

EXCHANGE AREA TRUNK PLANT
 GENERAL DESIGN CONSIDERATIONS

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1. GENERAL

1.01 This issue of the section, which replaces Issue 1 and addendum, has been revised in the light of the present view that exchange trunks should be designed to meet transmission objectives based on keeping the average of over-all transmission consistently good for all central office areas, rather than on the over-all limiting concept used in the past. Loop and

1.05 In addition to the engineering of trunk plant to meet growth requirements, problems which require special study may arise from time to time. These cases are usually outside the ordinary routines and may involve such things as the loading of existing non-loaded cables, replacing older types of loading with lighter and higher cutoff types, respacing or interspacing of loading and major rearrangements of existing plant due to changes in office locations or the addition of new offices.

2. SELECTION OF FACILITIES

(A) General

2.01 The general objective in selecting types of facilities for exchange area trunks is to meet the transmission objectives and signaling requirements in the most economical manner. Theoretically, this might be accomplished by treating as variables all portions of the trunk plant which introduce transmission losses. Practically, it is not only more economical but produces more uniform and more flexible plant if the number of gauges, types of loading and repeating coil ratios are restricted to a few standard arrangements. This simplifies plant design, construction, maintenance, and administration thus reducing over-all costs.

2.02 Selection of central office trunk equipment is usually governed by the type of office and by the type of trunk. In some cases, however, there is a choice of repeating coil ratio or type of pulsing or of signaling. These may have some influence on the gauge and loading. The design of trunk facilities to meet transmission and signaling requirements, however, usually involves only the choice of gauge, type of loading and, in some instances, the location of repeaters.

2.03 Trunk design data are usually set up in tabular form listing the required trunk groups with the types of offices, length, resistance limit for signaling, transmission objective (allowable loss), and the gauge and loading of the theoretical facility for each group. The computed loss and resistance of the theoretical facility may also be shown. These data, in conjunction with records of the existing facilities, permit assignment of such facilities in a manner which will provide trunks most nearly meeting the theoretical design.

(B) Cable Gauges

2.04 The gauges of cable facilities usually used in trunk plant are 26, 24, 22, and 19 and, in some instances, 16 and 13. Because of the higher allowable losses in interlocal trunks, the greater percentage of trunk mileage

in this type of plant is in the finer gauges, while the larger portion of the coarser gauges is in toll connecting and tandem trunks. The need for 16 and 13 gauge exchange trunks has been eliminated by use of improved instrumentalities. Cheaper repeaters and carrier systems in the future should reduce the requirement for 19 gauge, except as this may be governed by signaling limitations.

2.05 The choice of gauge to be used for a particular trunk group involves not only meeting the transmission requirements but also the resistance limitations imposed by signaling. For tandem and toll connecting trunks transmission may require a gauge well within the signaling limit. With the exception of certain offices with low signaling limits, gauge selection for interlocal trunks is apt to be more dependent upon transmission than upon signaling, except where fine gauge, repeatered facilities are involved. When signaling limits are controlling they may usually be extended either by trunk circuit modifications or by use of auxiliary trunk equipment. The choice between these alternatives and the use of coarser gauge conductors must rest upon a comparison between the cost of additional equipment and the savings effected by use of finer gauge cable. In general, the field of use for auxiliary equipment is in cases where the requirement for gauges coarser than 22 can be reduced.

(C) Phantom Group Facilities

2.06 The use of quadded cable in phantom groups is generally confined to the longer tandem and toll connecting trunks, particularly tributary trunks. The use of compositing equipment required for d-c signaling on phantom groups adds considerably to the cost, and this must be weighed against the cost penalties involved in sacrificing the phantom circuit. The minimum distance over which it is economical to employ phantom groups and composite signaling varies materially. Twenty to fifty miles is the usual range, but for distances over twenty miles the choice may be governed by resistance limitations of loop signaling equipment rather than by economic considerations. Formerly the use of repeaters to meet transmission requirements forced the use of composite signaling and phantom groups because 22-type and V-type repeaters were not adaptable to loop signaling. With the introduction of the E-type repeater it is now often possible to meet transmission requirements within the resistance limits imposed by loop signaling, thus reducing to some degree the economic field of use for composite signaling phantom groups. However, loop signaling involves sacrifice of the phantom circuit which should be considered. N carrier, which is adaptable to either paired or non-phantomed

quaded facilities, may prove very attractive for distances over about twenty-five to thirty miles, and in specific instances for somewhat shorter distances, particularly when low trunk losses are required. On ringdown trunks, phantom groups with E-type repeaters may be used to advantage at shorter distances.

(D) Loading

2.07 Theoretically in the loading of cables both the inductance and the spacing of the loading coils may be treated as variables selected to suit particular conditions. However, it has been found to be more economical and to result in more flexible plant if loading systems are restricted to a few uniform spacings and coil inductances which appear to be most desirable and compatible with over-all design objectives.

2.08 Prior to 1934 the loading systems which had been adopted as the most desirable from the standpoint of costs and apparent transmission advantages were M88, H135 and H175. By that time substantial reductions in loading costs and the availability of effective transmission data had pointed out the advantages of providing wider band transmission than that afforded by these loading systems. As a result, H88, D88, D175, B88, B135 and B175 were proposed as the recommended loading systems. These facilities permit the use of finer gauge cable than the older systems because of their improved frequency characteristics and lower attenuation. D175 has had little use, and B175 although recognized, has limited application. Although they have smaller attenuation, the B-spaced systems have the disadvantage of substantially higher impedance, with some adverse effects on crosstalk performance and on impedance matching. The shorter distances involved in allowable spacing deviations for B loading is a further disadvantage incurred in underground construction.

2.09 Since the 300 series, and more recently the 500 series, combined telephone sets have come into general usage, it has been recognized that the higher quality transmission afforded by these sets calls for connecting facilities of equivalent quality. For this reason it has become necessary to provide the higher cutoff trunk facilities or to allow for the distortion transmission penalties which are imposed by the older, low cutoff loading systems.

2.10 In view of the growing requirements for lower loss tandem and toll connecting trunks and the increasing use of E-type repeaters on these trunks, plus the requirements for high return losses, it appears desirable to avoid the use of the higher impedance B-spaced

loading systems. This applies in particular to crossbar tandem trunks, since in most cases no impedance matching is practicable on outgoing trunks except by means of E-type repeaters. The use of E-type repeaters in such cases would have a dual advantage in that (1) they permit matching the impedance of the facility to that of the office and (2) the gain available will usually allow the use of H88 loading rather than B spacing. In cases where signaling limitations do not force the use of coarse gauge, the repeaters may also make it possible to reduce the gauge as well as the loading.

2.11 In underground construction the costs of the additional manholes or enlargement of existing manholes which may be required for B-spaced loading will be an important consideration and may well weight the decision in favor of H spacing and E-type repeaters. Furthermore, the loading gain afforded by B spacing is usually considerably less than that attainable with repeaters and H spacing. In aerial construction the costs of additional loading are not so important and the choice in this case may be more strongly influenced by the trunk loss considerations.

2.12 In general, it is not the practice in the design of facilities for a specific trunk group to make use of partially loaded facilities or more than one loading system. In assignment work, however, it often may be either necessary or advantageous to select such combinations. However, when three or more interoffice sections are required in the makeup of a trunk, non-loaded sections should not be placed between loaded sections. In assigning loaded complements, the end sections at the intermediate offices may be such that load spacing irregularities are introduced. The losses due to these irregularities may be determined from data in Section AB43.175. The effect on return losses may be approximated from data in Section AB92.077.

3. LOADING OF NON-STAGGERED TWIST CABLES

3.01 Nearly all of the 24 and 26-gauge cable in the plant is of staggered twist construction. A portion of the existing 22 and 19-gauge, however, is of non-staggered twist construction, which has materially greater capacitance unbalances. The loading of cable containing substantial amounts of non-staggered twist is not generally desirable, because of the relatively poor crosstalk performance. However, where it appears necessary to load such cable, the resultant performance may be anticipated, using the crosstalk index rating system as outlined in the following paragraph.

3.02 The crosstalk performance of a cable may be estimated, by calculating the R.M.S. value of crosstalk coupling in the cable, and using the crosstalk index rating chart of Section AB61.010 to determine the rating of the cable. The R.M.S. value of coupling may be computed using methods and data given in Section AB23.192. The coupling should be calculated for both ends of interlocal trunks and at the local office end of tandem and toll connecting trunks. In addition, a correction as shown in Table 1 should be added to the R.M.S. couplings, expressed in dbx, before using the rating index chart. This correction is necessary because of different talker volumes, circuit activity and other factors on local trunks as compared to toll trunks. The corrections apply where the majority of circuits in the sheath in question are of the type indicated.

Table 1

Correction to R.M.S. Coupling - dbx

When Using Toll Index Chart for Exchange Trunks

	<u>db</u>
Interlocal Trunks	-2.0
Tandem (long) Trunks	0
Toll Connecting Trunks	+6.0

3.03 When trunks containing substantial amounts of non-staggered twist are loaded, the fact that a crosstalk rating may be as high as "GOOD" does not mean that there are not a few couplings in the cable which are quite high, and might produce intelligible crosstalk. This is due to the broad distribution of couplings in non-staggered twist. For that reason, crosstalk coupling tests should be made after the cable is loaded and the worst couplings either balanced out, if possible, or the pairs removed from assignment.

3.04 The crosstalk index rating of trunks containing non-staggered twist will seldom be good enough to permit the use of repeaters on them. The effect of a repeater, however, may be taken into account in the R.M.S. coupling calculation. If the majority of pairs in the sheath are repeatered, the effect will be to increase the coupling at the point of the repeater by twice the gain of the repeater.

4. TERMINATION OF FACILITIES

(A) General

4.01 The 1000-cycle impedance of the types of trunk facilities in general use varies from about 300 ohms for coarse gauge non-loaded

cable to about 1900 ohms for Bl35 loaded facilities. Since such trunks may be connected to loops, toll circuits or to other trunks with a wide range of impedances, it is the practice to make use of inequality ratio repeating coils, or in some cases, autotransformers, to reduce reflection losses wherever the improvement in transmission is sufficient to warrant the cost of such equipment. With ideal transformers these losses could be largely eliminated within a selected band of frequencies for particular combinations of facilities. However, all coils have internal losses which reduce the net transmission improvement and unless they are required for other reasons such as signaling or provision of battery supply, or unless the net transmission or return loss improvement is large, repeating coils are not ordinarily specified if the regular trunk circuit does not require them. Furthermore, administrative considerations require that the number of types of coils be kept small and that the routines for their use be simple enough for practical application.

(B) Local Offices

4.02 The outgoing ends of trunks at local central offices are not generally equipped with repeating coils and it is usually impractical in manual "A" operator cords, district selectors, district junctors or step-by-step repeaters, to provide repeating coils or autotransformers for matching the various combinations of impedances. In the case of subscribers' or operators' recording-completing trunks, each trunk is equipped with a battery supply repeating coil which may be selected to provide the desired ratio. No other coil is included between the trunk and the station when the connection has been established.

4.03 The incoming ends of interlocal trunks at manual and panel offices are usually equipped with unity ratio battery supply repeating coils and the impedance range of the majority of such trunks usually makes this ratio coil preferable. In most cases, even though some transmission improvement may be gained for high impedance trunks, the provision of inequality ratio coils on some of the trunk circuits so complicates and limits the assignment of trunk equipment that the practice is considered undesirable. In step-by-step and crossbar offices the battery supply to the station on interlocal trunk circuits is of the bridged impedance type and no repeating coil is included. To provide repeating coils or autotransformers of two ratios for these trunk circuits would involve costs not justified by the transmission gains attainable.

4.04 Incoming tandem and toll completing trunks at all types of local offices are now usually equipped with repeating coils. Ratios of either 1:1 or 1.5:1 may be specified as required for these trunks without unduly complicating assignment practices. In future design the trend will probably be away from the general use of repeating coils on these trunks, since with 500-type telephone sets the repeating coil type battery supply offers no important advantage over the bridged impedance type.

(C) Tandem Offices

4.05 At crossbar tandem offices all incoming trunks except through supervision trunks are equipped with repeating coils whose ratio may be specified to match the trunk impedance to that of the office. At other types of tandem offices repeating coils are not usually provided on incoming trunks unless they are equipped with auxiliary circuits, such as pulse repeaters. Outgoing tandem trunks are seldom equipped with repeating coils because of the costs involved and the relatively small improvement in the general grade of transmission, since the coil loss usually offsets the improvement in reflection loss. Where E-type repeaters having shunt elements are provided, they may be used to improve the impedance relationship. For trunks employing composite or simplex signaling, repeating coils are required and the proper ratio may be selected with little or no cost penalty.

(D) Toll Offices

4.06 At the toll office end the proper termination of recording-completing, toll switching and toll tandem trunks is important, not only from the standpoint of reflection loss but also to insure satisfactory return losses on connections to toll circuits equipped with repeaters. For these reasons it is particularly desirable to equip these toll office trunks with repeating coils which provide a termination approximating the toll office impedance, usually 600 ohms. The No. 3-type switchboard provides for repeating coils on all toll connecting trunks, but on the No. 1 board repeating coils are not used except on toll tandem trunks and outgoing dial trunks to step-by-step offices. Autotransformers can be used to improve the reflection and return losses at No. 1 boards, but are not recommended without special study of the requirements of the particular case. In special cases of repeater operation on toll connecting trunks, or where it is necessary to drop the switching pad on the toll circuit, special practices are employed for the selection of repeating coils as discussed in

Section AB22.128 of the practices. As in the case of tandem trunks E-type repeaters with shunt elements will provide impedance matching.

5. LAYOUT OF LOADING SYSTEMS

(A) End Sections

5.01 In selecting the locations of manholes for loading exchange area trunks, one of the most important considerations is the length of office end sections. While half-section terminations, including office capacitance, usually provide conditions satisfactory for both through and terminating trunks, such terminations are not always practical because of the geographical locations of offices, existing routes and manholes and differences in office capacitance associated with various trunk groups. The desirable arrangement is determined from consideration of transmission requirements and the plant costs of each of the several plans which may appear feasible.

5.02 For loaded trunks which terminate at a toll, or at a local dial tandem office also terminating intertoll trunks, half section will be the preferable termination. This is dictated more by the local interconnections than by toll completing requirements, since impedance compensators usually will be applied to the latter group in order to obtain better return losses against the compromise networks of the intertoll trunks.

5.03 Impedance compensation is applied at the toll office end of loaded trunks to modify their impedance, through the voice range, to a nearby constant value with a small angle. A description of the compensator circuit and the technique of its use is given in the AB22.128 group of sections.

5.04 It has been common practice to lay out loading systems beginning at the toll office with the closest practical approximation to the desired end section. In determining the location of the first loading manhole it is necessary to consider the office cabling and switchboard or switch multiple associated with the various trunks which will serve the office. These trunks may differ materially in office capacitance because of differing numbers of multiple or switch appearances and lengths of cabling to equipment connected to them. Where the repeating coil in the trunk is an inequality ratio type, the capacitance on the office side of the coil must be modified by the inverse of the coil ratio before it is added into the end section capacitance. For example, with a 1.5:1 ratio coil (line to office) a capacitance of .06 mf on the office side of the coil would be equivalent to .04 mf

on the line side. Since an end section can not be selected to match all the office capacitance conditions it is usually a compromise based on the average capacitance, which may be weighted in favor of some particularly critical condition and with some allowance for office growth where this appears to be advisable. In order to arrive at an average value of office capacitance it will be necessary to estimate as closely as possible from a knowledge of the arrangement of the particular office, the total lengths of jumper wire and office cabling to equipment, including switchboard multiple and appearances at test frames and positions, for a typical condition. From data on the various types of central office jumper wire and cable the total capacitance may be obtained and translated to equivalent feet of the type of cable whose end section is under consideration. If it is possible to make them, a few capacitance measurements would greatly simplify this procedure.

5.05 Frequently the existing manholes may determine the location of the first loading point. Where this results in end sections, including office capacitances, which are unsatisfactory, it will probably be necessary to consider corrective measures such as building out and, in some cases, an additional loading point in the office manhole or cable vault. In special instances, fractional coil or impedance compensator arrangements may be desirable. Because of the varying conditions of office capacitances and the importance of high return losses on toll connecting trunks and the effects on trunk groups cross-connected through the office, it is necessary to consider each case specifically.

5.06 At tandem offices (particularly those used or contemplated for use in toll completing) and in offices with outward toll boards which require recording-completing and toll switching trunks to distant local or tributary offices, as well as toll tandem trunks, the desirability of half-section termination, including office capacitance during the talking condition, becomes even more important. Departures from half-section in these cases will produce the equivalent of irregular loading spacing with consequent transmission impairment on all connections between loaded trunks. The transmission impairments can be evaluated from the data in Section AB43.175. Where length deficiencies due to allowance for office capacitance occur on trunks cross-connected together on the main frame, building out with capacitors may be employed if warranted.

5.07 The selection of the location for a tandem office or an outward toll board frequently is governed by such conditions as existing

buildings or new wire center locations. These in turn are subject to existing plant conditions that may include rather well-established cable route and loading patterns. Further sources of loading irregularities may be introduced by intermediate offices on the cable routes through which the trunks must be cross-connected. Studies of these conditions and consideration of the transmission requirements of the trunks will largely determine the magnitude of corrective measures necessary to provide the desired quality of loading uniformity.

5.08 The practice of laying out loading from the toll office has resulted in random end section terminations at local offices. Where the local office is not a cross-connect point on a main cable route an end section between about 0.2 and 1.0 section does not introduce sufficient penalty to warrant corrective measures, and is usually accepted as satisfactory.

5.09 In the case of a local office located on a main cable route a large part of the trunk cable facilities may be terminated on the main frame even though not all are required to serve the particular office. This provides a high degree of flexibility in making up both through and terminating trunk groups and increases cable fills as well as service insurance. On the other hand, cable terminations and continuing jumper expense merit close consideration with a view toward splicing as many pairs past the office as can be justified. End sections in such an office should be given careful consideration for the following reasons: (1) the possibility that it may become a tandem switching point or an outward toll board as discussed in Paragraph 5.06 and (2) the loading irregularities introduced in cross-connected trunks with the attendant penalties in transmission loss. One of the following methods of end section correction may prove attractive. If the end sections for routes to the main toll office and also to other offices happen to be full or nearly full section, then either half coil terminations or full coils, cross-connected in, would provide uniform loading on through trunks. Impedance compensation, fractional coil loading, or building out might be the most economical and feasible methods where other lengths are involved.

5.10 On cable routes where H-spaced and B-spaced loading use common loading manholes, it is obvious that if half-section termination is used for the H-spaced loading it will result in a full end section for the B-spaced loading. The latter may be corrected to the equivalent of half-section by placing a half weight coil on the B end section at a distance 2250 feet toward the office from the last full load point.

That is, if the length is 3000 feet including allowance for office capacitance, this places the half weight coil effectively in the center of the excess half section.

(B) Loading Spacing Uniformity

5.11 Increasing application of voice repeaters to exchange area trunk facilities in all fields, as well as on special service lines, requires closer attention to the design and uniformity of loading spacing than in the past. Uniformity of loading spacing is a dominant factor in the structural return loss, which in turn controls the gain capability of the repeater. This applies to the terminating repeater (or carrier terminal) of an intertoll trunk as well as to a voice repeater in the exchange trunk.

5.12 Spacing irregularities in a loaded trunk are generally divided into two classes (1) the deviation of the average spacing from the standard spacing and (2) the deviation of any one section from the average. Maintaining the average spacings close to the standard spacings results in a high degree of flexibility and avoids the additional costs which special arrangements usually involve. It further results in uniform attenuation and impedance characteristics for like facilities. In the case of trunks which may be used for repeated operation or connected to toll circuits which depend upon good return loss characteristics and proper impedance relationships with balancing networks this is especially important. The individual sections should be maintained close to average in order to avoid the impedance irregularities, reflection losses and poor return losses which unequal sections introduce.

5.13 Because of the necessity of meeting practical plant layout conditions, precise loading spacings usually are not attainable. However, generally adequate return loss performance can be obtained if the following deviations are not exceeded:

- (1) The deviation of average spacing from standard spacing should not exceed ± 2 per cent.
- (2) The deviation of the length of individual sections from the average section length should not exceed ± 3 per cent.
- (3) The per cent deviation of each section length from average section length should be determined for all sections and the numerical average of these percentages, disregarding signs, should be 1.2 per cent or less, where practicable.

The cumulative effect of a series of small deviations, positive or negative from the average spacing, may be as great as that of a single larger deviation. In planning additional loaded cables on existing routes, it may frequently be found that the established loading patterns do not conform with the desired spacing limits. It will be advisable under such circumstances to consider carefully the requirements for the proposed cables, and to weigh all factors involved to determine the measures necessary to provide them with the proper uniform spacing at a minimum additional cost. When considering the need for such measures it will be helpful to have available structural return loss measurements from existing loaded pairs in the route.

5.14 Since the emphasis in the design of modern trunks is now on echo requirements, rather than singing, it will be desirable in the future to examine the return loss performance of the plant in the echo range of 500 to 2500 cycles, rather than at the critical singing frequency.

5.15 Measurements on existing trunk facilities give structural return losses in the echo range substantially better than those indicated by existing methods of computing at the critical frequency. Table 2 summarizes such measurements, made in two cities in 1952, covering a wide range of local trunk conditions. For comparative purposes the computed values for each structural layout are also shown. Consideration is being given to a modified method for computations, having results more in conformity with the measured results. In the meantime it would appear from the data that an H88 system having any pretense to uniformity of loading spacing and with no missing coils, is capable of structural return losses within the distributional values shown in Table 2 for the respective gauges.

(C) Correction of Spacing Irregularities

5.16 Irregular spacing can, of course, be corrected within the degree of accuracy required for transmission purposes by the addition of the proper values of resistance, capacitance and inductance. The different measures for accomplishing this and their relative benefits are covered in another section relating to the "Location, Detection and Correction of Impedance Irregularities in Loaded Exchange Area Cables."

6. TRANSMISSION CONTRASTS

6.01 Under previous methods of trunk design, the higher permissible trunk losses coupled with differences in signaling ranges for

TABLE 2
COMPARISON OF COMPUTED AND MEASURED STRUCTURAL RETURN LOSSES

Office	Length Kf.	Computed per AB22.151				Measured Structural Return Loss - db (Value for Each Pair is Average of Meas. at 5 Freq. vis., 500, 1000, 1500, 2000, 2500 cye.)				
		Deviations - %			63% R.L.	Lowest Pair	Highest Pair	Avg. of Group	Std. Dev.	
		System from Standard	Individual from Sys. Avg.	Ref.						
DETROIT TESTS										
<u>24 Ga. - H-88 Trunks</u>										
Vinewood	22.4	0.5	1.6	2.0	25	30.1	32.9	30.9		
Townsend	31.2	3.5	3.9	6.0	20	28.8	32.6	30.7		
Walnut	21.9	1.3	0.8	1.4	26	30.5	31.9	31.2		
Trinity	18.8	7.5	0.4	7.5	19	29.1	31.5	30.3		
Lakeview (c)	42.6	2.2	0.9	2.5	24	30.9	31.8	31.3		
								Distributional Results for 25 Pairs as a Group	30.9	1.0
<u>22 Ga. - H-88 Trunks</u>										
Webster (c)	32.5	M11	2.0	2.0	24	30.5	31.9	31.1		
Vermont (c)	46.7	1.3	2.3	3.2	22	32.4	35.7	34.4		
Royal Oak (c) (1)	66.9	0.1	1.2	1.4	25	29.2	30.9	30.0		
Royal Oak (c) (2)	66.9	0.1	1.2	1.4	25	29.8	32.2	30.8		
Luson	38.8	0.8	0.6	1.2	25	33.1	35.3	33.8		
Logan (c)	66.7	2.0	2.1	2.3	23	32.7	34.7	33.7		
Dunkirk (c)	51.0	0.2	1.7	2.1	24	29.2	31.1	30.2		
Birmingham (c)	105.0	0.3	1.2	1.6	25	29.9	32.3	31.5		
University (c)	48.0	0.1	4.0	5.0	20	11.2	26.7	22.7		
								Distributional Results for 40 Pairs as a Group (* University Group omitted)		31.9
<u>19 Ga. - H-88 Trunks</u>										
Kenwood (c) (1)	64.8	1.2	1.7	2.5	21	27.0	29.0	27.7		
Kenwood (c) (2)	64.8	1.2	1.7	2.5	21	27.0	29.7	28.5		
Centerline	59.2	0.5	2.6	3.6	19	10.8	28.6	21.6		
Wyandotte (c) (1)	69.3	M11	1.8	2.3	21	26.0	28.5	27.6		
Wyandotte (c) (2)	69.3	M11	1.8	2.3	21	25.1	29.8	28.2		
Lakeview (c)	42.6	1.3	1.9	2.7	20	22.8	26.2	24.6		
Roseville (c)										
Initial (d)	70.9	2.4	7.4	9.5	12	21.2	22.4	21.8		
After Correction (d)	73.5	1.5	1.2	2.1	21	25.3	27.0	25.9		
Wayne (c)	101.0	2.3	2.3	3.7	19	24.6	31.5	28.2		
								Distributional Results for 35 Pairs as a Group (* Centerline and Roseville-Initial omitted)	27.2	1.9
CHICAGO TESTS										
STE-WAB (e)	45.5	0.7	0.6	1.1	23	26.1	32.9	29.6	1.7	
WAB-STE (e)	45.5	0.7	0.6	1.1	23	23.3	29.6	26.3	1.7	
								Combined 60 Pairs	28.5	2.3

- Notes:** (a) Each group consists of 5 trunks selected at random.
 (b) All measurements made at Detroit Toll except the Chicago tests (see Note (e)).
 (c) Not uniform gauge throughout.
 (d) On initial test of Roseville trunks one section 2600 feet short corrected by building out with .04 mf condenser and after correction test made.
 (e) STE-WAB measurements on 40 pairs 19 DBB-H-88.
 WAB-STE " " 20 of same pairs in opposite direction.

interlocal trunks aggravated the problem of transmission contrasts which could occur between calls in reverse directions, between direct and alternate routes, or between trunks in the same group divided between different cable routes or different types of facilities.

6.02 The transmission objectives set forth in the sections dealing with the design of specific classes of trunks will tend to reduce the magnitude of this problem both in design and in assignment by reducing the possible contrast spread. With the grade of transmission which will result from these design objectives, contrasts which do not exceed 5 db will, in general, provide satisfactory conditions. It will be necessary in design, but more particularly in assignment, to bear in mind this contrast objective. This subject is discussed further in Section AB22.126 "Design of Interlocal Trunks."

7. REFERENCES TO INFORMATION APPLICABLE TO TRUNK DESIGN

7.01 The following tabulation lists the sources of information and data applicable in the design and layout of exchange trunk plant.

(A) Transmission Information

	<u>Reference</u>
(1) Design of interlocal trunks	AB22.126
(2) Design of toll connecting trunks - 2-wire switching	AB22.128.1
(3) Design of toll connecting trunks - 4-wire switching	AB22.128.2
(4) Effective trunk losses	AB43.175
(5) Terminal junction losses	AB43.125.1
(6) Intermediate junction losses	AB43.176

(7) Losses due to loading spacing irregularities

Reference

AB43.175

(8) Central office losses

(a) Community dial offices

AB43.280 to .292

(b) Other common battery offices

AB43.275

(9) Loss due to auxiliary trunk equipment

(a) Trunk long lines circuit

Use 1000-cycle insertion loss of additional equipment.

(b) Intermediate pulse repeater

Use 1000-cycle insertion loss adjusted for office cabling loss.

(10) Designation of loading systems

AB45.025

(B) Signaling Information

(1) Limiting trunk resistance

Use smaller of values on circuit drawings for incoming and outgoing circuits, or consult Equipment Engineer.

(2) Resistances of exchange cable and open wire

AB43.521

(3) Exchange area loading coils and cases

AB45.085