SWITCHING SYSTEMS MANAGEMENT
CROSSBAR TANDEM
ASSIGNMENT PRACTICES
TRUNK LINK FRAME

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1. GENERAL

1.01 This section is provided to give the crossbar tandem machine administrator uniform guidelines for assigning incoming trunk groups to the trunk link frames in a "Crossbar Tandem Switching System."

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 The title for each figure includes a number(s) in parentheses which identifies the paragraph(s) in which the figure is referenced.

1.04 The trunk link and trunk link extension frames shown in Fig. 1 provide facilities for the interconnection of any one of the incoming trunks appearing on the primary or extension primary switches with office junctors to any one

of the maxmum of 20 office link frames. The office link frames provide for the interconnection of office junctors with outgoing trunks. The interconnections are established under control of any one of the maximum of eight markers. The trunk link frame, consists of primary and secondary bays of switches and relay equipment comprising 200 links used for inteconnection of incoming trunks and office junctors. The primary ends of the links are arranged to serve 160 incoming trunks (basic frame) or 320 trunks (with trunk link extension frame). The secondary ends of the links serve 200 office junctors.

1.05 In assigning incoming trunks to the crossbar tandem trunk link frame, the machine administrator's primary objective is to balance the load carried by the various trunk link frames and the switches on these frames. However, since the trunk relays on the trunk frames are all cabled to the trunk link frame, the actual traffic assignments, are made are from the outside trunk facilities from the offices being served to the relays on the trunk frames.

1.06 In order that the assignment work may be performed to the best advantage, it is necessary that the machine administrator have a general knowledge of the equipment arrangements.

2. EQUIPMENT ARRANGEMENTS

INCOMING TRUNK FRAMES

2.01 The basic frames involved in the interconnection between incoming trunks and outgoing trunks are the trunk frames on which the trunk circuits are located, the trunk link frames which serve to interconnect the incoming trunks with office junctors, the sender link frames through which the trunks are connected to senders, and the office link frames which serves to interconnect the outgoing trunks with office junctors (Fig. 2). The trunk frame mounts 20, 30, 40 or 60 trunk circuits depending upon the type and complexity of the trunk circuit involved.

2.02 The trunk link frame shown in Fig. 1 consists of primary and secondary switches, 10 each with the incoming trunks on horizontals of the primary switches. Each of levels 2 to 9, inclusive, on each switch accommodates two trunks or a total of 16 per switch giving 160 as the total trunk capacity of the trunk link frame. Levels 0 and 1 are used for supervisory and control purposes to determine which of the two trunks on the other levels is to be connected on a given call sender link frame.

2.03 The sender link frame provides the trunks with access to the senders. Each frame has 10 groups of four primary-secondary links, each group having access on the primary switches to 10 trunks called a decade and on the secondary switches to 40 senders. Thus each frame may serve a maximum of 100 trunks arranged in 10 decades of 10 trunks each and can connect to a maximum of 40 senders where the secondary switches are not split and to a maximum of 80 senders where the secondaries are split. Splitting the secondary switches vertically permits some of the decades of trunks on the sender link frame to have access to one type of sender and the remaining decades to another type of sender.

ASSOCIATION OF TRUNK, TRUNK LINK, AND SENDER LINK FRAMES

2.04 Each decade of 10 trunks on the trunk frames is cabled directly to the trunk link frames and to the sender link frames. The trunks of a decade must be identical as regards circuit features, routing, and type of sender required. Trunks numbered 0 to 9 (first decade) are spread over like numbered levels of all of the 10 primary switches on the trunk link frame. Similarly the trunks of a second decade (10 to 19) are cabled to these same levels. This spreading of the trunks of a decade over all 10 primary switches has a very desirable load balancing effect. Where traffic separation facilities are being provided, the two decades of trunks cabled to the same horizontal levels of switches on the same trunk link frame must have the same class mark. There are 21 possible class of service marks which will be discussed in more detail later. In order to secure the maximum load balance between trunk link frames, the traffic engineer, in setting up the traffic order, distributes the decades of trunks in such a manner that each frame will, in so far as is practical, have assigned to it proportionate number of trunk relays of different types.

2.05 Also, the trunks in a decade are cabled to appear as a primary switch group of 10 trunks on the sender link frame from which the four links provide access to senders of the appropriate type to serve these trunks. The traffic order

specifies the number of decades of trunks on each sender link frame and the type of sender to be serving each decade.

2.06 Where centralized automatic message accounting (CAMA) equipment is involved each decade of trunks must also be cabled to a recorder and a call identity indexer each of which can serve a maximum 100 trunks and 10 calling office designations. The traffic order also specifies the originating trunk groups to be served by each recorder and its associated call identity indexer.

2.07 It follows, therefore, that each decade of trunks, being of the same type as to routing requirement, type of sender required, and circuit features, are cabled to the same horizontal levels of the 10 primary switches of a trunk link frame, to a primary switch on sender link frame, as well as to a recorder and call identity indexer where CAMA service is involved. Trunk assignment therefore, consists in allocating trunks to the appropriate type of trunk equipment cabled to the trunk link frames in a manner so that within the limits of the cabling arrangements an optimum amount of load balance will be achieved.

3. INCOMING CLASS OF SERVICE MARKS

3.01 There are 21 possible class of service marks. The incoming class of service marks, in combination with outgoing class marks assigned in the marker, may be used to deny customers or operators on a selective basis access to certain codes. One example would be to deny CAMA customers access to operator toll center and plant test codes. Another would be to deny wide area telephone service (WATS) customers who are served directly from the crossbar tandem access to codes in bands to which they have not subscribed.

3.02 Incoming trunk class information is also used to permit different treatments of the same code when dialed over different groups of incoming trunks. For example, if a crossbar tandem has two offices (A and B) with the same central office code, each located in a different NPA, homing on it, it will be necessary for the equipment to be able to identify the point of origin in order to properly route calls between offices A and B. This is accomplished by assigning a different incoming class mark to the trunks incoming from each office.

4. ASSIGNMENT OF TRUNKS

GENERAL

4.01 While the flexibility in the assignment of trunks to trunk link frames is restricted by the cabling of the various types of relays, the load on all frames and switches should be equalized as much as possible.

4.02 Before the trunk link frame assignment can be made, the following information must be obtained:

(a) The trunk frames of each type provided, the number of decades on each frame, and the number of trunk relays actually installed in each decade. (While the cabling from the trunk frames is in decades - groups of ten - less than ten relays may be installed in a decade.) The trunk link frame number and switch horizontals to which the decades are cabled and the trunks that are arranged for service observing and emergency switchboard access is also required. This information is provided in the traffic order, but it should be checked against the Western Electric wiring lists.

(b) The latest List A which indicates the service date and the number of working trunks anticipated in each group at the end of the engineering period, the engineering classification high usage, final, CAMA and the type of operation; multifrequency (MF), or dial pulse (DP). This list should be checked against the circuit orders and with the cutover committee to ascertain the exact number and proper numbering of circuits that will be working at cutover.

(c) The type of distant office, No. 4 crossbar, crossbar tandem, No. 5 crossbar, step-by-step, or other, should be determined. Because different types of offices select outgoing trunks in various ways, the usage (weighting) of incoming trunks to the crossbar tandem is affected. The idle indicating pattern on operator tandem trunks should also be determined.

INCOMING TRUNK ASSIGNMENT RECORD

4.03 The Incoming Trunk Assignment Record, Form E-4360, is the permanent office record of the trunks assigned on the trunk link frames.

As shown in Fig. 3, this form is actually a graphic representation of horizontals 2 through 9, with the even and odd appearances, of the primary switches of the trunk link frame. Each horizontal level (2-E, 2-O, 3-E, etc) on all ten switches on one frame represent a decade. The form is printed on both sides, and two facing pages are used to represent the ten switches on a frame.

4.04 The office name and trunk link frame number should be entered at the top of each sheet. For extension frames, "EXT." should be entered following the frame number. The type trunk, switch number, trunk frame and trunk relay (equipment) number should be entered in the appropriate spaces. The infomation should be copied from the traffic order or wiring list. Since the originating office is specified in the traffic order for CAMA trunk groups, the trunk group name should be entered in the "Name" column. The "Remarks" column may be used to designate the relays that are arranged for service observing and those arranged for switchboard access, the incoming class and incoming traffic separation marks and trunk weightig designation. The box labeled "Trunk Type Data" may be used as a legent for class and traffic separation marks.

INITIAL ASSIGNMENT PROCEDURES

A. Allotting Trunks to Trunk Link Frames

4.05 In allotting trunks to trunk link frames there are two primary objectives. First, each trunk link frame should contain approximately the same number of trunks, and second, each frame should carry approximately the same load. With extension frames, the load should be spread evenly over the regular and extension frames.

4.06 Generally more trunk relays are provided than the number of trunks to be assigned. The spare relays on each trunk link frame should be approximately equal and proportional to the total number of relays provided.

4.07 To secure approximately the same load on each frame the trunks in each circuit group should be weighted according to the load they may be expected to carry.. Generally, the incoming trunks may be classified into three broad categories, Intertoll, CAMA or local, and switchboard. The tables in Fig. 4 provide a procedure for estimating the load each trunk in a circuit group may be expected to carry. In Fig. 4, the "Heavy" trunks are those which are selected first in the originating office.

4.08 In allotting the trunks in each group to the trunk link frames, a convenient work sheet should be prepared with one column for each trunk link frame and one column for each trunk link frame extension, if any. A sample worksheet is provided in Fig. 5. The number of relays of each type (MF-MF, MF-DP, etc.) that are cabled to each frame should be entered at the top of the columns. One work sheet should be prepared for each type of relay.

4.09 As the trunks in each group are allotted to the trunk link frames they should be classified as "Heavy," "Medium" or "Light" by use of a different colored pencil for each weighting.

4.10 For offices without trunk link extension frames, trunk groups of similar size and traffic characteristics are assigned in pairs, one left to right across the frames and the other right to left. In this way the total traffic load on each frame will be approximately the same.

4.11 In Fig. 6 it should be noted that the "group starts" (ie, the first choice trunks at the distant offices) are moved by pairs of frames to the right with the assignment of each subsequent pair of groups until the last pair of frames (4 and 5 in Fig. 6) are reached. The assignment of pairs of group starts is then reversed, moving by pairs of frames from right to left as illustrated. This reversal in the assignment of group starts is continued until all groups have been assigned. In the above examples as each trunk number is entered on the distribution sheet it should be graded as to "Heavy" or "Light" by the use of a different colored pencil.

4.12 If an odd number of trunk link frames are provided, the last frame should be paired with the first frame for grouping. For example, if five frames (numbered 0 through 4) are to be assigned, the group starts would be paired on the following frames: 1 and 0, 3 and 2, 0 and 4, 3 and 2, etc.

4.13 Where trunk link frame extensions are provided, consideration must be given to the fact that the trunks on the associated regular and extension primary bays of the frames will be

competing for the same trunk links to a common secodary bay. To reduce the possibility of failure to secure a link and to get approximately equal usage of the switches on the regular and extension bays, the trunks in the first group of a pair of trunk groups is assigned to the regular frames on the first "sweep" and then alternating between the extension and regular frames on succeeding "sweeps." The process is reversed and started on the extension frames with the second group of the pair. The first trunk group has its group start on Frame 1 (regular) and is assigned left to right. As shown in Fig. 7, this procedure is repeated for each subsequent pair of trunk groups with the group starts shifting from left to right across the frames and then reversing.

4.14 Figure 8 illustrates the positioning of group starts for both an even and an odd number of trunk link frames with extensions.

4.15 In all of the exhibits in this section Trunk Groups A and B, C and D, E and F, etc, are paired for assignment. The trunk numbering for two-way groups should be checked carefully when determining group starts since, in some cases, the highest numbered trunk will be the first choice in the distant office. Group H in Fig. 6 is an example of this situation.

4.16 It may be found that certain types of trunk relays are provided in small quantities and are cabled to only one or two of the trunk link frames. In this case the assignment of the trunk groups requiring these relays will, of course, be confined to these frames.

4.17 Tandem trunks should be assigned in groups of 5 if idle indicating is provided on that basis.

4.18 When all the groups have been assigned to the trunk link frames, a check should be made for load balance between the frames. This may be done by totaling the number of heavy, medium and light trunks assigned to each frame. The number of trunks in each category should be approximately the same on each frame. Any pronounced unbalance on one or more frames may be corrected by reassigning trunks from frame to frame. When the frames are in reasonable balance, the assignment of the trunks to the switches on the frames may be undertaken.

B. Assignment of Trunks to Switches

4.19 The trunk relays of a particular type (MF-MF, MF-DP, DP-DP, etc) are ordinarily spread over more than one link frame, usually over most or all of the frames. However, the assignment of a small group, as mentioned above, may be confined to one or two frames because of cabling limitations.

4.20 In allotting trunks to switches there are several other restrictions imposed by the cabling and circuit arrangements:

(a) The trunks assigned to each level of a primary switch must be given the same incoming traffic separation class mark. In other words, the two trunks that are assigned to horizontals 2E and 2O on a particular switch must have the same traffic separation class mark. The same applies to 3E and 3O, 4E and 4O, etc.

(b) All of the relays in a decade must have the same incoming class of service mark. Where Outward WATS subscriber lines are terminated directly on the crossbar tandem, one or more decades per band with a separate class of service per band are required.

(c) Service observing requires special relays. The relays in each decade that are arranged for service observing will be specified in the traffic order. The number of trunks in each trunk group to be assigned to the service observing relays should be obtained from the supervising service observer or the area traffic staff. Trunks assigned to these relays should be ***first choice incoming.***

(d) Certain relays are arranged for switchboard access to provide a means of handling emergency calls in the event of machine failure or extreme overloads. The traffic order will specify the relays that are arranged for switchboard access. Emergency access trunks should be assigned in the following groups where direct circuits are provided:

(1) Home Sectional and Regional Center.

(2) Regional and Sectional Centers in adjacent regions.

(3) Key dependent Class 4 (Toll Center) offices.

(e) Where CAMA service is provided on the crossbar tandem, all of the trunks from a particular central office or CAMA trunk group must be assigned to decades which are cabled to the recorder group designated to serve that group.

(f) Because of cabling, when a sender link frame location is assigned to the sender attachment delay recorder (SADR), the associated trunk relay and trunk link frame appearance may not be used for traffic trunk assignment.

4.21 Within the limits of the cabling limitations approximately the same number of "Heavy," "Medium," and "Light" trunks should be assigned to each switch on a frame. When two or more trunks of the same group are assigned to the same frame they should, where possible, be assigned to different switches on that frame. In addition, wherever possible, two "Heavy" trunks should not be assigned to the same switch level, eg, 2-E and 2-O.

4.22 A check of the traffic balance should be made on each switch, on a frame and between frames by assigning each "Heavy" trunk a weight of 3, each "Medium" trunk a weight of 2, and eight "Light" trunk a weight of 1. The sum of the weights for each working trunk on a switch should be within about 5 percent of the total weight on the other switches on the frame. The total weight of the ten switches on each frame should be within about 5 percent of all other frames.

SUBSEQUENT ASSIGNMENT PROCEDURES

4.23 The same general procedures for trunk assignments as are used in making initial assignments apply to subsequent assignments. The objective is to maintain, as nearly as practical, a balance of the load of individual frames and switches. In making subsequent assignments, however, actual usage data should be used to supplement theoretical weighting factors.

4.24 The most common problems encounted in making new assignments to an existing office involve additions of new trunk link frames - both regular and extensions. It is obviously impractical to reassign the entire office to achieve a frame loading balance whenever new trunk link frames are added. It would be advisable, however, for both loading and service protection reasons to spread new trunk groups over as many frames as possible. It will be necessary for the machine administrator to weigh the costs of trunk rearrangements against the service needs. If an office has no matching loss, loading of new frames through rearrangements should be on gradual basis.

4.25 When trunk link extension frames are added, the opportunity for service affecting imbalances are increased because the trunks on the regular and extenson frames are competing for links to the secondary bay. New trunks should be spread as evenly as possible over all extension frames. A balance between "Heavy," "Medium," and "Light" trunks is necessary on switch levels (eg, 2E and 2O on the regular and extension frames combined). Usage on trunk link frames and matching loss should be studied when trunks are added to extension frames, and reassignments should be made as required.

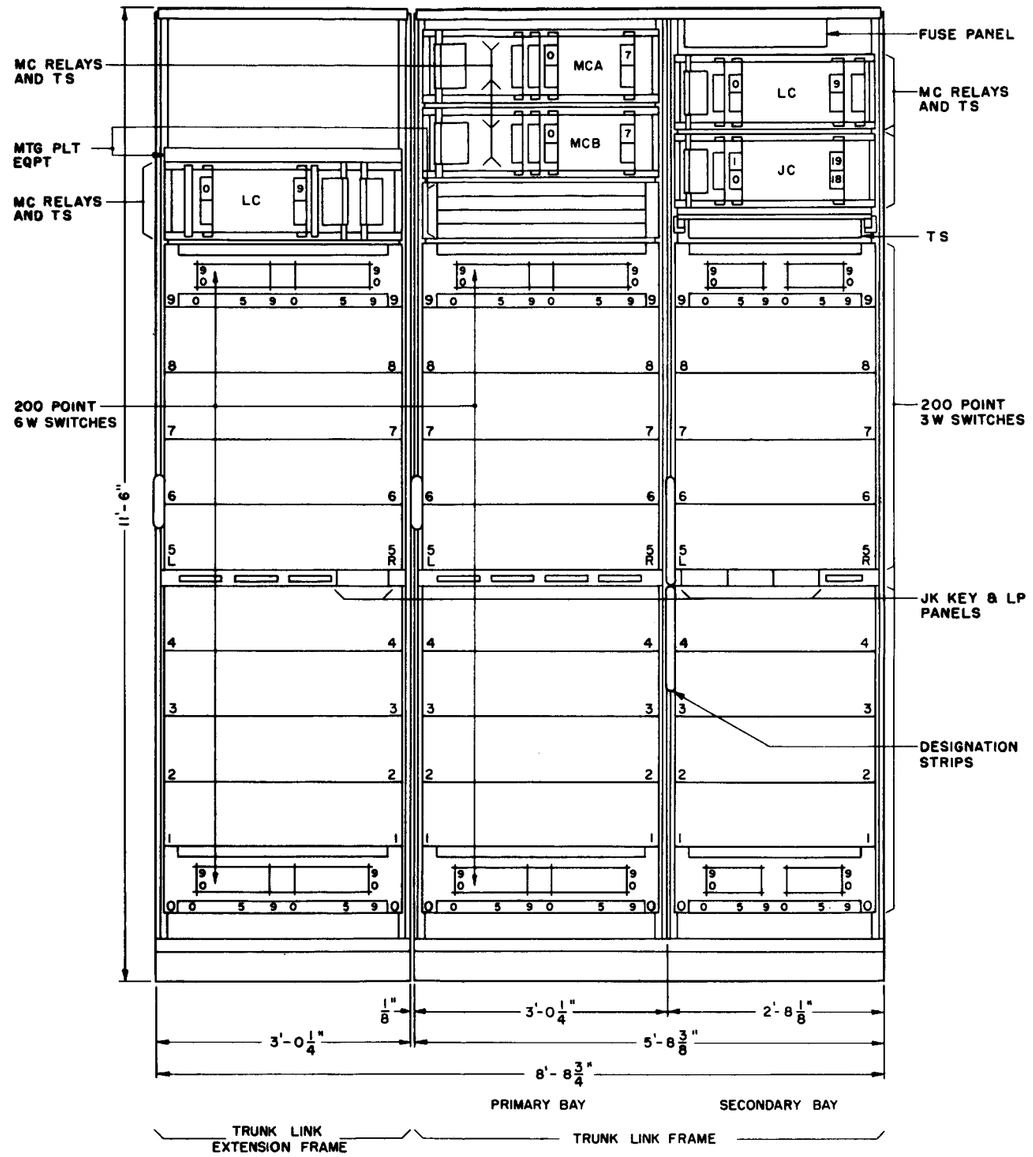
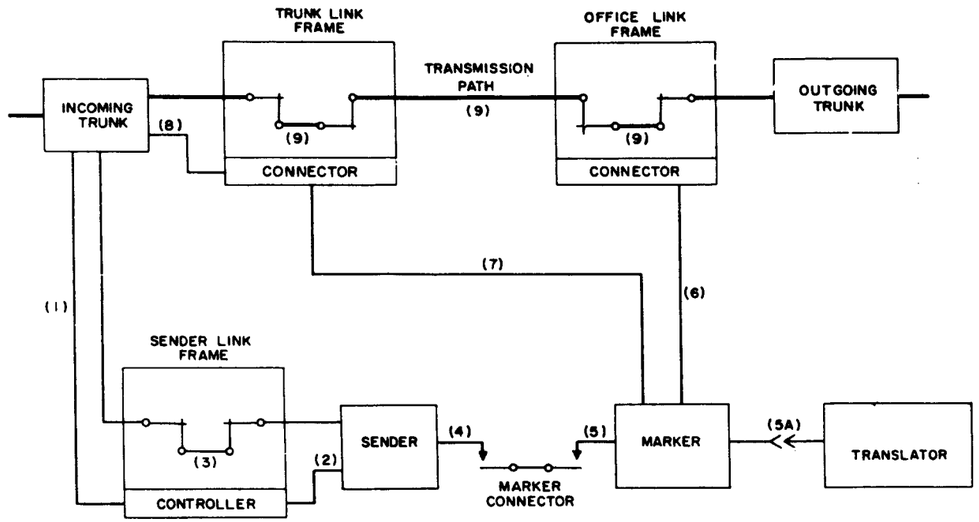


Fig. 1—Trunk Link and Trunk Link Extension Frames



PATH OF A CALL THROUGH A CROSSBAR TANDEM OFFICE

Fig. 2—Path of a Call Through a Crossbar Tandem Office

Printed in U.S.A.

Form E-4360 (6-55)

INCOMING TRUNK ASSIGNMENT RECORD

CROSSBAR TANDEM

OFFICE _____ CROSSBAR INCOMING FRAME _____

TYPE TRUNK	SW LOC	NAME	No.	TRUNK FR	TRUNK EQUIP	REMARKS
	9-0					
	9-E					
	8-0					
	8-E					
	7-0					
	7-E					
	6-0					
	6-E					
	5-0					
	5-E					
	4-0					
	4-E					
	3-0					
	3-E					
	2-0					
	2-E					
	9-0					
	9-E					
	8-0					
	8-E					
	7-0					
	7-E					
	6-0					
	6-E					
	5-0					
	5-E					
	4-0					
	4-E					
	3-0					
	3-E					
	2-0					
	2-E					

TRUNK TYPE DATA

TYPE TRUNK	WIRING OPTIONS

TYPE TRUNK	SW LOC	NAME	No.	TRUNK FR	TRUNK EQUIP	REMARKS
	9-0					
	9-E					
	8-0					
	8-E					
	7-0					
	7-E					
	6-0					
	6-E					
	5-0					
	5-E					
	4-0					
	4-E					
	3-0					
	3-E					
	2-0					
	2-E					
	9-0					
	9-E					
	8-0					
	8-E					
	7-0					
	7-E					
	6-0					
	6-E					
	5-0					
	5-E					
	4-0					
	4-E					
	3-0					
	3-E					
	2-0					
	2-E					

Fig. 3—Incoming Trunk Assignment Record

I. Intertoll Trunk Load Estimating Table

ENGINEERING CLASSIFICATION	INTERTOLL TRUNKS TYPE GROUP	NUMBER HEAVY	NUMBER MEDIUM	NUMBER LIGHT
High Usage	One-Way	All	None	None
Final	One-Way	Half	Half	None
High Usage	Two-Way	Half	None	Half
Final	Two-Way	Quarter	Quarter	Half

- Trunks which are classified as neither high usage nor final should be treated as finals.

II. Switchboard Trunk Load Estimating Table

SIZE OF GROUP	TANDEM TRUNKS WITH IDLE INDICATING ON SUBGROUPS OF 5 NUMBER HEAVY	NUMBER MEDIUM	NUMBER LIGHT
10-15	2	2	1
20-105	2	3	None
110-200	4	1	None
Over 200	5	None	None

- This table applies to tandem or switchboard trunks equipped with idle indicating. One indicator for each five trunks.
- For tandem trunks not equipped with idle indicating but tested from left to right by the operator, it will be sufficiently accurate to assume one-half are heavy, one-quarter are medium and one-quarter are light.

III. CAMA Trunks

- For CAMA trunks from step-by-step selectors, one-half of the trunks from each subgroup should be considered heavy, one-quarter medium and one-quarter light. Because of the random selection of CAMA trunks from No. 5 Crossbar Offices,all trunks should be considered as medium.

Fig. 4—Trunk Load Estimating Tables

INCOMING TRUNK RELAY ASSIGNMENT – TANDEM

TYPE _____

INC. FRAME _____

RELAY NO.	TRUNK GROUP NAME	TRUNK GROUP NO.	TRUNK LINK FRAME	S-H	TYPE	CLASS	REC. NO.	SER. OBS.	T.A.	PENDING DISCONNECT
49										
48										
47										
46										
45										
44										
43										
42										
41										
40										
39										
38										
37										
36										
35										
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33										
32										
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09										
08										
07										
06										
05										
04										
03										
02										
01										
00										

INCOMING TRUNK RELAY ASSIGNMENT – TANDEM

TYPE _____

INC. FRAME _____

RELAY NO.	TRUNK GROUP NAME	TRUNK GROUP NO.	TRUNK LINK FRAME	S-H	TYPE	CLASS	REC. NO.	SER. OBS.	T.A.	PENDING DISCONNECT
99										
98										
97										
96										
95										
94										
93										
92										
91										
90										
89										
88										
87										
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Fig. 5—Sample Incoming Trunk Relay Assignment Worksheet

ALLOTTING TRUNKS TO TRUNK LINK FRAMES WITHOUT EXTENSIONS

Type of Relays - MF-MF Number of Relays		TRUNK LINK FRAMES					
		0 60	1 60	2 60	3 50	4 50	5 50
TRUNK GROUP	NO. TRKS & SELECTION ORDER						
Grp "A"	1-22		1*	2	3	4	5
(Final)		6	7	8	9	10	11
		12	13	14	15	16	17
		18	19	20	21	22	
Grp "B"	1-20	1*					
(Final)		7	6	5	4	3	2
		13	12	11	10	9	8
		19	18	17	16	15	14
							20
Grp "C"	1-8				1*	2	3
(HU)		4	5	6	7	8	
Grp "D"	1-8	3	2	1*			
(HU)			8	7	6	5	4
Grp "E"	1-7						1*
(HU)		2	3	4	5	6	7
Grp "F"	1-7	5	4	3	2	1*	
(HU)						7	6
Grp "G"	1-5				1*	2	3
(HU)		4	5				
Grp "H"	5-1	3	4	5*			
(HU)						1	2

*Group Start

Fig. 6—Allotting Trunks to Trunk Link Frames Without Extensions

ALLOTTING TRUNKS TO TRUNK LINK FRAMES WITH EXTENSIONS

		TRUNK LINK FRAMES											
		0	0E	1	1E	2	2E	3	3E	4	4E	5	5E
Type of Relays - MF-MF													
Number of Relays		60	60	60	60	60	60	50	50	50	50	50	50
TRUNK GROUP	NO. TRKS & SELECTION ORDER												
Grp "A" (Final)	1-23			1*		2		3		4		5	
			6		7		8		9		10		11
		12		13		14		15		16		17	
			18		19		20		21		22		23
Grp "B" (Final)	1-23		1*										
		7		6		5		4		3		2	
			13		12		11		10		9		8
		19		18		17		16		15		14	
							23		22		21		20
Grp "C" (HU)	1-14							1*		2		3	
			4		5		6		7		8		9
		10		11		12		13		14			
Grp "D" (HU)	13-1		11		12		13*						
		5		6		7		8		9		10	
							1		2		3		4
Grp "E" (HU)	1-9											1*	
			2		3		4		5		6		7
		8		9									
Grp "F" (HU)	9-1		5		6		7		8		9*		
						1		2		3		4	
Grp "G" (HU)	1-5												1*
		2		3		4		5					
Grp "H" (HU)	1-5	5		4		3		2		1*			
Grp "I" (HU)	1-5								1*		2		3
		4		5									
Grp "J" (HU)	4-1	2		3		4*							
													1

*Group Start

Fig. 7—Allotting Trunks to Trunk Link Frames With Extensions

POSITIONING OF TRUNK GROUP STARTS WITH EXTENSION FRAMES

TRUNK LINK FRAMES (EVEN NUMBER)

	0		1		2		3		4		5	
	REG.	EXT.	REG.	EXT.	REG.	EXT.	REG.	EXT.	REG.	EXT.	REG.	EXT.
TRUNK GROUPS	L	B	A	K	J	D	C	I	H	F	E	G
		N	M			P	O			R	Q	

TRUNK LINK FRAMES (ODD NUMBER)

	0		1		2		3		4	
	REG.	EXT.	REG.	EXT.	REG.	EXT.	REG.	EXT.	REG.	EXT.
TRUNK GROUPS	E	B	A	J	I	D	C	H	G	F
	O	L	K			N	M			P

Fig. 8—Positioning of Trunk Group Starts With Extension Frames