APPLICATION OF RESISTANCE DESIGN

1. GENERAL

1.01 This section describes the method by which the principles of Resistance Design are applied to the practical problem of designing customer loops. It is reissued to clarify and update Resistance Design methods.

1.02 Resistance Design is predicated upon controlling transmission losses by limiting the maximum conductor loop resistance. This is accomplished by observing the following Resistance Design Rules:

(1) Maximum conductor loop resistance of 1300 ohms (central office range permitting).

(2) Load all loops over 18 kf.

(3) Limit bridged tap on nonloaded loops to 6 kf or less.

(4) Limit end section plus bridged tap on loaded loops to 15 kf or less.

(5) Use only 500 sets beyond 10 kf.

(6) Design load spacing deviations normally within ±120 ft.

(7) No bridged tap between load points.

(8) No loaded bridged taps.

1.03 Consistent application of all the above design rules will result in a distribution of loop losses that will result in satisfactory transmission to all customers.

2. DEFINITION OF TERMS

2.01 ***Resistance Design Limit*** — The maximum design value of outside plant conductor loop resistance to which the "Resistance Design" method is applicable. This value is set at 1300 ohms to control transmission losses.

2.02 ***Resistance Design Boundary/Long Loop Boundary*** — Both terms are synonymous with the boundary established as the furthest extension for applying the "Resistance Design" method.

2.03 ***Resistance Design Area*** — That area enclosed within the Resistance Design Boundary.

2.04 ***Long Loop Area*** — That area between the Resistance Design Boundary and the exchange service area boundary.

2.05 ***Office Supervision Limit*** — That conductor loop resistance beyond which the operation of the central office relays or ferrods is uncertain.

2.06 ***Office Design Limit*** — The maximum resistance value to which the loop should be designed for a particular office. This will be the supervision limit for those offices with supervisory limits less than 1300 ohms. For offices with supervisory limits exceeding 1300 ohms, the Resistance Design Limit of 1300 ohms is controlling.

2.07 ***Design Loop*** — The customer cable loop under study to which the Office Design Limit or Resistance Design Limit is applied in determining the proper gauge cable to use. It is normally the longest expected during the period of fill of the cable involved.

2.08 ***Theoretical Design*** — The cable make-up by gauge necessary in the Design Loop to just meet the Office Design Limit. It does not take into consideration any practical or economic considerations.

3. DETERMINATION OF RESISTANCE DESIGN BOUNDARY

3.01 A major decision that is to be made in the application of the Resistance Design method is that of establishing the Resistance Design Boundary. In other words, the point at which Resistance Design should stop and Long Loop Design begin. Basically, the Resistance Design concept should be applied to the bulk of the loops in the urban areas where the density and

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growth potential are moderate to heavy. The Long Loop Design concept places emphasis on the treatment of individual loops and, as such, is only intended for application to that small percentage of lines in sparsely settled areas where the design must be specialized to fit local conditions. The Long Loop Design procedures are outlined in Section AB22.082/AG15.120.

3.02 From the preceding definition of the Resistance Design Boundary, it should be clear that this boundary is not fixed or static. The boundary should be changed to accommodate the changing conditions surrounding the distribution of the customers and our own plant. The Resistance Design Boundary should be reevaluated using the guide lines listed for each outside plant project.

3.03 Figure 1 illustrates how offices with different supervisory ranges are affected differently by the 1300-ohm Resistance Design Limit. Office "A" represents those offices with supervisory limits less than 1300 ohms. With these offices it is generally more economical to select a cable gauge so that the densely settled areas are within the Office Design Limit. The present high cost of long line equipment will not ordinarily prove economical to extend the supervisory ranges to 1300 ohms. In some situations it will be advisable to study the economies of coarser gauge cable versus long line equipment and finer gauge cable. All loops over 1300 ohms require additional transmission considerations as well as long line circuits for range extension as discussed in Section AB22.082/AG15.120.

3.04 Office "B" does not present a problem because the Office Supervision Limit is the same as the Resistance Design Limit.

3.05 Office "C" represents the situation where the Office Supervision Limit is greater than the Resistance Design Limit. In such situations there is a tendency to stretch the Resistance Design Limit so that finer gauge cable may be used. Such design would result in substandard transmission and it is the engineer's responsibility to assure that this does not occur.

3.06 The provision of dial long line equipment is dependent solely upon the supervision requirements of each office and not related to Resistance Design. Offices with supervision limits exceeding 1300 ohms may have some loops in the Long Loop Area (over 1300 ohms) that do not require dial long line circuits, but transmission for such loops will require study and treatment as detailed in Section AB22.082/AG15.120.

4. DETERMINATION OF DESIGN LOOP

4.01 The length of the Design Loop is determined by the engineer based on his knowledge of the local service requirement and with the aid of the commercial forecast and other relevant data. It is normally the longest loop within the Resistance Design Area to be served by the cable being studied. In those cases, where cable is being proposed that will take care of future growth involving longer loops than those presently working in the cable, the Design Loop will be the longest loop anticipated to serve the new area during the period of fill of the cable. In these cases, the Design Loop may be referred to as the ultimate loop. Some cables may contain facilities that will be extended outside the Resistance Design Area. They should not control the gauging of the cable but should be studied on the basis of Long Loop Design.

4.02 Where the ultimate loop is longer than either the present or proposed loop, the Theoretical Design and gauge selection is based on this ultimate loop. However, the actual present and proposed make-up should be shown on the Resistance Design Work Sheet. The ultimate length may be shown by a dotted line in the proposed design space. (See Example 2, Par. 10.04.)

4.03 In some cases there may be more than one design loop for a particular cable. When a major branching occurs before the gauge change point, each branch may have a different gauge requirement. Therefore, each branch should have a design loop and each should be shown on a separate design work sheet.

5. GAUGE SELECTION

5.01 In order to determine what gauge cable or combination of gauges are required for any loop, the Theoretical Design should first be determined. This can be done easily with the use of form E5199 (Fig. 3). Having determined

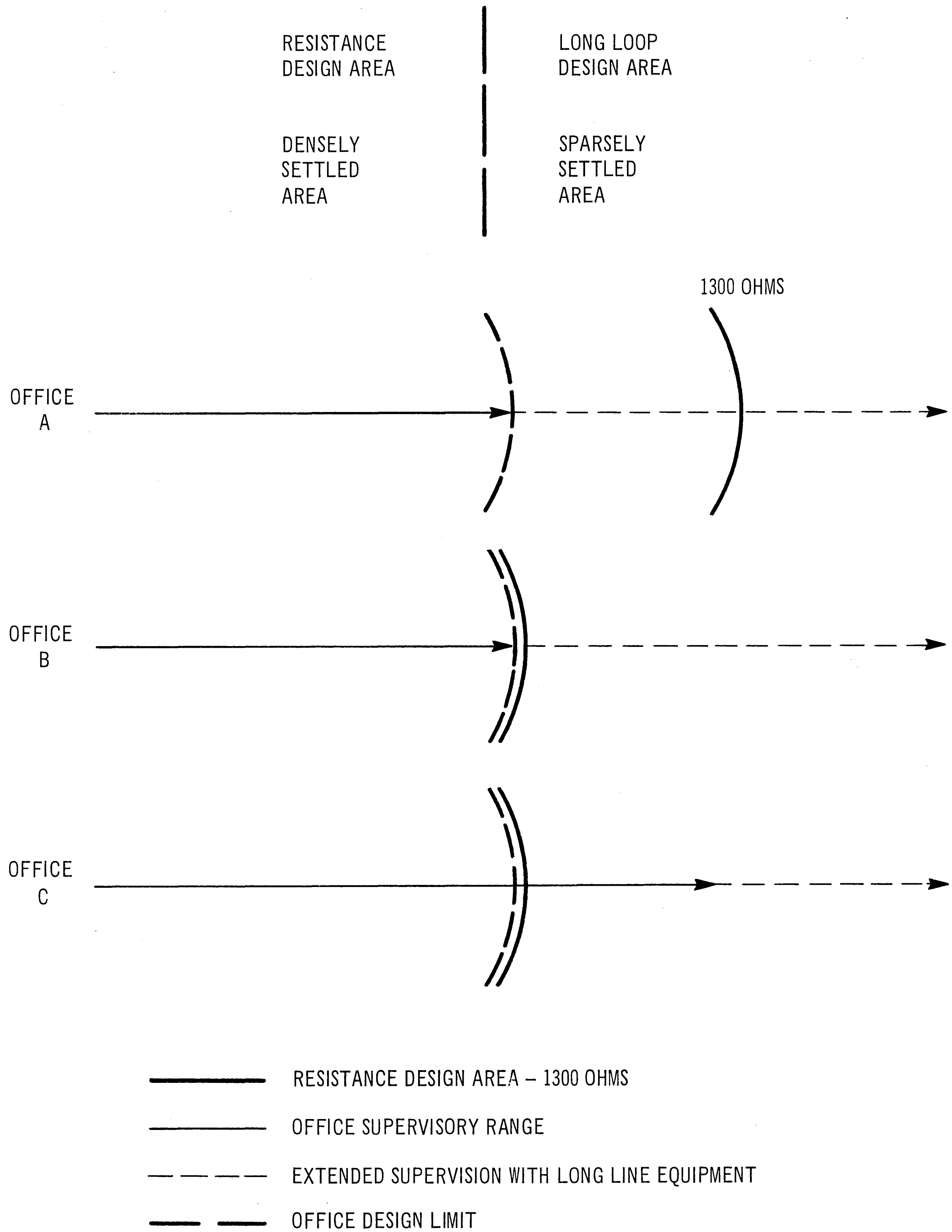

RESISTANCE DESIGN AREA
LONG LOOP DESIGN AREA
DENSELY SETTLED AREA
SPARSELY SETTLED AREA
1300 OHMS
OFFICE A
OFFICE B
OFFICE C
RESISTANCE DESIGN AREA – 1300 OHMS
OFFICE SUPERVISORY RANGE
EXTENDED SUPERVISION WITH LONG LINE EQUIPMENT
OFFICE DESIGN LIMIT

Fig. 1

the length of the design loop and knowing the Office Design Limit, it is a simple matter of plotting to find the Theoretical Design. See the following case (A) for the step-by-step procedure.

Case A: Length of Design Loop is 20 kf and Office Design Limit is 1300 ohms. Find the Theoretical Design for this cable. On form E5199 (Fig. 2) find the intersection of the 20 kf line and the 1273-ohm (1300 ohms minus the allowance for load coils) line. This point is designated as point "A". Notice that is falls between the 26-gauge and the 24-gauge line. This immediately indicates that the Theoretical Design will consist of 24- and 26-gauge cable. Draw a line parallel to the line representing the coarser of the two gauges (in this case the

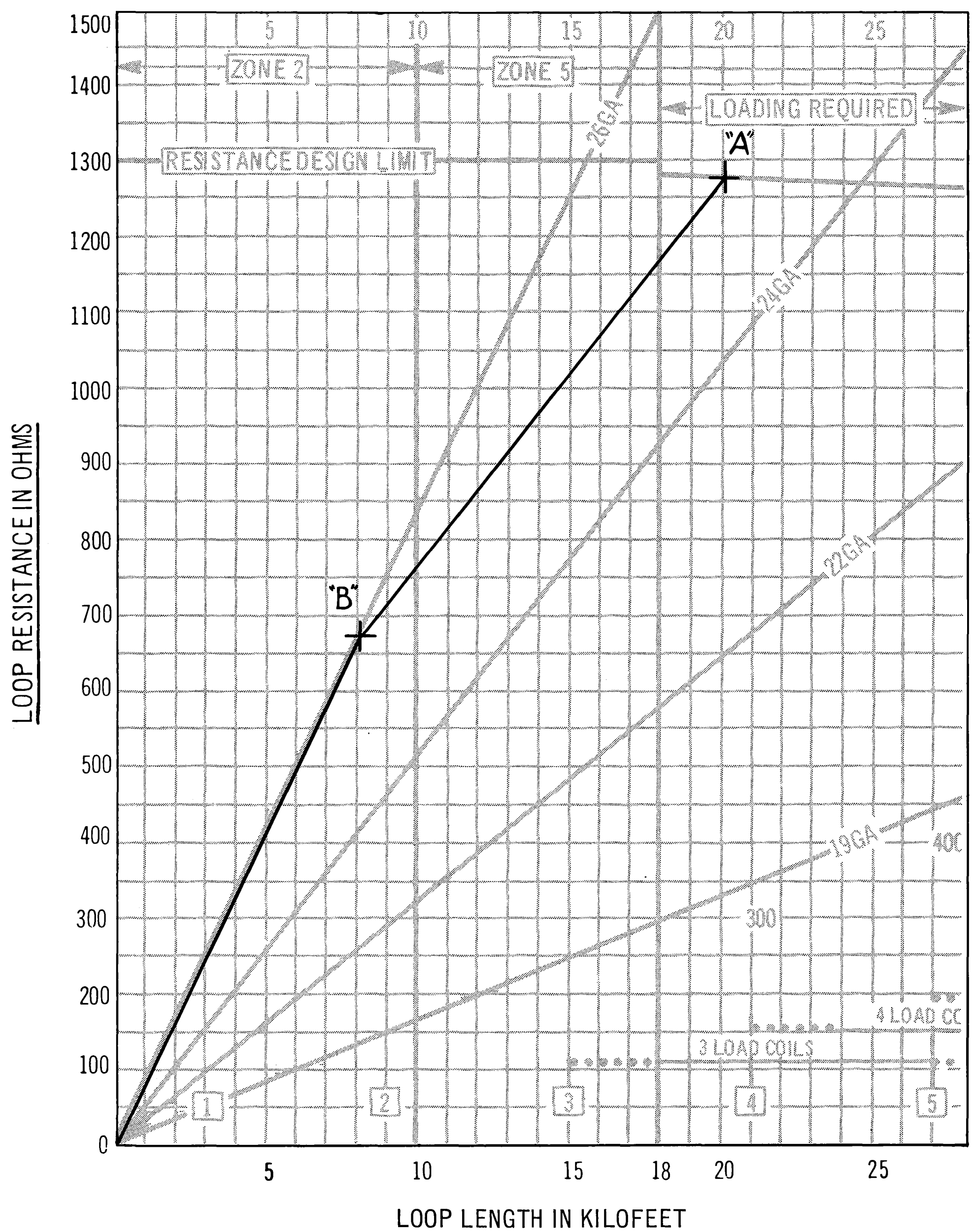


Fig. 2

24-gauge cable line) passing through point "A" to where it intersects the finer gauge line (in this case the 26-gauge line). This point of intersection is designated point "B" and the horizontal interval to the left of point "B" indicates the amount (8 kf) of the finer of the two gauges, or 26 gauge in this case, permissible in this loop. Therefore, the Theoretical Design for this 20 kf loop consists of 8 kf of the 26-gauge and 12 kf of the 24-gauge cable.

5.02 When more than one gauge is required in the Theoretical Design, the most economical design will result from the use of the two finest consecutive gauges, i.e., 26 and 24 or 24 and 22. It is advantageous to place the finer gauge cable closest to the office where a higher concentration of pairs is required.

5.03 Once the Theoretical Design is determined, actual plant conditions must be weighed to establish the point at which the actual change in gauge will be made. The following cases illustrate these conditions.

Case B: Consider the case where the theoretical gauge change point falls in the middle of a conduit section. The actual gauge change point is moved back to the first suitable manhole toward the CO, or to a branch or change in feeder cable size.

Case C: The theoretical gauge change point is just beyond a major branching or a tapering of the main feeder cable. If it is within two or three sections, consideration should be given to making the gauge change point correspond with the branch or taper point.

The gauge change point should not be moved farther from the central office than it is on the Theoretical Design.

5.04 In some cases where duct space is at a premium as under rivers, streams, railroads, and highways it may be advisable to undergauge a cable in order to get more pairs per duct. Where a cable is undergauged for this purpose, it is necessary that coarser gauge cable be provided in another part of the loop to compensate for the increased resistance caused by the undergauging.

6. BRIDGED TAP

6.01 Bridged tap is that portion of any cable pair that is not in the direct path between the telephone and the central office. It can be described electrically as any branch or extension of the cable pair in which no direct current will flow when a telephone connected to that pair is in use.

6.02 In considering the amount of bridged tap on any pair, it is found that its length will depend on the terminal from which it is computed. Thus, in limiting the bridged tap to a maximum of 6000 feet for all telephones, it must be computed for the worst condition. This is normally the closest terminal to the central office as measured via the actual cable route. Therefore, for each work order the closest terminal in each pair count must be checked and the bridged tap limited to 6000 feet. There must be no bridged tap between load coils nor any loaded bridged tap. Bridged tap is inefficient use of copper. While some bridged tap may be necessary, it is in the interest of both efficiency and transmission to reduce it to a minimum. PIC cable and ready-access terminals reduce the necessity for multiple appearances.

6.03 Bridge lifters have been developed to eliminate the effect of bridged tap and at the same time maintain the flexibility associated with the multipling of a pair. However, the use of these devices, is limited by economic and some physical characteristics. Where the use of these devices can be justified on an economic basis and all existing lines will work properly with bridge lifters, special administrative procedures must be set up to avoid any future problems due to their use in the outside plant. For more information on the use and the limitation of bridge lifters, see Section AB22.095/AG15.150 and associated subsections.

7. LOADING AND LOADING SYSTEMS

7.01 All customer loops longer than 18 kf should be loaded. The maximum number of load coils consistent with the "H" spacing of every 6000 feet should be placed on a loop in order to conform to the desired transmission distribution.

7.02 All loading should be H88; however, it is not necessary to change existing H44 loading (44 millihenry coils spaced at nominal 6000 foot intervals) in primarily residential areas. All load coils on a pair must be of the same weight, i.e., all 88 millihenry or all 44 millihenry.

7.03 The spacing of load coils should be held as close as practicable to the 6000 foot interval. The objective in customer loop plant should be to place the load coils to within ±120 feet of the theoretical 6000 feet. Some economic or practical considerations may occasionally justify deviations up to ±500 feet but each case should be weighed against its transmission shortcomings. Deviations in existing plant of up to ±500 feet are acceptable.

7.04 Although spacing deviations up to ±500 feet are not ordinarily detrimental to subscriber loop transmission, the increasing probability of subscriber loops being used for data, special services, and conversion to exchange trunks makes it even more important that the loading be placed as accurately as practicable. It should be recognized that any liberties that are taken with the loading for economic or other reasons may require correction at a later date if a more critical service is placed upon the lines in question. Loading deviations over 120 feet should be taken on the short side so that they may be corrected at a later date, if necessary, by electrically building out.

7.05 The central office end section for each office should be determined locally with due consideration given to the amount of office wiring involved. The recommended end section length should be listed in an appendix to this section. This first coil should be placed as close as is physically and economically possible to the recommended location, as this coil is the most critical as far as spacing is concerned.

7.06 The recommended customer end section including bridged tap is 3 to 12 kf. The length of the customer end section plus bridged tap may be computed from any terminal in a pair count as it will be the same for any terminal. To care for those cases where extensive multipling becomes necessary, an end section plus bridged tap limit of 15 kf is acceptable.

8. SELECTION OF STATION SETS AND ZONING

8.01 The proper selection of station sets is a vital part of Resistance Design. Transmission zones should be established to indicate where 500-type sets are required.

8.02 The area from the central office out to a cable length of 10 kf is designated as Transmission Zone 2. The 500-type sets may be used in this zone but are not required. The area beyond 10 kf is designated as Transmission Zone 5 and 500-type sets are required. For further information on zoning, see Section AB22.076/AG15.220.

9. MISCELLANEOUS

9.01 Multiple Line Wire (MLW) is intended for use in those areas where growth is quite slow and limited. However, transmission characteristics of nonstabilized types vary appreciably with changes in the weather, so there are special rules that must be adhered to in Resistance Design Areas. For Resistance Design, 24- and 22-gauge MLW (urban wire) must be considered as equivalent to 26 and 24 gauges, respectively. The 19-gauge MLW (rural wire) can be considered the same as 19-gauge cable in Resistance Design, but the amount of the nonstabilized type used in the Resistance Design Area should be limited to 10 kf. For loops containing more than 10 kf of 19-gauge MLW outside the Resistance Design Area, long loop design should be used. Loading of MLW used in Resistance Design is the same as for cable. For further information on the use of MLW, see Section AG34.100.

9.02 Multiple Line Wire of the type that has been stabilized for wet and dry operation has the same characteristics as its equivalent gauge cable. Resistance Design methods can be used for it in the same manner as they are used for cable.

9.03 "C" Rural Wire is intended for use in areas where one or two pairs are sufficient to care for the area for an economic period. It has attenuation characteristics comparable to that of 19-gauge MLW. Therefore, all the design rules that apply to 19-gauge MLW also apply to "C" Rural Wire.

When placing more than one wire in a span, the wires should be separated by at least 3 inches. This is due to the poor crosstalk characteristics of this nontwisted wire. For further information about the use of "C" Rural Wire, refer to Section AG34.200.

9.04 Open wire within the Resistance Design Area will eventually be replaced with cable and should be considered as such when gauging relief cable.

9.05 The use of a concentrator in the customer's loop plant does not alter the basic Resistance Design rules. However, different type units will have various signaling and control limits from the CO to the remote unit and from the remote unit to the customers. Therefore, when a concentrator is being contemplated, the BSPs concerned with that particular type concentrator should be referred to for specific signaling, control and supervisory requirements.

9.06 Nonstaggered twist (NST) cable does not satisfy present day crosstalk requirements for ordinary telephone service or balance and noise requirements for special service lines. It may, in general, be identified by the fact that it is either 22- or 24-gauge cable manufactured prior to 1921 or low capacity 19-gauge cable manufactured prior to 1910. NST cable should be identified and removed whenever an opportunity is presented. Where it will remain in plant for some time use it only on nonloaded loops, because the crosstalk is worse when the NST is loaded.

9.07 Facilities to a customer's location are occasionally provided over different routes. Where such conditions exist, the facilities over the two routes should be of similar losses so that transmission contrasts will not occur.

10. USE OF FORM E5199

10.01 The Resistance Design Work Sheet (form E5199) was developed to aid in the transmission design of customer loops. It can also be used for studies of customer loop where transmission is a consideration.

10.02 With each work order submitted for approval, a Resistance Design Work Sheet should be included for each separate branch feeder path involved. The only exception is when the cable loops involved can be served on all 26-gauge cable. In this case, a note on the engineer's drawing or key map to the effect that all loops are within the 26-gauge area and that the maximum amount of bridged tap is within 6000 feet will suffice.

10.03 The procedures for using form E5199 are outlined as follows:

(1) Determine the Office Design Limit for the office (see local appendix on office resistance ranges).

(2) Determine the Design Loop or Loops and their lengths.

(3) Find the Theoretical Design as described in Par. 5.01 of this section and draw it out in the space provided at the top of form E5199.

(4) Draw out the make-up of the existing cable in the space provided on form E5199.

(5) Determine the actual gauge required in that portion of the cable being placed or activated on this job (see Par. 5.03) and show the proposed layout in the space provided. Show any new cable being placed in heavy lines.

(6) Determine the loading requirement and show the points at which the loading is being placed on the proposed layout.

(7) Check the proposed distribution to see that no potential terminal location will create more than 6000 feet of bridged tap. Note which loop on the job has the greatest amount of bridged tap and indicate the amount in the space provided on form E5199.

10.04 Following are a few examples to illustrate the use of form E5199. Details as to the choice of the size of the cable and other outside plant considerations are not covered here but will be found in the appropriate sections.

Example 1 (See Fig. 4)

In a metropolitan office, relief is needed in a cable from the CO out to a point 11,000 feet from the CO. From the CO to a point 3000 feet out there are adequate spares in an existing 26-gauge cable, if 26 gauge will be adequate for this portion of the loop. The office has an Office Design Limit of 1300 ohms having recently been converted from an office with a more restrictive signaling limit. In this example, the same routing will be used for existing and proposed plant and 22,000 feet will be used as the longest loop.

(1) The Resistance Design Limit is 1300 ohms minus 27 ohms for load coils or 1273 ohms.

(2) The Design Loop will be the longest loop served by this cable which is 22,000 feet.

(3) To determine the Theoretical Design, start from the point at which the 22 kf line intersects the Resistance Design Limit (approximately 1273 ohms at 22 kf because of the allowance for load coils) and draw a line parallel to the 24-gauge line intersecting the 26-gauge line. (Line "A" — "B".) The Theoretical Design for this loop is then 4 kf of 26 gauge and 18 kf of 24 gauge.

(4) Now draw the existing cable layout which is as shown on form E5199 in Figure 4.

(5) From the Theoretical Design, it can be seen that 26-gauge is adequate out to 4 kf so the 26-gauge cable that is available to the 3.0 kf point can be used for this job. It is assumed in this instance that the 3.0 kf point is a major branching point. Therefore, the 3.0 kf point is selected as the actual gauge change point. If however, 3.0 kf is not a logical cable change point, the 26-gauge cable should be extended as far toward 4 kf as practicable. This job will then consist of placing 8 kf of 24-gauge cable between the 3.0 kf point and the 11.0 kf point. This is shown by the heavy line in the proposed Plant space on form E5199 (Fig. 4).

(6) Since the Design Loop is greater than 18 kf, loading will be necessary. The number of pairs requiring loading will depend on the number of pairs having appearances beyond 18 kf. In this example, the existing loading is within the load spacing requirement so that the same locations may be used for placing the new load coils. The existing loading as well as the new loading is 88 millihenry coils and the loading points should be shown on both the "Present Plant" and the "Proposed Plant" layouts.

The end section plus a bridged tap will be the same at all terminals in which a given pair count appears, so it may be computed from any terminal. In this example, ***assume*** that the pair count that includes the Design Loop has the greatest end section plus bridged tap and assume that the Design Loop has 4.6 kf of bridged tap. Therefore, the end section (7320 feet) plus bridged tap (4600 feet) equals 11,920 feet. This figure is noted in the appropriate spot on the design work sheet.

(7) The distribution of all nonloaded pairs must be checked for bridged tap. The actual or potential terminal location which is closest to the central office in each pair count should be checked to make sure the bridged tap as computed from this point is less than 6000 feet. When this is computed the appropriate box on the work sheet should be checked and the longest bridged tap should be noted. All bridged tap should also be checked to make sure that there is no bridged tap that includes any load coils or any bridged tap between load coils.

Example 2 (Fig. 5)

A new subdivision is being built and the cables now feeding this area need relief. The office is a CDO with an Office Design Limit of 1000 ohms. The longest present loop in the area to be served by this cable is 23 kf, however, it is anticipated that within a year or two the service area of this cable will be extended out to include loops of 25.5 kf in length. Also assume that the new cable will go into conduit for the first 5.0 kf with the remainder being buried construction.

(1) The Office Design Limit for this office is 1000 ohms.

(2) The Design Loop in this case is the longest loop ultimately to be served by this cable. Even though these customers will not be served by the cable now, they will be during the life of the cable and it must be designed accordingly.

(3) Find the point of intersection of the 25.5 kf line and the 964-ohm (1000 ohms minus 36 ohms for 4 load coils) line. From this point ("A") draw a line parallel to the 22-gauge line to where it intersects ("B") the 24-gauge line. This, then, depicts the Theoretical De-

sign of 7.4 kf of 24-gauge and 18.1 kf of 22-gauge cable. The Theoretical Design is transcribed into the space provided at the top of the work sheet.

(4) The existing loop is drawn out in the space provided, indicating the present loading as well as the gauge make-up. Even when the existing cable is being abandoned (we will not go into the possible re-use in place of this cable or whether it is removed in this section), it should be shown for comparison with the new for possible contrast problems.

(5) In this example, it is assumed that the cable is buried beyond 5.0 kf so that the gauge change point is not dependent on manhole locations. It is further assumed that the cutting lengths of the cable work out so that the actual gauge required for this job is 24-gauge from the CO out to 7.4 kf and 22-gauge, beyond that point. Note that if the cable was designed just to the 23.0 kf (line C-D) rather than to the ultimate length it would require 5.2 kf (difference between D and B) less 22-gauge cable. However, it would be impossible to extend this cable in the future without paralleling or replacing some part of it.

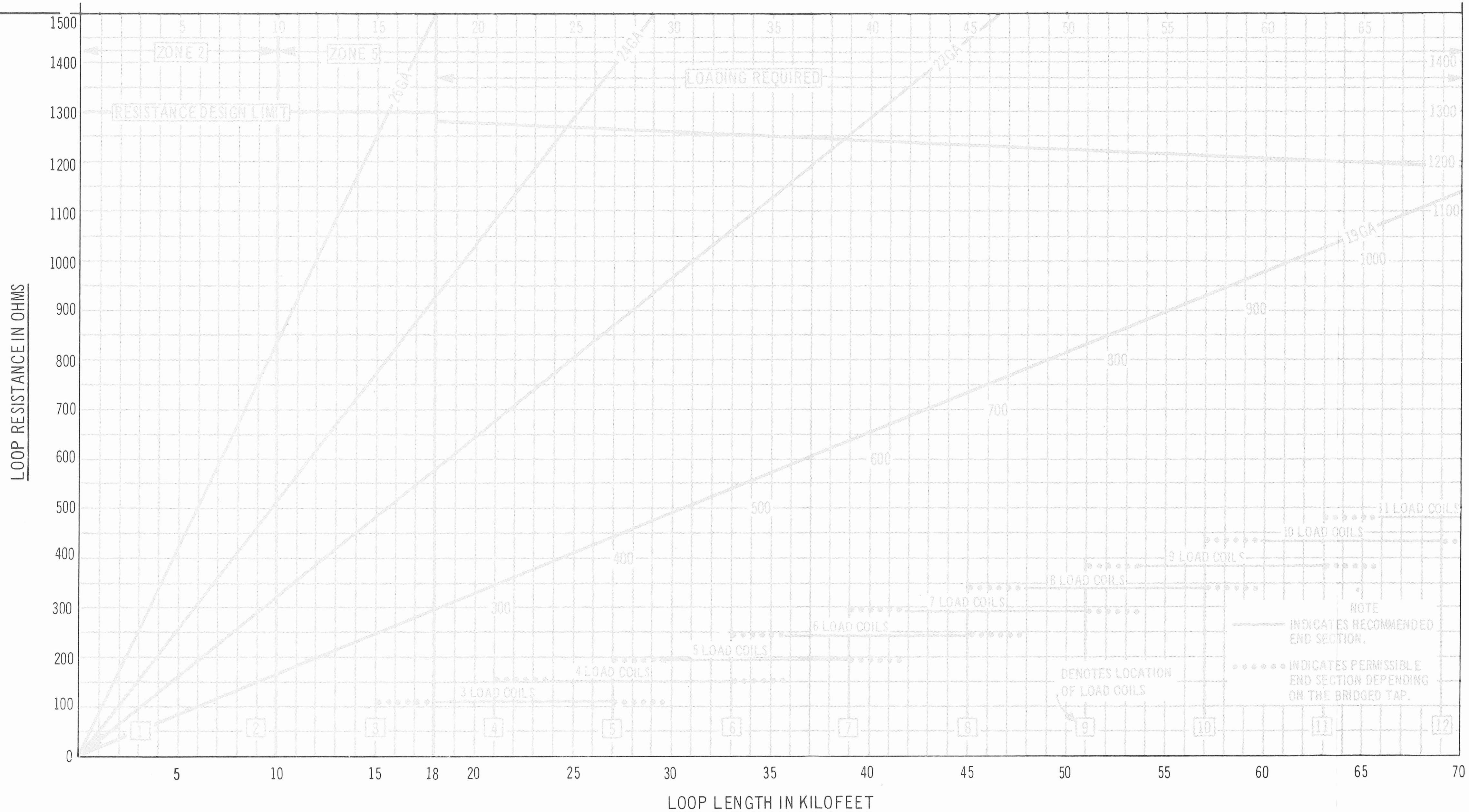
(6) All loops on this job are beyond 18 kf so all loops will be loaded. The first point of loading will be placed in the same manhole that the existing loading is in, as this is within tolerance for underground loading. The second and third points will be at 6000 foot intervals. The existing load spacing can not be used as it is beyond the requirement. All customer end sections fall within 3 to 12 kf so 3 load points are adequate. When the cable is extended to 25.5 kf the fourth load coil will be placed on these long loops.

(7) Since there is no distribution before 18 kf only a check for bridged tap between load coils or loaded bridged tap needs to be made.

E5199 (5-65)

RESISTANCE DESIGN WORK SHEET

THEORETICAL DESIGN	
PRESENT & PROPOSED PLANT	



EXCHANGE: ____________
CENTRAL OFFICE: ____________
WORK ORDER # ____________
C.O. EQUIPMENT: ____________

OFFICE
DESIGN LIMIT: (OUTSIDE PLANT) ________

PROPOSED RES. ____________

L.L. EQUIP. REQUIRED
ON LINES BEYOND: ________ FT.
OF L.L. CIR. NEEDED: ________

BRIDGED TAP

B.T. WITHIN 6000 FT. ☐ YES ☐ NO

LONGEST B.T.
ON THIS JOB: ________ FT.

LONGEST B.T. ON THIS
JOB (Non-Loaded Loops) ________ FT.

ENGINEER: ________ DATE ________

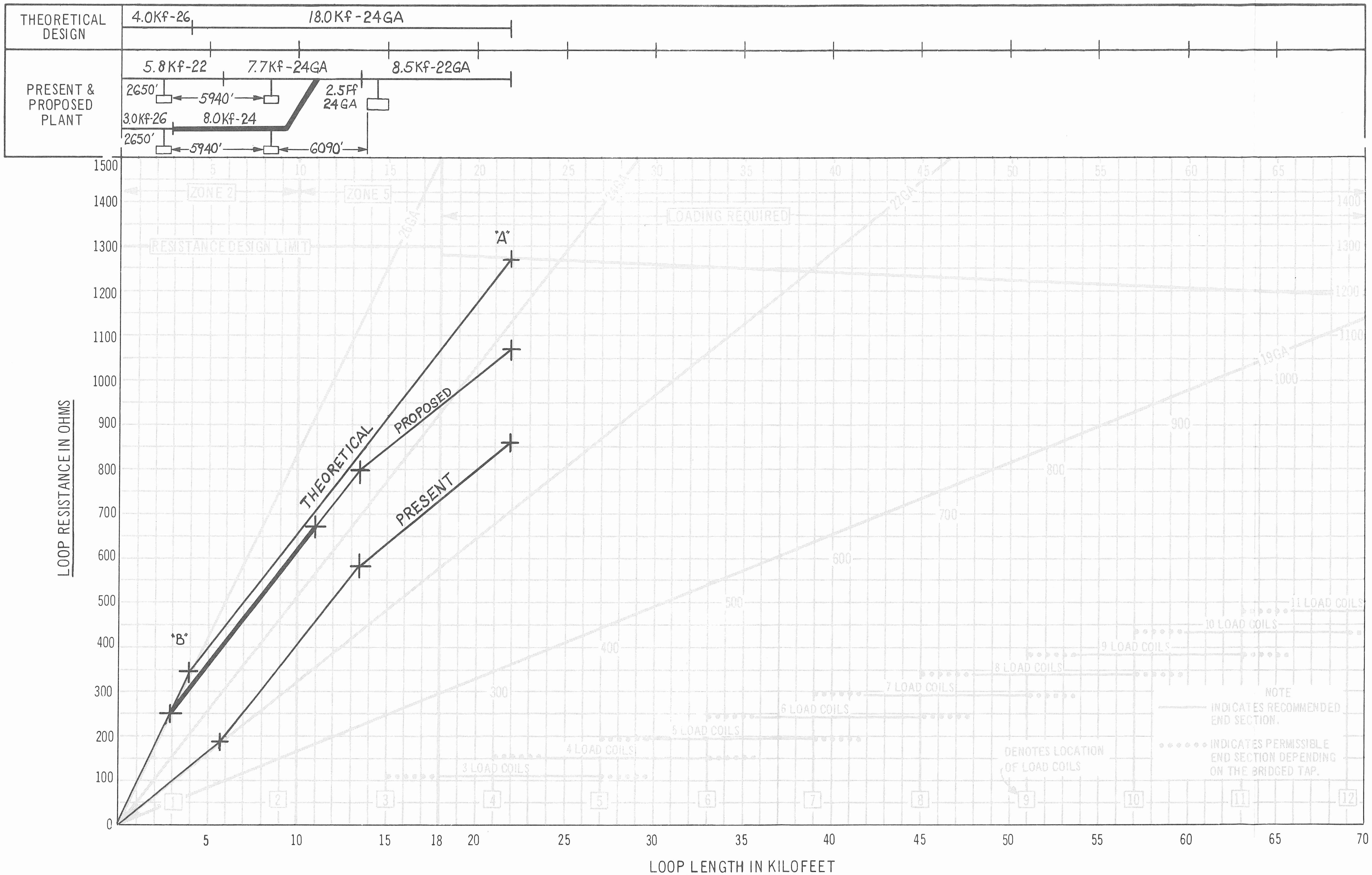
RULES FOR RESISTANCE DESIGN

1. RESISTANCE DESIGN LIMIT IS 1300 OHMS (C.O. EQUIP. PERMITTING)
2. LOAD ALL LOOPS OVER 18,000 FEET
3. CUSTOMER END SECTION PLUS BRIDGED TAP:
   MINIMUM – 3,000 FT.
   MAXIMUM – 15,000 FT.
   OPTIMUM – 3-12,000 FT.
4. LIMIT BRIDGED TAP TO 6,000 FT. FOR ANY STATION ON NON-LOADED LOOPS.
5. USE ONLY 500 TYPE SETS BEYOND 10KF
6. LOAD SPACING DEVIATIONS WITHIN ±120 FT. FOR EXCEPTIONS SEE BSP AB 22.075.1/AG15.100
7. LIMIT MULTIPLE LINE WIRE TO LESS THAN 10,000 FT. FOR RESISTANCE DESIGN
8. NO BRIDGE TAPS BETWEEN LOAD COILS.
9. NO LOADED BRIDGED TAPS.

Fig. 3

E5199 (5-65)

RESISTANCE DESIGN WORK SHEET



EXCHANGE: ALPHA

CENTRAL OFFICE: MAIN

WORK ORDER #: PROJ 805376

C.O. EQUIPMENT: #5X-BAR

OFFICE DESIGN LIMIT: (OUTSIDE PLANT) 1300Ω

PROPOSED RES. 1060Ω

L.L. EQUIP. REQUIRED ON LINES BEYOND: NOT APPLICABLE FT.

OF L.L. CIR. NEEDED: NOT APPLICABLE

BRIDGED TAP

B.T. WITHIN 6000 FT. ☒ YES ☐ NO

LONGEST B.T. ON THIS JOB (Non-Loaded Loops) 4360 FT.

LONGEST B.T. + E.S. ON THIS JOB: 11,920 FT.

ENGINEER: J.J.J. JR. DATE 3/27/64

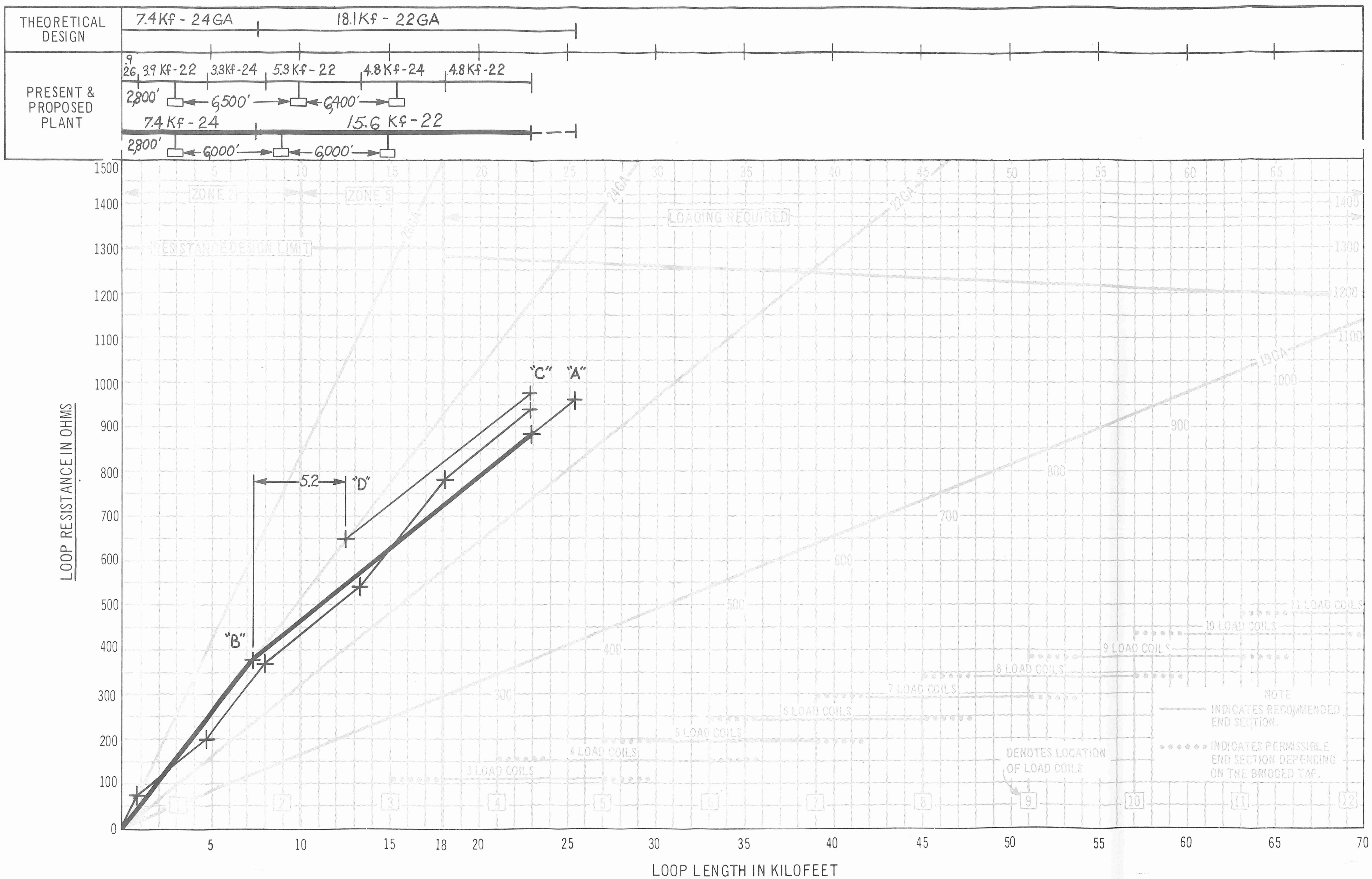
RULES FOR RESISTANCE DESIGN

1. RESISTANCE DESIGN LIMIT IS 1300 OHMS (C.O. EQUIP. PERMITTING)
2. LOAD ALL LOOPS OVER 18,000 FEET
3. CUSTOMER END SECTION PLUS BRIDGED TAP:
   MINIMUM – 3,000 FT.
   MAXIMUM – 15,000 FT.
   OPTIMUM – 3-12,000 FT.
4. LIMIT BRIDGED TAP TO 6,000 FT. FOR ANY STATION ON NON-LOADED LOOPS.
5. USE ONLY 500 TYPE SETS BEYOND 10 KF
6. LOAD SPACING DEVIATIONS WITHIN ±120 FT. FOR EXCEPTIONS SEE BSP AB 22.075.1/AG15.100
7. LIMIT MULTIPLE LINE WIRE TO LESS THAN 10,000 FT. FOR RESISTANCE DESIGN
8. NO BRIDGE TAPS BETWEEN LOAD COILS.
9. NO LOADED BRIDGED TAPS.

Fig. 4

E-5199 (5-65)

RESISTANCE DESIGN WORK SHEET



EXCHANGE: EAST BAY
CENTRAL OFFICE: CENTRAL
WORK ORDER # PROJ. 8000001
C.O. EQUIPMENT: SXS

OFFICE DESIGN LIMIT: (OUTSIDE PLANT) 1000 Ω

PROPOSED RES. 880 Ω

L.L. EQUIP. REQUIRED ON LINES BEYOND: NOT APPLICABLE FT.
OF L.L. CIR. NEEDED: NOT APPLICABLE

BRIDGED TAP

B.T. WITHIN 6000 FT. ☐ YES ☐ NO

LONGEST B.T. ON THIS JOB (Non-Loaded Loops) NOT APPLICABLE FT.

LONGEST B.T. + E.S. ON THIS JOB: 10,550 FT.

ENGINEER: R.L.M. DATE 3/27/64

RULES FOR RESISTANCE DESIGN

1. RESISTANCE DESIGN LIMIT IS 1300 OHMS (C.O. EQUIP. PERMITTING)
2. LOAD ALL LOOPS OVER 18,000 FEET
3. CUSTOMER END SECTION PLUS BRIDGED TAP:
   MINIMUM – 3,000 FT.
   MAXIMUM – 15,000 FT.
   OPTIMUM – 3-12,000 FT.
4. LIMIT BRIDGED TAP TO 6,000 FT. FOR ANY STATION ON NON-LOADED LOOPS.
5. USE ONLY 500 TYPE SETS BEYOND 10 KF
6. LOAD SPACING DEVIATIONS WITHIN ±120 FT. FOR EXCEPTIONS SEE BSP AB 22.075.1/AG15.100
7. LIMIT MULTIPLE LINE WIRE TO LESS THAN 10,000 FT. FOR RESISTANCE DESIGN
8. NO BRIDGE TAPS BETWEEN LOAD COILS.
9. NO LOADED BRIDGED TAPS.

Fig. 5