CUSTOMER LOOP PLANT DESIGN

1. GENERAL

1.01 This section is revised and reissued to clarify and update the rules for "Resistance Design." It deals with the general principles and objectives for Resistance Design which are to be used in the design of normal customer loops. Design procedures to care for the transmission requirements of special service lines, PBX trunks, and CENTREX loops are in the AB22.300 series.* Long loops in sparsely settled areas are to be designed in accordance with AB22.082/AG15.120.

1.02 Resistance Design is a simplified method for designing customer loops based upon establishing a resistance limit and applying a few simple rules for controlling the transmission loss. Consistent application of the "Resistance Design" method will yield a distribution of loop losses that will result in satisfactory transmission for all customers.

1.03 The design requirements for special service lines are covered in practices dealing with each particular service. Normally, outside plant installed in accordance with the Resistance Design rules is adequate for most special services.

2. DEFINITIONS

2.01 The following definitions apply to terms as used in this practice:

Resistance Design Limit — The maximum 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.

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

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

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

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

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.

3. RESISTANCE AND GAUGE SELECTION

3.01 The maximum resistance to which loops should be designed using the Resistance Design method is 1300 ohms and is known as the Resistance Design Limit. In offices with supervisory limits less than the 1300 ohm Resistance Design Limit, the Office Supervision Limit becomes the Office Design Limit. In offices with supervisory limits exceeding 1300 ohms, the Resistance Design Limit (1300 ohms) is controlling and becomes the Office Design Limit.

3.02 The conductor loop resistance is based upon subtracting allowances of 200 ohms for the D.C. resistance of the telephone set, 25 ohms for 500 feet of drop wire, 10 ohms for office wiring and 10% for local temperature variation (cable resistance is normally given in ohms/length at 68°F) from the external circuit loop which is determined by the central office equipment capabilities. Therefore, no further adjustment of the 1300 ohm Resistance Design Limit or to the Office Design Limit need be made.

3.03 Since the Office Design Limit will vary with different types of switching equipment in an office, an appendix to this practice should be prepared locally giving the Office De-

* In most cases the transmission objectives for these services can be met using the plant designed in accordance with this section.

sign Limit for each office in the Company or Area involved.

3.04 The gauge of the customer loop is determined by selecting the gauge or combination of gauges so that the resistance to the farthest cable termination does not exceed the Office Design Limit. Maximum use should be made of the finest gauges and the finest gauge should normally be placed nearest the office. Where a combination of gauges is required, the most economic design consists of the two finest consecutive gauges, i.e., 26 and 24 or 24 and 22, which just meet the Office Design Limit.

3.05 When loading is required, the resistance of the load coils must be considered as part of the outside plant loop resistance. The most convenient method to handle this is by reducing the Office or Resistance Design Limit by the amount of the load coil resistance in the areas where loading is appropriate. The loop resistance for each load coil is 9 ohms for 88 millihenry coils and 5 ohms for 44 millihenry coils. In cases where 1574 type inductors are used in the outside plant, deduct 25 ohms from the Office Design Limit for each inductor used.

4. BRIDGED TAP

4.01 Bridged tap results from multiple appearances of a cable pair due to branches, or from its extension beyond the point where the customer is connected. It is any portion of the cable pair that is not in the direct current path between the central office and the telephone station. Bridged tap adds capacitance to the line causing a greater attenuation of the voice signal, particularly at the higher voice frequencies.

4.02 To minimize the loss caused by bridged tap, it should be held to a minimum consistent with reasonable flexibility of the outside plant. In no case should it exceed a total of ***6,000 feet for any telephone*** on nonloaded loops. For loaded loops, bridged tap should be the minimum practicable in accordance with paragraph 5.04.

5. LOADING

5.01 All loops over 18,000 feet are to be fully loaded. The transmission loss characteristic of cable increases as the square root of the frequency and on longer lengths of cable this higher attenuation in the upper range of the voice frequency band seriously impairs the quality of voice transmission. This rising loss characteristic is primarily due to the distributed capacitance of the cable pair. Loading (inductance added at regular intervals) will equalize this and produce a relatively constant loss over the entire voice band. The major benefit of loading is in the higher voice frequencies, however, there will be some decrease in loss in almost all of the frequencies of the voice band.

5.02 The standard loading plan used in the Bell System is H88. This consists of 88 millihenry load coils placed at intervals of 6,000 feet along the cable pair. This spacing should be held as close to the 6,000 feet as practical. For customer loops, it is recommended that the objective for load spacing deviation be within ±120 feet. Some economic or practical considerations may occasionally justify deviations up to ±500 feet, but each case should be weighed against its transmission shortcomings. Special projects need not be initiated to correct existing loading unless it exceedes ±500 foot deviations or for some special service lines or trunks which may require closer tolerances.

5.03 The first load coil from the central office is the most critical as far as spacing is concerned. In determining its location, the capacitance of the office wiring must be taken into consideration. Since the amount of office wiring will vary from office to office, it is recommended that a local appendix to this practice be prepared giving the recommended distance to the first coil for each office in the Company or Area involved. This distance (cable end section) should be such that when the allowance for office wiring is added, the combination will be equivalent to 3,000 feet of cable.

5.04 Recognizing that multiple branches of cable pairs are sometimes necessary and that the bridged tap resulting from these branches has relatively the same effect on transmission as a longer end section, a combination of these two is used in setting the limits at the customer's end of a loaded cable. The recommended minimum distance between the last load coil and any station is a combination of end section and bridged tap totaling at least 3,000 feet. Less than 3,000 feet of cable or equivalent may cause abnormally high sidetone. The total end

section plus bridged tap should not exceed 15,000 feet and where practicable, it should be in the order of 9000 to 12000 feet.

6. STATIONS (TELEPHONE SETS)

6.01 The provision of the proper telephone set is a vital part of Resistance Design. On loops beyond 10,000 cable feet from the central office, 500 type sets should be provided. Transmission zones should be established designating where the 500 type set is needed and where other sets are permissible. For more detailed information on the type equipment recommended in each zone, see AB22.076.