

ADMINISTRATIVE PROCEDURES AND METHODS

FIELD ENGINEERING

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of this term should not be construed as a supersedure of such assignment.

2. DEFINITION OF FIELD NOTES

2.01 Field notes are the recording at a specific location of the physical details that:

- (a) Control the manner in which work operations are performed
- (b) Influence the economic selection of materials or engineering plans
- (c) Are used in the estimation of the amount of time, money, or materials required to perform specific work operations.

2.02 Field notes comprise information gathered by an engineer outside the office with the thought that data may be used (supplemented as necessary by office engineering) by clerical forces to draw finished work prints. Information gathered anywhere outside the office is considered to be field notes.

3. GENERAL ITEMS TO BE CONSIDERED

3.01 The notes should be clear and neat so as to be easily understood by others and so that there will be no question as to the exact meaning. All information and data observed in the field should be written down and never left to be filled in later from memory. Standard symbols should be used, except that pole and anchor symbols should be used on notes to represent usage in the field and not ownership. When the field notes are being transcribed, the ownership of the poles shown must be determined from the office records. This verification may indicate that a change in ownership or contact arrangement should be made. Care should be taken so that the notes shall not be subject to any interpretation other than that intended by the person preparing the notes.

3.02 Inasmuch as people not familiar with the locality will probably use the notes and will be guided only by what is written down, it is very important that the notes show all necessary data without any useless information. Information shown on field notes which need not be shown on the work print may be circled.

3.03 Clarity is of vital importance. To obtain clearness, it is suggested that no attempt be made to sketch to scale in most cases. However, there may be instances where it will be desirable, especially in block cable work, highway work, or railroad crossings, where scale drawings are available and can be used for showing telephone work to be done.

3.04 Care should be exercised so as not to crowd the field notes. Paper is cheaper than the extra time that will often be required to interpret or explain congested notes. Also, errors that may result from crowded notes might be costly to correct. Furthermore, the final construction prints should not be crowded. Anyone transcribing the field notes is more likely to avoid crowding if the field notes are not compressed. Use legible printing or writing, neither too large nor too small. Write or print notes near the items to which they apply. Draw arrows, if necessary, to associate notes with proper items.

3.05 It should not be necessary for the engineer to rearrange or to redraw the notes before they are transcribed by clerical people. If the engineer draws notes in the field so that they can be transcribed easily, there will be fewer questions and less supervision will be required on the part of the engineer.

3.06 The engineer will find it a decided advantage to learn to draw notes freehand. With a little practice, this can be done so as to produce good, clear sketches rapidly and with minimum effort. In practically all cases, notes should be taken by working up the page. The engineer should start at the bottom of a page and draw the notes in the same direction in which he moves. This is much less confusing than turning the notes constantly in order to draw objects in their correct relative positions. Notes drawn in this manner can be easily turned, in the office, so as to result in a print with the north arrow pointing in any desired direction.

4. NECESSITY FOR FIELD TRIPS

4.01 Engineering field trips are required when good judgment and knowledge of local conditions indicate that field investigation is necessary in order to prepare a practical job which will satisfy safety requirements, engineering, and maintenance.

4.02 It is recommended that all jobs involving joint work with other utilities be checked in the field. Also, the following are examples of the type of activity that will normally require field trips: all work covering pole line extensions; cable additions, extensions, or replacements; highway and street changes; building construction or alterations involving cable; cable terminations on frames; buried and underground cable; submarine cable; and additional subscriber wire jobs.

4.03 Many jobs (such as replacing defective terminals, adding subscriber wire to existing spare pins, and replacing occasional defective solely owned telephone poles or crossarms reported by other telephone employees) may not require field surveys. In some instances where a reliable detailed inspection of pole and wire plant has been made by construction forces, an engineering survey may not be necessary unless joint construction, power conflicts, reroutes, or other special engineering considerations are involved. However, good judgment should be exercised before a decision is made against making a field visit. "Office engineering" has often replaced a pole or terminal with a new item where the unit should have been removed entirely.

5. PREPARATION FOR FIELD TRIPS

5.01 Before leaving the office for any field investigation, the engineer should first know the problem and should have as clear a conception as possible of what to do. It is important to be familiar with the reason and the necessity for proposed additions to or changes in existing plant. In addition, one should know in advance the type of plant which is going to be inspected or considered (such as cable, open wire, poles, or conduit). Complications should be anticipated insofar as possible, and where it seems necessary, the engineer should take along telephone company coordinates or power company representatives, either to obtain ideas and advice or to coordinate and expedite the completion of the work.

5.02 The engineer should consider all items of tools and records that may be needed in the field. The type and location of the territory to be covered should be kept in mind. In most cases, field work should be done by one man; however, when it is necessary to drive and take notes under adverse weather or traffic conditions,

it may be safer and more advantageous for two people to work together.

5.03 The engineer should arrange a trip, if several jobs are to be surveyed, so as to minimize traveling (in other words, to do the job in the most efficient manner). Thinking along the line of efficiency, plans should be arranged, if possible, to avoid hazardous weather and driving conditions. Many times a much better survey and consequently better and more accurate notes will result if the engineer uses good judgment in deciding when to make a field trip. Under some conditions, however (such as storm damage surveys or where appointments have been made with other people), the engineer may have no choice.

6. TOOLS REQUIRED FOR TAKING FIELD NOTES

6.01 On a field trip, the engineer should carry only those tools that are practical for doing the day-to-day job.

6.02 These tools can be divided into three groups:

(a) Tools that each engineer should generally have:

- (1) Briefcase.
- (2) Clipboard.
- (3) Paper —8-1/2 by 11 inches, cross-ruled.
- (4) Rural route and city street map.
- (5) State highway map.
- (6) Cloth measuring tape—150 feet in length.
- (7) Pull finder.
- (8) Guy rule.
- (9) Safety glasses and hard hat.

(b) Tools that generally should be in each car:

- (1) Flashlight.
- (2) Stakes and lineman hammer.
- (3) Range rods.

- (4) Vertical measuring device (Teleheight, range finder, etc.).
 - (5) Footometer or some measuring device on car.
 - (6) Manco or equivalent measuring wheel.
 - (7) First aid kit.
 - (8) Manhole cover lifting device.
 - (9) Chalk, etc. (Small items should be kept in containers so that a check can be made before starting a field trip. Such containers will facilitate tool transfers between cars.)
- (c) Tools that should be in each office for use as occasion requires:
- (1) Topographical contour maps.
 - (2) County maps.
 - (3) Steel tape —200-foot.
 - (4) Steel tape —300-foot (optional for offices doing extensive rural work).
 - (5) Hand level.
 - (6) Range finder.
 - (7) Transit (optional).

6.03 The preceding paragraph lists the most commonly used tools. Their use or the use of substitute items should be governed by the needs of the job and by the particular location. As new tools are developed, their field of use by engineers should be carefully balanced by their cost and application.

7. MEASURING TECHNIQUES

7.01 The most important principle of measurement is a knowledge of required accuracy. Service wire spans, certain overhead guys, and similar types of plant do not require precision, and the use of it is a waste of time and money. On the other hand, underground conduit and large cable require a high degree of accuracy. The engineer should use good judgment in length determinations for this type of plant, since deficient measurements

for big cables can be very costly where additional splicing and related types of work are required.

7.02 The types of measuring devices and their uses are described in the following data:

(a) **Measuring Wheel:** The accuracy of conventional measuring wheels ranges from 1 to 100 feet per 1000 feet of length and depends on a number of factors. The tool should be in good condition and the tire should not be excessively worn. It should be checked every 6 months by a comparative measurement against a known length of about 1000 feet. Calibration factors should be posted on the handle. If the tire becomes too worn, it should be replaced. The smoother the surface of the ground, the more precise the measurement. Ground with rough contours may introduce intolerable inaccuracies. Likewise, sand, brush, grass, and other obstructions can cause such variations as to preclude the use of the tool. As in all measuring procedures, marking of start and stop points is significant in the attainment of proper accuracies. Efficiency is the principal advantage of the measuring wheel, since it may be used easily by one person. Safety advantages are also significant in that no trailing tape lines exist to become entangled with vehicular traffic. The measuring wheel should never be used from a moving vehicle. This tool is recommended for use in general exchange work, with the exception of underground conduit and large cable leads. It is generally impractical for block and building cable work. Excellent results may be obtained if good judgment has been applied in the choice of use, depending on field conditions.

(b) **Linen Tape:** This device is a very versatile tool, useful in many exchange plant measurements. The accuracy is somewhat limited and may vary from about 5 to 20 feet per 1000 feet of length. Old tapes tend to stretch, particularly when wet. Brush and wind may cause the measurement to be extended due to the bulges introduced in the tape. As in the case of the measuring wheel, start and stop points should be well marked and the number of lengths properly recorded, since errors of this type are usually greater than others. The advantages of linen tape include ease in handling, and in addition, use of the tape permits much of the work to be done by one individual. The free end of the tape can be inserted into pole

"checks" when measuring existing spans. A metal pin that can be inserted into soft earth facilitates measurements on new extensions. Linen tape is not bothered by kinking, and in the event that it is run over by a vehicle, it will not break as a steel tape will. Although breakage is not a problem with linen tapes in vehicular traffic, care should be used to avoid accident to the public or to employees. In some instances for safety reasons, two persons are needed for taping in certain congested traffic situations. A further advantage of linen tapes is their inability to conduct electricity that requires extra precautions when using steel tapes. Linen tapes that contain metal reinforcing should not be used. **No type** of tape should be thrown over electric wires as a means for measuring their height. Linen tape offers extensive use advantages in simple exchange work involving short sections of plant and in building and block cable work. The 150-foot length is recommended for general purpose use. This type of measuring tool is not recommended for underground conduit, toll, and other important cable lines where accuracy requirements are high.

(c) **Steel Tape:** This is a high-use tool that provides the greatest accuracy of all the measuring instruments commonly used by engineering people. With reasonable care, precision ranging from 1 to 5 feet per mile can be obtained. When mistakes are made, they are usually due to poor workmanship and are often caused by improper marking of tape ends or by miscounting the number of lengths. Wind and temperature change effects are usually minor and are much less than found for linen tapes. The steel tape is the superior tool in rough country. Steel tapes come in convenient lengths of 100 and 200 feet for city work and can be obtained in longer sections for toll and rural work. **Caution** must be applied when any possible exposure to power wires exists. Chainmen should learn to grasp the tape with the leather thong to minimize chance of contact. The tape should not be dragged across railroad tracks due to the possibility of activating signal systems. Care should be used to avoid kinks, since the tape may break easily when in a kinked condition. Precautions should be taken to avoid having vehicular traffic run over the tape. If this is inevitable, the tape may be protected by keeping it flat on the street. **In no case** should the

chainman be exposed to entanglement in the event of a traffic encounter. The tape should be rolled up at once when not in use. During wet weather, the use of a cloth to dry the tape during rolling operations will add to the utility and life of the tool. Sleeves with low melting point solder that may be activated with a match should be kept handy to effect prompt repairs in the event of a break. The steel tape is much better stored on the reel than in loose coils. Steel tape is recommended for all high-accuracy work including toll, underground conduit, and large cable items.

(d) **Footometers or Odometers:** These instruments installed on company vehicles are useful for rough measurements such as preliminary work and often for aerial wire. The accuracy often deviates as much as 10 percent. Each office should develop a routine for calibrating the instrument, since the accuracy varies considerably due to tire wear and pressure changes caused by different temperature conditions. Usually, a fixed measurement is available by which the device can be checked for percent deviation and then used with suitable accuracy for measuring many lengths. This calibration should be made whenever a change has occurred to alter a prior correction factor. When used in this fashion, the tool offers opportunity for one-man operational efficiency. Safety conditions should be considered, however, and care used before setting up a work operation on frequently used roads. With a good calibration, the tool may be used for some small size rural cable work and for aerial wire extensions.

(e) **Speedometer:** The regular car speedometer is useful for rough preliminary measurements only. It can be depended upon to provide accuracy only in the range of 400 to 600 feet per mile.

(f) **Pacing:** Pacing is useful in a good deal of preliminary work and for measurements requiring limited accuracy. The engineer may practice pacing and use this measuring means with suitable accuracy for many short length items and often in cases where the other tools are unavailable or impractical for a particular field condition.

7.03 Plant engineers should follow certain principles in making linear measurements to procure necessary accuracy.

(a) **Measuring Procedures:** The head chainman carries the front end of the tape and carefully marks the point to which it has been measured. The front end of the tape is always kept ahead. The rear chainman holds the rear end of the tape or some intervening even foot at the last point measured and calls out the location and the tape reading. The head chainman then calls out the front location while the rear chainman listens to see if it is correct. If this system is used, the chance of error is almost eliminated. Chainmen should work as a team and have an agreeable set of signals. The tape should be kept straight and held with a steady pull of about 12 pounds at the time of measurement. Graduations in the marked feet at each end of the tape should be properly interpreted in the reading of the section. Care should be used to avoid confusion between the numbers 6 and 9.

(b) **Slope Measurements:** For aerial cable or wire or for out-of-sight plant the measurements should parallel the grade of the cable or wire. This generally means that cable measurements should be made parallel to the ground surface. This process is a contrast to land measurements that are made using a level tape with a plumb bob at the lower end where slopes are steep.

(c) **Accuracy Considerations:** As stated, accuracy should be a function of good judgment. It is very important to make the **right count** of tape lengths, whereas a few inches of error in an extended cumulative measurement are relatively insignificant. Practical accuracy limits for the various types of plant should be as follows:

Aerial wire ± 10 feet per 1000 feet of length

Distribution cable ± 2 feet per 1000 feet of length

Conduit, large exchange cable, and toll cable ± 1 foot per section or 1000 feet of length

7.04 There are a number of practical tools and methods to assist in determining heights.

(a) **Pole Markings:** For existing stepped poles, determine height of attachment through the use of the manufacturer's pole brand and the step spacing. The brand is always 10 feet from the butt, and by subtraction of the belowground

section, the starting height can be calculated. Steps are placed 3 feet apart, and by the addition of the stepped sections, the attachment level can be quite closely estimated.

(b) **Clearance Sticks:** Standard clearance sticks made of insulated material can be used for measuring heights up to 30 feet. Always wear rubber gloves when using clearance sticks in the vicinity of power conductors.

(c) **The clinometer, or abney level** as it is sometimes called, is another instrument available for measuring heights. Figure 1 depicts the procedure for using this tool. The vertical arc should be set at 45 degrees. Then the instrument should be placed to the eye in a braced fashion while the operator steps forward until the line of sight intersects the point being measured. By measuring the horizontal (ground) distance to the object and adding the height of the eye, the total heights can be determined.

(d) **Range Finders:** These are split-image instruments made similar to a camera range finder that can be focused. A description and discussion of their use are found in Section 620-255-601.

7.05 The engineer of outside plant must often work with highway department stationing, and on occasion, should be able to draw a referenced profile for telephone plant using that system. To develop such a line, the following procedure is provided:

(a) **Horizontal Measurement:** Linear reference points are established by determining stations. Stationing is a unit of length measuring 100 feet, and the beginning of a line is known as station 0 + 00. A point 100 feet from the beginning is station 1. A point 200 feet from the beginning is station 2. A point 300 feet from the beginning is station 3, etc. Intervening points between stations are called plus points. A point 331.0 feet from the beginning of a line would be 3 + 31.0 and a point 15,220 feet along the line would be 152 + 20, while a point 32.5 feet from the beginning would be 0 + 32.5. This system is used nearly everywhere in roadwork, irrigation, and other similar engineering projects. It has many excellent advantages.

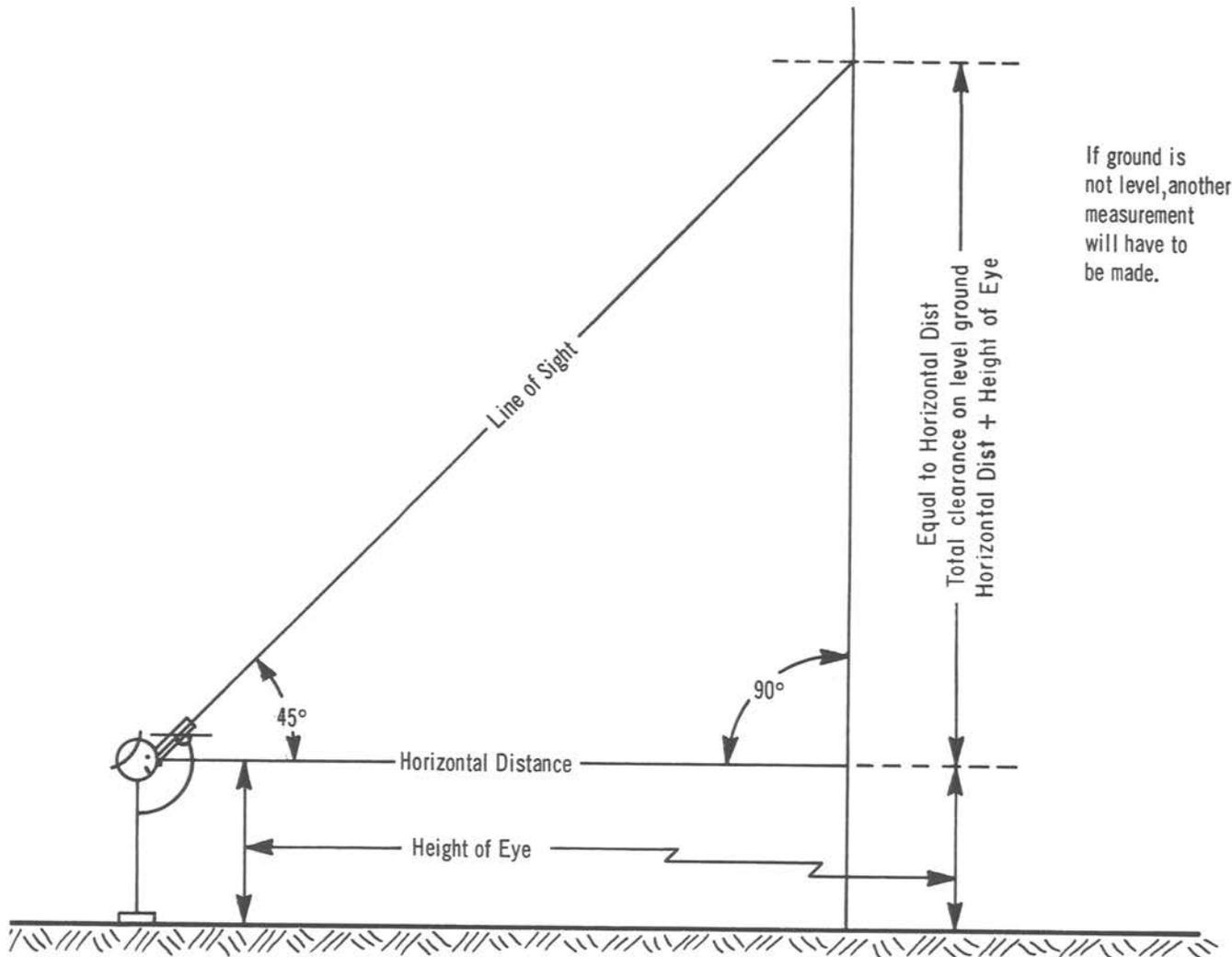


Fig. 1—Measuring Elevations with a Clinometer or Abney Level

- (1) All parts of the line can be readily identified in relation to the rest of it.
 - (2) It is easy to record and the line as a whole can be studied easily.
 - (3) Distances between points can be found by taking the differences between stations.
- (b) **Vertical Measurements:** Most outside plant leveling can be accomplished by using a simple clinometer, although a surveyor's level would be required for occasional long lines in cross-country problems. The example provided herein would employ a clinometer and a range rod. Turning points would be established as

the leveling process progressed. These locations (called TPs) are the reference points where the instrument is moved along the line to another setup.

(c) **Profile Plotting:** After calculating the elevations, which involves nothing more than simple adding or subtracting, the elevations can be plotted on graph paper. This is the desired profile. The scale chosen for the profile is important. If the horizontal and vertical scales are the same, the product will be a rather flat looking diagram. To bring out the elevations in a more useful way, most profiles have different horizontal and vertical scales, as shown in Fig. 2. Calculations are shown for this example in Fig. 3.

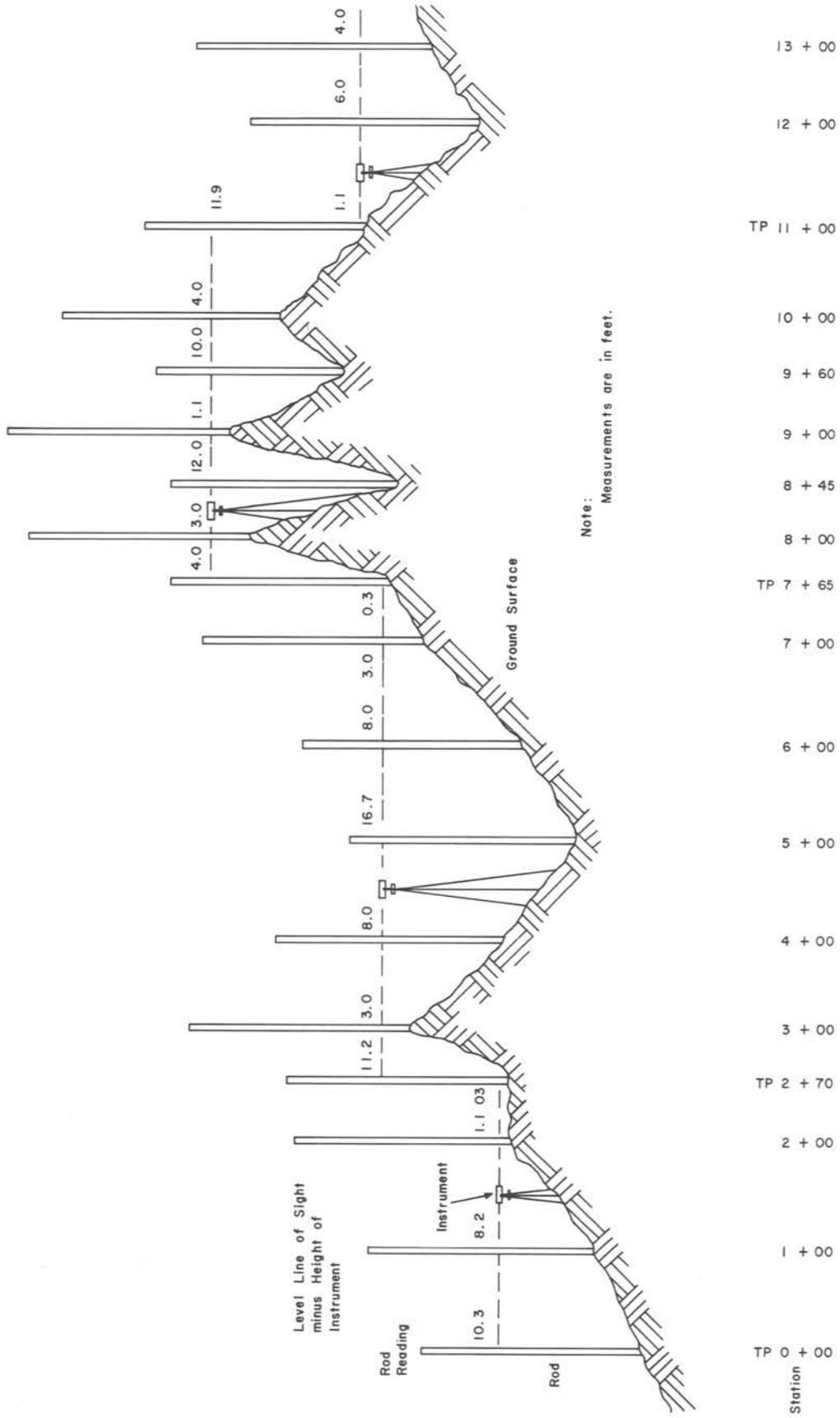


Fig. 2—Profile Leveling

Note*

Ground Elevation of 122.0
is a typical survey elevation
procured from a prior determination.
The engineer may adjust this
to zero (0).

Station	Plus (+) (Ft)	Elevation on Rod (Ft)	Minus (-) (Ft)	Ground Elev (Ft)	
TP	10.3	132.3		122.0*	Ground surface at station 0 + 00 (Ground surface)
0 + 00			10.3	122.0	
1 + 00			8.2	124.1	
2 + 00			1.1	131.2	
2 + 70			0.3	132.0	
TP	11.2	143.2	0.3	132.0	Ground surface at 2 + 70
3 + 00			3.0	140.2	
4 + 00			8.0	135.2	
5 + 00			11.7	131.5	
6 + 00			8.0	135.2	
7 + 00			3.0	140.2	
7 + 65			0.3	142.9	
TP	11.0	153.9	0.3	142.9	At 7 + 65
8 + 00			5.0	150.9	
8 + 45			12.0	141.9	Dry gully
9 + 00			1.1	152.8	
9 + 60			10.0	143.9	Dry gully
10 + 00			4.0	149.9	
11 + 00			11.9	142.0	
TP	1.1	143.1	11.9	142.0	At 11 + 00
12 + 00			6.0	137.1	
13 + 00			4.0	139.1	

Fig. 3—Sample Level Notes

8. PRELIMINARY FIELD SURVEY

8.01 The objective of a preliminary or explorative survey is to secure all the data necessary to determine which one of a choice of routes or plans is the most feasible. The preliminary survey may be made either by walking or by using a car. It will not be necessary to make detailed notes at this time, but if the job is extensive, some sketchy memoranda may be needed as reminders when several alternate plans are to be compared. If portions of a proposed route present difficulties, it will often be necessary to return and go over the difficult portion until a satisfactory overall plan can be obtained.

8.02 Before beginning the preliminary survey, the engineer should be provided with the best available map showing existing telephone plant in the area to be investigated. In many cases, suitable drawings on which to place the field notes should be prepared by the clerk in the office (see Section AG11.413). A skillful engineer with prior knowledge of the area will thus be able to project a tentative plan with sufficient accuracy to select the most feasible route or routes for preliminary checks in the least possible time. Guard against the conviction, however, that it is unnecessary to look elsewhere than along the tentative projected route. The inaccuracies of the map, local peculiarities, and other physical structures may make what appears to be the most promising map plan the wrong solution when thorough field analysis is completed.

8.03 The question of a proper route or location for a line or additional plant to be placed is primarily an economic one, involving not only the cost of construction but of maintenance and operation and a consideration of immediate and future needs.

8.04 It is the duty of the engineer making the field survey to determine how and where additional plant should be built. The problem in making a preliminary survey is how to secure the best route that will provide the facilities needed. Keeping in mind the maintenance and operation of the proposed plant, the engineer may divide his investigation into two parts. First is the selection or the identification of the beginning and the end of the proposed construction. Often the approximate starting point and the end of proposed work will be ascertained in advance by a preliminary office

review and by the location of existing plant. In some cases, an Exchange Feeder Route Analysis Program (EFRAP) study will have contributed to the route selection decision. Second is the fitting of proposed plant to the existing topography and structures that may be encountered in such a manner as to keep the cost of construction and maintenance at a minimum.

8.05 The reconnaissance involved in a preliminary field survey is a rapid general survey of the area through which additional plant needs to be built. In many cases there will be only one practical route, but there may be many questionable items to consider along that route, such as which side of a road should be used, existing pole lines, highway or private property, tree conditions, future building construction, possible highway changes, and many others. The engineer should develop vision and imagination and should exercise them when planning new plant. Nothing can take the place of an intimate personal knowledge of the problems that may be encountered. Therefore, on jobs of any size, it is important that the overall picture be investigated prior to making detailed notes. It is often helpful to go over a proposed route, either by walking or by using a car, in both directions. Many times things will look different when viewed from the opposite direction.

8.06 On many jobs, a preliminary survey and a detailed survey can be made with one field trip. In other words, the engineer should avoid making a second field trip where possible. Some of the larger undertakings may require several days for preliminary investigation, however, and longer for detailed surveys.

8.07 The foregoing paragraphs have dealt with general considerations relative to preparing field notes. The balance of this section pertains to taking detailed notes in connection with the various types of work that the engineer will encounter in the field.

9. DETAILED NOTES—COMMON ITEMS

9.01 Certain items that should be listed on all field notes, regardless of the type of construction involved, are specified as follows:

- (a) Central office area
- (b) Tax district (optional by company)

- (c) Street or road name and/or pole or buried cable route number
- (d) Type of highway (state, county, town, etc.)
- (e) North point
- (f) Highway or private
- (g) Intersecting streets or roads
- (h) Landmarks (railroads, pipelines, bridges, churches, schools, etc.)
- (i) Number on each sheet and cross-references between sheets.
- (j) Date on each sheet
- (k) Engineer's name or initials
- (l) Need for right-of-way and permits
- (m) Direction to central office
- (n) Direction to nearby communities for orientation purposes
- (o) Base rate area boundary
- (p) Tie-in with existing plant.

10. DETAILED NOTES—POLE LINE

10.01 The number of new pole line extensions should be limited to a very few locations in each operating district, with the current emphasis on buried plant. Generally, most pole work will be confined to replacement items. Since some sections of new line will still be required, however, the following is provided for the engineer's assistance.

10.02 The field notes taken for pole line construction should be closely coordinated with associated aerial cable and wire work, etc. They should include these items:

- (a) Existing landmarks. Show distances, if applicable.
- (b) Pole locations. On highways or streets, pole locations should be referenced to center lines, property lines, curbs, sidewalks, etc. For pole lines on private right-of-way, references

should be made to property lines, fences, walls, etc. Special care should be used in locating poles on which large terminals, underground laterals, concentrators, etc., are installed. Locations vulnerable to future change, vehicular traffic, etc., should be avoided.

- (c) Pole numbers (telephone and others).
- (d) Unusual soil conditions.
- (e) Power crossings and parallels. Show power voltage and emphasize any potential HAZARDS to pole placing.
- (f) Underground structures.
- (g) Guying (lead and location if restricted).
- (h) Telephone attachments on pole.
- (i) Foreign plant on pole.
- (j) Condition of plant. When poles are deteriorated, they should be marked on the notes as HAZARDS. Specifications should include removal or replacement of unsafe plant.
- (k) Ground clearances. Rough ground contours should be accounted for in pole sizing.
- (l) Clearances from foreign plant. Impaired clearances should be emphasized and so indicated with HAZARD comments. Corrective instructions to eliminate the impaired clearance should be provided.
- (m) Pole heights and classes proposed.
- (n) Removals. All pole removals should be subject to HAZARD notes by engineering forces. A high portion of accidents occurs with removal work.
- (o) Space required by foreign company.
- (p) Actual span measurements.
- (q) Line rehabilitation. When new plant is added to any existing line, the engineer should evaluate the condition of the total line and chances for immediate or future change. When major replacement is in order, consideration should be given to respacing or lead relocation.

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Included in the analysis should be a choice between maintenance of 100 percent telephone line versus use of joint power lead. Buried plant selection is discussed in Part 11.

- (r) Effect of future extensions.
- (s) Effect of any highway changes.
- (t) Special right-of-way considerations.
- (u) Tree work involved.
- (v) Considerations for special equipment (loading, carrier, crossboxes, etc.).
- (w) Special construction considerations.

11. DETAILED NOTES—AERIAL CABLE

11.01 Although aerial cable is fast being replaced by buried and underground cable as a major plant specification, many additions will still be required in the years ahead where costs of undergrounding are prohibitive. Field studies will play a greater part in the selection of the type of plant as pressures increase to place the out-of-sight items. These recommendations will discuss some of those considerations, as well as items to be reviewed when the aerial choice is elected.

11.02 Aerial plant, like buried or underground plant routes, should always be designed in accordance with the Outside Plant Plan. Growth forecasts should be verified before proceeding.

11.03 The following items should be reviewed in the selection of the type of plant:

- (a) Condition of poles and cost of replacement.
- (b) Condition of existing aerial cable and expected life.
- (c) Cost of construction. Field or roadside and aerial versus buried plant.
- (d) Relationship with other street, alley, or rear lot line plant in the vicinity. Will these need replacement soon and where is the lowest cost location? It may be that a new grid of buried plant in the parking strips will be more economical than replacing costly rear lot line pole and cable plant.

(e) What are drop wire change costs?

11.04 When aerial plant is selected, the following items should be reviewed:

(a) Pole line rehabilitation. Specifications should be included for individual pole replacements. New anchors, guys, and supporting strand should be indicated when required. Use of double lashings, pre-lashing, or self-supporting strand cable should be noted as appropriate.

(b) HAZARD considerations. In the proposal of aerial cable extensions and reinforcements, the engineer must be aware of and make notes regarding the grading of telephone cable with respect to power and other foreign wires. This includes conditions in midspan as well as on poles of both joint and 100 percent owned types. When corrective action is required, specifications should include appropriate pole replacements or rearrangements by telephone forces or by other utilities.

(c) Span measurements, including distances to crossovers and facility splices

(d) Distribution points and terminals. The number of drop transfers should be noted.

(e) Load coil locations, including structural requirements.

(f) Control and access point location permanency.

(g) Underground service entrances.

(h) Cable removals and transfers.

(i) Protection. The engineer should specify fuse cable and/or protected terminals, as required. In certain cases, the joint use of high-voltage tie lines requires a knowledge of power company circuit breaker ratings and approval of telephone company protection engineers. Cable plant in the vicinity of power substations requires a similar analysis and often requires specification of neutralizing transformers.

(j) Cable extension arm usage. The engineer should consider the use of these items to eliminate minor angles and to obviate the need for high-cost anchors.

- (k) Gas pressure plugs, contactors, and pipe-and/or pole-mounted dryers.

12. DETAILED NOTES—BLOCK CABLE

12.01 It is necessary in many of the built-up sections in towns and cities to place distribution cables on or in buildings, with distribution terminals so located that service can be furnished without excessive block wire runs. The best preparation for taking field notes for placing block cable is to have a copy of the block cable drawing made up from office records or to procure commercial building maps available in some cities. Also, the engineer should be familiar with the aerial, buried, and/or underground cable surrounding the block in question and should know how the distribution cables can be fed in the block.

12.02 The following are some of the items to be considered during the field review of the work:

- (a) When entrance will be underground, show detail location or riser cable on or in building.
- (b) Note in detail where cable should be attached to buildings, including type of hardware.
 - (1) Where open spaces between buildings are bridged by aerial spans, show details of building attachments. In some cases, an elevation drawing, in addition to the horizontal plan, will clarify the way the work is to be done.
 - (2) Note how to avoid electric wires, clothes-lines, and steam pipes and how to clear doorways, passageways, and fire escapes.
 - (3) To facilitate entry by telephone workmen, show location of access to building that will be fed from this block cable.
 - (4) When a right-of-way condition exists, provide an explanatory note for the craftsman.
- (c) Indicate the location of terminals and the wiring limits. Provide appropriate notes for terminals with long tails.

(d) Detail existing block wire runs and note those locations where plant is to be removed or changed.

(e) Indicate protection exposure and provide specifications for fuse cable and protected terminals.

(f) Furnish gas pressure plugs and other air pressure equipment notations.

(g) Consider future building changes in the design and provide appropriate explanatory notes for telephone forces.

13. DETAILED NOTES—LARGE BUILDING CABLE

13.01 Building cable field notes in large commercial, industrial, and apartment buildings are usually developed from the Building Industry Consultant's (BIC) conduit drawings. The BIC representative will have determined main building cable terminal rooms, key equipment closet locations, riser conduit systems, and floor terminal locations. The engineer should verify measurements and space capacities in the preparation of all specifications.

13.02 Where duct has not been provided, the method of cable attachment should be specified. Hung ceiling construction should be avoided.

13.03 At terminal locations, the engineer should note backboard positions and the detail arrangement of terminal sections and stubbing where required.

13.04 In the larger buildings where main-frame terminations are required, refer to Part 18 for instructions.

13.05 When building cable projects include sections to exterior parts of a complex, such as in large industrial plants, recommendations provided in Part 12 on block cable should be followed where applicable.

13.06 The engineer should refer to sections in the AG54 series for detailed instructions on building cable.

14. DETAILED NOTES—AERIAL WIRE

14.01 Aerial wire additions are presently confined to limited amounts of open line wire in addition to multiple wire. The following checklist describes the items to be reviewed when placing wire:

- (a) Clearance. The construction of open line wire is a particularly **HAZARDOUS operation and all power conditions that may cause accident should be noted. This also applies to wire removal operations.** Clearances should be determined and pole heights, grade arms, and other items should be specified to minimize danger.
- (b) Type of wire. In open-wire construction, span economies and transmission limits are controlling.
- (c) Kind of crossarms and pin notations.
- (d) Transposition types.
- (e) Tree notations. This is important both for open wire and multiple wire.
- (f) Distribution points.
- (g) Protection and drainage devices for higher voltage joint-use rural lines.
- (h) Span lengths.

15. DETAILED NOTES—UNDERGROUND CONDUIT

15.01 Planning underground conduit falls into two general classifications. One is the long trunk or toll underground route involving miles of subway through rural areas. This is a special project involving the use of aerial photographs and/or land surveys and unusual right-of-way conditions. The other and more usual job is building a relatively short section of a new subway in a city, which may be the extension or the reinforcing of an existing conduit run. This section describes the usual conduit construction found in urban situations.

15.02 Ordinarily, conduit extensions are built under specific estimates and the choice of route would be selected and be in accordance with the Outside Plant Plan.

15.03 Preliminary to the actual taking of field notes, the engineer should secure prints of the street from the city, county, or state authorities. These prints will give the best information on location of the water system, storm and sanitary sewer systems, catch basins, and hydrant locations. The type and thickness of pavements can usually be obtained from the same source. The engineer should also be aware of local practices regarding the breaking of pavement, since this may have a direct effect on the timing of certain projects. Underground electric, gas, oil, water, and steam pipe systems should also be located from plans of the companies involved. In some locations reliable information may be lacking, but any information that can be gained by talking with the city engineer and utility engineer is valuable. Whether or not the engineer wants to have preliminary office sketches made of the proposed routes depends upon the information secured and the knowledge of local conditions.

15.04 A key point to check before beginning any underground construction is the permanency of existing roadway grades and alignments. The engineer should design all structures insofar as possible to avoid future disruption of service.

15.05 As the engineer surveys the proposed route in the field, the following are some of the items to be reviewed and included in field notes:

- (a) The location of existing underground systems should be checked by noting the location of:
 - (1) Manholes (all types).
 - (2) Hydrants.
 - (3) Catch basins.
 - (4) Water shutoff valves.
 - (5) Electric power poles fed from underground systems.
 - (6) Outside cellar entrances.
 - (7) Coal pockets, rock formations, and types of soil.
 - (8) Electric transformer vaults.
 - (9) Trees.

- (10) Visible gas and water meters.
 - (11) Traffic or marker lights fed underground.
 - (12) Boulevard lighting systems.
- (b) Manhole locations should all be treated as critical and examined for the following criteria:
- (1) Physical barriers of both the aboveground and subsurface type.
 - (2) Location of subsidiary cables to be fed from the manholes.
 - (3) Buildings to be fed underground.
 - (4) Unsafe locations, considering future maintenance work. Manholes should be located out of the heavily traveled portions of the streets and away from intersections.
- (c) The alignment of the system should be determined and the engineer should show whether conduit is to be run in the street, between the curb and the sidewalk, or under the sidewalk.
- (d) Measurements should be provided as follows:
- (1) Show the distance from fixed landmarks to the location of both the proposed manholes and the conduit run.
 - (2) Provide linear measurement along the proposed route of the subway between manholes.
 - (3) Note footage to obstacles near the proposed work.
 - (4) Note the distance between the curb and the sidewalk, and the width of the sidewalk as appropriate.
 - (5) Show the location of driveways.
- (e) Show in detail subsidiary conduit runs.
- (f) Note the necessity for sump-type drains in manholes.
- (g) Note where duct entrances should be placed in manholes for future needs, both for laterals and extensions of main run.
- (h) Determine the need for a city permit and make necessary notes for its preparation.
- (i) To assist in getting a visual picture of the existing underground systems, particularly in a business section, a visit into the basements of adjacent buildings may be helpful. Depth and location of water, sewer, gas, and electric services should be noted.
- (j) In some instances profiles showing estimated positions of underground obstructions should be prepared. These are also beneficial to show future highway grade changes and are helpful where steep slopes and other unusual grade problems are present.

16. DETAILED NOTES—BURIED CABLE AND BURIED WIRE

16.01 Many of the field problems that prevail for buried cable and wire plant are common with those of underground conduit. As buried plant becomes more and more extensive in city street plant, it will in fact become well integrated with the conduit systems. For this portion of buried plant, the applicable items covered in Part 15 should also be observed for directly buried cables.

16.02 Buried plant additions should all be designed in accordance with the Outside Plant Plan. In addition, each section provided in the old aerial distribution areas should conform with a future out-of-sight plan for the area. This program should reflect long-range plans for use of streets, alleys, or rear lot lines. The age of existing pole and cable plant and cost of replacement in the same location should be weighed against reconstruction of a new buried plant in the parking strip or on a similar location.

16.03 Since buried plant is extensively used in new subdivisions and in the more sparse areas where additional types of field observations must be made, the following are described to augment the list provided for conduit:

- (a) Soil conditions over the total length of the line should be analyzed. If rock situations exist, the engineer should know the percent of

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the project affected before canceling buried proposals from the job. Costs of breaking hard surface streets as well as those with light bituminous coverings should be known factors in all field problems.

(b) The immediate and future disposition of aerial plant should be planned and the following items should be considered:

- (1) The feasibility of lowering existing suitable feeder-type aerial cable in the trench with the proposed or with a subsequent buried cable should be determined.
- (2) Space requirements for future replacement of aerial plant in the same roadway cross section should be analyzed and related to the current proposal.

(c) In some of the larger buried cable runs provision should be made for manholes to accommodate initial and future splicing configurations.

(d) The retention of occasional poles for limited periods along the line of new buried cables may offer economies and the engineer must arrange plant designs to accommodate this feature. Life of existing poles should be considered and current and future replacement costs compared with rearrangements.

(e) The conversion of telephone service wires may have an important bearing on the choice of type of plant, and the engineer should review the problems and methods required to handle this facet of the work.

- (1) The cost of augering or pushing pipes under hard surface thoroughfares should be considered.
- (2) Methods of placing drops in lawns with winch lines and small plows, trenchers, and slot spaces should be compared.
- (3) The placing of drops through rockeries and shrubs or under bulkheads by pushing methods should be contemplated.

(f) The location of buried splices and pedestals for load coils, branch feeds, and flexibility splices including terminals and access and control points must be reviewed to provide security from

vehicular traffic and future road changes. In addition, accessibility for maintenance must be afforded. Aesthetics and permanency of location are most important considerations.

(g) The location of the buried cable trench, plow, or bore line should be referenced to appropriate geographical markings.

- (1) On rural roads and highways, the line should be measured with respect to highway center or property line.
- (2) In subdivisions or other cross-country areas, the line should be located in relation to property line or curb lines.
- (3) The length of cable loops to poles, pedestals, and buried splices must be included to attain proper overall measurements.
- (4) Type of property, such as farmland, timber, residential tracts, etc., should be noted.

(h) The use of joint random lay cable in subdivisions with various utilities is becoming more and more prevalent each year. The depth of a trench suitable to both utilities is usually determined by negotiation with the local power company; however, field conditions may indicate the need for additional depth at specific locations. To maximize joint usage that includes common trenches for service drops, telephone connection points or terminal locations should be coordinated with those of power company secondary pedestals. The engineer should work out a timing schedule with the power company for all joint buried undertakings.

(i) When company-owned CATV cables are installed with regular telephone cables, electronic gear locations will need to be determined and housing items coordinated.

(j) Type of cable sheath should be specified and should be in accordance with recommendations for protected, lightning exposed, and gopher-infested locations.

(k) Gauge of cable should be specified, subject to normal transmission requirements, as outlined in System practices. Buried trenching offers the opportunity for low-cost installation of more than one cable, and the engineer may

wish to place a "through" cable along with a looped-in distribution cable of different gauge (and/or size) in some instances.

(l) Air pressure components should be included which, in most cases, will involve plugs for PIC-pulp junctions at buried-aerial connections.

(m) The engineer should be familiar with the type of construction tools required and the probable cost of each installation. Principal tools are:

- (1) Plow.
- (2) Trencher.
- (3) Backhoe.
- (4) Hand tools.
- (5) Air hammer tools to break concrete.
- (6) Casing installation equipment.
- (7) Pushing devices.

(n) Sections AG56.100 and AG56.101 provide further instruction on the design of buried cable systems.

17. DETAILED NOTES—UNDERGROUND CABLE

17.01 In preparation for taking field notes for proposed underground cable, the engineer will find it desirable to have work prints prepared by an engineering clerk from office records. These prints should, in most cases, be checked in the field. The advance preparation of preliminary plans will aid in ascertaining the scope and details to be covered in the field. A joint field check with the splicing foreman is always desirable, and in some cases, should include the line foreman.

17.02 The following are some of the items to be considered during the field review of the work:

- (a) Check the route of the proposed work as related to the Outside Plant Plan.
- (b) If more than one telephone subway or confusing manhole locations are involved, be sure to identify clearly the subway and the

manholes to be used. Measurements should be verified when necessary.

(c) Check physical condition of manholes for gas, water, etc., and ascertain whether any manhole rehabilitation work is required. This should be done in a joint effort with construction forces. When HAZARDS such as gas leaks are present, make suitable notes to describe arrangements for removal. In those cases where joint manhole occupancy exists with electric cables, make plans for positive identification of such plant by power company representatives who should **BE PRESENT**, as required, during work operations. Joint manhole occupancy only exists in a few locations in the Bell System. Essentially all of these conditions are on private property. When augmenting plant in these locations, every effort should be made to eliminate these improper conditions. ***There shall be no new joint manhole construction under any conditions.***

(d) Check the number of ducts and note present duct usage, particularly those occupied by city and others and not reflected on the records.

(e) Note the duct that should be used for proposed cable and the duct of cables to be removed.

(f) Prepare suitable sketches of manhole cable layout as necessary for work print preparation and for further office studies, to determine the proper engineering job.

(g) If cable loading is involved, notes should clearly indicate where loading is to be located.

(h) Consider conditions involved in lateral cable changes and additions.

- (1) Check lateral pole location, size, and condition.

- (2) Check number of lateral ducts available and include a verification of the number of pipes that are terminated on the pole.

- (3) Verify the desirability of the lateral pole location with respect to vulnerability, etc.

- (4) Determine plan for physically placing relief cable, considering lateral duct conditions.

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- (i) New underground cables should be integrated with any existing air pressurization. Plugs and connections to manifolds should be specified.
- (j) Length determinations for underground cable cutting lengths may be made from existing record measurements where these have been substantiated. Where this is not the case, sections will need to be chained. Provide sufficient lap to reach the far end of the manhole at both ends. Where cable must be looped around manhole, provide additional length.

18. DETAILED NOTES—FRAME TERMINATION

18.01 When central office terminations are necessary, the engineer should visit the office and should prepare field notes in order to reflect complete engineering plans on the prints. It will generally be desirable to review the proposed work jointly in the central office at the location with the splicing foreman. In some cases where frame congestion exists, the central office equipment engineers will have to be consulted to provide the necessary space. A written request should be prepared to confirm necessary additions.

18.02 The following are some of the items to be checked and studied at the central office when planning added main-frame cable terminations:

- (a) Note location of existing duct entrance or aerial entrance into central office. Observe the number of spare ducts and show their relative location on a sketch.
- (b) Draw a detailed elevation of the main frame and show the following if involved in proposed work:
 - (1) Vertical numbers.
 - (2) Existing cable terminations.
 - (3) Cable numbers.
 - (4) Pair numbers for existing cables broken down into complements, as required, where subscriber and trunk pairs are terminated.
 - (5) Consider whether any rearrangements of existing cables or counts are justified, in line with the proper plan for this main frame.

- (6) Check to ascertain whether any tip cables or complements of tip cables, either terminated or unterminated, are spare and can be used for new cable.
- (7) Indicate where spare protectors are located and transfers of units as appropriate.
- (8) Indicate the spare verticals or the spare portions of verticals which are not equipped with protectors.
- (9) Be sure to note whether any added main frame or verticals are required, and if so, where and how many.
- (10) Prepare written request for appropriate protectors.
- (c) Determine and show on sketch, approximate location of proposed tip splice and also plug splices if gas pressure is involved. This should be discussed with splicing foreman.
- (d) Determine the size and length of tip cables required.
- (e) If loading, capacitors, or combination networks are to be placed in the central office, ascertain where they should be located and spliced.
- (f) Show on a sketch the cables to be removed and be sure that cable removals are reflected in all decisions under the foregoing items.
- (g) Where a new office is involved, the engineer should review building plans in the field prior to building construction, to be sure that entrance ducts are properly located with respect to entrance route and proper cable and splice locations inside the building.
- (h) In some ESS offices where frames are designed on the "short jumper" principle, the engineer will have to balance trunk and subscriber complements to minimize long jumpers in restricted wire troughs.
- (i) In the large offices where cable vaults are involved, a detailed survey and study of the layout should be made jointly with the splicing foreman.

- (1) Make sketch of the vault, showing existing cables insofar as they may affect the placing of proposed cable.
- (2) Select duct to be used entering the vault so as to secure proper location for racking new cable in vault.
- (3) Select and indicate ducts to be used for tip cables to terminal room.
- (4) Check to be sure adequate racks are available.

18.03 All of the preceding items applying to terminating cable in central offices must also be considered by the engineer when planning for additional feeder or house distribution cables for larger PBX installations.

19. SPECIAL ENGINEERING PROCEDURES—CATV

19.01 The addition of CATV networks in some sections of distribution plant has given impetus to special engineering techniques. A recommended method to accomplish this work is to take aerial photographs under precise sun and shadow conditions. Results will indicate all pole locations, in addition to homes requiring service. Span measurements are as accurate as with present chaining practices. Reputable firms are available to provide such aerial photo service.

19.02 The photos can be used to develop a basic print to which other specifications may be added.

20. TOLL AND OTHER CROSS-COUNTRY CABLES

20.01 The use of aerial photos to study cross-country routes is recommended when substantial distances are involved. This type of engineering can promote extensive time saving for work that would otherwise require many man-hours.

21. CONTRACT ENGINEERING

21.01 The use of professional surveyors to run lines, to triangulate distances across water, and to do other similar tasks is highly recommended because of the special nature of the work. These individuals possess land survey data and can certify many line locations requiring right-of-way, that telephone engineers cannot economically provide. Most company engineers become involved in facility design and become rusty in the surveying skills which can be done much better by experienced people practicing in the field.

21.02 Regular field layout work can also be done by reputable firms for very inexpensive fees. District engineering managers should consider this type of activity when large rural and other similar projects require extensive manpower commitments. The use of these firms is not recommended for normal facility work.