

**NO. 5 CROSSBAR  
AUTOMATIC CALL DISTRIBUTOR SYSTEM  
PHASE II  
TRANSMISSION ENGINEERING CONSIDERATIONS**

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4. TRANSMISSION PLAN AND REQUIREMENTS . . . . .	11	1. INTRODUCTION	
A. General . . . . .	11	1.01 The No. 5 Crossbar Automatic Call Distributor (ACD) System functions as an incoming trunk concentrator and call distributor, apportioning traffic to teams of operators who may be collocated with the crossbar switching-equipment or at a remote location. The No. 5 ACD System is capable of operating with all existing local, tandem, and toll switching systems within the Bell System.	
B. Local DA Trunking . . . . .	12	1.02 The No. 5 ACD System provides operator assistance for the following classes of service:	
C. Intra-NPA-DA Trunking . . . . .	12	(a) Local 411 directory assistance. The network between local end offices and the ACD may include one stage of trunk concentration.	
D. Toll DA Trunking . . . . .	15	(b) Intra-Number Plan Area (NPA) (555-1212 or 1 + 411) directory assistance. These calls enter the ACD system from either a sector or directional tandem office or a toll office and should not be concentrated.	
E. Intercept Trunking . . . . .	15	(c) Toll (NPA-555-1212) directory assistance. Incoming calls enter the ACD system from a class 3 or higher class toll office and should not be concentrated.	
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(d) Intercept assistance for calls that cannot be completed because of a number change, service disconnect, or trouble are intercepted at the receiving end office. Intercept trunks between the receiving end office and the ACD may be concentrated, but no more than one stage of concentration should be used.

**1.03** The No. 5 ACD System Phase II as designed with the intent of terminating all types of directory assistance (DA) and intercept traffic. It is basically a 900-ohm, 2-wire crossbar switching system which distributes traffic from approximately 2700 incoming trunks terminated on the line link frame to a maximum of 500 operators at auxiliary service positions (Fig. 1).

**1.04** The ACD System Phase II was designed with more flexibility than its predecessor Phase I. The Phase II concept allows operator A to transfer incoming traffic to operator B, a service assistant (SA), or an outgoing trunk (OGT). These types of calls can be made with a minimum of transmission degradation through the application of a bridged negative impedance converter (NIC). Operator B may have to add a SA, in rare circumstances, but should never access an OGT. The first operator (A) should know the final destination of the incoming call.

**1.05** The Phase II system has a night closing feature whereby all incoming traffic may be switched by the use of night closing trunks, to a distant No. 5 ACD System, No. 23 desk, No. 3 CL switchboard, and Centralized Intercept Bureau (CIB) for completion. This allows the traffic engineer to make load adjustments and minimize the operator force requirements.

**1.06** The No. 5 ACD System Phase II has stringent requirements of Inserted Connection Loss (ICL), Echo Return Loss (ERL), Singing Return Loss (SRL), noise, delay, overall circuit connection length, and system cabling lengths, as the ACD system terminates the intertoll network on toll DA and toll originated intercept traffic.

**1.07** This section presents transmission guidelines for a centralized number service system based on the No. 5 ACD System Phase II. Transmission requirements are given for ICL, ERL, round trip delay (RTD), and maximum connected circuit length applicable to each type of DA and intercept connections. These requirements are

placed on the physical plant to insure that it will meet the No. 5 ACD System transmission design.

## **2. SYSTEM DESCRIPTION**

**2.01** The No. 5 ACD System Phase II apportions traffic from the incoming trunks to teams of operators which may be remote from the ACD. In the Phase II system (Fig. 2), operator A may transfer any type of traffic to a number of destinations, including:

- (a) Service assistant (SA).
- (b) An operator B in a different operator group served by the same ACD.
- (c) Dedicated outgoing trunks to:
  - (1) Distant Bell System ACDs, desks, and switchboards.
  - (2) Independent company service bureaus.
  - (3) Automatic Intercept Service (AIS).
  - (4) Telephone switching offices for access to the DDD network for emergency service only.

**2.02** The incoming traffic is divided between DA and intercept (Fig. 2). All types of DA traffic are received by ACD line circuit SD-28040-01 and switched across the line link frame (LLF) to the trunk link frame (TLF) to an operator at an Auxiliary Service Position (ASP). The operator then completes the DA request or may transfer the call to another operator, a SA, or an OGT. The incoming intercept traffic is directed to the ACD line circuit intercept, SD-28048-01. Three types of intercept traffic are recognized, namely, machine announcement, trouble, or operator-handled. The incoming line circuit determines the routing by means of the supervision transmitted from the switching office. If the traffic is operator handled, the call is switched from the LLF to the TLF to the ASP. The operator then has the same capability to transfer the call as the DA operator.

**2.03** To follow an operator transferring an incoming DA request to an OGT, see Fig. 3. The incoming traffic is of DA type and is connected from LLF to TLF (1) and over the position trunk to the ASP. The operator A decides to transfer

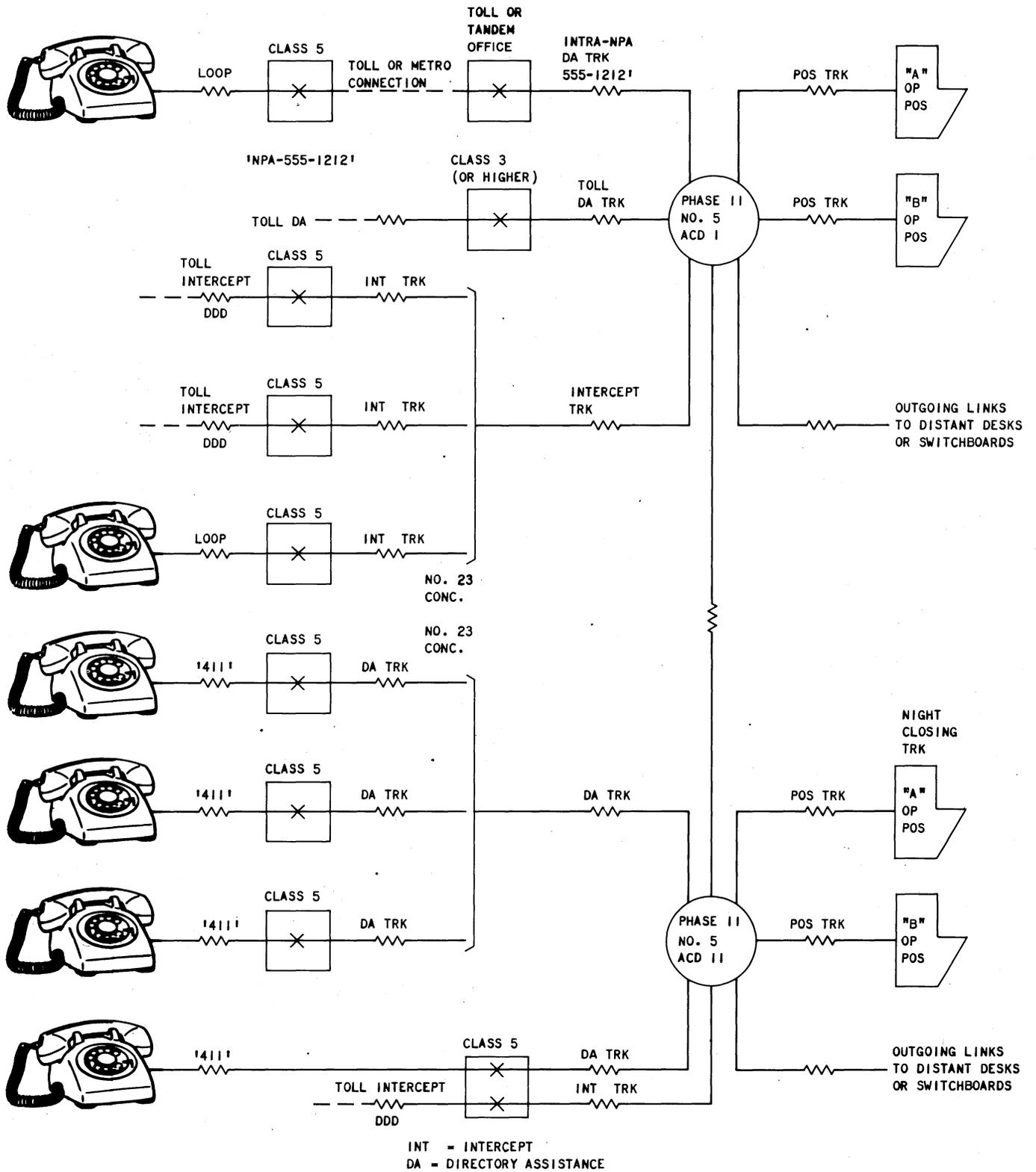


Fig. 1—Basic Call Distributing System for Combined Directory Assistance and Intercept Service

the call to a distant ACD over an OGT. The operator signals the line circuit and a digit register is attached (2). The operator, using a TOUCH-TONE® dial, sends the access information to the transfer line circuit (3) appearance on the LLF which is switched to the TLF appearance of the OGT. A 3-way bridge has been established, and under this condition, the line circuit would terminate in an impedance less than 900 ohms and a severe degradation in the circuit balance and net loss would occur. To correct this condition, a negative impedance converter in the OGT circuit is connected to the circuit and electrically restores the termination impedance and the circuit balance. If the originating operator releases, a termination is connected to the primary line circuit to maintain the line impedance and circuit balance.

**2.04** The sequence of operator A making a transfer to operator B is shown in Fig. 4. The incoming DA traffic is connected via the primary line circuit appearance (1) to operator A. Operator A signals over the trunk link (TL) of the position circuit that a transfer is desired, and a digit register is attached (2). Operator A using a TOUCH-TONE® dial sends the access information and a TL of a junctor is connected to the transfer appearance of the line circuit (3). The line link (LL) of the junctor connects to the TLF appearance of the position circuit to operator B at the ASP (4). The NIC in the junctor circuit operates to maintain the circuit impedance and balance.

**2.05** To transfer a call from either operator A or operator B to a SA, follow the same sequence as an operator to OGT transfer. In this case, the NIC in the SA position circuit would function to maintain circuit performance.

**2.06** The operators at the ASPs may be grouped in teams of local DA, toll DA, and intercept. The No. 5 ACD System Phase II has the capability of closing down an operator team and routing the incoming traffic to another operator team. This allows the traffic engineer to apply load balance and reduce the operator requirements during light load periods.

**2.07** During nonbusy traffic hours, the No. 5 ACD System Phase II has the capability of closing down the entire system and transferring all incoming traffic to a distant No. 5 ACD System Phase II for call completion.

### 3. TRANSMISSION OBJECTIVES

#### A. General

**3.01** The No. 5 ACD System Phase II or Phase I is designed to meet the same transmission objectives for the Bell System unified number services.

#### B. Operator Sidetone

**3.02** The proposed nominal sidetone objective for customers is taken as the standard for operators as well. This objective is a mean acoustic to acoustic sidetone path loss of 12 dB. Sidetone losses between 8 and 16 dB are acceptable.

#### C. Loss-Noise Grade-of-Service

**3.03** Loss-Noise grade-of-service (GOS) presented to customers on toll calls is also the objective for customer operator connections.

**3.04** An estimate of Loss-Noise "Good or Better" (GOB) subjective opinion for DDD calls is shown in Fig. 5 versus the route mileage between end offices. Figure 5 includes curves of 90 percent worst, average, and 10 percent best loss-noise quality.

**3.05** Loss-noise grade-of-service for an ACD operator customer connection is to be the same as the average quality of the equivalent DDD connection. The equivalent DDD connection is one having the same length of regular message network facilities as the ACD connection. Thus the objective is independent of the length of facilities dedicated to operator service inside the ACD system. A secondary objective is that the range of ACD connection ratings should be no greater than the range of ratings for the equivalent DDD call. Figure 5 shows that grade-of-service on toll calls is essentially constant for the first 150 miles or so of connection length and diminishing gradually thereafter. With a DDD call less than 150 miles in length referred to as a short toll call objective, Table A lists the loss-noise grade-of-service objectives for different types of ACD number services established.

On nonextended calls, quality approximating that of Fig. 5 will be provided. On extended calls, five percent degradation is allowed. *Further creeping*

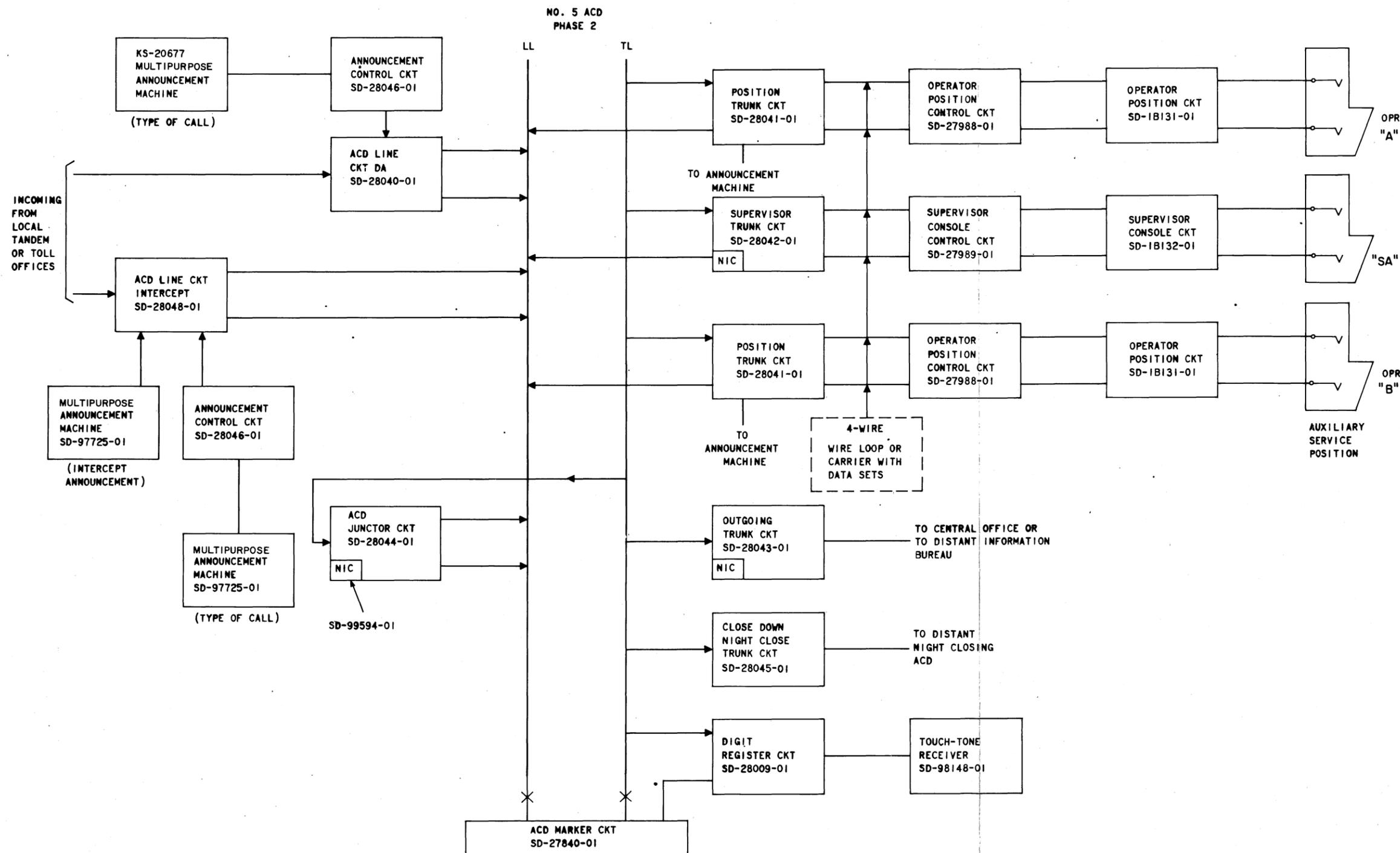


Fig. 2—No. 5 ACD System Phase II

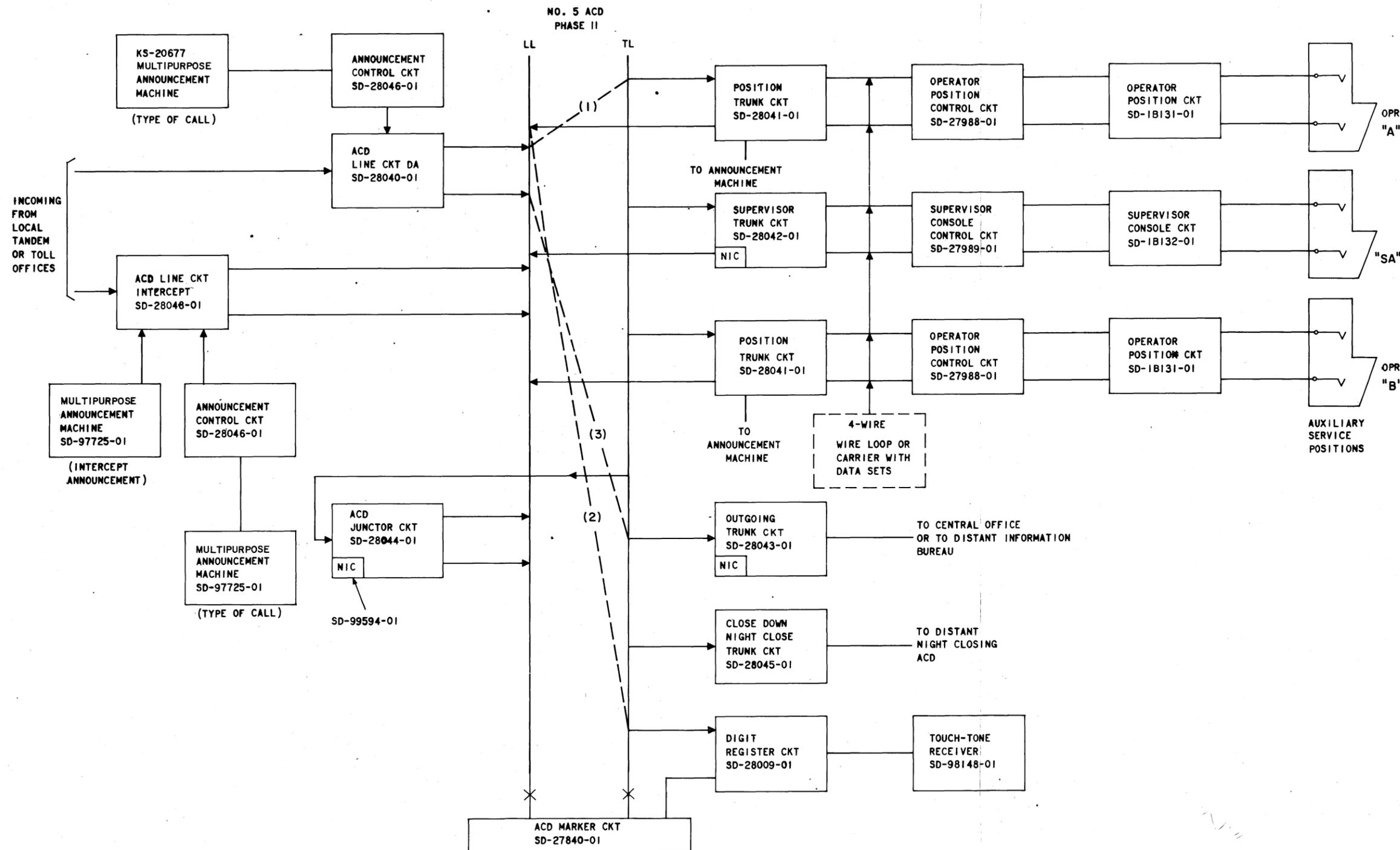


Fig. 3—No. 5 ACD System Phase II—Operator "A" Transfer to Outgoing Trunk

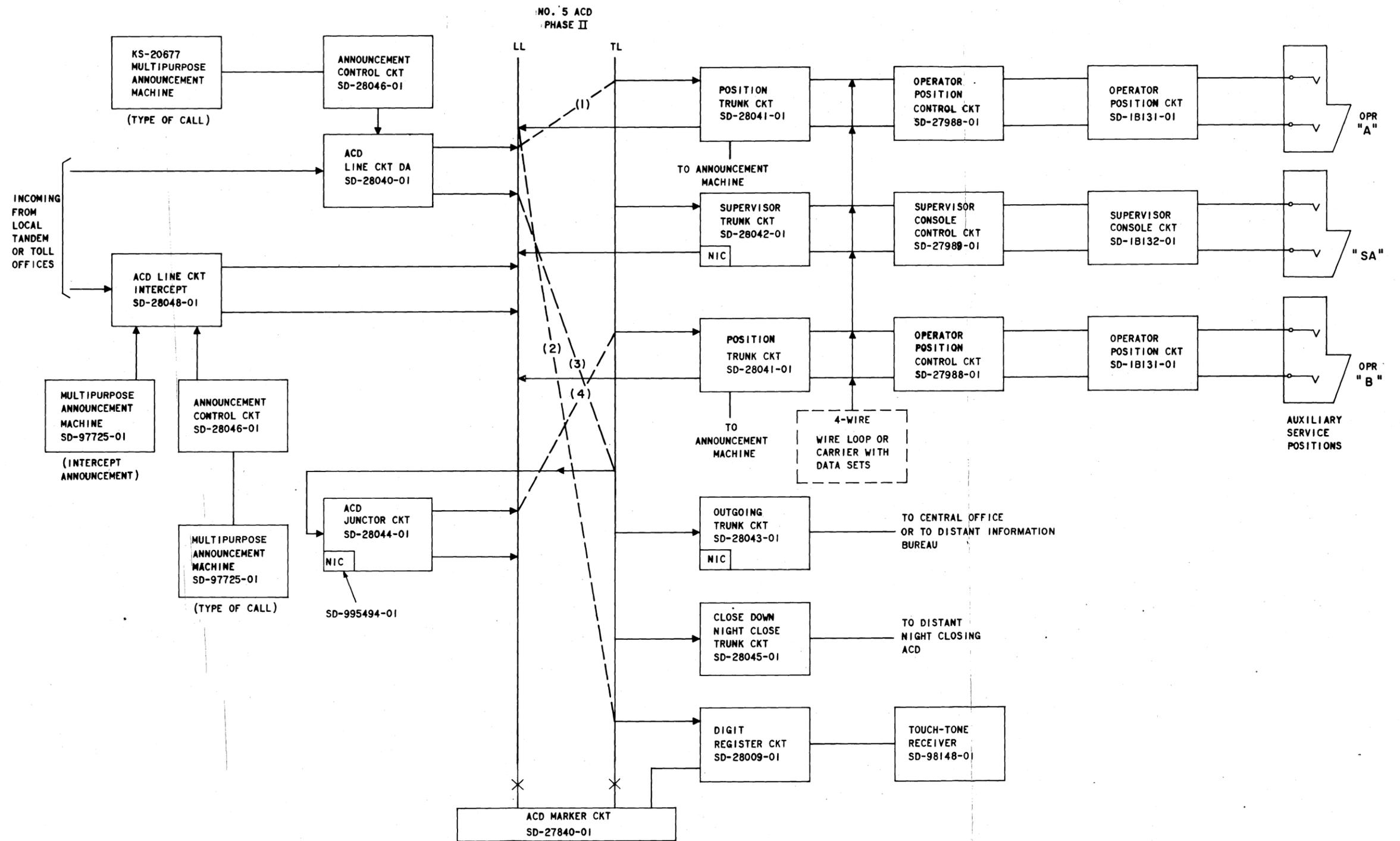


Fig. 4—No. 5 ACD System Phase II—Operator "A"  
Transfer to Operator "B"

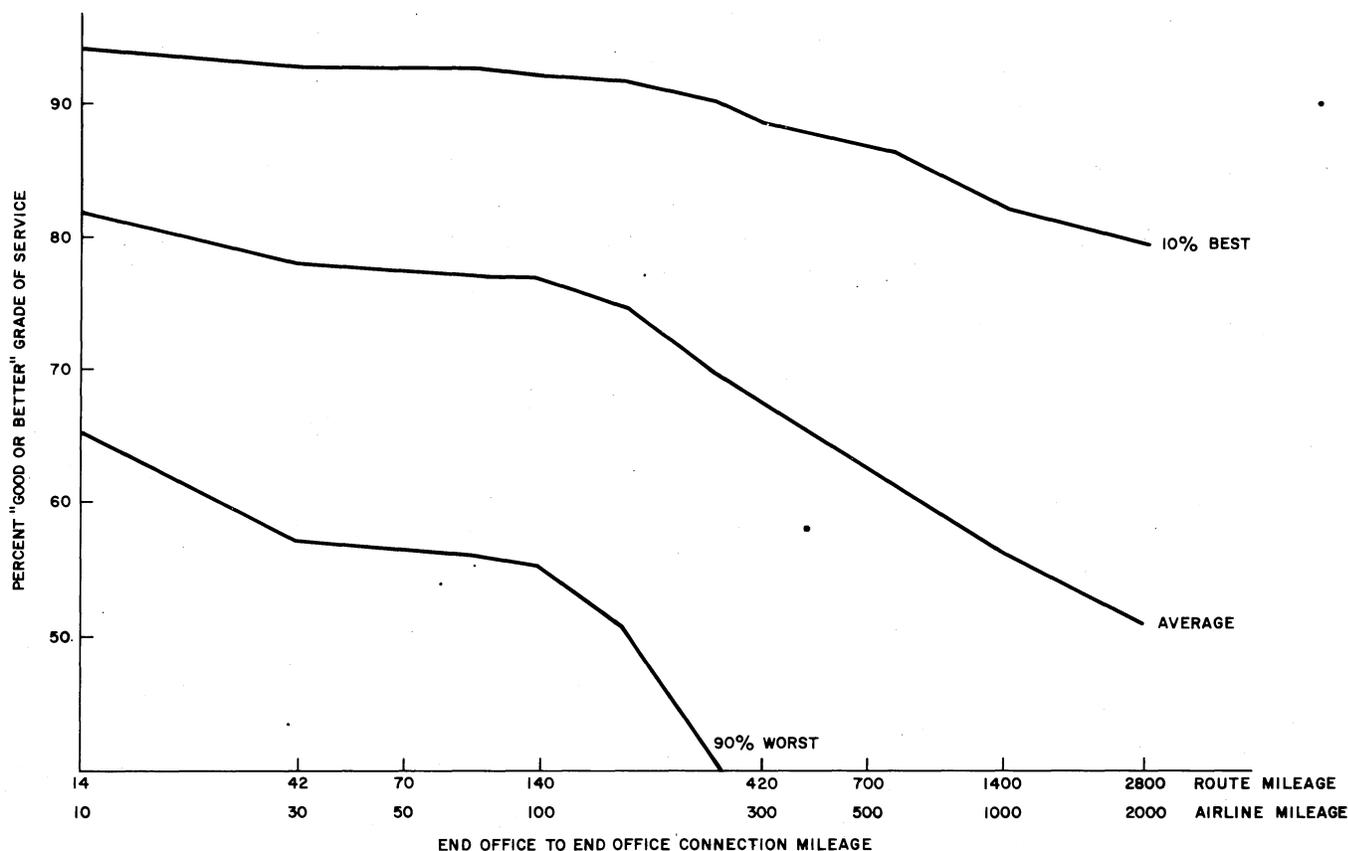


Fig. 5—Connection Route Mileage Loss-Noise Quality of DDD Calls

*degradation introduced by multiple stages of trunk concentration is not recommended.*

**D. Talker Echo Grade-of-Service**

**3.06** The talker echo objective for connections between customers and Bell System operators is based upon estimates of talker echo grade-of-service received by present toll customers under via net loss rules. The objective is again stated in terms of "equivalent toll quality" independent of the connection length of trunks dedicated to operator service within the ACD system. Table B shows the ACD connections and their echo objectives.

Use of balance procedures at the ACD and high-quality operator position facility and telephone apparatus make operator rather than customer talker echo controlling.

**4. TRANSMISSION PLAN AND REQUIREMENTS**

**A. General**

**4.01** This transmission plan specifies the ICL and ERL requirements for each type of DA

TABLE A

**LOSS-NOISE GRADE-OF-SERVICE**

SERVICE	QUALITY NOT SIGNIFICANTLY WORSE THAN
Local and intra-NPA DA	Average short toll quality
Local and intra-NPA intercept	Average short toll quality
Toll DA and intercept	Average equivalent toll quality

TABLE B

## TALKER ECHO GRADE-OF-SERVICE

CONNECTION	QUALITY
Local and intra-NPA DA, and local and intra-NPA — intercept	99-percent GOB in 90 percent of each type of connection
Toll DA and intercept	85-percent GOB in 90 percent of each type of connection

and intercept call handled in a No. 5 ACD System Phase II.

**4.02** When a particular trunk combination will handle more than one type traffic, the trunk transmission requirements for the most stringent type traffic must be used. For example, a trunk group expected to handle both DA and intercept should meet the intercept requirements. It is important that the GOS the customers are accustomed to in these type calls be maintained as near as possible in a centralized call distributing system.

**4.03** Balancing requirements play a vital part of overall transmission performance as toll DA and intercept traffic is an extension of the intertoll network. Careful impedance control is also necessary if the NIC is to operate properly. Balancing requirements and procedures are not covered in this section but are covered in Sections 660-478-301 and 660-478-502.

**4.04** According to the No. 5 ACD Phase II transmission plan, the ACD switch has been proposed to have the same level in the switching hierarchy as a toll office switch having class 4 rank. Consequently, it is a -2 TLP and has been equipped for TP2 testing. For the purposes of loading the carrier trunks, all connections terminating on the ACD LL frame should present a minimum loss of 2 dB from the originating class 5 office. The 2-dB minimum loss requirement is necessary to limit the maximum average volume delivered to the ACD switch, which is assumed to be -18.8 VU (volume units), in order to maintain the ACD as a toll switch.

**B. Local DA Trunking**

**4.05** A subscriber placing a local DA (411) call, connects through the class 5 office to an ACD incoming trunk (Fig. 6). The call is switched across the ACD to a position trunk terminating with an operator at the ASP. The incoming trunks may be concentrated with the trunks between the concentrator and the ACD on 4-wire facilities.

**4.06** The transmission requirements for local DA on ICL, ERL, delay, and maximum circuit connection lengths are shown in Table C and Fig. 6. The round trip delay requirement is increased an additional 2 milliseconds (ms) when incoming trunk concentration is used. The maximum circuit connection length is extended 100 miles when an extension trunk is added to the overall connection.

**C. Intra-NPA-DA Trunking**

**4.07** A subscriber placing an intra-NPA-DA call may be routed within the NPA via the toll DA network, or in metropolitan and heavily populated suburban areas, via a dedicated "local-only" network or combined local-toll arrangement.

**4.08** The intra-NPA-DA calls routed via a metropolitan local-only network is shown in Fig. 7. The incoming trunk from either the directional or sector tandem switching office is switched across the ACD to an operator at the ASP. The incoming trunks should not be concentrated.

**4.09** The transmission requirements for ICL, ERL, delay, and maximum circuit connection lengths are shown in Table D and Fig. 7. The incoming trunks between the directional or sector tandem offices and the ACD are to be engineered using 4-wire facilities. The ICL of the incoming trunks can be 0.5 dB if there is a 2.0-dB minimum loss between the subscriber loop termination and the tandem office at the incoming trunk of the ACD. Under these conditions, the maximum connection lengths allowed are 250 miles directional tandem and 500 miles sector tandem to the ASP. The round trip delay remains the same with or without an OGT or night closing extension. The maximum circuit connection length may be increased 100 miles when an extension trunk is added to the overall circuit connection.

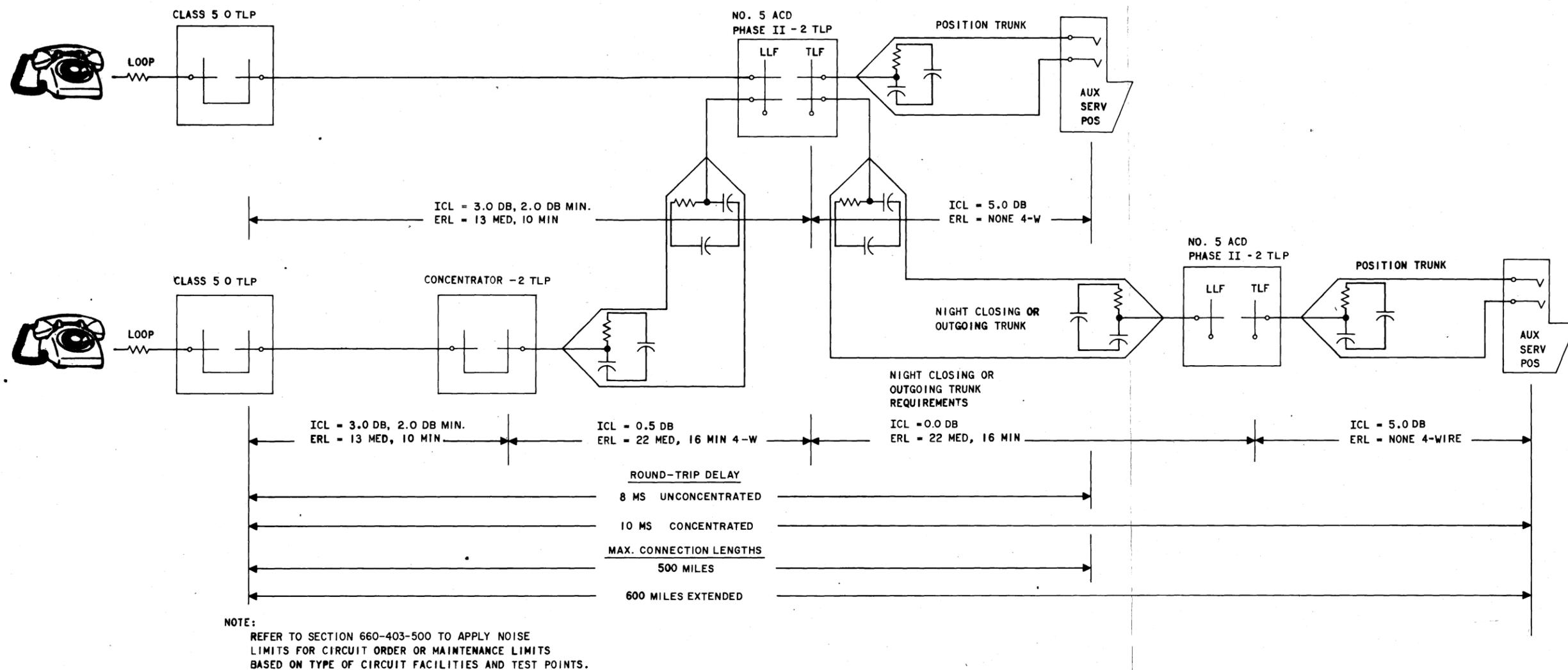


Fig. 6—No. 5 ACD Phase II Local DA Transmission Requirements Concentrated, Unconcentrated, Nightclosing

TABLE C

## TRANSMISSION REQUIREMENTS NO. 5 ACD – PHASE II

LOCAL DIRECTORY ASSISTANCE – 411 TYPE CALLS		
	ICL	ERL
Class 5 office to ACD or Concentrator	3.0 dB	13 dB
Concentrator to ACD	0.5 dB	22 dB
ACD to ASP	5.0 dB	—
Night closing trunk	0.0 dB	22 dB
Round trip delay:		
Unconcentrated	8 milliseconds	
Concentrated	10 milliseconds	
Maximum connection length:		
Without night closing	500 route miles	
With night closing	600 route miles	

*Note:* Refer to Section 660-403-500 for noise requirements.

#### D. Toll DA Trunking

**4.10** A subscriber placing a toll DA (NPA-555-1212) call connects from a class 3 or higher office to an ACD incoming trunk (Fig. 8). The call is switched across the ACD to a position trunk terminating with an operator at the ASP. Toll DA trunking does not allow for trunk concentration, and a system being engineered should not consider ACD incoming trunk concentration. The incoming trunk between the toll office and the ACD is considered to be an intertoll trunk and requires use of 4-wire facilities.

**4.11** The transmission requirements of ICL, ERL, delay, and maximum circuit connection lengths are shown in Table E and Fig. 8. In the toll DA transmission plan, the OGT or night closing trunk has a requirement of 0.0-dB ICL. The round trip delay requirement is the same with or without an extension trunk addition. The maximum circuit connection length allows an additional 100 miles when an extension trunk is added to the overall circuit connection.

#### E. Intercept Trunking

**4.12** Intercept calls may originate from a local subscriber, from the intra-NPA network, or

from the intertoll network (Fig. 9). The intercept transmission requirements are the most stringent because intercept service is an extension and termination of the toll network (see Table F). The intercept incoming trunks may have one stage of concentration. The incoming trunk between the concentrator and the ACD will require a 4-wire facility with an ICL of 0.0 dB.

#### F. Combined DA and Intercept Trunking

**4.13** A combined DA and intercept transmission arrangement is shown in Fig. 10. When intercept and DA traffic are handled by a single operator team in a No. 5 ACD Phase II, the intercept transmission requirements for the position trunk must be used (see Table G). Phase I operator positions attached to a Phase II ACD should not handle intercept traffic.

**4.14** To avoid operator talker echo problems, the voice-switched attenuator (VSA) should be enabled in the unified telephone circuit (UTC) associated with positions handling both intercept and toll DA. In addition, the maximum length of the trunking between the class 3 or higher access office for toll DA and the operator at the ASP should not exceed 100 facility miles.

**4.15** In systems combining intercept and local or intra-NPA-DA, maintaining good customer and operator loss-noise GOS on DA calls requires that class 5 office-to-ACD DA trunks should meet a 2-dB minimum design loss and be equipped with pads as required. All tandem office-to-ACD trunks should have a design loss of 2.0-dB nominal. These trunks must meet terminal balance requirements at the ACD, refer to Section 660-478-301. Because of the net reduction in operator echo path loss on DA calls when intercept ICL requirements are used, the VSA should be enabled in combined intercept and local or intra-NPA-DA positions when the round trip echo delay of any connection in the system exceeds 5 ms. Regardless of the round trip echo delay in combined positions, the VSA should be enabled at all times when handling toll DA.

**4.16** Night closing, outgoing, or overflow extension trunks handling combined traffic to ACD systems Phase II should be handled only at Phase II ASPs equipped with VSA. If toll DA calls are among those extended, the length of trunks connecting the class 3 or higher access office and the ASP should be limited to 200 facility miles. The intercept mileage remains the same for extended systems.

## **5. ENGINEERING CONSIDERATIONS**

### **A. General**

**5.01** When a transmission plan is engineered for a No. 5 ACD System, several specific problem areas, which are an important part of the overall system operation, must be considered.

### **B. Operator Position Trunks**

**5.02** The No. 5 ACD System Phase II operator position trunks are 4-wire. There are four circuits that function in tandem to complete the circuit from the TLF to the ASP. These four circuits are the position trunk circuit, the voice-frequency or carrier facility, the operator position control circuit, and the operator position circuit (Fig. 11).

**5.03** The position trunk circuit incorporates a 24V4C repeater to convert the 2-wire TLF appearance to 4-wire and provides for gain adjustment and equalization as a part of the overall position trunk ICL adjustment. The 4-wire facility portion

of the position trunk circuit is composed of either voice-frequency cable using dc loop signaling or carrier channels using data sets for signaling. The sidetone amplifier is shown outside the position circuit in Fig. 11 for ease in drawing, but it is an integral part of the position circuit.

**5.04** The 4243B network provides automatic gain control (AGC) and VSA features that were not available in the No. 5 ACD Phase II operator and supervisory assistant telephone circuits (Fig. 11). This network should be provided in all operator positions for its AGC suppression of high-level signals which would otherwise cause operator acoustic disturbance. The VSA feature should only be enabled when called for by the transmission plan. The network is available as a plug-in applique unit provided with a plug and jack arrangement for interconnecting into existing No. 5 ACD Phase II telephone circuitry.

**5.05** In a 4-wire telephone circuit, a small amount of the operators transmitted speech is returned over the receive path as echo reflection. This reflection is developed at the far-end loop and toll DA connecting trunk which causes an unbalance condition at the position hybrid of the ACD switch. If the round trip circuit delay is short, the operator hears the energy as sidetone. When the system connection length becomes long, the round trip delay increases and the returned energy is heard by the operator as an echo. The echo results in a poor talker echo GOS for the operator.

**5.06** To reduce the echo, the VSA control circuit constantly monitors the operator's speech level and controls the output of the variable gain amplifier (VGA) in the operator's receive circuit (Fig. 11). The VSA control circuits operate at a threshold of -41 dBm and reduces the VGA output on a linear basis. As shown in Fig. 12, the VGA presents zero gain at the -41 dBm transmit threshold level and reduces the gain on a linear basis to a loss of -15 dBm as the transmit path power increases to -31 dBm and remains constant as the transmit level increases.

**5.07** The AGC feature at the 4243B network prevents excessive levels of speech or noise which may result in acoustic disturbance to the operator. As shown in Fig. 12, the AGC control samples the receive path level and controls the gain of VGA. With an input level of less than -22 dBm, the VGA operates at zero gain. As the

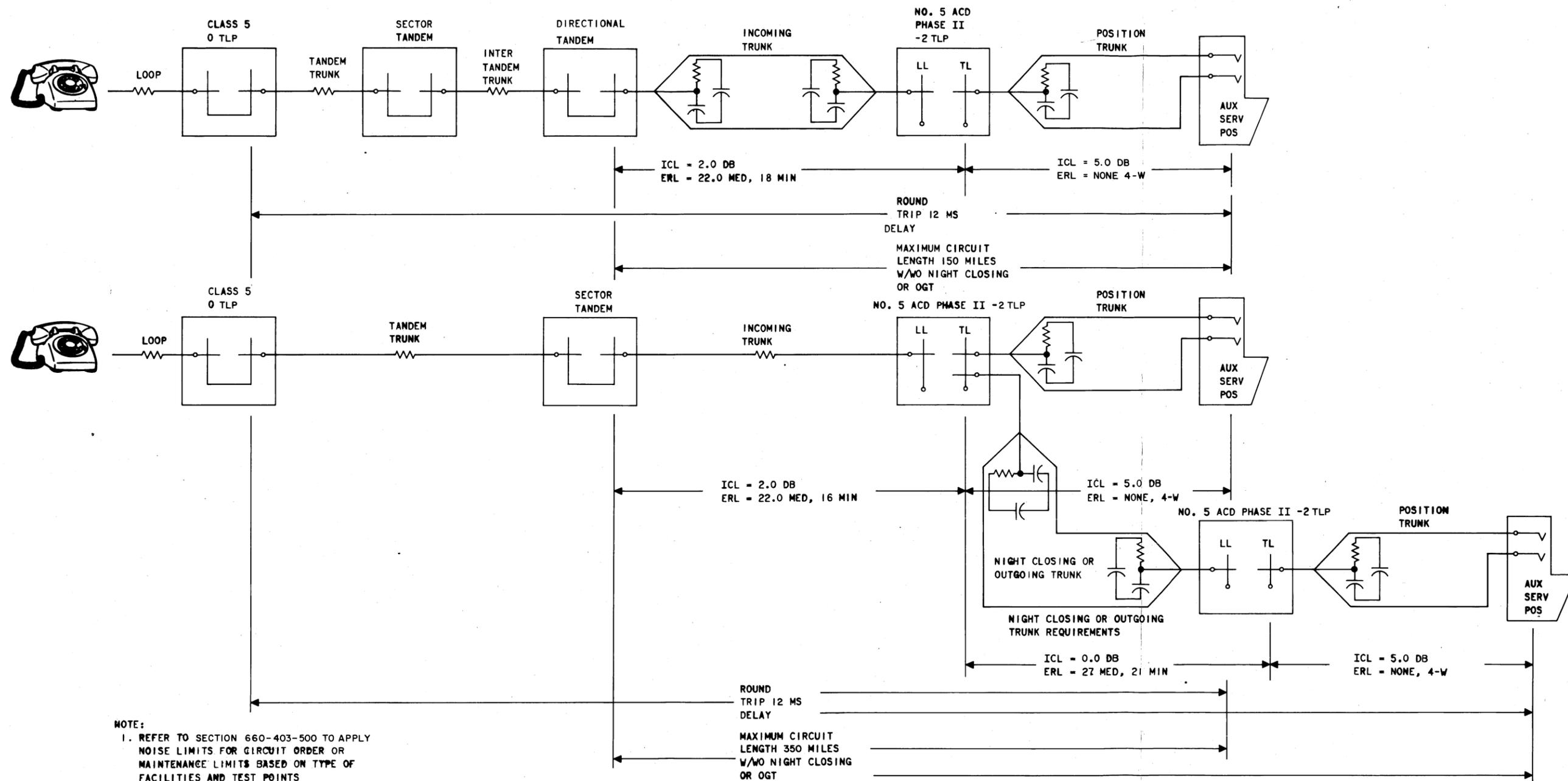


Fig. 7—No. 5 ACD Phase II Intra-NPA-DA Transmission Requirements

TABLE D

## TRANSMISSION REQUIREMENTS NO. 5 ACD – PHASE II

INTRA-NPA-555-1212 TYPE CALLS		
	ICL	ERL
Directional tandem to ACD	2.0 dB	22 dB
Directional tandem to ACD	0.5 dB*	—
Sector tandem to ACD	2.0 dB	22 dB
Sector tandem to ACD	0.5 dB*	—
Night closing trunk	0.0 dB	27 dB
Round trip delay:		
Class 5 office to ASP	12 milliseconds	
Maximum connection length:		
Directional tandem to ASP	150 route miles	
Directional tandem to ASP	250* route miles	
Sector tandem to ASP	350 route miles	
Sector tandem to ASP	500* route miles	

*Note:* Refer to Section 660-403-500 for noise requirements.

\* See 4.09.

input level increases above  $-22$  dBm, the VGA maintains the operator receiving level to a maximum of  $-22$  dBm. The receive level power input to output power is shown in Fig. 13.

### C. Operator Headsets

**5.08** At present, within the Bell System, there are several varieties of operator headsets being used. These headsets have varying electroacoustic efficiencies and impedances. An ACD operator may handle several different types of traffic especially when on a night closing team. Because of these problems, care must be exercised in equipping the operators with certain headsets to be used by Phase II operator teams.

**5.09** Because of the expected high usage of the lightweight headsets, the lineup guidelines for ACD operator trunks are based on the use of the 60A and 61A headsets. The 60A, 61A, KS-20778 List 16A, or KS-21118 should be used by Phase II operator teams. The 52A, 52AD, 52S, KS-19796,

or unmodified KS-20778 should not be used by ACD Phase II operators.

### D. Operator Sidetone and Room Noise

**5.10** The Phase II 4-wire operator telephone circuit incorporates a separate amplifier to provide local operator sidetone. This amplifier can be adjusted to provide the objective 12 dB of acoustic sidetone path loss when a 60A or equivalent operator headset is used.

**5.11** Intercept presents special sidetone problems in the ACD system Phase II because the reflections generated at the intercepting end office and at the concentrator are amplified by the high electroacoustic efficiencies of the ACD operator trunk. To solve this problem, the sidetone amplifier is not used in the operator telephone circuit until the length of the ACD connection becomes so long that these reflections begin to turn into operator talker echo. A maximum RTD of 5 ms is suggested between intercepting end office and the operator. When the RTD exceeds 5 ms, the voice-switched

attenuator and the sidetone amplifier should be provided in the operator telephone circuit.

**5.12** The worst case for ACD intercept operator sidetone will occur on local intercept calls because of the echo contribution of the local plant at the originating end office. Referred to the concentrator or ACD end of the circuit, the sum of loop and concentrator trunk reflections plus the addition of the intercept operator trunk return gain yields an acoustic sidetone path loss distribution of  $10 \sigma 2$  dB. About 15 percent of these calls will have losses below the minimum 8-dB objective. However, this is the worst case; and on metro intertandem and toll intercept calls, performance nearing the 12-dB sidetone path loss objective will be realized. Since the majority of the traffic will be metro tandem and toll, the sidetone performance should be acceptable.

**5.13** The sidetone objective of 12 dB assumes an operating room noise level which is comparable to that of a typical subscriber location. Excessively high room noise may result in customer and operator transmission complaints due to severe receiving sidetone penalty caused by room noise feedback through the sidetone path.

**5.14** Excessive room noise may cause nonoperation of the VSA associated with the 60A or 61A operator headset as well as the VSA in the operator telephone circuit. Operation of these amplifiers due to excessive room noise will defeat the voice-switched feature and create a severe operator sidetone problem. Therefore, it is recommended that the room noise be held to an average level of 55 dB (A) (see note) and a maximum of 62 dB (A).

**Note:** Refer dB re 0.00002 N/m<sup>2</sup> with A-weighting—see ANSI (American National Standard Institute) S1.4, issued 1971.

#### **E. Circuit Round Trip Delay**

**5.15** Customer-operator ACD connections cannot meet talker echo performance objectives unless the RTD requirements are complied with. The RTD increases as the circuit length increases. When the circuit is composed of cable, the delay is greater per circuit mile (Fig. 14) than with the circuit made up of carrier facilities (Fig. 15).

**5.16** As the RTD increases, the voice energy returned to the operator appears as an echo, and the circuit will approach an unacceptable condition. To overcome this condition, a voice-switched attenuator is added in the operator receive circuit. The attenuator presents approximately 0.5-dB bridging loss in the nonoperated state and increases to a 15-dB loss when the operator is talking. The sidetone amplifier is connected on the operator side of the attenuator so that the sidetone is not reduced when the network is operative.

**5.17** The voice-switched attenuator (4243B network) is not a part of the operator position control circuit or the operator position circuit but is magnetically mounted and connected by means of plugs. The VSA should always be used if the RTD of the connected circuit exceeds the delay requirements for the type of service used.

#### **F. System Balancing**

**5.18** The No. 5 ACD System plays a very important part in the intertoll network transmission plan because it terminates and switches intertoll traffic. The class of office in the No. 5 ACD varies with the type of traffic the ACD is handling. It may be classed as a sector tandem, directional tandem, or a class 4 or class 3 toll office. The ACD should meet balance requirements for the highest class connection of which it may be a part. Because the transfer feature allows any line circuit to become involved in a 3-way connection where one or both of the operators may be remote from the ACD switching machine, the ACD should at least meet terminal balance requirements on every connection except unconcentrated local DA.

**5.19** In cases where a line circuit, terminating a 4-wire incoming facility, is switched to a dedicated night closing trunk or is transferred by an operator to an outgoing trunk circuit, the connections should meet through balance requirements since the ACD has a class 3 rank in these cases. Balance requirements and test procedures for the No. 5 ACD System are covered in Sections 660-478-301 and 660-478-502.

#### **G. System Wiring Restrictions**

**5.20** The No. 5 ACD System Phase II incorporates new features which impose stringent restrictions in the system wiring if transmission objectives proposed for Bell System operator services are to

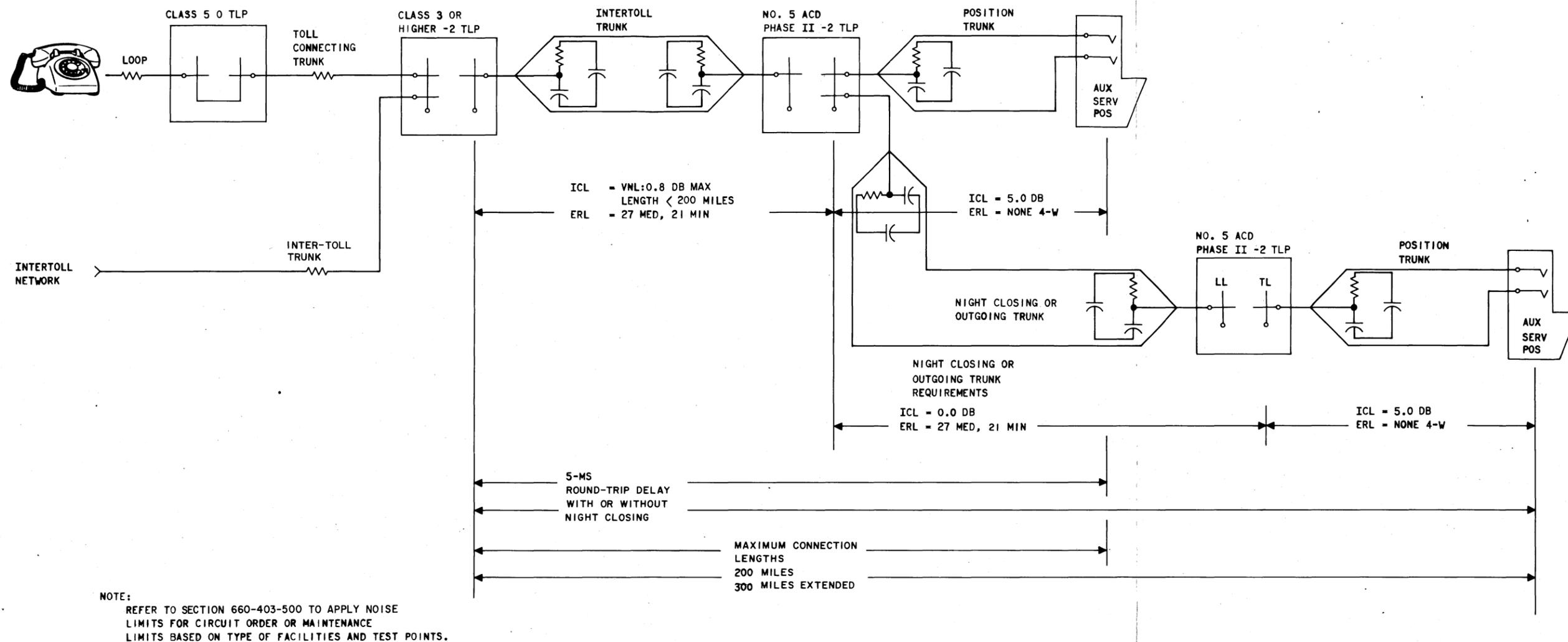


Fig. 8—No. 5 ACD Phase II Toll DA Transmission Requirements

TABLE E

## TRANSMISSION REQUIREMENTS NO. 5 ACD – PHASE II

TOLL DIRECTORY ASSISTANCE – NPA-555-1212 TYPE CALLS		
CLASS 3 OFFICE TO ACD	ICL	ERL
0 to 125 miles	0.5 dB	27 dB
126 to 200 miles	max-0.8 dB	27 dB
Night closing trunk	0.0 dB	27 dB
Round trip delay	5 milliseconds	
Maximum connection length:		
Without night closing	200 route miles	
With night closing	300 route miles	

*Note:* Refer to Section 660-403-500 for noise requirements.

be met. The transfer capability of the ACD Phase II is the feature most confining to the transmission plan and system layout. A toll DA call, entering the ACD from a class 3 or higher toll office, transferred to an outgoing trunk, or transferred via the junctor to another operator team must meet through balance requirements if the transfer destination is another switching point.

**5.21** Figure 16 shows the maximum and minimum lengths of the various segments of office wiring which can be allowed if night closing trunks or OGTs are switched by the ACD. Considerations which affect this layout plan include the following:

(a) Longer wiring lengths are allowed on the line side of the ACD switch than on the trunk side since both ends of the line circuit are run to an intermediate distributing frame (IDF) and back while the trunk circuits are hard wired to the trunk link frame.

(b) Restricting wiring lengths from the trunk link frame to the trunk circuits to a range of 20 to 200 feet allows the objectives to be met with no drop buildout capacitors on the trunk side. This is an advantage since in the majority of connections the ACD has class 4 rank and present class 4 balance practices call for building out the line side of the switch only.

(c) Since the wiring lengths associated with the NICs are properly restricted, the network buildout (NBO) capacitor of each NIC will be set to .002  $\mu$ f further simplifying the office balance procedures.

**5.22** The wiring lengths from the junctor circuits to the line link appearances may be run through a distributing frame only if the 100-foot length is not exceeded. This may necessitate using a small cross-connect field located near the junctor circuits. The 100-foot length could be exceeded if 22- or 19-gauge cable is used for the junctor wiring. The cable capacity increases with cable length, and the increase in capacity would require an adjustment in the network buildout capacitors in the NICs.

#### H. No. 23 Trunk Concentrators

**5.23** When the transmission plan for a No. 5 ACD System Phase II proposes using a No. 23 trunk concentrator, several modifications must be made to improve the performance of intercept and local DA connections. The modifications are as follows:

(a) Use of low-loss transformers and midpoint capacitors in the concentrator trunk circuits.

**SECTION 852-406-101**

(b) Provision of jacks in the trunk circuits for line-up and maintenance.

**5.24** The ICL of a properly modified No. 23 concentrator is 0.6 dB at 1 kHz between 900-ohm terminations.

**I. No. 1 Trunk Concentrators**

**5.25** The No. 5 ACD System Phase II proposes a new concentrator that is a 4-wire crossbar switch with improved transmission and maintenance features. Shown in a typical local DA arrangement (Fig. 17), the No. 1 Trunk Concentrator (TC) can concentrate 2-wire and 4-wire incoming trunks to an ACD. The trunks between the No. 1 TC to the ACD should be engineered as 4-wire facilities.

**5.26** In order to match the carrier levels (-16 and +7 dB level) in the carrier facility, pad loss is necessary in the transmit and receive pairs.

The transmission requirement for ICL is 3.0 dB from a 2-wire or 4-wire incoming trunk to the No. 5 ACD routed via the No. 1 TC.

**6. REFERENCES**

**6.01** The following list of reference sections are given to assist the transmission engineer in the No. 5 ACD System design:

<b>SECTION</b>	<b>TITLE</b>
103-106-115	Return Loss Measuring Set KS-20501
660-478-XXX	No. 5 ACD System Balance Practices
801-205-174	Portable Auxiliary Trunk Test Set

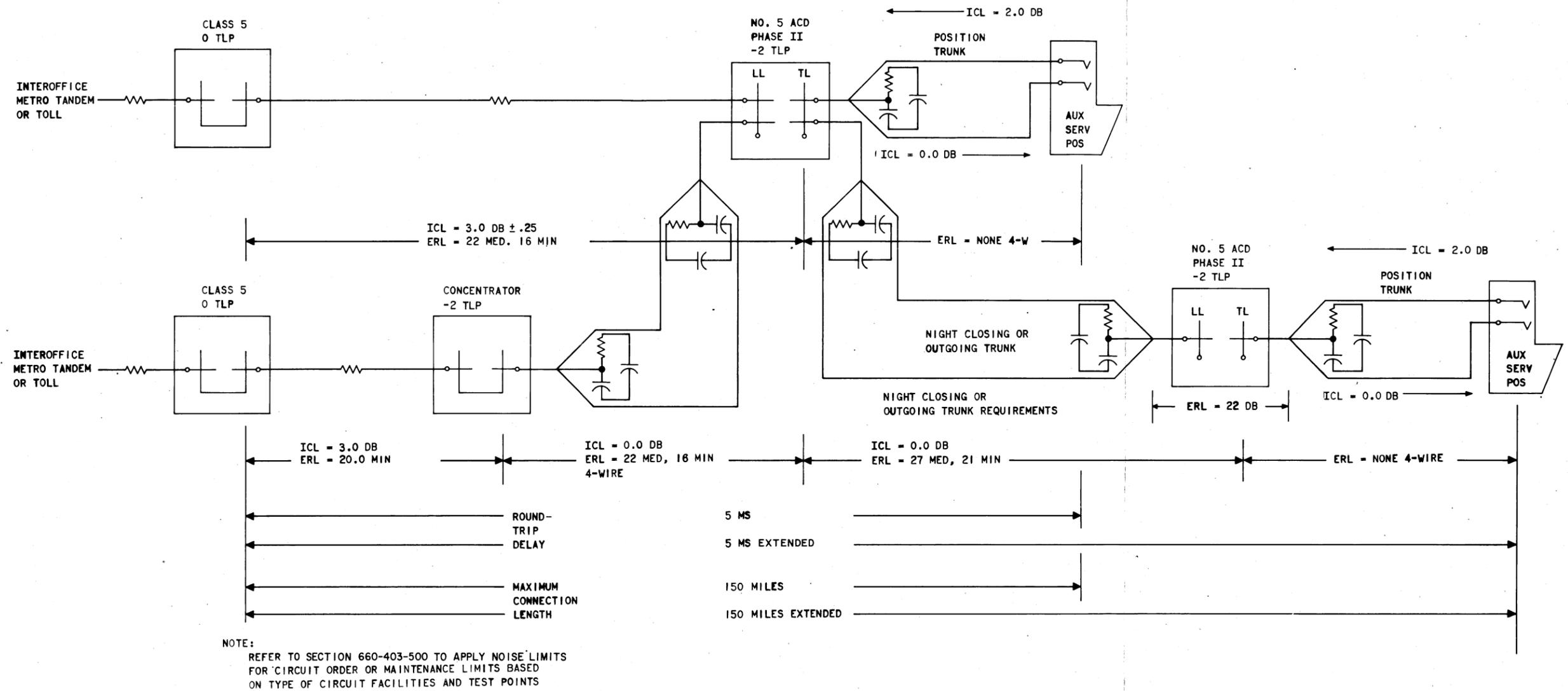


Fig. 9—No. 5 ACD Phase II Intercept Transmission Requirements

TABLE F

## TRANSMISSION REQUIREMENTS NO. 5 ACD – PHASE II

INTERCEPT CALLS		
	ICL	ERL
Class 5 office to ACD or Concentrator	3.0 dB	22 dB
Concentrator to ACD	0.0 dB	22 dB
ACD to ASP	0.0 dB	—
ASP to ACD	2.0 dB	—
Round trip delay:		
Class 5 office to ASP	5 milliseconds	
Maximum connection length:		
Class 5 office to ASP	150 route miles	

*Note:* Refer to Section 660-403-500 for noise requirements.

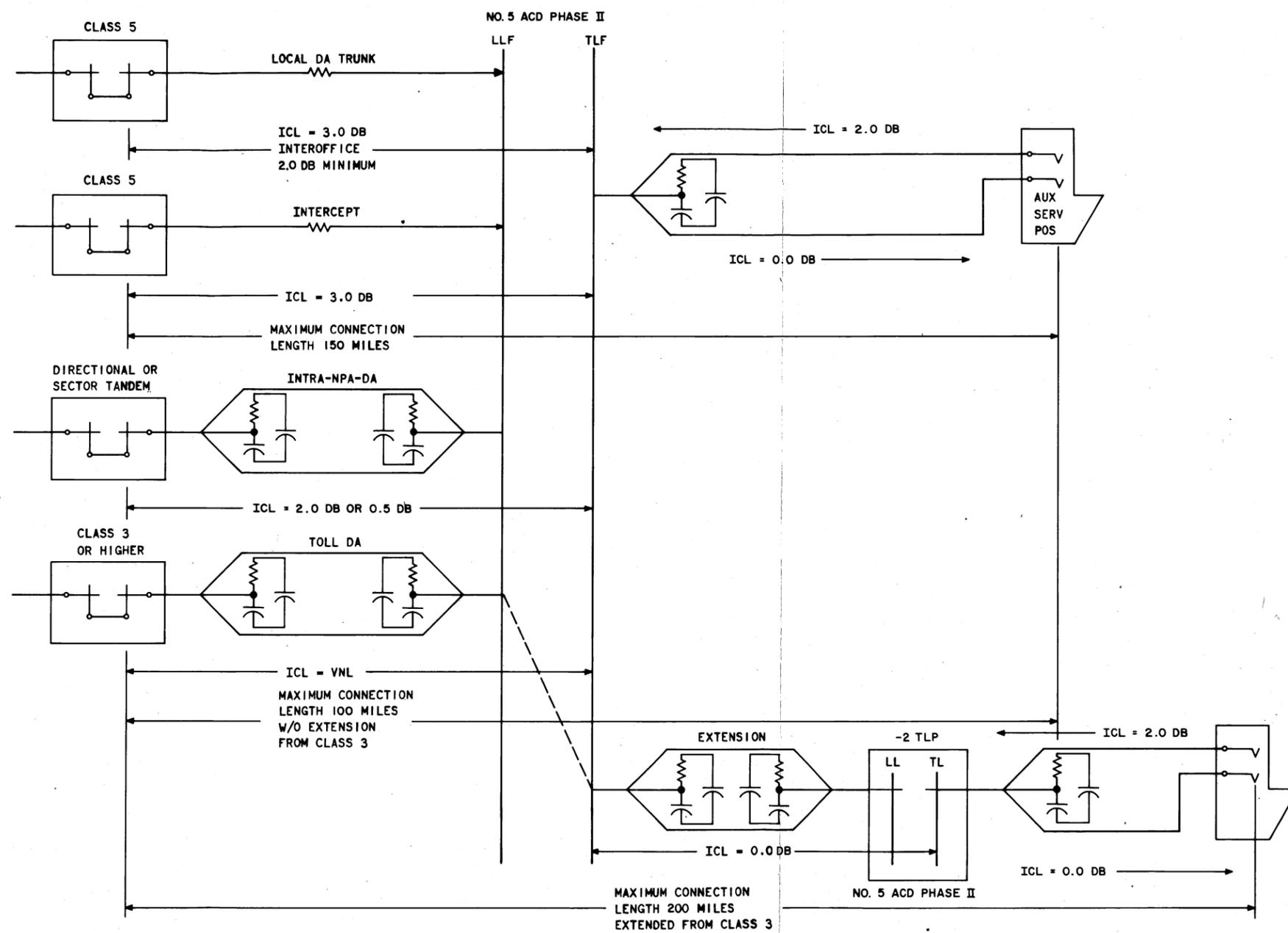
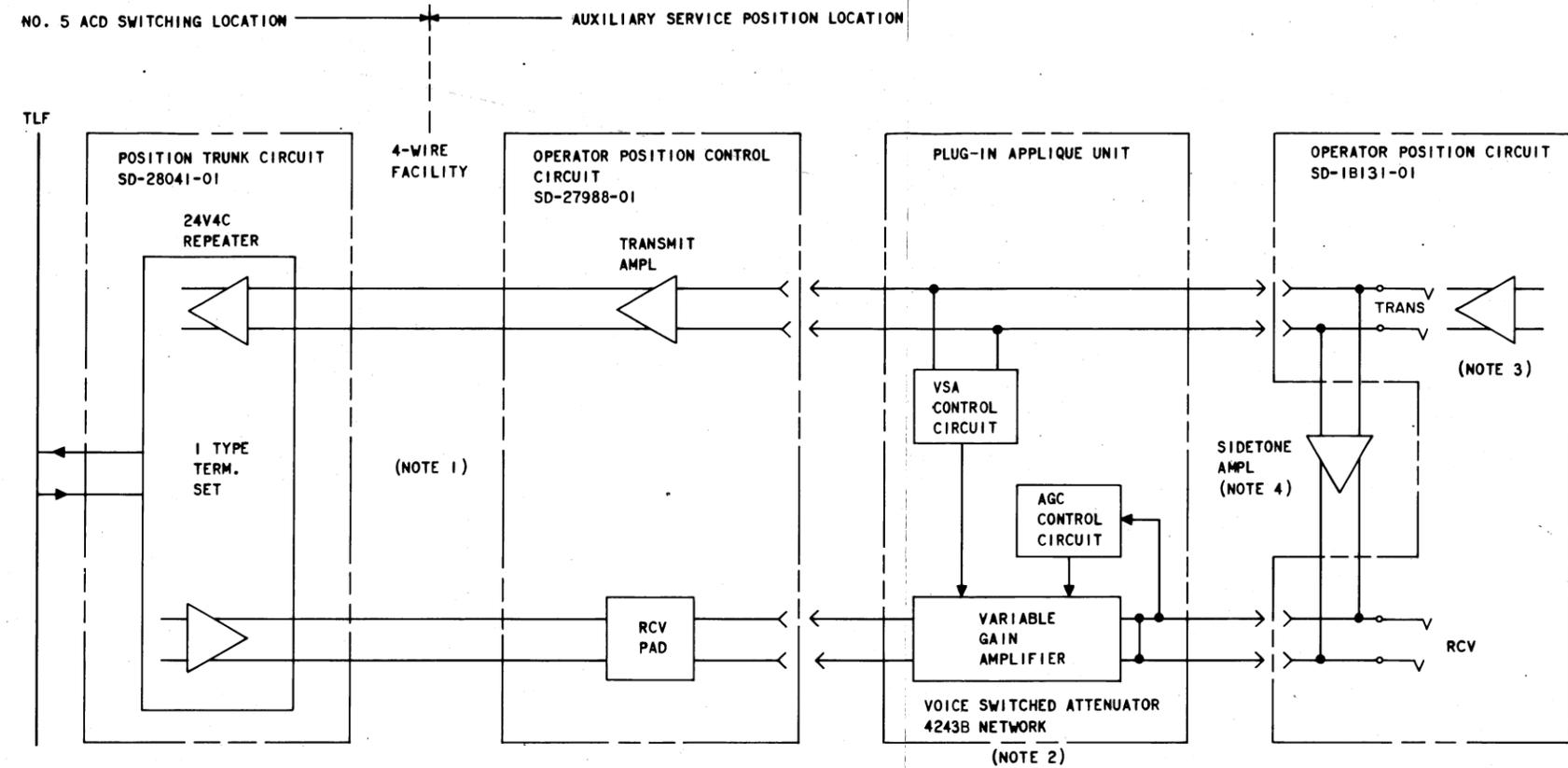


Fig. 10—No. 5 ACD DA and Intercept Combined Team Operation Transmission Requirements

TABLE G

## TRANSMISSION REQUIREMENTS NO. 5 ACD – PHASE II

DIRECTORY ASSISTANCE – INTERCEPT COMBINED TEAM		
	ICL	ERL
Local and Intra-NPA		
Class 5 office to ACD	3.0 dB	22 dB
Intra-building minimum	2.0 dB	—
Tandem office to ACD	2.0 dB	22 dB
ACD to ASP	0.0 dB	—
ASP to ACD	2.0 dB	—
Round trip delay:		
Any connection	5 milliseconds	
Maximum connection length:		
Class 3 office to ASP		
Without night closing	100 route miles	
With night closing	200 route miles	
Intercepting end office to ASP	150 route miles	



- NOTES:
1. THE FACILITY CONNECTING THE POSITION TRK CKT AND THE OPERATOR POSITION CONTROL CKT IS MADE UP OF CABLE OR CARRIER WITH DATA SETS.
  2. THE APPLIQUE UNIT IS A VOICE-SWITCHED ATTENUATOR WHICH IS PLUGGED IN BETWEEN THE POSITION CONTROL AND POSITION CIRCUIT AS REQUIRED TO REDUCE ECHO RETURN TO THE OPERATOR AND CONTROL RECEIVE LEVEL.
  3. THIS AMP. IS VOICE-SWITCHED AND IS A PART OF THE 60A OR 61A OPERATOR HEAD TELEPHONE SET.
  4. THE SIDETONE AMPLIFIER IS A PART OF THE POSITION CONTROL CIRCUIT SD-27988-01.

Fig. 11—No. 5 ACD System Phase II Operator Trunk Circuit

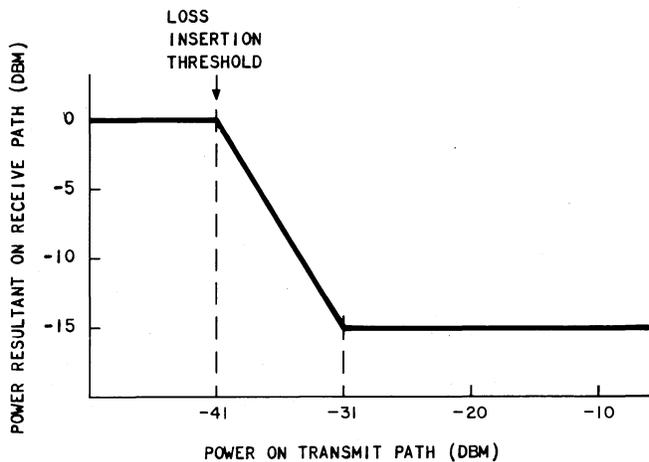


Fig. 12—Receive Path Loss vs Transmit Path Power 4243B Network

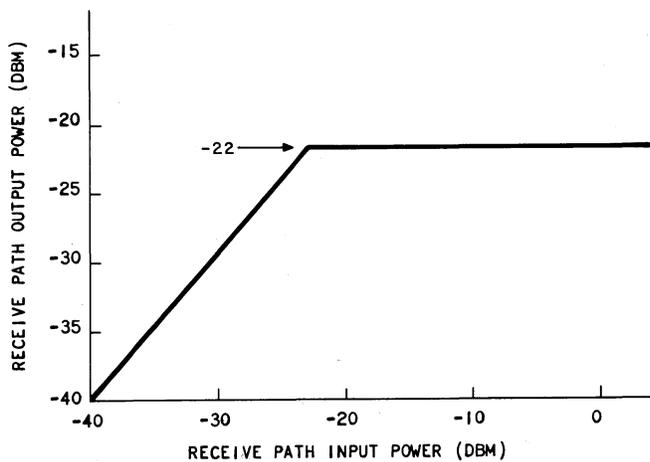


Fig. 13—Receive Path Output vs. Receive Path Input 4243B Network

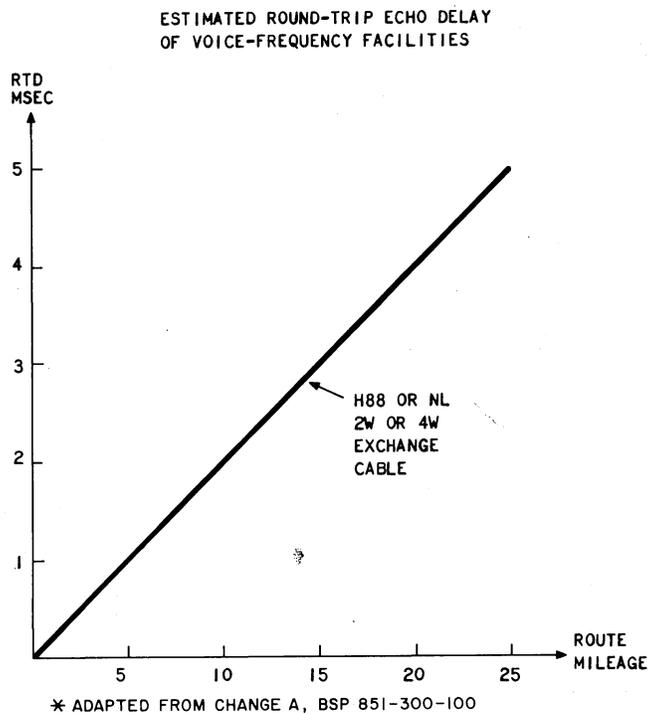


Fig. 14—Estimated Round-Trip Echo Delay of Voice-Frequency Facilities

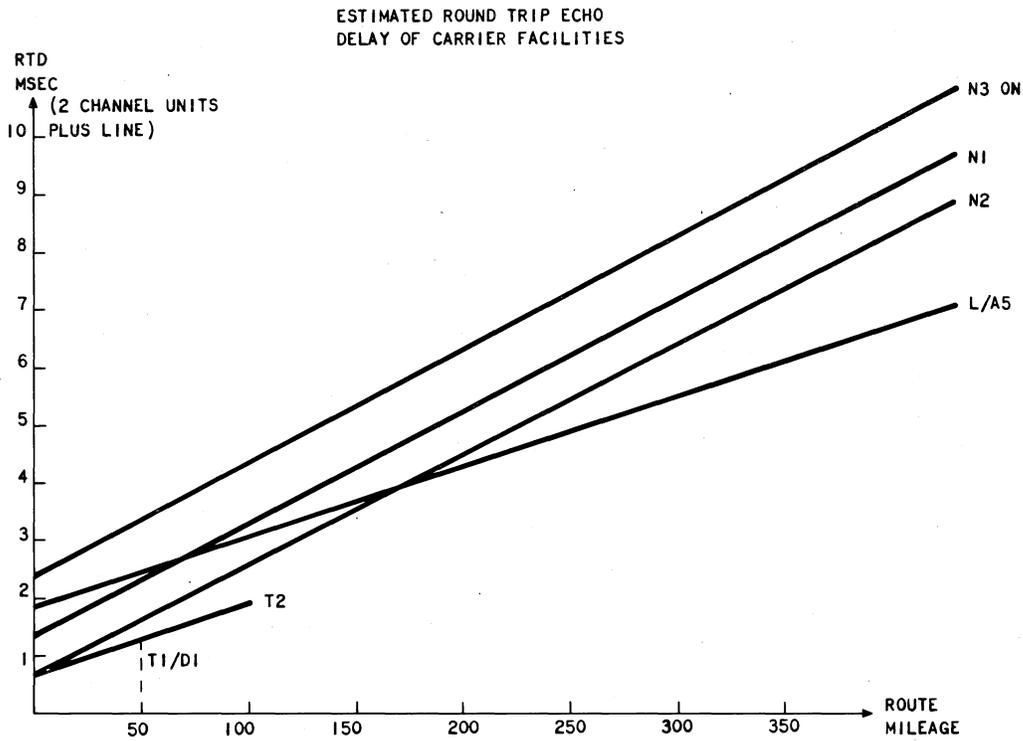
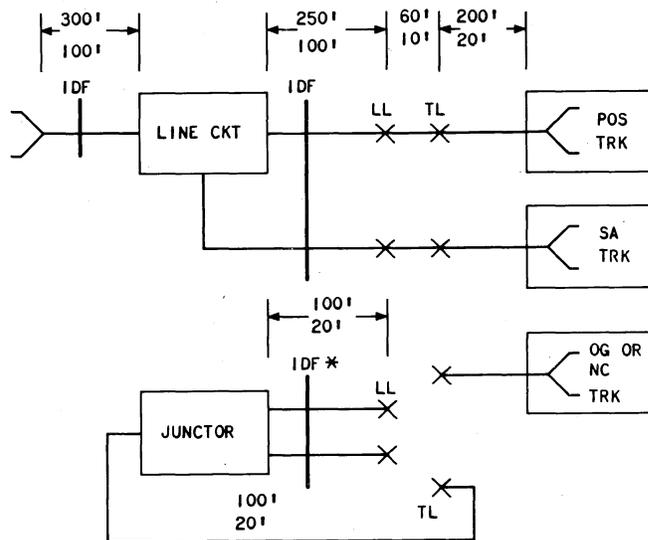


Fig. 15—Estimated Round-Trip Echo Delay of Carrier Facilities



\* - JUNCTION LINE APPEARANCES MAY BE RUN THROUGH DISTRIBUTING FRAME ONLY IF 100' LENGTH IS NOT EXCEEDED.

Fig. 16—No. 5 ACD Phase II Office Wiring Restrictions for 24 Gauge Cable

LOCAL DA ACCESS TRUNKS - CONCENTRATED  
2-WIRE AND 4-WIRE TO NO. 1 TRUNK CONCENTRATOR

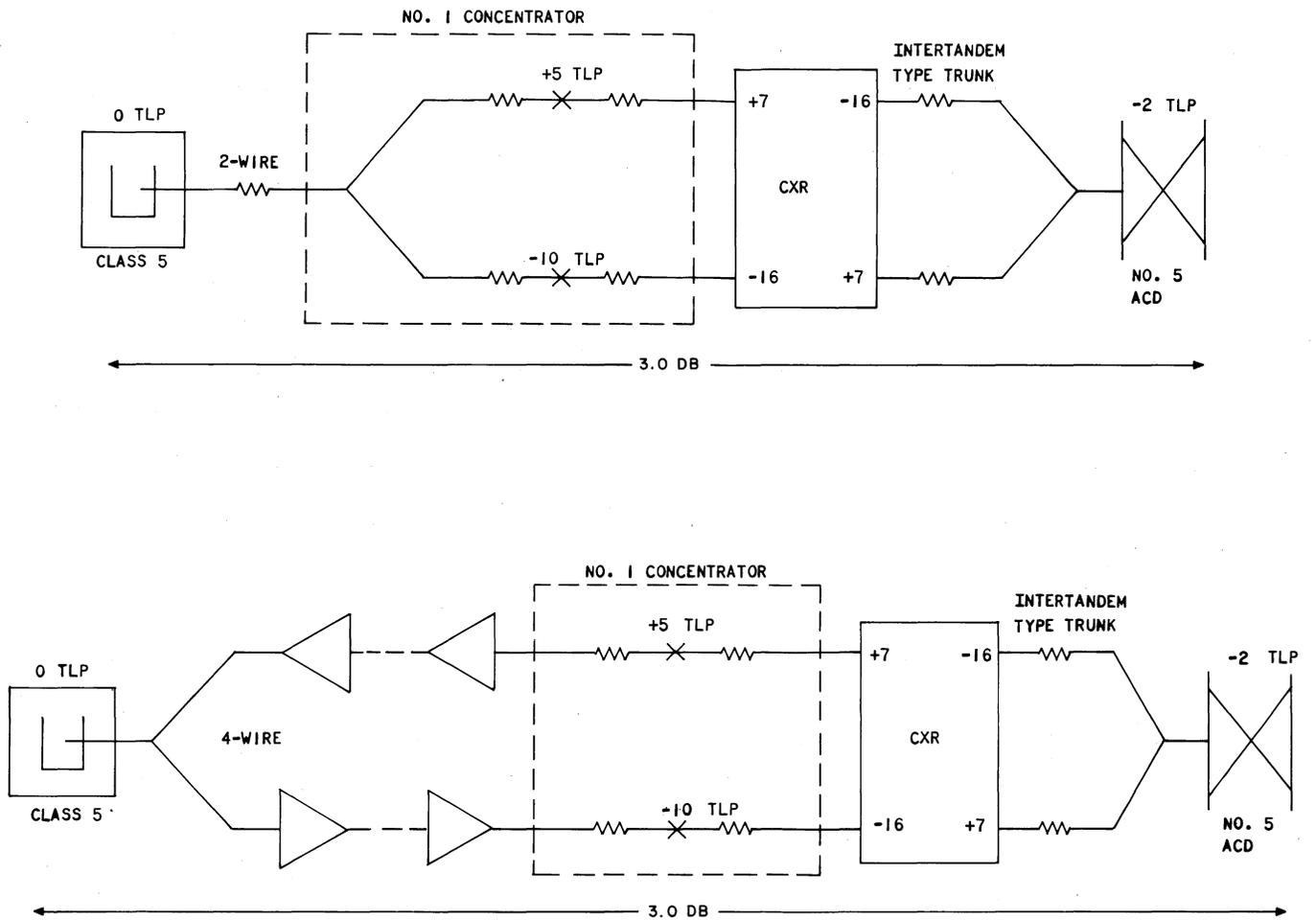


Fig. 17—Local DA Access Trunks—Concentrated 2-Wire and 4-Wire to No. 1 Trunk Concentrator