, PC-2 (Proposed conversion to REA 7 CFR 1755.200);

s. REA Bulletin 1751F-670, Outside Plant Corrosion Considerations;

t. REA Bulletin 380-1, Rights-of-Way and Title Procedures; and

u. The following REA Telecommunications Engineering and Construction Manual (TE&CM) Sections:

    1. 116 Plant Engineering and Record System (Proposed conversion to REA Bulletin 1751B-101);

    2. 210 Telephone System Design - Sizing Criteria (Proposed conversion to REA Bulletin 1751B-204);

    3. 424 Design Guideline for Telecommunications Subscriber Loop Plant (Proposed conversion to REA Bulletin 1751H-101);

    4. 611 Design of Pole Lines (Proposed conversion to REA Bulletin 1751F-611);

    5. 628 Plastic-Insulated Cable Plant Layout (Proposed conversion to REA Bulletin 1751F-628);

    6. 630 Design of Aerial Cable Plant (Proposed conversion to REA Bulletin 1751F-630);

    7. 635 Construction of Aerial Cable Plant (Proposed conversion to REA Bulletin 1751F-635);

8. 650 Guys and Anchors on Wire and Cable Lines (Proposed conversion to REA Bulletin 1751F-650);

9. 801 Electrical Protection Fundamentals (Proposed conversion to REA Bulletin 1751F-801);

10. 805 Electrical Protection at Subscriber Stations (Proposed conversion to REA Bulletin 1751F-805);

11. 815 Electrical Protection of Aerial Cable (Proposed conversion to REA Bulletin 1751F-815); and

12. 822 Electrical protection of Carrier Equipment (Proposed conversion to REA Bulletin 1751F-822).

1.4 Staking personnel should attend the Pre-Staking Conference and staking should conform to the agreements and requirements contained in the Pre-Staking Conference minutes. When construction is planned to be performed on public rights-of-way, it also is recommended to have a department of transportation official at the Pre-Staking Conference.

1.5 Even though it is beneficial to the staking engineer to be familiar with the material listed in Paragraph 1.3 above, staking personnel are not usually expected to fully design the aerial outside plant. They are expected to make field measurements of cable and wire lengths as well as span lengths and locate poles, terminals, guys, anchors, branch splices, subscriber terminations, etc. They verify the general route which has been tentatively selected by the system design engineer and should discuss any difficulties noted in the proposed routing with the system design engineer before making any changes.

1.6 In the case of aerial plant, firm decisions should be made in the design stage and a qualified resident project representative should be on the project during construction. The resident project representative should be capable of exercising good engineering judgement in making necessary changes during construction with full consideration given to all the factors in the design of the project.

2. PRE-STAKING ACTIVITIES

2.1 Before staking begins, the staking engineer should receive assurances that any available rights-of-way (R/W) agreements or permits have been obtained. Any suitable means, such as easement strip maps to indicate the R/W conditions, may be used for this purpose. Property owners who wait until staking is performed to observe the route taken before granting an easement should be noted as well as the status of easements on other properties. The REA borrower should furnish a qualified person to accompany

the staking personnel to negotiate with landowners for easements. Any special precautions to be observed by the contractor should be noted on the construction drawings.

2.2 When service order activities indicate changes in subscriber estimates, the resident project representative should be informed and, if necessary, action should be taken to revise the initial design to ensure that construction will be adequate to meet subscriber demands. Any design changes should be reflected in the construction drawings of the project, but 7 CFR 1753.3 requires that written approval for significant changes must be obtained from the borrower and REA.

2.3 The staking engineer should conduct the staking operation in a manner to assure that the installed plant conforms to the latest edition of the National Electrical Safety Code (NESC), National Electrical Code (NEC), local and state laws; rules, regulations, and orders of state regulatory bodies, whichever are the most stringent; and the approved LD.

2.4 The staking engineer should stake only those lines shown in the approved LD except for minor changes dictated by field conditions. The resident project representative should inform the staking engineer of any routes, leads or service connections which for any reason are not to be constructed and for those additional routes that are to be constructed regardless of the reason.

2.5 Careful consideration should be given to the usability of R/W obtained on each parcel of land on which cables are to be constructed. If the R/W are not satisfactory from a construction standpoint because of poor routing, hazardous conditions, heavy clearing, inadequate guying space, etc., the resident project representative should discuss the conditions with the borrower so that an attempt can be made either to procure additional R/W or to relocate the proposed section of route.

2.6 Careful consideration should be given to the location of station equipment in staking the main line pole locations adjacent to a subscriber's premises so that aerial drop and station ground wiring will be as short as practicable.

2.7 In connection with the staking of proposed joint use or joint occupancy lines, the staking engineer should prepare and submit to the resident project representative detailed information concerning pole changes, insert poles, and other changes or modifications in existing pole lines of other utilities to accommodate the borrower's facilities. Such information should be prepared with the full participation of the other utility's engineering department.

2.8 The staking engineer should provide detailed instructions on the construction drawings regarding the point of attachment of the borrower's facilities on poles for joint use or joint occupancy.

2.9 When the borrower is required to submit engineering information as a prerequisite for procuring a permit, license, franchise, or authorization from public bodies or private corporations in connection with proposed construction, the staking engineer should furnish the resident project representative with the necessary field data to prepare the required information and drawings for the borrower. Examples of situations for which permits may be required are:

a. Trimming or removal of trees in public R/W;

b. Crossing of highways;

c. Crossing navigable streams or other bodies of water;

d. Crossing railroads;

e. Joint use or joint occupancy of poles with another utility;

f. Crossing aerial facilities of other utilities;

g. Crossing land owned or controlled by public bodies;

h. Location of poles in incorporated cities or towns; and

i. Sensitive environmental areas.

2.10 The borrower and resident project representative should agree on the type of markers, the method and time of installing and identification of the markers, and the symbols to be used during the staking operation. All of the above items should be agreed to at the Pre-Staking Conference and discussed at the Pre-Bid Conference.

3. NATIONAL ELECTRICAL SAFETY CODE

3.1 It is very important that the staking engineer know and understand the requirements set forth in the National Electrical Safety Code (NESC) for telecommunications system outside plant construction as well as the requirements of the local authorities in the particular locality where staking is to be performed.

3.2 Some localities (states and/or municipalities) have requirements for telecommunications pole line construction which are more stringent than those of the latest edition of the NESC. The authorities administering these provisions expect that the more stringent requirements be observed. For localities where no

requirements are established, the provisions of the latest edition of the NESC should be followed. REA Loan Contracts and Mortgages require borrowers to observe all appropriate codes that may pertain.

3.3 The portions of the NESC that the staking engineer should be particularly concerned with are Parts 2 and 3 which deal with the installation and maintenance of overhead and underground lines. NESC rules are not intended to serve as a basis for designing or staking telecommunications plant. The rules should be considered as the minimum standards that should be met to help assure the plant is constructed to withstand the mechanical loads and stresses to which it will be subjected, be reasonably protected from the possible effects of electrical disturbances, and be relatively free from hazards to the general public and to persons maintaining the facilities.

4. NATIONAL ELECTRICAL CODE

4.1 The purpose of the National Electrical Code (NEC) is the practical safeguarding of persons and property from hazards arising from the use of electricity. The NEC includes the basic minimum provisions for installation of telecommunications facilities on subscribers' premises.

4.2 Chapter 8, "Communications Systems", Article 800, "Communication Circuits," of the NEC discusses minimum conductor insulation requirements and station grounding. Most authorities make it mandatory to observe the requirements set forth in the NEC unless their local requirements are more stringent, in which case, the latter should be observed.

5. OUTSIDE PLANT ASSEMBLY UNITS

5.1 The general pole line and aerial plant design of the approved LD should be translated by the resident project representative into a specific design in sufficient detail to enable construction of the plant. To facilitate this, a standard "assembly unit" has been devised for most major components of the outside plant. By specifying the appropriate type, quantity and location of standard and non-standard assembly units on the construction drawings, the design engineer depicts the complete physical outside plant as contemplated in the LD. The detailed descriptions of all standard pole line and aerial plant assembly units are given in REA Bulletin 345-153, REA Form 515f (Planned conversion to REA Bulletin 1753F-011(515f)). Where standard assembly units are insufficient to provide for unique construction requirements, the design engineer should create detailed "nonstandard assembly units" to meet those requirements. The nonstandard assembly units should be approved by REA.

6. STAKING

6.1 The aerial cable route and outside plant assembly units are recorded on the construction drawings developed by the resident project representative.

6.2 The staking engineer should begin staking by checking the status of easements, by marking control points on the LD maps and by making a reconnaissance of the proposed construction areas checking for the items listed below:

a. Terrain;

b. Location of establishments;

c. Natural control points;

d. Appropriate locations of poles, anchors, terminals, etc;

e. Location of the first attachment on the subscriber's building, the station protector and/or network interface device location and the most effective ground electrode available; and

f. R/W clearing and trimming units.

6.3 Control points are those points or areas along a proposed construction route where circumstances demand special consideration by the staking engineer in specifying appropriate construction units. Examples of control points are:

a. Street, alley, and highway intersections;

b. Street, alley, and property lines;

c. Rivers, streams, gullies, drainage ditches, and canals;

d. Ridges and depressions;

e. Angles and corners in highways, streets, and roads;

f. Private driveways, field entrances, and fence corners;

g. Railroad R/W;

h. Pole lines of other utilities;

i. Junctions between cable and wire;

j. Junctions with branch cables;

k. Cable terminal locations;

l. Subscribers' premises;

m. Trees and brush;

n. Restricted R/W;

o. Rock outcropping;

p. Changes in grade; and

q. Areas identified as environmentally sensitive.

6.4 Aerial enclosures should be placed along aerial cable leads at the following locations:

a. At subscriber distribution points within a reasonable distance to all prospective subscribers;

b. At junctions with lateral runs of cable; and

c. At cable loading and repeater points.

6.5 The data necessary to be shown on the construction drawing may be recorded in a notebook or on a construction drawing as the route is being traveled. This field data may then be recorded on the construction drawing back at the office. Information that will be necessary for construction is recorded on one set of construction drawings. Information pertaining to removal of existing plant is recorded on a separate set of construction drawings.

6.6 The information to be included on the construction drawings is that which is necessary to prepare the plans and specifications as well as that which is needed to construct the outside plant. The construction drawings should be prepared so that they may be used as permanent plant records.

6.7 After the subscriber data is brought up-to-date on the map, the actual construction route is selected and recorded while considering all physical obstructions that might affect the construction along the route. The actual sizing of the cables for the cable plant layout, line assignments, and the proper size aerial enclosures may be performed in the engineer's office from notes and measurements taken during the field staking. The construction drawings containing the above information should be made available to the interested parties for discussion at the Pre-Bid Conference.

6.8 Permission should be obtained from department of transportation authorities at locations where public R/W are to be used. Possible highway improvements, such as road widening, should be considered in staking the plant. Future road work can result in costly telecommunication plant rearrangements.

The cable route should be selected so as to minimize property damage. Location of the proposed poles should be selected to minimize possible damage from vehicular traffic and to allow for easy maintenance access.

6.9 The cable route should be marked on the construction drawing by reference to natural or manmade landmarks so as to facilitate the placement and future location of the cable.

6.10 Highway crossings should be discussed with department of transportation authorities and any necessary permits obtained. The cable route should be planned to cross the road only as necessary to serve subscribers. Since road crossings are often undesirable and expensive, the staking engineer should select the side of the paved road for the most general routing of the cable which will result in the fewest crossings. If numerous crossings are necessary, placing the cable on both sides of the road may be the most economical choice.

6.11 Following discussions with department of transportation officials and visual inspection of the route, the staking engineer can verify the preliminary entries of control points on the LD maps or construction drawings.

6.12 The staking engineer should proceed along the route, marking and detailing the following information (some of which may be done in the resident project representative's office) on the plant construction drawings:

a. Location and type of the aerial enclosures and poles;

b. Pole numbers;

c. Span lengths and cable sag;

d. The lengths of aerial service wires in meters (or feet) from aerial enclosures to subscriber's premises;

e. Pairs, gauge and type of cable or wire;

f. Number of optical fibers and type of fiber optic cable;

g. Tentative load point and repeater locations;

h. Tentative lightwave repeater locations;

i. Type of station protections;

j. Special considerations such as obstructions, minor route deviations, easement reservations, etc;

k. Grounding and bonding procedures to observe at special sites; and

l. All miscellaneous construction units for the plant installation such as grounds, etc.

6.13 Markers should be used to show the location of the following:

a. Proposed pole and anchor locations;

b. Proposed miscellaneous units; and

c. Proposed street, road and/or highway crossing locations.

The cable route and pole number should be marked on the markers so as to be legible at the time of construction.

6.14 Where difficulty will be encountered in finding the markers at a later date, the marker locations should be indicated by driving four-foot building laths adjacent to the markers or by providing some other suitable method of identification. Where markers are located on private R/W that are hidden from the road because of brush, trees, or crops, a suitable method of identification (such as a strip of bright colored cloth or plastic marking tape tied on a fence or some other visible road side location) should be provided to indicate each marker location from the road. Where permitted by department of transportation authorities, a colored stripe could be painted on the edge of the pavement to show the approximate location of the marker. It will also be helpful to place appropriate notes on the construction drawings.

6.15 The staking engineer should determine the control points in each section of route and stake approximately equal span lengths as close to the basic span length as practicable between those control points. The span lengths should be varied from the basic span length to avoid undesirable pole locations such as depressions, ditches, etc.

6.16 A transit, preferably with stadia hair, should be used to measure the route between control points. The transit should be set up and leveled over one of the control points if one point is visible from the other. Taking a "foresight" on the range rod placed vertically at the other control point establishes the route. A rodperson then proceeds toward the other control point and the transit person sights the rodperson in at points along the route where the poles are to be located. A marker with the pole number is then driven at each pole location.

6.16.1 If conditions exist where neither control point is visible from the other, the transit may be set up at some intermediate location such as the top of a knoll where the range rods are visible at each control point. The instrument is then set up on a point estimated to be on the route by backsighting on

one of the control points and reversing the telescope on its horizontal axis as a check to determine the extent to which the transit is out from the route. By a "juggling in" procedure and repetition of the above check one or more times, the instrument is finally placed on the route. A rodperson then proceeds toward the transit from each control point and the transit person sights the rodperson in at each pole location.

6.16.2 There may be some sections of the route between control points where it is difficult to sight in the range rods because of brush, trees, crops, or other obstacles. In such instances it may be possible to run a parallel route along the edge of a road where visibility is unobstructed. If so, a route may be run as previously described and the pole locations determined by offset. If this method is used care must be taken to make certain that equal offset distances are measured at right angles to the route established along the road and in the same plane to assure that the markers will be located in the route.

6.16.3 When using the transit at control points to sight in markers, the instrument should also be used to measure the angle of change in the route if there is to be an angle in the route at the control point. If there is an angle, the transit should be used to bisect the angle and establish the route along which an anchor is to be located. A marker should be driven at the anchor location.

6.16.4 The transit may be used to determine differences in elevation between two points by taking a rod reading at each point with the instrument level and taking the difference in the two readings to determine the differences in elevation. Obtaining this information is valuable in "grading" a route, determining clearances at highway and power crossings, and in marking railroad crossings. The same information may be obtained but with a lesser degree of accuracy by using a hand level. The hand level is a simple device which is held at eye level and the farthermost end raised or lowered until the bubble is in the center of the tube. When this occurs, a point on a rod in line with the horizontal line is noted and approximate levels are measured.

6.17 Ready-access enclosures or fixed count terminals should be specified within a reasonable distance from potential subscribers.

6.18 The major portion of a aerial plant construction drawing is devoted to a sketch of the cable to show the route of the aerial plant, the location of poles and anchors, clearing and trimming instructions, and other related units. Distances and sags between spans along the construction route and all other control points should be shown. This should include all intersections.

6.19 In addition to knowledge of the outside plant units and the project area, the staking engineer should be familiar with the capabilities of suspension strand and pole line hardware and classes and height of poles generally used by contractors. This should aid in the selection of the proper route and construction units required.

6.20 Pole numbering should be in accordance with REA Telecommunications Engineering & Construction Manual (TE&CM) Section 116, Plant Engineering and Record System, (Proposed conversion to REA Bulletin 1751B-101) or some other suitable numbering system.

6.21 The maximum permissible span lengths for cables depends on the weight of the cable, the strength of the supporting strand, the conductor temperature, and the loading conditions to which it may be subjected. In addition to the above factors, the span lengths may also be influenced by other factors. In urban areas, the span length may be determined by the length of the city block, the placement of aerial enclosures, driveways, and property lines. In suburban and rural areas factors such as terrain, ground clearance, aerial enclosure locations, branch cables, corners, control points, and the possibility of joint use or joint occupancy with other utilities could have an effect on determining the span length.

6.22 Uniform spacing of poles for aerial cable is not usually critical and advantage should be taken of terrain features to achieve long spans with minimum length poles. Large disparities in span lengths should be avoided. No particular concern need be given to an occasional span shorter than adjacent spans except from an economy viewpoint. However, it may be necessary to use an occasional span longer than the average span to avoid driveways, building entrances, etc. In these cases, the longer span should not exceed the average span length by more than 15 percent. In some cases it may be desirable to adjust several adjacent spans to equalize the load or in line guying may be used for this purpose.

6.23 For copper cables, REA TE&CM Section 630, Design of Aerial Cable Plant (Proposed conversion to REA Bulletin 1751F-630), gives final unloaded sags for cables lashed to galvanized steel suspension strand. REA TE&CM Section 635, Construction of Aerial Cable Plant (Proposed conversion to REA Bulletin 1751F-635), gives initial sags and tensions with cable in place and final sags for ground clearance for various suspension strand sizes versus cable weights.

6.24 For lashed and self-supported fiber optic cables, the design engineer should obtain sag and tension data from fiber optic cable manufacturers which will enable the staking engineer to select pole heights to provide the required ground clearance.

6.25 The aerial cable terminal poles should be located so as to provide the best aerial drop wire distribution within the terminal wiring limit, with adjacent spans adjusted. The pole adjacent to a terminal should be considered a control point.

6.26 To meet transmission objectives, especially with respect to maintaining the proper end sections beyond the last load point or repeater location, particular care must be exercised when making subscriber assignments. A thorough explanation of bridge taps and excessive end sections and their effect on transmission loss and frequency response is given in REA TE&CM Section 424 (Proposed conversion to REA Bulletin 1751H-101).

6.27 When the field work has been completed by the staking crews and the necessary entries on the construction drawings are completed, the staking engineer may turn the construction drawings over to the design engineer. This is for preparation in final form and insertion of other data so the construction drawings can be released for use in the preparation of the "Plans and Specifications."

7. RIGHTS-OF-WAY (R/W) CLEARING AND TRIMMING

7.1 REA Bulletin 345-153, Specifications and Drawings for Construction of Pole Lines, Aerial Cables and Wires, Form 515f, (Proposed conversion to REA Bulletin 1753F-011(515f)) defines the R/W clearing and trimming units to be used in aerial plant construction. The clearing and trimming units are descriptions of limits within which clearing and/or trimming should be performed to the specified specifications without regard to the amount of timber to be cut or brush to be cleared.

7.2 The minimum R/W widths within which clearing should be done is based on the type of pole line facility to be constructed. For aerial cable plant the minimum R/W width should be 1.5 meters (5 feet) on each side of the centerline of the pole line, however, the staking engineer may deviate from the above guideline when conditions exist that warrant such a deviation.

7.3 The staking engineer should determine the amount of clearing and trimming needed in each span and record the applicable units and lengths on the construction drawings.

7.4 The staking engineer should provide explicit instructions for clearing or trimming and shaping fruit, shade, and ornamental trees on the construction drawings. The staking engineer should also designate all trees to be removed or topped.

7.5 The information in Paragraphs 7.3 and 7.4 should be agreed to at the Pre-Staking Conference and discussed at the Pre-Bid Conference.

8. POLE SELECTION

8.1 The height and class of the pole to be used in the construction of the aerial plant should be agreed to at the Pre-Staking Conference and discussed at the Pre-Bid Conference.

8.2 Poles of sufficient height should be specified to maintain clearances in accordance with the NESC requirements where future aerial drops may be installed to provide service to potential subscribers.

8.3 Vertical clearances in accordance with at least the minimum NESC requirements should be maintained over and along public streets, alleys, roads, driveways, field entrances, etc. The pole heights can vary because of needed clearance, terrain, and cable sag. The staking engineer should reference the cable manufacturer's sag data on the various types of suspension strand with cable when determining individual pole height requirements.

9. ANCHORS AND GUYS

9.1 Adequate strength and proper alignment of the pole line structure should be achieved. Anchors and guys at corners, deadends, and other points of strain should be of the proper size to maintain the loading conditions on the facilities expected to be developed over a twenty year period.

9.2 Anchors and guys should have a lead to height (L/H) ratio value of at least "1" wherever practicable so that the minimum size guy and anchor assemblies can be utilized.

9.3 The use of side anchors at corner pole locations in the R/W may limit the lead. However, if corner pole locations could be shifted to a driveway line, fence line, line of trees, or outcropping rock, etc., satisfactory leads may be obtained in many cases without objections by the property owner.

9.4 In cases where property owners do not allow installation of anchors on their property it may be possible to install guy stubs with overhead guys at these locations at a reasonable distance back from the lead where a group of trees, drain, or other physical condition may allow such construction.

9.5 Situations may arise where pole keys or push braces may be required. These methods should be used only when physical conditions or R/W restrictions prevent the use of normal construction.

9.6 Corners and slight angles should be accumulated around curves and the number of guys and anchors should be kept to a minimum.

9.7 When an overhead guy is installed and the electric supply line occupies the opposite side of the road, the overhead guy and down guy should be attached to the electric supply line pole when possible. This not only saves the cost of a guy stub, but allows grounding of the guy to a multigrounded neutral, if one exists, saving the cost of two strain insulators.

9.8 Guys that are classified as exposed guys are considered to be an electrical hazard to telecommunications personnel and the public and should be electrically protected. The electrical protection of an exposed guy can be accomplished by effectively grounding the guy or by insertion of insulators in the guy to isolate the electrical hazard. Wherever practicable the guy should be grounded by bonding the guy to the neutral of the multigrounded supply system or by bonding the guy to a systematically and effectively grounded cable strand.

9.9 All angles guyed and unguyed should be recorded on the construction drawings.

10. JOINT USE OR JOINT OCCUPANCY PLANT

10.1 Staking of joint use or joint occupancy routes requires that detailed information be made available to the staking engineer prior to when staking actually commences. Details of joint use or joint occupancy agreements and details of sections of route on which joint use or joint occupancy is proposed should be known to the staking engineer. The practicability of utilizing joint poles should be based upon pole strength tables, separation tables, and staking curves. Pole strength tables, separation tables, and staking curves for joint poles should be developed on the basis that the power conductors should be sagged in accordance with the power conductor manufacturers' tables. Experience indicates that quite often the power conductors are not sagged in accordance with the manufacturers' data and consequently this introduces a problem of making a new determination of actual sags. This information should also be obtained prior to the actual staking of the route. If the sags are appreciably different than that outlined in the manufacturers' data for power conductors, it may be necessary to prepare new separation tables.

10.2 The need for strict compliance with NEC and NESC requirements cannot be overemphasized. Carelessness in obtaining correct separation between power conductors could possibly result in fatal accidents to line personnel and expensive damage to the telecommunications plant and subscriber's premises. Where there is any question as to the actual sag of the power conductor, a representative of the power company should be contacted to make actual determinations of the sag characteristics in the route. In indicating the separation requirement on the construction drawing, the staking engineer is required to base this separation on the distance from the bottom of the lowest electrical facility

from which the measurement is made to the drilling point for the attachment of the telecommunications facilities. This distance should include code separation and space for the telecommunications facilities above the drilling point. Separations should be kept as uniform as is practicable and economical.

10.3 The poles used in the power lead should provide adequate strength for the additional telecommunications facilities. Pole strength tables provide information for this determination. Where the strength of an existing pole is considered to be marginal, the staking engineer should consult with the resident project representative before indicating a changeout. The pole strength tables were prepared on the basis of five diameters of power conductors and 0.6 meters (2 foot) incremental increases in separation. There should be adequate strength in many cases where the tables indicate that the strength in the pole is marginal.

10.4 Guying requirements for telecommunications facilities attached to joint poles should generally fall at the same pole where guying is provided for the power facilities. The staking engineer should consult with representatives of the power company to determine if there is adequate strength in the existing power company's anchor assembly for use by the telecommunications facilities. Where strength of the existing anchor assembly of the power company is inadequate for use by the telecommunications facilities, guying requirements for the telecommunications facility should be in accordance with the provisions in REA TE&CM Section 650, Guys and Anchors on Wire and Cable Lines, (Proposed conversion to REA Bulletin 1751F-650).

10.5 To properly determine guying requirements, it is necessary to measure the angles in the existing pole line. A transit cannot be conveniently used for these measurements, because to measure the line angle the transit would have to be placed in the exact position occupied by the corner pole. An instrument called, a "pull finder," provides a method for measuring this angle. The angle in the line and the distance from the pole to the anchor to be used should be recorded on the construction drawings.

10.6 The factors in staking nonjoint use cable apply also to joint use or joint occupancy cable plant. In addition, the factors of separation and clearance should also be considered. Where long spans are involved, the difference between initial and final sag as a result of loading conditions becomes appreciable after the cable has reached its final sag. Because of the necessity of maintaining code clearances and separations initially and finally, both the stringing sags and design or unloaded sags must be taken into account when staking joint use or joint occupancy construction. In some cases where adequate ground clearance cannot be obtained with 6M strand without pole

changeouts, consideration should be given to the use of 10M strand which can be placed at higher tension and less sag than 6M strand.

11. TERMINAL BLOCKS

11.1 REA accepted filled terminal blocks should be used in ready-access enclosures and fixed count terminals to avoid moisture and corrosion problems.

12. RAILROAD CROSSINGS

12.1 The NESC specifies minimum vertical and horizontal clearances for aerial and underground railroad crossings, as well as minimum strength requirements for poles, conductors, anchors and guys, and maximum crossing spans. The Association of American Railroads also publishes requirements regarding clearances, strength of poles, conductors, anchors and guys, and span lengths titled "Specification For Communication Lines Crossing the Tracks of Railroads."

12.2 Some railroads as well as states or municipalities may have specifications which differ from the NESC and the Association of American Railroads. Therefore, before design and staking work is undertaken, railroad and/or state or municipal officials should be consulted regarding their crossing requirements. The more stringent requirements should be followed.

12.3 A drawing showing the detailed crossing layout is often necessary for submission to railroad and/or state or municipal officials for approval and for inclusion in the crossing agreement.

13. STATION INSTALLATIONS

13.1 Station installations include the staking of aerial drop wire assembly units, station protector assembly units, and/or network interface device (NID) assembly units.

13.2 Where the objectives of safety and electrical protection conflict with the objectives of appearance and economy, the decision should always favor safety and protection.

13.3 Aerial drop wire should be staked to conform with the station protector or NID location which will facilitate connections to the subscriber's inside wiring and which, at the same time, will ensure interconnection between the telecommunications, power, and water pipe grounds. REA recommends that the station protector or NID location be chosen to be as close as practicable to where there is easy access to the electric service grounding system (electric service grounding

conductor, metal conduit covering the electric service grounding conductor, or other means of access to the electric service grounding system).

13.4 Drop poles, including cable terminal poles, should be located so as to permit the most direct drop wire route, free of tree and foliage interference and intervening pole line and building structures. Drop wires should not be installed in front of windows and over doors, and should not be attached to the structure under roof drainage areas where ice, snow, or excessive moisture can affect the drop wire.

13.5 Where it is necessary to clear streets, alleys, and highways with drop wires attached to structures too low to provide proper ground clearance, a service pole should be used. Wherever practicable attachments should be made to the other company's pole when covered by attachment, joint use or joint occupancy agreements.

13.6 Aerial drop wire sag tables list the minimum sags. The staking engineer's ground clearance calculations should, whenever practicable, include greater sag if no additional cost is involved.

13.7 When staking aerial drop wires from or on joint use or joint occupancy poles, three primary factors should be considered: climbing space; the requirements of the other joint user; and the requirements of the NESC. Attachments to foreign poles should comply with the NESC rules for separation and clearance, and the separation should be shown on the construction drawing for the benefit of the contractor.

14. ELECTRICAL PROTECTION

14.1 The staking engineer should be provided with the detailed protective measures to be employed which have been decided upon in the system design. REA TE&CM Sections 800 through 825 (Proposed conversion to REA Bulletins 1751F-800 through -825) include details regarding applicable protection practices.

14.2 In order to minimize the possibility of conflict with or interference from power distribution systems, crossings of power and communication systems should be minimized. Where an excessive number of crossings are contemplated, joint use or joint occupancy construction should be considered.

14.3 Joint pole crossings should be used whenever practicable. In order to keep the cost of such crossings to a minimum, existing power poles should be used as crossing poles to the maximum practicable extent. Spans adjacent to joint crossing poles should be adjusted so that the joint crossing pole can be used as a telecommunication support pole, and not just as a clearance pole. Where a multigrounded neutral (MGN) type of

power conductor is crossed, a joint pole crossing has the additional advantage of making the MGN available for grounding cable shields, support wire, and power contact protectors. In many instances the ability to obtain coordinated protection is dependent upon the availability of an MGN as a ground electrode for telecommunication protective devices. Where it is not practicable to use an existing electric power pole as a joint crossing pole, consideration should be given to having the power company set an additional pole in their route and attach their conductors to it for the joint pole crossing. Under no circumstances should a crossing pole which is too short for attachment of the power conductors be set in the power company's line (or close enough to the power line to constitute a structural conflict). It is inherently more difficult to provide effective protection of telecommunications plant against power contacts with other than MGN type systems. Therefore, more reliance should be placed on the structural strength of crossings to prevent contacts. For this reason it is even more important to obtain joint pole crossings with non-MGN power lines than it is to obtain them with MGN type power lines.

14.4 Pole lightning protection wires should be used only in areas of high lightning incidences and at poles which are severely exposed to lightning. Engineering judgement should be used in selecting which poles are to be provided with protection. Guidelines for making such selection are contained in REA TE&CM Section 815, Electrical Protection of Aerial Cable (Proposed conversion to REA Bulletin 1751F-815).

14.5 The PM2 unit is intended for grounding drainage units. In most areas it does not produce a low resistance ground and therefore, should not be used where low resistance ground is required unless the ground resistance measurements in the area indicate that an adequately low resistance can be expected to result from its use. In areas of high earth resistivity, if it is necessary to use a driven ground because of the lack of any other suitable electrode, a PM2 unit supplemented by one or more PM2-1 units should be specified.

14.6 It is important that the staking engineer understand the difference in the objective of station protection as compared to plant protection. Plant protection is primarily concerned with balancing the cost of maintaining unprotected plant and the value of service interruption against the cost of applying and maintaining protective devices which will reduce or eliminate this plant maintenance. Station protection is concerned with the personal safety of the subscriber, protection of the subscriber's premises against fire and protection of the station equipment and wiring against damage and circuit outage. Adequate protection of persons and premises should be provided at all station installations.

15. FINAL INVENTORY CONSTRUCTION DRAWINGS

15.1 Final inventory construction drawings are usually made after construction by correcting the initial construction drawings. Due to construction changes, the initial construction drawings may require some modifications, particularly in regard to pole locations, span lengths, cable lengths, and anchor and guy locations. The resident project representative and contractor should agree on all the quantities and units appearing on the final inventory construction drawings. The corrected construction drawings are then prepared in final form as permanent plant records.

15.2 The "as built" or final inventory construction drawings should provide the following information in complete detail:

a. An inventory of all outside plant units installed; and

b. The physical location of the aerial facilities.

15.3 These construction drawings should give a record of the amount of materials and their location in the field, and also provide the borrower with a basis for a reliable schematic with which to locate the cable either for trouble-shooting, upgrading, or coordinating with other utilities and construction activities that might occur in the future.