

subject: Customer Telephone Facilities - 770A PBX Traffic
Business Services - Facilities Engineering
Information



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MAY 13 1972

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MR. MORSE to: General Traffic and Switching Managers (Copies to Chief Engineers)

Mr. Adame
Mr. Adams

from: Traffic Operations Director - Business Services

synopsis: The attached Notes provide the latest available traffic information on the 770A PBX and supersedes letters GL 71-06-009 (June 1, 1971) and GL 71-07-037 (July 8, 1971). Information is included on equipment, traffic registers, trunk balance, traffic engineering and a sample traffic order.

* * *

The 770A PBX has been under continuous design development which has changed information faster than it can be documented. The attached Notes reflect the status of the PBX as of January 10, 1972. Development is continuing at the present time and any new or changed information will be included in later correspondence.

The Notes supersede General Letters GL 71-06-009 (June 1, 1971) and GL 71-07-037 (July 8, 1971) for planning and traffic engineering purposes. They may be used in the interim in place of the proposed Traffic Business Services - Traffic Facilities Practice - Division D, Section 7 until more formal Traffic Engineering Notes are released early in the second Quarter of 1972.

If there are any questions, Mr. J. L. Baker may be called in Denver on Area Code 303 427-3818.

A large, stylized handwritten signature in black ink.

Traffic Operations Director

Attachment

1. GENERAL

The 770A PBX is a cabinetized common control switching system using a single marker and a three stage crossbar network. It is designed as an economical, competitive PBX system offering 100, 200 and 300 Series Service Packages and Hotel/Motel features. A 2-type console is used as an attendant position. Two consoles are available on a trunk multiple basis. Switch-board operation is not provided.

The system is unique in what functions it is capable of performing. These functions and the limitations should be understood before committing the system to a particular customer.

2. CAPACITY

2.01 The various components of the 770A PBX are plug-ended. This design allows greater flexibility and relative ease in providing additional equipment. The capacity is determined by several factors.

Lines

2.02 A line switch has 40 line ports. Station lines, attendant position circuits, conference circuits and tie trunks require one line port each. A maximum of 10 line switches (400 line ports) may be provided.

Trunks

2.03 A trunk switch has 20 trunk ports, which terminate central office type trunks, tie trunk interface circuits, intercom trunks, busy tone trunks, attendant trunks, dial pulse registers, dial transfer units, and conference circuits. Intercom trunks and dial transfer units require two trunk ports while the conference circuit requires five trunk ports. All other circuits require one trunk port. There is no theoretical limit to the number of trunk switches that may be provided. There is a practical limitation of ten trunk switches or 200 trunk ports.

Calls

2.04 The number of calls that can be processed per hour depends upon the following: the number of registers provided, the capacity of the marker, and the network CCS capacity. A minimum of two registers are provided. The register capacities are discussed in the Engineering Steps. Maximum register quantities are unlimited. The capacity of the marker is expected to handle most systems. The actual marker capacity will vary with each system and with the percent of intercom traffic. See marker capacities in 5.01 and in the Engineering Steps.

The network is flexible and provides a wide range of CCS capabilities at all line sizes. Table B of the Engineering Steps illustrates this range.

Attendant Positions

2.05 One or two 2-type consoles with 30 direct trunk terminations can be provided. With one console, any combination of Central Office and attendant trunks may be used with, however, the attendant trunks being limited to a maximum of 10. Two consoles share the 30 trunks (maximum 24 C.O. trunks and 6 attendant trunks) on a multiple basis.

When DSS is provided, the 1-type selector console is used for 200 lines, and two 1-type selector consoles for 400 station lines.

Future plans call for using the new 23-type consoles, and for switched loop operation.

3. FIELD OF USE

3.01 The 770A PBX provides 100, 200 and 300 Series Service packages and certain Hotel/Motel features for customers that have requirements in the 40 to 400 line range. Because line ports are required for certain trunks as previously mentioned, a full 400 station line system cannot be provided.

Optional Features

3.02 Flexible number of stations (Hotel/Motel)
Lockout
Message Waiting (Hotel/Motel)
Single Digit Dialing (Hotel/Motel)
Station Message Registers (Hotel/Motel)
Tie Trunks (two-way Dial Repeating)
Toll Restrictions (Toll Access Digits 0 and 1 only)
Toll Terminal (Hotel/Motel)
TOUCH-TONE [®] Calling

4. SYSTEM ARRANGEMENT

All equipment is mounted on frames within cabinets. There are three frames per cabinet. The dimensions of each cabinet are 26 inches deep by 55 inches wide by 81 inches high. The frames are hinged so that they swing out in a gate-like fashion for access.

5. BASIC EQUIPMENT

Marker

5.01 One marker is provided with each 770A PBX. The marker is the basic control element of the system and is used once or twice in the completion of each call. The marker establishes connections between station lines, trunks and the registers and can process only one call at a time. On simultaneous bids for service, a lockout and preference arrangement is

provided. Preference is given to register (read-out) connection bids over dial tone bids. The marker makes only one attempt to complete a call. If the marker is unsuccessful within the predetermined time interval, the marker releases, which results in a failure to match condition. The marker will proceed with the next call if a marker bid is waiting. If the marker is taken out of service, or fails, the existing connections stay up but no new calls will be processed.

Register

5.02 The register furnishes dial tone and stores the pulses on all calls within the PBX. It can receive directly only rotary dial pulses. When TOUCH-TONE[®] calling is provided, a TOUCH-TONE[®] receiver is provided with each register, which receives the pulses and transfers them to the register.

When the full complement of digits have been stored, the register signals the marker to complete the call, and is released from the call unless the call is a C.O. call and the calling station is toll restricted. In that case the register remains on the call long enough to monitor the first digit dialed into the C.O. If the initial digit is 1 or 0 (toll access codes), the connection is broken down and reorder tone returned by the register.

The number of registers required is determined by the traffic load.

Line Switch

5.03 The line switch unit consists of a line switch circuit and a 10 x 20 6-wire crossbar switch which provides 40 line ports and 20 paths (links) to the mid-switch. The horizontals of the line switch serve as line ports, the verticals serve as links to the horizontals of the mid-switch. Each horizontal serves two line ports since each line requires three wires. Furthermore the horizontals are split in the middle so that each "half switch" has 20 line ports. Therefore, each group of 20 line ports has access to ten verticals (links) to the mid-switch. A maximum of 10 line switches may be provided.

Mid-Switch

5.04 The mid-switch is a 10 x 20, 3-wire crossbar switch serving as the second stage in the three-stage network. Each link from a given line switch appears as a horizontal cross-point on a single horizontal level of the mid-switch; i.e., each cross-point on horizontal 0 of the mid-switch serves the 20 links from line switch A, etc. Where more than one mid-switch is provided, each link from a line switch is multiplied to the same horizontal cross-point of every mid-switch.

The 20 verticals of the mid-switch act as the links to the trunk switch. Since the linkage between the mid-switch and the trunk switch is on a one for one basis, one mid-switch is required for each trunk switch provided.

Trunk Switch

5.05 The trunk switch is a 10 x 20, 6-wire crossbar switch and provides 20 trunk ports which are used for the various types of trunks required. The 20 links from the mid-switch appear as the 20 verticals on the trunk switch. Each 6-wire horizontal is arranged to provide two trunk port paths. Considerable flexibility is possible since most trunks may be randomly located on any available trunk port. The trunk switch units are provided in increments of 20 trunk ports each, but individual trunk circuits may be ordered in actual quantities required.

For systems requiring more than 20 trunk ports, one or more additional trunks switches must be provided.

Attendant Trunks

5.06 Attendant trunks are used to complete dial "0" calls from a station or tie trunk to the attendant. Stations or tie trunks dialing restricted trunk codes 6, 7, 8 or 9 are also routed to attendant trunks. A maximum number of trunks that may be provided is 10 when there is one console, or 6 with two consoles.

Central Office Trunks

5.07 Two-way Central Office Trunk units may be used for two-way central office, one-way outgoing central office, one-way incoming central office, FX, WATS, INWATS, or toll terminal trunks. A maximum of 24 trunks may be direct terminated on a two console operation. The trunk access codes are 6, 7, 8 and 9.

Intercom Trunks

5.08 Intercom trunk circuits are used in completing direct dialed station-to-station calls and tie trunk to station calls. Calls to unassigned stations lines are connected to intercom trunks. These trunks require two trunk ports per circuit. Both ends must be assigned in the same trunk switch and on the same horizontal. Four trunks are on a single mounting plate. However, all of them do not have to be plugged in.

Busy Tone Trunks

5.09 The Busy Tone Trunk provides 60 IPM busy tone on station-to-station calls to busy station lines. Permanent signals originating within the PBX also are connected to a busy tone trunk. One busy tone trunk is mounted on each mounting plate with four intercom trunks. However, the intercom trunks may be ordered without a busy tone trunk.

Tie Trunks

5.10 The 770A PBX is designed to work with dial repeating tie trunks via a tie trunk interface circuit. Access to the tie trunks is by single digit codes 6, 7 or 8. The tie trunks connect to the PBX equipment via a tie trunk interface circuit. Incoming calls use a station line termination. Tie lines have dial access to all stations via the intercom trunks and to all trunk codes if not restricted. An incoming Central Office call cannot be connected to a tie trunk.

Dial Transfer Unit

5.11 A station dial transfer unit is required to provide the call transfer-individual, consultation hold, and add-on features. These features are provided on incoming central office trunk to station calls only. One station dial transfer unit provides two transfer circuits for a maximum of eight central office trunks. The ratio may be reduced by providing additional transfer units. However, each unit will require two trunk ports each. The dial transfer trunk circuit remains up for the duration of the first transferred call.

5.12 The dial transfer unit is used when the trunk answer any station feature is provided. An incoming Central Office call is answered by dialing a trunk code: 6, 7 or 8.

Attendant Controlled Conference Circuit

5.13 The Conference Circuit permits a maximum of five conferees. Only one Central Office trunk may be connected to the conference circuit. A tie trunk cannot be connected to the conference circuit.

Attendant Position Circuit

5.14 One Attendant Position Circuit is required per console. It provides direct access to three registers for attendant dialing. It has a line appearance for attendant originated calls.

6. ATTENDANT FACILITIES

6.01 The 770A PBX uses the 2-type telephone console and the 1-type selector console (DSS). Switchboard operation is not provided. A maximum of two consoles may be provided. The console may be equipped with either a rotary or a TOUCH-TONE dial. If TOUCH-TONE is provided on the console only, TOUCH-TONE receivers are provided for the three direct connected registers only. The console has direct trunk terminations only.

Two Console Operation

6.02 Multiple console operation with direct trunk terminations can be provided with the 770A PBX where traffic conditions require more than one attendant. All trunks are multiplied at two attendant consoles. This arrangement is limited to two telephone consoles with no more than thirty key

terminated trunks. Each console may also be equipped with associated (DSS) selector consoles. Both consoles receive an indication when any trunk requires attendant handling and either attendant is able to select the trunks requiring assistance. A lockout arrangement prevents simultaneous trunk seizures by the attendants. Each attendant is able to handle calls simultaneously on separate, independently established connections. All incoming signals, audible and visual, to the attendants are received on both consoles and can be answered by either attendant. Only one attendant can be connected to the same trunk at a given time. When the attendant operates the pickup key, the associated trunk key lamp lights at the answering console only. While the call is in progress, normal trunk supervision is received on the source and destination lamps at the answering console. The DSS lamp associated with the called station will light at both DSS selector consoles. When a trunk is placed on hold, the trunk lamp at the console responsible for placing the trunk on hold will wink at 30 IPM. At the other console the trunk lamp associated with trunk on hold remains dark and the source and destination lamps remain steady. Either attendant can enter a trunk connection that has been placed on hold by depressing the associated trunk key.

Lockout

6.03 Prevents the attendant from re-entering a central office trunk connection after the called station answers. The attendant may re-enter the connection only in response to a recall signal or before the called party answers.

Conference

6.04 The conference key is located on either console. The attendant at the non-conference console receives a request for a conference call over the attendant trunk, the attendant dials the conference code and passes the call to the conference console.

Attendant DSS

6.05 The 1-type selector console allows the attendant to complete incoming central office calls to the PBX stations by operating the appropriate selector console key. The selector console (DSS) busy-lamp field display gives the attendant a constant visual indication of the condition, busy or idle, of each station. Depressing a selector DSS key automatically connects the calling party to the desired extension line and starts ringing. The DSS selection performs the same function as the register. Each telephone console may be equipped with one or two 200 DSS selector consoles, thereby giving the attendant DSS access to 200 or the full 400 stations lines, as required.

Night Service

6.06 Flexible night connections and remote answer can be established by either attendant. Removal of the handset or headset plug from the console extinguishes all lamps and silences all audibles at the console.

7. TRAFFIC REGISTERS

7.01 The following traffic register leads are provided and must be equipped because of the traffic sensitivity of the 770A system. The registers must be ordered separately; i.e., not as part of the Traffic Order.

Overflow

<u>Register Number</u>	<u>Register Lead Designation</u>	<u>Function</u>
1	AB	All mid-to-trunk switch links busy.
2	ARB	All registers busy.
3	APB	All matching paths busy through the switching network.
4	AAB	All attendant trunks busy.
5	COB	All outgoing central office trunks busy. (Dial 9 only)
6	BTB	All busy tone trunks busy.
7	AIB	All intercom trunks busy.
8	ATB	All trunks busy (except intercom trunks). (Includes AAB, COB, BTB and level 6, 7 and 8 tie trunks.)
9	AEB	All equipment busy (Includes AAB, COB, BTB and AIB.)

Peg Count

10	DCC	Scores once each time the marker completes an operation. Includes MTM.
11	MTM	Scores once each time the marker times out.
12	ICT*	Scores once each time an attempt is made to connect an incoming central office call.
13	INT*	Scores once each time an attempt is made to connect to an intercom call.
14	OCT*	Scores once each time an attempt is made to connect a call to an outgoing central office trunk.
15	ATT*	Scores once each time an attempt is made to connect a call to an attendant trunk.
16	RGC	Scores once each time a register connects to the marker in the read-out mode.
17	OTT	Scores once each time an attempt is made to connect a call to a level 6 outgoing tie trunk.
18	ITT	Does not function under present design.

<u>Register Number</u>	<u>Register Lead Designation</u>	<u>Function</u>
19	SRG1	Spare. (Lead appears at the marker terminal strip U44)
20	SRG2	Spare. (Lead appears at the marker terminal strip U43)

* Represents an attempt by the marker to find an idle trunk before connection to a trunk or to reorder if all trunks are busy.

7.02 To connect levels 7 and 8 for peg count:

Level 7 is the M1 lead in the marker and appears at the marker terminal strip U23. Crossconnect U23 to U44 which is the SRG1 lead to register 19. Level 8 is the M2 lead in the marker and appears at the marker terminal strip U24. Crossconnect U24 to U43 which is the SRG2 lead to register 20.

Traffic Register Operation

7.03 The use of the Overflow and Peg Count registers will give an indication of the performance of the machine in terms of adequate provision of components and trouble indication. The following information can be derived from these traffic registers:

- Marker Peg Count - total seizures - DCC register
- Register Peg Count - total seizures - RGC register
- Total Calls, In and Out through the PBX switching network excluding incoming Central Office calls connected by DSS - RGC register
- Originating calls from the line side; includes station, tie trunks, attendant circuit line, and conference - sum of INT + OCT + ATT + OTT + (SRG1 and 2 if used for levels 7 and 8 registers)
- Permanent signals from the line side - RGC register minus the sum of ICT + INT + OCT + ATT + OTT + (SRG1 and 2 if used for levels 7 and 8) registers.
- Total overflow to trunk codes 6, 7 and 8 - ATB register minus the sum of AAB, COB and BTB registers.
- Marker Time Out - MIM register operates on all matching paths busy, some calls to a busy station in a station hunt group, calls to a busy station when using dial transfer. This applies to some of the systems but not all of them.
- Originating Matching Loss - APB register. Indicates an idle trunk but no available link from either the line-to-mid-switch of the mid-to-trunk switch or both. There is no method of determining which links caused the matching loss.
- AB register indicates all links to all trunk switches are busy. This should be a rare occurrence and not happen at all if a trunk port is not used.

- AEB register - totalizes trunk overflow. May be useful in case of a trunk overflow register failure. Readings could be generated by subtracting the sum of the other trunk overflow registers from this register.

Note: Incoming tie trunk calls function in the same manner as a station originated call. There is no method of counting these calls separately.

8. TRAFFIC CONSIDERATIONS

Numbering Plan

8.01 Station numbering is based upon a three-digit number plan. A three or four digit numbering plan is available with the Hotel/Motel 770A PBX which permits the PBX stations to be matched with the room numbers. Single digit dialing for room service, etc., is available for Hotel/Motel PBX's. A typical three-digit numbering plan is:

REGULAR PBX

DIALING CODE	DESTINATION
0	Attendant
1	Unassigned
2XX	Stations
3XX	Stations
4XX	Stations
5XX	Stations
6)	(Tie Trunks, FX, Conference,)
7) -----	(WATS, Trunk Answer-Any-)
8)	(Station)
9	Central Office Trunks

HOTEL/MOTEL PBX

0	Attendant
1	Unassigned
2-7	Single Digit Dialing (Stations)
6	Miscellaneous Trunks
7	Miscellaneous Trunks
8	Toll Terminal
9	Central Office
Flexible 3 or 4 Digits*	Stations (Room Numbers)

*Note: The first digit of station numbers cannot be the same as a trunk code; 6, 7, 8 or 9. The use of four digit station numbers will solve any conflict in numbering plans, such as 2234, 2355, etc.

Line Balance

8.02 Each line switch is divided into two subgroups of 20 line ports each.

Each subgroup has access to all trunk ports in the system via 10 links. An intercom call (station-to-station call) requires two links. When an intercom call is completed within one subgroup, two of the ten links are used. Assignments should be made so that stations or tie lines which generate a considerable amount of intercom traffic are assigned to different subgroups.

As in any PBX system, station numbers must be assigned evenly over every line switch and subgroup. Balancing of the lines is essential to achieving the call carrying capacity of the switching network and reduce the probability of matching loss. Heavy users and tie trunks must be evenly distributed over all the subgroups.

Trunk Balance (Very Important)

8.03 The Engineering Steps detail the sizing of the switching network. The stated CCS per line values can only be obtained by balancing the trunks as evenly as possible over all the trunk switches. The order of trunk switch selection by the marker is from the highest numbered trunk switch to the lowest numbered trunk switch. Marker selection of a trunk occurs in the highest numbered trunk switch where an idle trunk of the type dialed is available and there is an available path from the calling line switch to the trunk switch. If more than one trunk of the type dialed is available within a trunk switch, the marker will select the trunk which appears on the lowest numbered trunk port.

For example: A PBX with four trunk switches A, B, C, D has idle dial 9 trunks in each trunk switch. All trunk switches have idle paths to the line switches. Trunk Switch D will be selected by the marker. When there are available paths from the line switch only to trunk switches A, B and C - then C will be selected. When the trunk switch has several idle trunks, the one appearing on the lowest numbered trunk port will be selected; starting with A0, U0, A1, U1 -- A9, U9. This is helpful when both one-way outgoing and two-way trunks have the same dial trunk code. By assigning the outgoing trunks on the lower numbered trunk ports and the two-way trunks on the higher numbered trunk ports, the one-way trunks will be selected first by the marker.

8.04 Marker time out will cause the order of trunk switch selection to change.

When marker time out occurs, the marker will give first preference to the middle trunk switch if there is an odd number of trunk switches, or to the trunk switch to the left of the middle if there is an even number of trunks; i.e., switch B if there are switches A, B, C and D. The order of trunk switch selection by the marker is from the middle numbered trunk switch to the lowest numbered trunk switch then from the highest numbered trunk switch to the middle numbered trunk switch. The next marker time out will return the order of trunk switch selection to the highest numbered trunk switch.

8.05 Distribution of trunks over all the trunk switches for each trunk group, will be done at the time of manufacture only under certain conditions. They are:

1. The PBX is a Series Service offering and is a large station and trunk size.
2. The PBX has three or less trunk switches which are in one cabinet.
3. When specifically requested to be balanced by the Telephone Company.

8.06 Distribution of trunks will be done only within a cabinet unless the Telephone Company requests differently in the following cases:

1. Hotel/Motel PBX's.
2. The PBX has a low CCS per line which would be reflected in a high station-to-trunk ratio.

8.07 Careful consideration should be given to trunk balance as described earlier in the text. Failure to balance trunks can result in:

1. Incoming matching loss.
2. Failure to achieve engineered call carrying capacity of the switching network.
3. A condition where the first ten or the second ten links from the mid-switch to the highest numbered trunk switch will all be busy. Even with idle trunks available in this trunk switch, one-half of all the station lines cannot be connected to these trunks. This is due to the busy link condition. This condition can be created if primarily outgoing trunks, and registers are assigned to the highest numbered trunk switch in an unbalanced method.

9. TRAFFIC ENGINEERING

The 770A PBX Switching Network is growable due to its plug-in crossbar switch design, and may be engineered to provide a wide range of traffic capacities.

The Traffic Engineer must determine the switching network configuration, marker and register capacities on the basis of stations, trunks and call rates for each system. This can be done by using the procedure that follows:

Engineering Steps

1. 770A Engineering Data
Estimate the total busy hour calls and holding time for all types of calls expected. Compute the busy hour CCS, register seizures and marker seizures for each type call using Figure 1.

2. Intercom Trunks

Total the busy hour usage requirements for:

- Direct dialed Station-to-Station
- Attendant completed Station-to-Station
- Attendant originated to station calls
- Tie Line to station
- Single digit dialing for room service (Hotel/Motel)

Using Poisson Table 10 P.01, determine the number of intercom trunks required.

3. Central Office, Toll, FX, WATS and INWATS Trunks

Two-way type C.O. trunks may be used for all types of Central Office trunks including FX, WATS and INWATS trunks. Use Poisson Table 10 (P.01) for determining trunk quantities for each group.

4. Tie Trunk Interface Circuits

Determine the number of Tie Trunks required using Poisson Table 10 (P.01) by trunk group. The total of these groups represents the tie trunk interface circuits required.

5. Attendant Trunks

Total the busy hour usage for all attendant trunk calls. Use the Poisson Table 10 (P.01) and determine the attendant trunk requirements. These trunks have short holding times. They release on attendant assisted trunk and station connections.

6. Registers

Total the busy hour register seizures for all calls from Step 1, Figure 1, Column L, and determine the register requirements from Table A.

7. Dial Transfer Units

Determine the number of dial transfer units required by dividing the total two-way and incoming Central Office trunks by 8. This figure rounded to the next whole number represents the dial transfer units required.

8. Conference Circuit

Determine the number of conference circuits required by the customer. Each circuit has 5 trunk port appearances and one line port appearance.

9. Busy Tone Trunks

Provide one busy tone trunk for each 100 lines or fraction thereof to be served by the system. The system should be equipped with a minimum of two busy tone trunks.

10. Trunk Switches

Enter the trunks from Steps 2 through 9 in the following table:

<u>Trunk Circuits</u>	<u>Trunk Ports Per Circuit</u>	<u>Ports Required</u>
_____ Intercom	X 2 =	_____
_____ Central Office	X 1 =	_____
_____ Tie Trunk Interface Type	X 1 =	_____
_____ Attendant	X 1 =	_____
_____ Registers	X 1 =	_____
_____ Dial Transfer Unit	X 2 =	_____
_____ Conference	X 5 =	_____
_____ Busy Tone	X 1 =	_____
_____ Total Ports		_____
Total Trunk Ports _____ ÷ 20 = _____		Trunk Switches _____ Rounded

To obtain the number of trunk switches required, multiply the trunk circuit entries by the port per circuit figure, obtain total ports and divide by 20. This number rounded off to the next whole number of trunk switches required based on terminations. (Use this figure in Step 13C.)

11. Mid-Switches

Provide one mid-switch for each trunk switch provided.

12. Line Switches

Total the number of station lines, attendant position circuits, tie trunks, interface circuits and conference circuits required at the exhaust of the engineering period.

This number divided by 40 and rounded off to the next whole number represents the number of line switches required.

Total Lines _____ ÷ 40 = _____ Line Switches _____ Rounded

13. Switching Network Call Carrying Capacity

A. Total the busy hour line port CCS requirements.

This is the total of the following:

- Conference line port CCS
- Station originating, plus terminating CCS
- Attendant position line port CCS
- Tie Trunk interface line port CCS

- B. Calculate the average CCS per line by dividing the busy hour line port CCS (13A) by the total lines (Total of the station lines, attendant position circuits, tie trunk interface circuits tie trunk interface circuits and conference circuits required at the exhaust of the engineering period from Step 12.)
 $13A \div 12 = \underline{\hspace{2cm}}$ CCS per line
- C. Compare the calculated average CCS per line with the capacity of the network configuration under consideration from Table B. This is the intersection of the trunk switches from Step 10 and the line switches from Step 12 at the desired level of service.
- If the calculated average CCS per line is equal to or less than that obtained in Table B, the network call carrying capacity is sufficient.
 - When the calculated CCS per line is greater than that shown at the intersection of the columns in Table B, follow the horizontal (Line Switches) column to the right to obtain a CCS per line that is equal to or greater than the calculated CCS per line. This vertical column represents the number of trunk switches necessary to obtain this capacity. Adjust the trunk switches necessary to obtain this capacity. Adjust the trunk switches in Step 10 to correspond to the new number of trunk switches. The trunk CCS load must be distributed as equally as possible over all trunk switches in order to obtain the required CCS per line.
 - If no value can be found that is equal to or greater than the calculated CCS per line, a decision must be made whether the 770A PBX is the proper system to provide for the customer.

14. Marker Call Carrying Capacity
Total the busy hour marker seizures from Step 1, Figure 1, Column M. This should not exceed 2665.

ENGINEERING DATA WORK SHEET

Figure 1

A	B	C	D	E	F	G	H	I	J	K	L	M
	EQUIPMENT COMPONENT REQD. PER CALL					FACTORS		ESTIMATES		CALCULATIONS		
	C.O. TYPE TRK	TIE TRK INT	ATND TRK	DIAL TRANS TRK	INTER-COM TRK	REG	MKR	CALLS	HOLD TIME SEC	CCS (IXJ) 100	SEIZURES	
											REG (GXI)	MKR (HXI)
Station to Attendant			1			1	2					
Station to Station Note 2												
Dialed Direct					1	1	3					
Through Attendant			1		1	2	4					
Sta. to C.O., FX or WATS W/O Toll Rest.												
Dialed Direct	1					1	2					
Through Attendant	1		1			2	3					
Sta. to C.O. or FX W/Toll Restriction												
Dialed Direct	1					1.3	2					
Through Attendant	1		1			2.3	3					
Sta. to Tie Trunk Note 3												
Dialed Direct		1				1	2					
Through Attendant		1				2	3					
Sta. or Tie Trk with Restricted Class of Service to Trk Code 6,7,8, or 9												
Dialed Direct			1			1	2					
Through Attendant												
Attendant to Sta.					1	1	2					
Attendant to C.O., FX or WATS	1					1	1					
Att. to Tie Trunk		1				1	1					
C.O., FX, or IN-WATS to Sta. Note 1												
Attendant Dial	1					1	1					
DSS	1						1					
Tie Trunk to Sta. Dialed Direct		1			1	1	3					
Through Attendant		1	1		1	2	4					
Tie Trunk to Att.		1	1			1	2					
Tie Trk to C.O., FX or WATS W/O Toll Rest.												
Dialed Direct	1	1				1	2					
Through Attendant	1	1	1			2	3					
Tie Trk. to C.O. or FX W/Toll Rest.												
Dialed Direct	1	1				1.3	2					
Through Attendant	1	1	1			2.3	3					
Tie Trk to Tie Trk. Dialed Direct		2				1	2					
Through Attendant		2	1			2	3					
Call Transfer - Dial To Station				1		1	1					
To Attendant			1	1		1	1					
Total												

Note:

1. Call must be handled by attendant
2. Include single digit dialing for room service, valet service, etc. on Hotel/Motel systems.
3. Include Trunk Answer Any Station and Conference access.

TABLE A

770A PBX REGISTER CAPACITIES

AVERAGE BUSY HOUR

REGISTER REQUIREMENTS	DIAL PULSE		TOUCHTONE ^R	
	CALLS	CCS	CALLS	CCS
2	130	8.6	240	9.4
3	370	23.8	640	25.9
4	620	40.3	1190	47.5
5	970	63.1	1800	72.0
6	1160	75.6	2130	86.4
7	1510	98.3	2770	110.9
8	1820	118.1	3380	135.4

ATTACHMENT - NOTES 770A PBX

TABLE B

770A PBX

Estimated Line Capacity (CCS)

Line Ports	<u>Trunk Ports</u>										Line Switches
	20	40	60	80	100	120	140	160	180	200	
40	10.04 9.14	10.08 9.35	10.13 9.50								1
80	7.52 6.84	9.07 8.21	9.75 8.70	10.04 9.00	10.05 9.20	10.05 9.3					2
120	4.97 4.57	7.52 6.84	8.57 7.78	9.20 8.25	9.50 8.60	9.60 8.80	9.60 9.10	9.40			3
160	3.60 3.31	6.08 5.54	7.52 6.84	8.32 7.56	9.0 8.1	9.4 8.5	9.5 8.78	9.5 9.0	9.1	9.2	4
200		4.93 4.57	6.55 5.94	7.52 6.84	8.17 7.38	8.58 7.80	8.85 8.05	9.0 8.26	9.1 8.42	9.1 8.60	5
240		4.18 3.82	5.65 5.18	6.77 6.16	7.52 6.84	8.06 7.31	8.55 7.70	8.85 8.0	9.0 8.2	9.0 8.35	6
280		3.60 3.31	4.97 4.54	6.08 5.54	6.91 6.30	7.52 6.84	7.99 7.24	8.35 7.6	8.54 7.9	8.6 8.1	7
320			4.43 4.07	5.47 4.82	6.34 5.76	7.02 6.37	7.52 6.84	7.92 7.20	8.2 7.5	8.3 7.7	8
360			3.96 3.64	5.15 4.54	5.83 5.33	6.55 5.94	7.09 6.44	7.52 6.84	7.82 7.2	8.0 7.55	9
400			3.60 3.31	4.54 4.18	5.36 4.90	6.08 5.54	6.66 6.05	7.16 6.48	7.6 6.9	7.9 7.3	10
	1	2	3	4	5	6	7	8	9	10	

Trunk Switches

Upper figure is CCS/Line at 2% matching loss

Lower figure is CCS/Line at 1% matching loss

TABLE C
CLASS OF SERVICE

Class of Service	Dial Codes Allowed			
	6	7	8	9
C2	X			
C3		X		
C4			X	
C5	X		X	
C6		X	X	
C7	X	X	X	
C8				X
C9			X	X
C10		X		X
C11	X			X
*C12	X		X	X
*C13	X	X		X
*C14	X	X	X	X

* C14 may be used for non-toll restricted class of service

* C12 or C13 may be used for toll-restricted class of service

TRAFFIC ORDER

Area _____
 Customer _____
 Address _____
 Series _____ Line Size _____ Trunk Size _____

<u>Station Line Requirements</u>	<u>Forecast</u>		
	<u>Cutover</u>	<u>2 years</u>	<u>Ultimate</u>
Stations	_____	_____	_____
Tie Trunks	_____	_____	_____
Attendant Position Circuits	_____	_____	_____
Conference	_____	_____	_____
(a) Total Station Line Ports	_____	_____	_____
Line Switches Required -- (a ÷ 40)	_____	_____	_____
Registers - Dial Pulse _____ TOUCH-TONE _____	_____	_____	_____

<u>Trunk Requirements</u>	<u>Dial Code</u>	<u>Toll Yes</u>	<u>Restrict No</u>	<u>Forecast</u>		
				<u>Cutover</u>	<u>2 years</u>	<u>Ultimate</u>
CO Trunks - 2-way	_____	_____	_____	_____	_____	_____
1-way outgoing	_____	_____	_____	_____	_____	_____
1-way incoming	_____	_____	_____	_____	_____	_____
FX Trunks - 2-way	_____	_____	_____	_____	_____	_____
1-way outgoing	_____	_____	_____	_____	_____	_____
1-way incoming	_____	_____	_____	_____	_____	_____
Toll Trunks (Hotel/Motel)	8	_____	_____	_____	_____	_____
WATS	_____	_____	_____	_____	_____	_____
INWATS	_____	_____	_____	_____	_____	_____
(b) Total CO Type Trunks	_____	_____	_____	_____	_____	_____
(c) Intercom Trunks	_____	_____	_____	_____	_____	_____
(d) Busy Tone Trunks	_____	_____	_____	_____	_____	_____
(e) Attendant Trunks (Dial 0)	_____	_____	_____	_____	_____	_____
(f) Total Tie Trunks	_____	_____	_____	_____	_____	_____
(g) Total Trunks (Total b-f)	_____	_____	_____	_____	_____	_____
Trunk Switches (Required for Termination)	_____	_____	_____	_____	_____	_____
(g ÷ 20)	_____	_____	_____	_____	_____	_____
Trunks Switches (Required from engineering step 13)	_____	_____	_____	_____	_____	_____

ATTENDANT FACILITIES

Console Code _____ Quantity _____ Color _____ Type Dial _____
 Handset _____ Headset _____
 DSS Console Quantity _____ Color _____ Stations _____

TRAFFIC ORDER

Service Features

Series 100
 Call Transfer - Attendant
 DOD
 Night Service - Flexible
 Night Service - Fixed

Provide

Fixed Night Service Assignments*

Trunk	Station	Trunk	Station	Trunk	Station
_____	_____00	_____	_____00	_____	_____00
_____	_____10	_____	_____10	_____	_____10
_____	_____20	_____	_____20	_____	_____20
_____	_____30	_____	_____30	_____	_____30

Power Failure Transfer

Power Failure Transfer Assignments*

Trunk	Station	Trunk	Station	Trunk	Station
_____	_____00	_____	_____00	_____	_____00
_____	_____10	_____	_____10	_____	_____10
_____	_____20	_____	_____20	_____	_____20
_____	_____30	_____	_____30	_____	_____30

*Fixed Night Service Stations must be the same as Power Failure Transfer Stations
 Station Restriction of Outgoing Calls

Restricted Stations (see Table C)

Codes	Sta to Sta	Codes	Sta to Sta	Codes	Sta to Sta
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Station Hunting

Series 200 Features (Includes 100 Series)

Attendant Camp-On
 Attendant Controlled Conference
 Attendant DSS with Busy Lamp Field

Series 300 Features (Includes 200 Series)

Call Transfer - Individual, Consultation Hold, Add-On

Trunk Answer Any Station

Optional Features

Tie Trunks

Code _____

Flexible Numbering of Stations

Room Number Assignments

Room No. to Room No.	Room No. to Room No.	Room No. to Room No.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

TRAFFIC ORDER

Provide

Lockout
Message Waiting
Single Digit Dialing

Single Digit Assignments

Code	Assigned	Sta. No.	Code	Assigned	Sta. No.
2	_____	_____	5	_____	_____
3	_____	_____	6	_____	_____
4	_____	_____	7	_____	_____

Toll Terminal (Dial 8)

Message Registers

Toll Restriction (Toll Access Digits 0 and 1 Only)

Traffic Registers

Provide a _____ (color) Desk/Wall (strike one) mounted traffic register cabinet containing 20 traffic registers. Fully equip and connect all registers

Connect SRG1 lead to _____.

Connect SRG2 lead to _____.

Locate the register cabinet _____

TRAFFIC

CONSOLE ASSIGNMENTS

Key	Trunk	Destination
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		
26.		
27.		
28.		
29.		
30.		

CONTROL KEYS

Key	Designation	Function
1	Excl Src	
2	Excl Dest.	
3	RLS SRC	RELEASE SOURCE
4	SIG SRC	SIGNAL SOURCE
5	SIG DEST	SIGNAL DESTINATION
6	NITE	CONTROLS NIGHT CONNECTIONS
7	PA/RLS	POSITION AVAILABLE/RELEASE
8	HOLD	HOLD
9	RLS DEST	RELEASE DESTINATION
10		
11		
12	POS BY	POSITION BUSY

MISC. KEYS

Key	Designation	Function
1		
2		
3		
4		
5		
6		

REMARKS