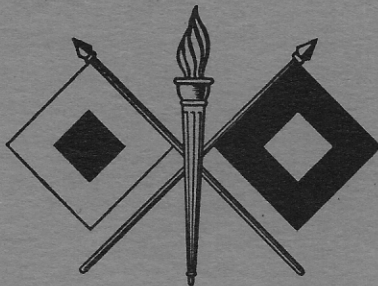


**FIXED PLANT
TRAFFIC ENGINEERING
REFERENCE DATA**



This text is approved for resident and extension course instruction at The Signal School only. It reflects the current thought of this school and conforms to printed Department of the Army doctrine as closely as possible.

16 APRIL 1956

THIS TEXT WILL BE RETURNED
TO THE SIGNAL SCHOOL UPON
COMPLETION OF THE SUBCOURSE
WITH WHICH ISSUED

HEADQUARTERS
THE SIGNAL SCHOOL
FORT MONMOUTH, N. J.

16 April 1956

School Text Sig 660-85, Fixed Plant Traffic Engineering Reference Data, has been prepared for use in resident instruction, and is published for the information and guidance of all concerned. It reflects the current thought of the School and conforms to Department of Army Doctrine as closely as possible. Development and progress under such doctrine is continuously subject to change. Suggestions and criticism relative to form, contents, purpose or use of this manual are invited and should be referred to the Secretary, The Signal School, Fort Monmouth, New Jersey. Comments received will be considered in the preparation of an official manual.

WILLIAM D. HAMLIN
Brigadier General, USA
Commandant

OFFICIAL:

OSCAR C. BUSER
Lt Colonel, Signal Corps
Secretary

DISTRIBUTION:

Special

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SECTION I. GENERAL

1. PURPOSE

The purpose of this text is to provide the student signal officer with necessary information, tables, charts, and diagrams for traffic engineering of fixed plant telephone and teletypewriter installations. Charts, diagrams, and tables appearing here may be modified to better serve a particular installation and may vary according to local conditions. The data included here are to be used in conjunction with other material presented in traffic engineering courses at The Signal School.

2. SCOPE

This text contains information on the organization and functions of a typical traffic branch; factors to be considered in estimating telephone and teletypewriter requirements; telephone switchboard arrangements, operations, and procedures; format of military directories; and traffic engineering for manual and dial PBX telephone systems. Samples of Department of the Army traffic data forms are included.

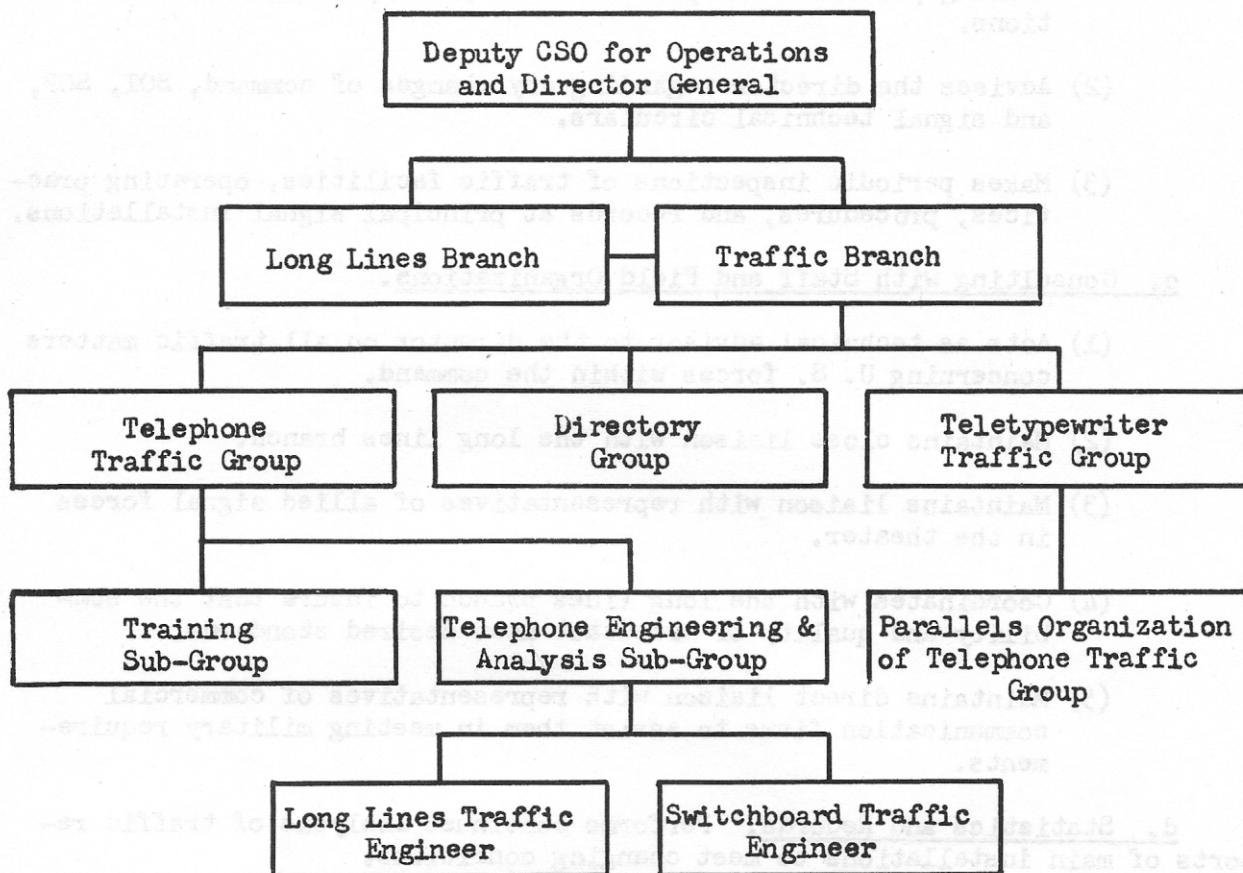
3. REFERENCES

The following applicable regulations should be consulted for reference:

AR 105-10	Communications Economy
AR 105-15	Field Signal Communications
AR 105-25	Operation of Fixed Networks and Communication Centers
SR 105-20-1	Leased Communication Circuits
SR 105-20-2	Control and Justification of Telephone Systems
SR 105-20-20	Telephone Traffic Data

SECTION II. TRAFFIC BRANCH ORGANIZATION

4. ORGANIZATION CHART OF A TYPICAL TRAFFIC BRANCH



5. TRAFFIC BRANCH RESPONSIBILITIES

a. Estimating Initial and Subsequent Theater Requirements.

- (1) Is responsible for traffic engineering and operating practices of the theater wire communication system.
- (2) Receives traffic requests from the field and forwards them to the appropriate branch -- either the telephone or the teletypewriter branch.
- (3) Receives all requests to add, terminate, rearrange, or cease broadcast of telephone and teletypewriter circuits in excess of 25 miles.
- (4) Coordinates all requirements of the telephone, directory, and teletypewriter branches.
- (5) Issues approved traffic requests for circuits to the long lines branch for completion.

b. Standardizing Operating Practices.

- (1) Exercises staff supervision of telephone and teletypewriter operating practices and procedures at principal signal installations.
- (2) Advises the director regarding any changes of command, SOI, SOP, and signal technical circulars.
- (3) Makes periodic inspections of traffic facilities, operating practices, procedures, and records at principal signal installations.

c. Consulting with Staff and Field Organizations.

- (1) Acts as technical advisor to the director on all traffic matters concerning U. S. forces within the command.
- (2) Maintains close liaison with the long lines branch.
- (3) Maintains liaison with representatives of allied signal forces in the theater.
- (4) Coordinates with the long lines branch to insure that the stability and quality of broadcast meet desired standards.
- (5) Maintains direct liaison with representatives of commercial communication firms to assist them in meeting military requirements.

d. Statistics and Records. Performs continued analysis of traffic reports of main installations to meet changing conditions.

6. TELEPHONE TRAFFIC GROUP

a. Engineering and Layout.

- (1) Performs traffic engineering of all military telephone and program circuits, face layouts, and trunking schemes of telephone switchboards; and the inclusion of local dial switching centers in the major networks.
- (2) Maintains and analyzes telephone traffic records, traffic circuit diagrams, and reports for engineering purposes.
- (3) Issues traffic requests covering approved circuits and positions.
- (4) Coordinates engineering; and analyzes requirements of training, management, and directory.

b. Management and Supervision.

- (1) Performs staff operational supervision of military switchboards in the theater.

- (2) Establishes direct liaison with traffic sections of major U. S. and allied commands.
- (3) Inspects traffic functions, operator's quarters, etc.
- (4) Prepares material for SOP's, SOI's, signal technical circulars, and letters.
- (5) Prepares traffic diagrams and route bulletins.
- (6) Maintains and operates telephone training sub-groups and coordinates training programs of all major commands.

7. TRAINING SUB-GROUP UNDER TELEPHONE TRAFFIC GROUP

- a. Operates and maintains the staff training group for operator training and assigns qualified personnel to major exchanges.
- b. Establishes training plans and procedures for military and civilian personnel.
- c. Coordinates training for major command headquarters down to army level.
- d. Insures that all training is accomplished in accordance with existing regulations.

8. TELEPHONE ENGINEERING AND ANALYSIS SUB-GROUP

a. Determining Initial Circuit Requirements for a New or Proposed Network.

- (1) Obtains original telephone trunk data and central office location, if available, from headquarters of commands involved.
- (2) Evaluates requirements, based on traffic estimates. These requirements must be justified.
- (3) Keeps informed on the type operation involved, the troops involved, and the tactical net to remain.
- (4) Establishes type of circuit -- via, terminal, or point-to-point.
- (5) Prepares traffic specifications.

b. Determining How Closely Existing Plant Facilities Meet Current Requirements.

- (1) Collects and studies concurrent telephone service and circuit usage data.
- (2) Maintains personal interest in service performance, keeping in mind service standards.

- (3) Insures that the existing plant is used to do the job, that plant forces maintain equipment in off traffic hours, and that traffic requirements are met by the plant forces.
- (4) Insures that an adequate margin of traffic safety has been engineered to care for unforeseen peaks of traffic.

c. Maintaining Satisfactory Load Distribution Over Existing Circuit Networks to Minimize Delays and Complaints.

- (1) Makes continuous studies of fluctuation in traffic.
- (2) Checks the character and distribution of the load by circuit group.
- (3) Has authority to make routing changes and circuit rearrangements.
- (4) Keeps traffic loads well balanced.

d. Preparing Estimates of the Number and Arrangements of Circuits Required to Handle Future Traffic Loads. Estimates probable future volumes of traffic by circuit groups either for short term periods or for incorporation into the permanent network of the long lines system.

9. LONG LINES TRAFFIC ENGINEER

a. Engineering Service Bases. Develops engineering service bases in terms of overall speed and number of calls.

b. Long Distance Trunk Requirements. Determines the number and arrangement of trunks by past experience and by use of trunk capacity tables.

c. Routing.

- (1) Designates routes for various types of calls.
- (2) Designates alternate and divided routes based on speed and economy.
- (3) Periodically analyzes volume and service characteristics of individual traffic items.
- (4) Determines additional traffic paths.

d. Trunk Administration.

- (1) Maintains satisfactory and balanced speed of service.
- (2) Relieves overload in some groups by shifting to lightly used groups, temporarily or permanently.
- (3) Adjusts for out of order conditions and establishes emergency routes.

e. Engineering Data.

- (1) Assembles past and current information required for all phases of trunk engineering. Summarizes and interprets data on traffic volumes, busy hour trunk groups, loads, and related service results.
- (2) Decides on various types of studies to be prepared.
- (3) Is responsible for the preparation of traffic diagrams and route bulletins.

10. SWITCHBOARD TRAFFIC ENGINEER

- a. Determines type of switchboard for initial and future requirements.
- b. Draws up face and keyshelf plans for telephone switchboards.
- c. Specifies how intra-office trunks will operate.
- d. Coordinates with operating forces to:
 - (1) Make traffic layout changes.
 - (2) Make plug counts, holding time studies, and maintaining traffic data.
- e. Coordinates with training branch to:
 - (1) Prepare new operating features.
 - (2) Instruct operators in new procedures regarding operation of the switchboards.

11. DIRECTORY GROUP

- a. Prepares and publishes telephone and teletypewriter directories.
- b. Compiles all information from theater and major command headquarters.
- c. Receives all directories within the theater and maintains a comprehensive file of the directory system.
- d. Assists all major command headquarters in the preparation of standard Army directories.
- e. Coordinates with quasi-military groups, Air Force, Navy, and allied commands for information for the directory.
- f. Issues directories to all major installations.
- g. Prepares and issues SOP's, SOI's, and directives on directories.

12. TELETYPEWRITER TRAFFIC GROUP

The duties and responsibilities of this group parallel those of similar units in the telephone traffic group.

SECTION III. FACTORS FOR TELEPHONE TRAFFIC ENGINEERING

13. INTRODUCTION

In addition to using prepared traffic engineer tables and experience factors from known operating installations, the telephone traffic engineer must consider certain other factors which, where they apply, affect the size and operations of any Army telephone system. These additional factors are outlined in this section.

14. ESTIMATING STATION LINE AND TRUNK REQUIREMENTS

a. Size of unit (see also paragraph 31, Experience Factors):

- (1) Number of officers by rank.
- (2) Number of enlisted personnel by rank.
- (3) Number of comparable civilians.
- (4) Motor pools, messes, quarters, etc.

b. Providing alternate and divided routes:

- (1) VHF and RTT -- whether used continuously or as backup or emergency status.
- (2) At least two paths of reaching all exchanges.

15. GENERAL FACTORS AND ADJUSTING EXPERIENCE FACTORS OF OTHER UNITS

a. Type of unit and subordinate units.

b. Mission:

- (1) Combat -- advance or static.
- (2) Occupation.
- (3) Zone of interior.

c. Location:

- (1) How long occupied.
- (2) Size of location served.

- d. Permanency of installation -- allowing for growth:
 - (1) Expected gain and loss of served units.
 - (2) Trend in strength of superior unit.
 - e. Financial budget authorization.
 - f. Is speed of installation important?
 - g. Availability of equipment.
 - h. Circuits in trouble -- known or estimated.
 - i. Staff calling habits.
 - j. Percent of proposed or working station lines which will be allowed to place long distance calls.
 - k. Relative geography (effect of terrain -- islands, mountains, open country).
 - l. Relative availability of existing facilities.
 - m. Does unit use teletypewriter and messenger service? To what extent?
 - n. Type of directory and frequency of publication.
 - o. Restriction or classification of circuits.
16. DETERMINING TYPE OF SWITCHBOARD
- a. Manual.
 - b. Dial.
 - c. Common battery -- local battery.
 - d. Tandem.
 - e. Combination local and long distance.
 - f. Long distance.
 - g. One large versus several small centrals.
 - h. Will switchboard do tandem switching for surrounding centrals?
 - i. Type switching desired.
 - j. Suitable space available.
 - k. Will selected equipment provide all the necessary features?

1. Commercial or tactical type boards.

17. DETERMINING SWITCHBOARD POSITION REQUIREMENTS

a. Calling rate of telephones served -- known or estimated for local and long distance calls.

b. Face plan.

c. Information, delayed, booking, intercept, test position and trouble positions.

d. Service observing positions.

e. Efficiency of available operators.

f. Cord pair per position.

g. Number of phones served and in system.

h. Future growth and space.

i. Type of service:

(1) Call back.

(2) Limited recording.

(3) Booking:

(a) Over busy circuit group.

(b) All circuits.

(c) Subscriber's privilege.

18. SWITCHBOARD OPERATING CONDITIONS FOR EFFICIENCY

a. Face plan:

(1) Proper location of trunks and lines for ease in handling.

(2) Proper multipling.

(3) Use of interposition trunks.

(4) Glass bulletin cover.

(5) Ticket boxes.

(6) Designation strips:

(a) Color scheme.

- (b) Alphabetical arrangement.
- (c) Numbering system.
- (7) Proper illumination of switchboard.
- (8) Busy lamps -- LTB Lamp.
- b. Efficiency of equipment (proper supervisory lights).
- c. Restricted and quiet area (sound proofing).
- d. Emergency lighting system.
- e. Operator's relief -- proper scheduling.
- f. Availability of eating facilities.
- g. Training programs (include SOP).
- h. Equipment and facilities for traffic checks.
- i. Lounge and rest rooms.
- j. Degree of training of operators (procedure, courtesy, and mechanics).
- k. Monitoring system for chief operator.
- l. Reporting of circuit outage (busy out circuits not in service).
- m. Proper dissemination of changed procedure.
- n. Line conditions.

19. CONTROL MEASURES

All or part of the control measures listed in this paragraph may be applied to control usage when required by limitations of budget, circuits, equipment, or operators; or by circuit and equipment outage.

a. Classifying Subscribers.

- (1) Class A: Authorized for transaction of official business with access to all facilities, to include long distance trunks at government expense.
- (2) Class B: Authorized as a military necessity; may be used for unofficial service with access to long distance trunks at subscriber's expense.
- (3) Class C: Authorized for transaction of official business but restricted to intra-post communication, with no access to long distance trunks.

(4) Class D: Restricted to special classes of service such as fire alarm, guard alarm, and watchman services.

b. Rationing Calls: To ration calls on a departmental basis, with a time limit on each call.

c. Limiting Conversations: To restrict each call to a definite time duration.

d. Limited Recording: To record each call with a minimum amount of information (calls are completed on first attempt) and to compile this information from the subscribers.

e. Service Observing: To improve operator service and to detect unnecessary conversation by subscribers.

f. Publicity and Command Directives: To limit conversations; restrict calls to official business; eliminate incidental and small talk; have text of conversation prepared ahead of time; use messenger service, teletype, or mail instead of telephone; and publicize use of telephone directory in order to place calls by number.

g. Justification: To require each subscriber placing a call to submit a justification, through channels, to the commander or his designated representative; each call to be reviewed, as directed, by departmental heads and command action taken to eliminate unnecessary calls.

h. Booking: To book all calls over busy trunk groups or all trunks, as required to insure fair distribution of usage or to restrict usage to specific personnel.

i. Distributing Calls: To arrange for trunked calls to be spread out over the day in order to have a level flow of traffic over the entire working day, thereby reducing the traffic during the busy hour. Such action may require command action staggering office hours and lunch periods of office personnel.

SECTION IV. SWITCHBOARD ARRANGEMENTS

20. ORDER OF ARRANGEMENT OF MAIN TYPES OF TRUNKS ON A TYPICAL LONG DISTANCE SWITCHBOARD OR COMBINATION LOCAL AND LONG DISTANCE SWITCHBOARD

Outgoing Dial Trunks	-	(operator to complete incoming LD calls)
Common Battery Manual Lines	-	(station lines) combination board
Local Exchange Trunks	-	(outgoing, incoming, or two-way trunks)
Long Distance Trunks	-	(outgoing, incoming, or two-way trunks)
Recording Trunks	-	Recording Trunks - (incoming dial)
Miscellaneous Trunks	-	(Chief Operator; Wire Chief, etc.)

TYPICAL ORDER OF ARRANGEMENT FOR STRIPS ON LONG DISTANCE SWITCHBOARD

Designation Strip	-	Designation Strip	-	Designation Strip
Line Lamp Strip	-	Line Lamp Strip	-	Line Lamp Strip
Jack Strip	-	Jack Strip	-	Jack Strip
Busy Lamp Strip	-	(if used)	-	Busy Lamp Strip

- A. Trunks should be arranged in alphabetical order from left to right.
- B. A color scheme should be used on the designation strips.
- C. The above order of trunks and strips is recommended, but may vary with the type of board.

24	MASTER												PARIS												25	VERSA																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
18	CONQUER												FAGLE REAR												19	REIM																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
12	LUCKY																								13	FRAN																	
	0 0																									0 0 0 0 0 0 0 0 0 0																	
	0 0																									0 0 0 0 0 0 0 0 0 0																	
	0 0																									0 0 0 0 0 0 0 0 0 0																	
6	ADSEC												TRIUMPH												7	BFRL																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0												0 0 0 0 0 0 0 0 0 0													0 0 0 0 0 0 0 0 0 0																	
1	ROUTING 0						INFO 0						CH 0						TRB 0						REPAIR							SUPERVISOR											
	0 0 0 0 0 0 0						0 0 0 0 0						0 0 0 0						0 0 0 0						0 0 0 0 0							0 0 0 0 0 0 0 0 0 0											
	0 0 0 0 0 0 0						0 0 0 0 0						0 0 0 0						0 0						0 0 0 0 0							0 0 0 0 0 0 0 0 0 0											

CABLE TURNING	HEAD SECT.	POSITION 1				POSITION 2				POSITION 3				FOOT SECT.
	PAN 0	PAN 1	PAN 2	PAN 3	PAN 4	PAN 5	PAN 6	PAN 7	PAN 8	PAN 9				PAN 100
	0 19	20 39	40 59	60 79	80 99	100 119	0 19	20 39	40 59	60 79				100 119

Head section required to
mount jacks and relays.
No cord circuits are installed.

Trunk and Station Jacks
make appearance every 6th
panel.

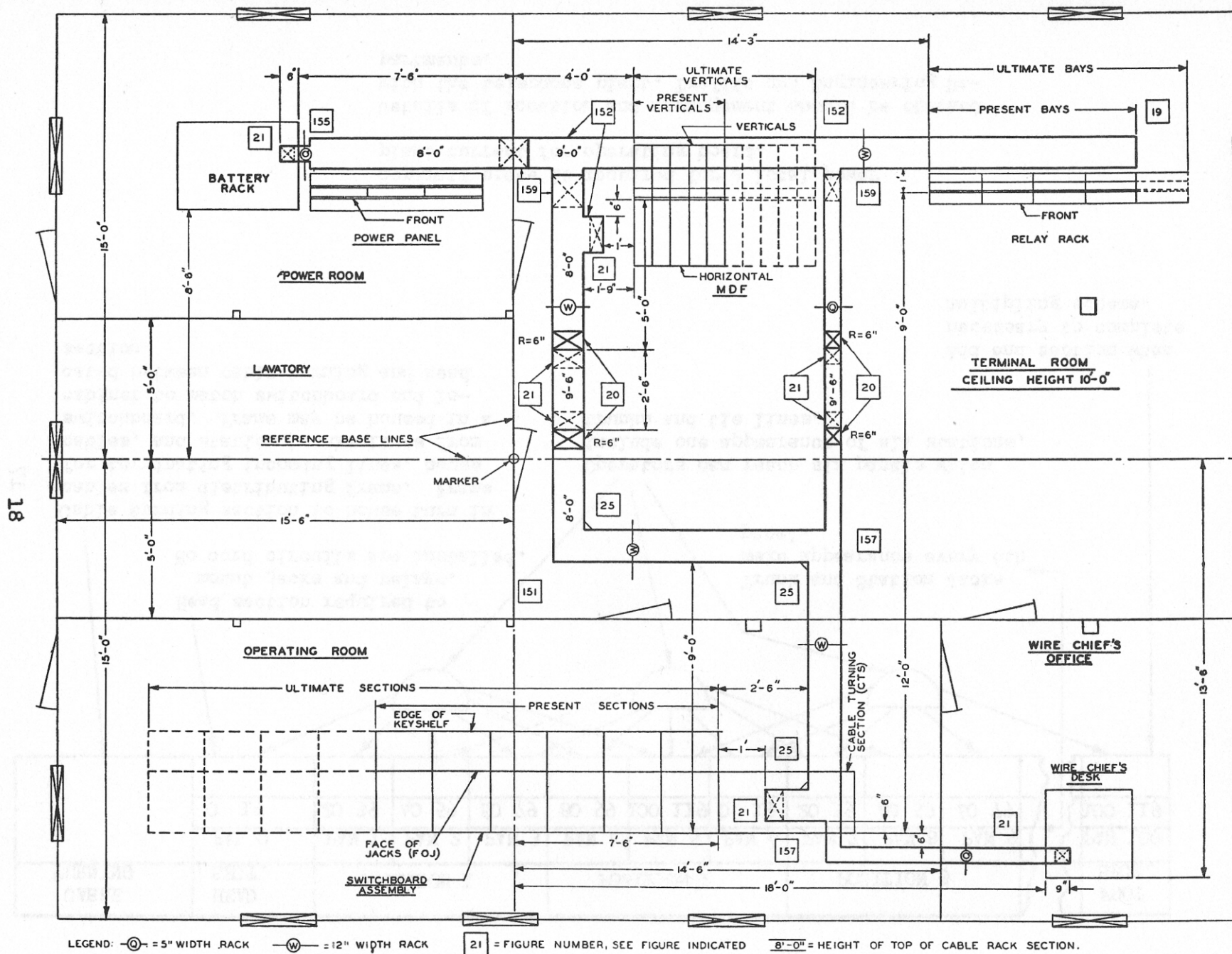
Operators can reach six panels which
include one appearance of all stations,
trunks and tie lines.

Add end section when
necessary to complete
multiplying scheme.

Cable turning section to house turn in
cables from distributing frame. Frame
for terminating incoming lines, house
cables, and station trunks lines from
switchboard. Frame may be housed in a
cabinet to match switchboard and lo-
cated between cable turning and head
section.

Separate space is required for a local power
plant current for operating board.

Details of location and arrangement should be checked
with the telephone plant, Traffic and Engineering De-
partments.



24. MAJOR ITEMS TO BE SPECIFIED IN THE TRAFFIC ORDER

The following items, if required, should be included in the traffic order:

- a. Number of positions.
- b. A sketch or table showing the detailed arrangement of the face equipment, to include all miscellaneous trunks.
- c. Number of common battery line equipments in each panel --
 - (1) With designation strips.
 - (2) With first and last jack stile strip number plates.
- d. Number of magneto line equipments.
 - (1) Magneto lines, with drops, including location of drops or with lamps.
 - (2) Toll lines and non-through supervision ring down trunks, with drops including location of drops, or with lamps, and with or without toll line busy lamps.
 - (3) Through supervision trunks, with or without plug supervision, jacks, busy lamps.
- e. Number of interposition trunks, panel and jack numbers to which each end of the trunks should be connected.
- f. Number and location of incoming trunks.
- g. Number and location of outgoing trunks.
- h. Number and location of miscellaneous trunks.
- i. Number and location of ticket boxes.
- j. Number and location of bulletin holders.
- k. Number of lamp caps of each type desired to fully equip all lamp sockets of the common battery, magneto, and miscellaneous multiples.
- l. Number of additional lamps for those lines and trunks which can have and will have more than one lamp appearance.
- m. Number of cord pairs per position.
- n. Are cords to be equipped for through supervision?
- o. Positions to be equipped with dial and dial cord.

- p. Number of ticket pad holders.
- q. Type number and location of ticket clips.
- r. Audible recall.
- s. Supervisors' circuit, including multiple jack number and position number for supervisors' telephone set jacks.
- t. Fuse alarm cut-off and pilot lamp signals.
- u. Emergency talking battery and key.
- v. Emergency lighting.
- w. Trunk location.
- x. Subscribers multiple with panel arrangements.
- y. Calculagraphs.

NOTE: There is no specific format.

SECTION V. TELEPHONE TRUNK REQUIREMENTS

25. SAMPLE SWITCHBOARD PEG COUNT FORM (Calls per Hour)

Switchboard _____

Unit _____

Position No. _____

Date _____

HOURS	Long Distance				Station to Station*	Local Exchange		Direct Lines To Local PBX		** Misc	Grand Total
	Origin- ating	Incom- ing	Thru	To- tal		Out- going	In- coming	Out- going	In- coming		
0001											
0800											
0900											
1000											
1100											
1200											
1300											
1400											
1500											
1600											
1700											
1800											
1900											
2000											
2100											
2200											
2300											
2400											
TOTAL											

*Station to Station: Also includes calls to Trouble, Information, Chief Operator, Routing, Booking, Interposition

**Miscellaneous: Includes taking messages, attendant dial, giving time, etc.

26. SAMPLE PLUG COUNT FORM

Time Interval																																TOTAL TIMES
TRUNK	02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60		
1	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X						28	
2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	29	
3	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	29	
4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	30	
5	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	28	
6	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	27	
7	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X		X	X	X		X	26	
8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	30	
9	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	27	
10	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X		X	X		X	X	25	
11	X	X		X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		26	
12	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	26	
13	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	27	
14		X	X	X	X	X	X		X		X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	24	
15		X	X	X	X	X	X	X	X	X		X	X	X		X	X		X	X	X	X	X		X	X	X	X	X	X	25	
16	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X		X	X	26	
17	X	X	X	X	X	X		X		X		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X		24	
18	X	X				X	X	X	X	X		X	X	X		X	X	X	X	X	X		X	X		X		X	X	X	22	
19		X	X	X	X	X	X			X	X	X	X	/	X		X	X	X	X	X	X	X	X		X	X				21	
20	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X		X		X	X	X		X						20	
TOTAL	17	20	17	18	18	20	18	17	15	18	16	18	19	16	18	17	18	16	18	17	19	17	19	17	16	16	17	16	17	15	520	

$$\text{Trunk minutes} = \text{Plug Count} \times \text{Interval} = 520 \times 2 = 1040 \text{ minutes}$$
$$\text{Average Trunk Usage} = \frac{\text{Plug Count}}{\text{Times Counted}} = \frac{520}{30} = 17.3$$

27. BUSY HOUR TRUNK MINUTE USAGE RECORD

Switchboard _____

Paris Military

	Oct.					Nov.			
Trunk Group	1	8	15	22	29	5	12	19	26

Trunks Installed

Trunks in Svc

Trunk Minutes

Per Group

No. of Calls

Holding Time

Per Call (a)

% Capacity (b)

Trunks Required

Frankfurt Military

Trunk Group

Trunks Installed

Trunks in Svc

Trunk Minutes

No. of Calls

Holding Time

% Capacity

Trunks Required

Remarks:

NOTE: This type of form may be used for local trunks as well as Long Distance.

(a) $\frac{\text{Plug X interval} \cdot \text{HT}}{\text{PEG}}$

(b) $\frac{\text{Trunk Minutes}}{\text{Max. Min. Capacity}} = \% \text{ of Capacity}$

28. LONG DISTANCE MANUAL TRUNK REQUIREMENTS

<u>TRUNKS REQUIRED</u>	<u>NORMAL SERVICE TRUNK MINUTES PER HOUR</u>	<u>FAST SERVICE TRUNK MINUTES PER HOUR</u>
1	1-36	1-9
2	37-78	10-33
3	79-126	34-62
4	127-176	63-96
5	177-228	97-135
6	229-281	136-175
7	282-335	176-216
8	336-390	217-258
9	391-446	259-301
10	447-503	302-345
11	504-560	346-390
12	561-617	391-436
13	618-674	437-482
14	675-731	483-529
15	732-788	530-576
16	789-845	577-623
17	846-902	624-671
18	903-959	672-719
19	960-1016	720-769
20	1017-1073	770-817
21	1074-1130	818-867
22	1131-1187	868-917
23	1188-1244	918-968
24	1245-1301	969-1019
25	1302-1358	1020-1070

Note 1: If facilities and/or financial budget authorizations permit, the FAST SERVICE column should be used. Judgment must be exercised in the case of heavily overloaded small trunk groups. For example, if a record on a four-trunk group showed 238 minutes of use, the NORMAL SERVICE table would show the need for six trunks, or two more than currently provided. However, since 238 minutes shows that all four trunks were in use practically every minute of the hour, it is obvious that many calls must have been turned back because of "all trunks busy" and thus were not accounted for the record. Consequently, at least three additional trunks must be added immediately and others added in accordance with subsequent records until the record shows 90-100% of capacity usage.

Note 2: NORMAL SERVICE table is based on 3-4% refusals in busy hour.

Note 3: FAST SERVICE table is based on 1-2% refusals in busy hour.

29. LONG DISTANCE TRUNK REQUIREMENTS

Busiest hour calls per group	Trunks per LD Group			Busiest hour calls per group	Trunks per LD Group		
	3-min holding time	5-min holding time	7-min holding time		3-min holding time	5-min holding time	7-min holding time
2	1	1	1	80	5	8	11
4	1	1	1	85	6	9	12
6	1	1	2	90	6	9	12
8	1	1	2	95	6	10	13
10	1	2	2	100	7	10	14
12	1	2	2	105	7	11	14
14	2	2	3	110	7	11	15
16	2	2	3	115	7	11	16
18	2	2	3	120	8	12	16
20	2	3	3	125	8	12	17
22	2	3	4	130	8	13	17
24	2	3	4	135	8	13	18
26	2	3	4	140	9	14	19
28	2	3	5	145	9	14	19
30	3	4	5	150	9	15	20
35	3	4	6	155	9	15	20
40	3	5	6	160	10	16	21
45	3	5	7	165	10	16	22
50	4	6	7	170	10	17	22
55	4	6	8	175	10	17	23
60	4	7	9	180	11	18	23
65	5	7	9	185	11	18	24
70	5	7	10	190	11	20	25
75	5	8	11	195	11	20	25
				200	12	21	26

NOTE: See also par 31d, page 27, and holding time formula par 36, page 31.

30. LOCAL TRUNK REQUIREMENTS

Busiest-hour calls per group	Trunks per local group		
	3-minute holding time	5-minute holding time	7-minute holding time
1-3	1	1	1
4	1	1	2
6	2	2	3
8	2	3	4
10	3	4	5
12	3	4	5
14	4	5	5
16	4	5	6
18	4	5	6
20	4	6	7
22	4	6	7
24	5	6	7
26	5	6	8
28	5	7	8
30	5	7	9
35	6	8	9
40	6	8	10
45	7	9	11
50	7	10	12
55	7	10	13
60	8	11	14
65	8	11	14
70	9	12	15
75	9	13	16
80	9	13	17
85	10	14	18
90	10	14	18
95	11	15	19
100	11	15	20
105	11	16	21
110	12	17	21
115	12	17	22
120	12	18	23
125	13	18	24
130	13	19	24
135	13	19	25
140	14	20	26
145	14	20	27
150	14	21	27

NOTE: See also par 31c, page 27, and holding time formula par 36, page 31.

31. EXPERIENCE FACTORS AND FORMULAS FOR STATION LINES, MISCELLANEOUS AND LONG DISTANCE TRUNKS FOR FIXED PLANT INSTALLATIONS (TO BE USED AS A GUIDE ONLY)

a. Station Lines.

- (1) One per general and field grade officer.
- (2) One per two company grade officers.
- (3) One per five enlisted personnel, first grade.
- (4) One per 50 enlisted personnel, other than first grade.
- (5) To each of the above add comparable civilians.
- (6) Add quarters and special telephones.

b. Miscellaneous Lines.

- (1) Intercept -- one per 100 subscribers.
- (2) Information --
 - (a) Local to information board -- one per 100 subscribers.
 - (b) Long distance to information board -- one per position in multiple.
- (3) Booking -- variable in proportion to type of operations.
- (4) Routing -- one or two lines per ten positions.
- (5) Intra-position -- variable in proportion to type of operations.
- (6) Chief operators -- one or two lines per installation.
- (7) Supervisors -- one per three to five positions.
- (8) Trouble -- two to five lines per installation.

c. Local Trunks.

- (1) Use same formula as long distance if calling rate of out and in calls is known.
- (2) If calling rate not known -- local trunks to long distance board -- four trunks per 100 subscribers served having access to long distance board.

d. Long Distance Trunks.

- (1)
$$\frac{\text{Calling rate} \times \text{number of phones served}}{7.5 \text{ average calls per hour}} = \text{Total long distance trunks required}$$
- (2) The average long distance calling rate on military telephone is .3 or .4 calls per hour. This calling rate factor will vary at different installations.

SECTION VI. TELEPHONE SWITCHBOARD REQUIREMENTS

32. POSITION REQUIREMENTS, SEPARATE LONG DISTANCE SWITCHBOARDS

Total busiest-hour traffic (outward, inward, and through calls). (Peg Count)	Positions required	Number of telephones which can be served by long distance switchboards	
		At 0.3 total long distance calls (inward, outward, and through) in the busiest hour per telephone served.	At 0.4 total long distance calls (outward, inward, and through) in the busiest hour per telephone served.
1-59	1	1-199	1-149
60-159	2	200-533	150-399
160-259	3	534-866	400-649
260-359	4	867-1,199	650-899
360-459	5	1,200-1,532	900-1,149
460-549	6	1,533-1,832	1,150-1,374
550-639	7	1,833-2,132	1,375-1,599
640-739	8	2,133-2,466	1,600-1,849
740-829	9	2,467-2,766	1,850-2,074
830-919	10	2,767-3,066	2,075-2,299
920-1,009	11	3,067-3,366	2,300-2,524
1,010-1,099	12	3,367-3,666	2,525-2,749
1,100-1,199	13	3,667-3,999	2,750-2,999
1,200-1,289	14	4,000-4,299	3,000-3,224
1,290-1,379	15	4,300-4,599	3,225-3,449
1,380-1,469	16	4,600-4,899	3,450-3,674
1,470-1,559	17	4,900-5,199	3,675-3,899
1,560-1,649	18	5,200-5,499	3,900-4,124
1,650-1,749	19	5,500-5,832	4,125-4,374
1,750-1,839	20	5,833-6,132	4,375-4,599

In addition to the basic assumptions, this table assumes that:

1. The traffic is of both long and short haul type.
2. The number of calls per operator in the busiest hour depends on the number in the team on duty. The number of calls per operator per hour is:
 - 1 operator, 60 calls per hour
 - 2 operators, 80 calls per hour each
 - 3 operators, 88 calls per hour each
 - 4 operators, 90 calls per hour each
 - 5 or more operators, 92 calls per hour each
3. The switchboard face layout permits every operator to reach every line and trunk. Additional positions (end positions) may be required to assure this.
4. Tickets are to be written on delayed calls only.

33. POSITION REQUIREMENTS, COMBINED LOCAL AND LONG DISTANCE COMMON BATTERY SWITCHBOARDS

Total busiest-hour traffic (originating, inward, and through calls). (Peg Count)	Positions required	Number of telephones which can be served by combined local and long distance switchboards.	
		At two orig. calls per telephone in the busiest hour.	At three orig. calls per telephone in the busiest hour.
1-99	1	1-27	1-17
100-264	2	28-72	18-48
265-439	3	73-120	49-80
440-599	4	121-164	81-109
600-764	5	165-209	110-139
765-919	6	210-252	140-167
920-1,069	7	253-293	168-195
1,070-1,224	8	294-336	196-223
1,225-1,374	9	337-377	224-251
1,375-1,529	10	378-419	252-279
1,530-1,684	11	420-462	280-308
1,685-1,834	12	463-503	309-335
1,835-1,989	13	504-546	336-363
1,990-2,139	14	547-587	364-391
2,140-2,294	15	588-629	392-419
2,295-2,449	16	630-672	420-448
2,450-2,599	17	673-713	449-475
2,600-2,754	18	714-756	476-504
2,755-2,904	19	757-797	505-531
2,905-3,059	20	798-840	532-559

This table is based on the following assumptions:

1. The number of telephones served is 1.5 times the number of loops connected to the switchboard.
2. Each operator handles all types of calls.
3. The number of calls per operator in the busiest hour depends on the number in the team on duty. The number of calls per operator per hour is:

- 1 operator, 100 calls per hour
- 2 operators, 133 calls per hour each
- 3 operators, 147 calls per hour each
- 4 operators, 150 calls per hour each
- 5 or more operators, 153 calls per hour each

4. The distribution of traffic is as given in paragraph 1112b, TM 11-486, April 1945, but the table permits variations as indicated below:

Local calls.....	40%	to	20%
Outward trunk calls.....	20%	to	30%
Inward and through (switched calls).....	40%	to	50%
TOTAL		100%	to 100%

5. The switchboard face layout permits every operator to reach every local line and trunk. Additional positions (end positions) may be required to assure this.

6. Tickets are to be written on delayed long distance calls only.

34. POSITION REQUIREMENTS, SEPARATE LOCAL COMMON BATTERY SWITCHBOARDS

Total busiest-hour traffic (originating and inward calls). (Peg Count)	Positions required	Number of telephones which can be served by local common battery switchboards.	
		At two orig. calls per telephone in the busiest hour.	At three orig. calls per telephone in the busiest hour.
1-149	1	1-52	1-34
150-399	2	53-139	35-93
400-649	3	140-227	94-151
650-899	4	228-314	152-209
900-1,149	5	315-401	210-267
1,150-1,379	6	402-482	268-321
1,380-1,609	7	483-562	322-374
1,610-1,839	8	563-643	375-428
1,840-2,069	9	644-723	429-482
2,070-2,299	10	724-803	483-535
2,300-2,529	11	804-884	536-589
2,530-2,759	12	885-964	590-642
2,760-2,989	13	965-1,045	643-696
2,990-3,219	14	1,046-1,125	697-750
3,220-3,449	15	1,126-1,205	751-803
3,450-3,679	16	1,206-1,286	804-857
3,680-3,909	17	1,287-1,365	858-910
3,910-4,139	18	1,366-1,447	911-964
4,140-4,369	19	1,448-1,527	965-1,018
4,370-4,599	20	1,528-1,607	1,019-1,071

This table is based on the following assumptions:

1. The number of telephones served is 1.5 times the number of loops connected to the switchboard.
2. The switchboard handles local and incoming calls. Outward long distance calls are passed to a long distance board for handling.
3. The number of calls per operator in the busiest hour depends on the number in the team on duty. The number of calls per operator per hour is:

- 1 operator, 150 calls per hour
- 2 operators, 200 calls per hour each
- 3 operators, 220 calls per hour each
- 4 operators, 225 calls per hour each
- 5 or more operators, 230 calls per hour each

4. Distribution of traffic (par 1112d, TM 11-486, April 1945):

Local calls.....	40%
Outward trunk calls.....	30%
Inward calls.....	30%
TOTAL	100%

5. The switchboard face layout permits every operator to reach every local line and trunk. Additional positions (end positions) may be required to assure this.

6. No tickets are to be written.

35. FORMULAS FOR SWITCHBOARD POSITIONS

a. Any Type Switchboard.

$$\frac{\text{TOTAL POSITIONS}}{\text{REQUIRED}} = \frac{\text{CALL RATE X NUMBER OF TELEPHONES SERVED}}{\text{OPERATOR SPEED}}$$

b. Long Distance Switchboard Only.

$$\frac{\text{TOTAL CORD PAIR REQUIRED}}{\text{REQUIRED}} = \frac{\text{TOTAL TRUNKS, STATION LINES AND MISC. TRUNKS}}{2 \text{ (CORDS PER PAIR)}}$$

$$\frac{\text{TOTAL POSITIONS}}{\text{REQUIRED}} = \frac{\text{TOTAL CORD PAIR REQUIRED}}{\text{CORD PAIR PER POSITION}}$$

c. Recommended Cord Pair Per Position:

- (1) Local switchboard - 15 cord pair per position.
- (2) Long distance switchboard - 9 cord pair per position.
- (3) Combination long distance and local switchboard - 12 cord pair per position.

SECTION VII. FORMULAS FOR TELEPHONE TRAFFIC COUNTS

36. HOLDING TIME

$$\frac{\text{PLUG COUNT X INTERVAL TAKEN}}{\text{PEG COUNT}} = \text{AVERAGE HOLDING TIME}$$

37. TRUNK MINUTES

$$\text{PLUG COUNT X INTERVAL TAKEN} = \text{TRUNK MINUTES}$$

38. CALLING RATE

$$\frac{\text{CALLS HANDLED}}{\text{TELEPHONES SERVED}} = \text{AVERAGE CALLING RATE}$$

39. CCS OR HUNDRED CALL SECONDS

$$\frac{\text{PLUG COUNT X INTERVAL TAKEN X 60"}}{100} = \text{TOTAL CCS}$$

40. AVERAGE TRUNKS IN USE

$$\frac{\text{TOTAL PLUG COUNT}}{\text{NUMBER OF TIMES COUNTED}} = \text{AVERAGE TRUNKS IN USE}$$

SECTION VIII. TELEPHONE SWITCHBOARD OPERATIONS AND PROCEDURES

41. TELEPHONE ROUTE BULLETIN

<u>POINT</u>	<u>FIRST ROUTE</u>	<u>ALTERNATE ROUTE</u>
ACRE (NAVY)	PARIS-CHERBOURG	LONDON-CHERBOURG
ADSEC	BRUSSELS	PARIS
AIX	PARIS-MARSEILLES	FINAL-MARSEILLES
ALBIS	PARIS-CHARTRES	PARIS-LE MANS-CHARTRES
ALENCON	PARIS-LE MANS	PARIS-ORLEANS-LE MANS
AMTEN	BRUSSELS	PARIS
ANGERS	PARIS-LE MANS	PARIS-ORLEANS-LE MANS
ANTWERP	BRUSSELS	PARIS
ARMOR	EAGLE MAIN-CONQUER	GANGWAY-EAGLE TAC-O
ATTIC	PARIS-LE MANS	PARIS-ORLEANS-LE M
AVRANCHES	PARIS-RENNES	PARIS-CHERBOURG
BARFLEUR	PARIS-CHERBOURG	LONDON-CHERBOURG
BAYEUX	PARIS	GOODGE ST
BOMBAY	GANGWAY	GANGWAY
BRANVILLE	PARIS-CHERBOURG	LONDON
BREST	PARIS-LE MANS	PARIS
BRITISH EMBASSY	PARIS	PARIS
BRUSH	PARIS-LE MANS	PARIS
BRYANSTON SQ, (LONDON)	DIRECT	DIRECT
BRUSSELS	DIRECT	DIRECT
CADET	FINAL	FINAL
CAEN	BRUSS	BRUSS
CARENTAN	BR	BR
CEDAR		
CENTURY		
CENTURY R		
CHANNEL		
CHART		
CA		

42. TOLL TICKET

DATE		SERIAL NO.	
SPEC. INST.			
☐ OFFICIAL		☐ UNOFFICIAL	
FROM			
TEL. NO.			
PERSON			
ORGANIZATION			
PLACE		TO STATE	
TEL. NO.			
PERSON			
FIRM OR ADDRESS			
FILING TIME		OPERATOR	
MINUTES		REMARKS	
CHARGES			
TOLL			
TAX (UNOFFICIAL CALL)			
REPORT (WHERE APPLICABLE)			
MESSENGER			
TOTAL			
WD AGO FORM 11-139 1 MAY 1945		TOLL TICKET (EDITION OF 16 JUNE 44 MAY BE USED)	
GPO-- O--894254 16-44422-1			

WEEK ENDING: _____

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44. PROPER CODES AND ABBREVIATIONS FOR TOLL SWITCHBOARD OPERATION AS USED BY COMMERCIAL COMPANIES

The following codes and abbreviations are standard for toll operation. Operating codes are not used in talking to subscribers, but for the purpose of passing reports to other operators and recording information on toll tickets. These codes are proven savers of circuit time.

a. Codes.

AY - Anyone.	OF - One of the firm.
AG - Try again.	RD - Ring down.
BNR - Messenger not returned.	RX - Through.
BY - The line is busy.	T - In-ticket required.
CA - Cancel or cancelled.	TD - Temporarily disconnected.
CF - Cannot find.	TLK - Talk or talking.
CTO - Cut-off.	TT - Temporarily transferred.
DA - Telephone does not answer.	U - Expected at (TIME).
DBL - Double connection.	UD - Do not know whether the called party will be there today.
LF - Left telephone.	UX - Not expected today and do not know when he will be there.
LK - Looking for party.	WH - We have, or ready with line or party.
MGLW - Send messenger; if called party is not there, leave word.	WT - Will talk.
MGOK - Send messenger; charge is OK.	
OD - Out of order.	

b. Abbreviations.

APT - Appointment.	LD - Long Distance.	PSD - Passed.
BK - Bank.	LOC - Local.	PERS - Personal.
CLK - Clerk.	MINS - Minutes.	PL - Places.
CT - Court.	NT - Night.	RES - Residence.
COV - Covers.	OK - Correct.	SPEC - Special.
D - Delay.	PVT - Private.	TEL - Telephone.
FIN - Finished.	PTY - Party.	VER - Verify.

SECTION IX. MILITARY DIRECTORIES

45. ESSENTIALS OF A MILITARY TELEPHONE DIRECTORY

a. Outside Front Cover:

Security classification in accordance with AR 380-5.
Name and insignia of command headquarters served by telephone exchange.
Date of publication of directory.
Warning.
Emergency number.
Special instructions deemed necessary.

b. Inside Front Cover:

Principal units served by telephone exchange.
Identification of signal officer in charge of telephone exchange.

c. Index: Guide to location of various classifications in directory, giving types of service and listing them by page number.

d. Emergency numbers:

Ambulance, chaplain, dispensary, fire, military police and utilities.
Not listed on front cover.

e. Telephone Service Calls:

Telephone information -- local and out of town.
Telephone repair.

f. Emergency Vehicle Service Stations: Location and numbers.

g. Night Duty Officers: Night duty officers of the various sections for regular or emergency use.

h. Telephone Dialing and Calling Instructions:

Dial instructions (if dial).
Any other special instructions necessary to aid good telephone service.

i. General Information:

Descriptions of abbreviations used throughout the telephone directory to save space and printing time.
Special instructions as to military use and privileges of military telephone system.
Use of telephone priorities in placing and completing calls.
Priority I, II, etc.

j. Classifications of Telephone Service:

Official.
Billets.
Military.
Civilian-Military.

k. Moves and Clearances: Procedures used in installation, moves and clearances of telephone service.

l. Alphabetical Section:

ACKERMAN, G. F. WOJG, G-2, HQB 320.....2-1234
Qrs: 4 Lichtensteinstr.....5-3022

Name, rank, section, location.....Official number
Address.....Billet number

m. Numerical Units Section:

Troop units designated by number are listed with cross reference for additional places to call in case of "don't answer", etc.

24th BASE POST OFFICE (ADJ Sec Hq Comd).....2-4020

NOTE: In this case, the adjutant general's section
of the headquarters command would be called
in case the post office number did not answer.

n. Classified Section (Several Typical Listing are Given):

Commander-in-chief and personal staff.
Allied contact section.
Judge advocate.
Military government agencies.

o. Miscellaneous Classified Section:

Accredited agencies.
Barber shops.
Messes.
Commercial services.
American Express.
Western Union.
American Telephone and Telegraph Company.
Press Representatives.

p. Form Request for Telephone Service:

This form is made up to contain all pertinent information so that when the applicant fills it out and forwards it to the signal officer, action may be taken to install a telephone for the applicant.

q. Inside Back Cover: Frequently called number form for use of person assigned directory.

r. Outside Back Cover:

Any special instructions deemed necessary.
Signal Corps insignia.
Any other insignia desired.

46. ESSENTIALS OF A MILITARY TELETYPEWRITER DIRECTORY

a. Outside Front Cover:

Security classification in accordance with AR 380-5.
Name of command headquarters served by the teletypewriter exchange.
Signal Corps or unit insignia.
Date of publication of directory.
Special instructions deemed necessary.

b. Inside Front Cover:

Principal units served by the teletypewriter exchange.
Identification of the officer in charge of the teletypewriter exchange with telephone number.

c. Index: Contains guide to the directory.

d. Teletypewriter Service Calls:

Teletypewriter information.
Teletypewriter repair and maintenance.
Teletypewriter installations, location, changes, and termination of service.

e. General Information:

Adherence to proper procedures to be used on the network.
Calling instructions for placing and receiving calls.
Description of abbreviations used throughout the directory.
Teletypewriter service to be used for official traffic only.

f. Commercial Facilities Available:

Commercial facilities available, if any.
Reference to procedures to be employed when utilizing commercial facilities.

g. Listings:

Geographically by towns and units located therein.
Alphabetically by unit.
Alphabetically by call sign.

h. Inside Back Cover: Blank form to list stations frequently called.

i. Outside Back Cover:

Military classification.
Signal Corps or unit insignia.

SECTION X. TELETYPEWRITER REQUIREMENTS

47. POSITION REQUIREMENTS -- FIXED PLANT-TYPE MULTIPLE TELETYPEWRITER SWITCHBOARDS (SWITCHED SERVICE)

Total busiest-hour traffic (outward, inward, and through calls). (Peg Count)	Positions required	Number of teletypewriter loops plus trunks.	
		At 1.5 calls (outward, inward, and through) in the busiest hour per teletypewriter loop served.	At 2 calls (outward, inward, and through) in the busiest hour per teletypewriter loop served.
1-20	1	1-13	1-10
21-48	2	14-32	11-24
49-78	3	33-52	25-39
79-104	4	53-70	40-52
105-138	5	71-92	53-69
139-169	6	93-113	70-85
170-202	7	114-135	86-101
203-238	8	136-159	102-119
239-274	9	160-184	120-137

This table is based on the following assumptions:

1. Each operator handles all types of calls and the total busiest-hour traffic is the sum of all types.

2. The distribution of traffic is:

Local calls.....	20% to	10%
Outward trunk calls.....	40% to	45%
Inward calls.....	40% to	45%
TOTAL	100%	100%

3. The switchboard face layout permits every operator to reach every loop and trunk.

48. TELETYPEWRITER TRUNK CIRCUIT REQUIREMENTS -- BASED ON HOLDING TIME
(SWITCHED SERVICE)

Total busiest-hour calls per trunk group (outward plus inward) (Peg Count)	Trunks per trunk group		
	15-minute holding time	20-minute holding time	25-minute holding time
1	1	1	1
2	2	2	2
3	2	2	3
4	2	3	3
5	3	3	4
6	3	4	4
7	3	4	5
8	4	4	5
9-10	4	5	6
11-12	5	6	7
13	5	6	8
14	6	7	8
15	6	7	9
16-17	6	8	9
18	7	8	10
19	7	9	10
20	7	9	11

49. TELETYPEWRITER TRUNK CIRCUIT REQUIREMENTS -- BASED ON GROUP COUNT
(SWITCHED SERVICE)

Total busiest-hour group count per trunk group (outward plus inward)		Trunks per trunk group
Keyboard Transmission	Tape Transmission	
1-649	1-1,399	1
650-1,499	1,400-3,399	2
1,500-2,599	3,400-5,699	3
2,600-3,699	5,700-7,999	4
3,700-4,699	8,000-10,299	5
4,700-5,899	10,300-12,999	6
5,900-7,199	13,000-15,699	7
7,200-8,399	15,700-18,399	8
8,400-9,699	18,400-21,099	9
9,700-10,899	21,100-23,799	10

This table is based on the following assumptions:

1. One group of text is assumed to consist of five typed characters and a space.
2. Twenty-five net groups per minute is taken as the average message speed with keyboard transmission.
3. Fifty net groups per minute is taken as the average message speed with tape transmission.
4. Groups counts are for the message text only; they do not include headings or endings.

50. TRUNK CIRCUIT REQUIREMENTS -- POINT-TO-POINT SERVICE (THEATER OR TACTICAL NETWORK)

NO. OF MESSAGES PER DAY*		NO. OF TRUNKS (half-duplex operation)	NO. OF GROUPS PER DAY	
Keyboard	Tape		Keyboard	Tape
- 131	- 262	1	- 12,500	- 25,000
132- 262	263- 526	2	12,501- 25,000	25,001- 50,000
263- 394	527- 789	3	25,001- 37,500	50,001- 75,000
395- 526	790-1052	4	37,501- 50,000	75,001-100,000
527- 657	1053-1316	5	50,001- 62,500	100,001-125,000
658- 789	1317-1578	6	62,501- 75,000	125,001-150,000
790- 921	1579-1842	7	75,001- 87,500	150,001-175,000
922-1052	1843-2105	8	87,501-100,000	175,001-200,000
1053-1184	2106-2378	9	100,001-112,500	200,001-225,000
1185-1316	2379-2631	10	112,501-125,000	225,001-250,000
1448-1578	2895-3163	12	137,501-150,000	275,001-300,000
1711-1842	3422-3684	14	162,501-175,000	325,001-350,000
1974-2105	3948-4210	16	187,501-200,000	375,001-400,000
2236-2378	4474-4737	18	212,501-225,000	425,001-450,000
2501-2631	5001-5473	20	237,501-250,000	475,001-500,000
2764-2894	5527-5789	22	262,501-275,000	525,001-550,000
3027-3163	6054-6315	24	287,501-300,000	575,001-600,000
3290-3421	6579-6842	26	312,501-325,000	625,001-650,000
3553-3684	7112-7369	28	337,501-350,000	675,001-700,000
3817-3947	7632-7894	30	362,501-375,000	725,001-750,000

The above table is based on each trunk handling half of its maximum capacity so there will be adequate facilities available for handling service in the busy hour.

*Number of messages per day columns are based on an average of 100 groups per message.

51. HISTORICAL DATA AND ESTIMATED FUTURE LINES AND STATIONS (DA AGO Form 11-204)

DA ^{AGO FORM} 11-204
1 AUG 48

52. SUMMARY OF EQUIPMENT (DA AGO Form 11-204A)

[illegible]DA AGO FORM 11-204A
1 AUG 48

53. TWO-MINUTE COUNTS OF EQUIPMENT USED (DA AGO Form 11-204B)

TELEPHONE TRAFFIC DATA TWO-MINUTE COUNTS OF EQUIPMENT USED		INSTALLATION		REPORTS CONTROL SYMBOL SIG-79 DATE OF RECORD												
NUMBER OF SWITCHES OFF NORMAL OR ALL TRUNKS BUSY LAMPS LIGHTED																
1. SWITCH OR TRUNK GROUP	1ST (a)		3RD (b)		1ST (a)		3RD (b)		1ST (a)		3RD (b)		1ST (a)		3RD (b)	
2. HALF HOURS STARTING AT 30																
3. MIN 30																
32																
34																
36																
38																
40																
42																
44																
46																
48																
50																
52																
54																
56																
58																
4. SUBTOTAL																
HALF HOURS	2ND	4TH	2ND	4TH	2ND	4TH	2ND	4TH	2ND	4TH	2ND	4TH	2ND	4TH	2ND	4TH
00																
02																
04																
06																
08																
10																
12																
14																
16																
18																
20																
22																
24																
26																
28																
5. SUBTOTAL																
HOURLY TOTALS	6. 1ST AND 2ND HALF HOURS															
	7. 2ND AND 3RD HALF HOURS															
	8. 3RD AND 4TH HALF HOURS															

DA AGO FORM 11-204B
1 AUG 48

54. HALF-HOURLY READINGS OF ALL REGISTERS (METERS) (DA AGO Form 11-204C)

[illegible]DA AGO FORM 11-204C
1 AUG 48

TELEPHONE TRAFFIC DATA										REPORTS CONTROL SYMBOL SIG-79											
CALLS HANDLED AT ATTENDANT'S POSITIONS										INSTALLATION											
RECORD KEPT BY OBSERVER					1. DATE																
					2. HOUR																
					3. POSITION NO.																
FROM EXTENSION OR TIE LINE	TO EXTENSION																				
	REF. TO PBX DIR.																				
	LOC. VIA MAN. (EXT. PASSES)																				
	(ATTD. PASSES)																				
	REF. TO PBX DIR.																				
	REF. TO EXCH. DIR.																				
	VIA DIAL (ATTD. DIALS _____ PULLS)																				
	REF. TO PBX DIR.																				
	REF. TO EXCH. DIR.																				
	TOLL AND LD VIA MAN. OR DIAL																				
	REF. TO EXCH. DIR.																				
	TO INFORMATION																				
	TO ATTENDANT																				
	TO EXTENSION, TIE LINE OR INFORMATION	FROM ATTENDANT																			
CALLS TRANSFERRED																					
FROM C.O. TRUNK (_____ PULLS)																					
REF. TO PBX DIR.																					
INCOMING COLLECT CALLS																					
CALLS SCREENED (restricted)																					
OTHER CALLS (Specify class)																					
CALLS AT SEPARATE INFO. POS. 1 REFERENCE																					
2 REFERENCES																					
TOTAL CALLS OBSERVED																					
RECORD KEPT BY ATTENDANTS					4. DATE																
SUM OF ALL CALLS NOT SEPARATED BY CLASSES KEPT BY ALL ATTENDANTS					HOUR		0900-1000														
							1000-1100														
							1100-1200														
							1400-1500														
							1500-1600														
							1600-1700														
					TOTAL SIX HOURS																
AVERAGE SIX HOURS																					

DA AGO FORM 11-204D
1 AUG 48

SECTION XII. TRAFFIC ENGINEERING FOR MANUAL AND DIAL PBX TELEPHONE SYSTEMS

56. GENERAL

a. Engineering Methods.

The engineering of PBX equipments requires considerable judgment and knowledge on the part of the traffic engineer of the characteristics and requirements of the particular installation concerned, and a broad experience of equipment requirements of installations similar in nature to the one in question. The engineering tables in paragraph 60 of this section and the engineering methods discussed, including the sample cases in paragraph 61, are to be considered as a guide rather than fixed rules to be followed. There are, however, certain general engineering principles which, if followed, will be of aid to the traffic engineer in determining requirements and will assist reviewing agencies in arriving at recommendations.

b. PBX Station Line and PBX Bridged Stations.

Throughout this section the term "station line" is used to designate a PBX main station. The term "station" is used to designate PBX main and bridged stations.

c. Hundred Call Seconds (CCS).

- (1) In engineering the various amounts of equipment required, especially dial equipments, it is customary to use as a basis for calculation the "hundred call second," abbreviated "CCS". Some telephone companies refer to this call as a "unit call". To obtain the number of hundred call seconds per station line (or station), multiply the average calling rate per station line (or station) by the holding time in seconds during the average busy hour and divide the product by 100. For example, assuming the average calling rate per station line during the busy hour to be 2.14 with an average holding time per call of 91 seconds, the hundred call seconds per station line will be:

$$\frac{2.14 \times 91}{100} = 1.95 \text{ CCS per station line}$$

- (2) Where equipment counts are taken during the busy hour (either by means of plug counts or switch counts) such counts are customarily made at 2 or 3 minute intervals. Assuming there are 857 working station lines at a given installation and that busy hour counts made at 2-minute intervals resulted in 1394 registrations, the hundred call seconds per line will be:

$$\frac{1394 \times 2 \times 60 \text{ seconds}}{100} = \frac{1673}{857} \text{ CCS} = 1.95 \text{ CCS per station line}$$

- (3) As the majority of the equipment capacity tables in paragraph 60 are based on hundred call seconds, it is essential that call rate, holding time, and usage count data be accurate and sufficient in number to give a reasonable picture of the average week-day busy hour conditions.

d. Station Line and Station Data

A record of the number of present working station lines and stations by classification (A, B, C, or D) should be prepared, and a similar list prepared for proposed station line and station requirements showing proposed classifications. Such a comparison may be of assistance in determining estimated call rates.

57. MANUAL PBX SYSTEM

a. Basic Traffic Data.

- (1) General. It is most important, when considering increasing or decreasing telephone equipment requirements at an installation, that every effort be made to obtain sufficient and reliable basic traffic data. In this connection, careful consideration should be given to the following procedures:
 - (a) Review the activities of all using units at the installation and determine the present and ultimate station line and station requirements as accurately as possible.
 - (b) Determine the station line and station requirements of incoming or outgoing units and, if possible, estimate the calling rate and holding times of their telephone traffic.
 - (c) Obtain from all available sources the most recent information regarding the permanency and anticipated degree of activity of the installation.
 - (d) Arrange for the preparation of peg counts, ticket counts, plug counts, and observer tally counts of all traffic items affecting the equipments involved.
 - (e) Compare results of all counts submitted with previous counts at the installation, if such are available, or with counts of installations having similar characteristics in order to obtain greater accuracy of estimates.
- (2) Switchboard Traffic Counts. Counts of switchboard calls should be taken in sufficient quantity and should represent average normal week-day conditions. Occasional peak days, or peak hours, resulting from sporadic excess traffic should not be included. Usually a two-day average count, hourly, between 0800 and 1800, and total day, will provide sufficient data for engineering requirements. It was formerly the general practice to request the local commercial telephone company to take such counts. It is now considered preferable, for the purpose of uniformity of procedure, that such data be prepared by personnel under the supervision of the service command whenever possible. In certain instances, however, until Army personnel can be properly trained for this, it may be desirable to request the assistance of the local commercial telephone company in the preparation of the traffic data. Where the data is obtained by Army personnel,

it is suggested that data regarding the number of calls be taken by the attendant; the principal items such as station line to station line and incoming calls are "pegged" on mechanical registers, if such are available, and the smaller items such as toll and tie line calls are recorded on tally. Calls which involve special operating methods, such as those requiring reference to a directory, may be recorded by an observer. This observer may also record the maximum number of cords in use per position and take holding time data by means of stop watch observations or plug counts. Care must be exercised to insure that all calls handled by the attendant are counted. This includes, for example, a separate "peg", or tally, for a call which was not completed on the first attempt; miscellaneous calls from station users requesting directory information; and similar calls. The more general types of calls for which data are required for engineering equipments are:

- Station line to station line.
- Tie line -- inward.
- Tie line -- outward.
- Station line to C. O. exchange trunk -- local. (Count calls passed by the attendant separately from those passed by the station line user.)
- Station line to trunk -- toll and L. D.
- C. O. exchange trunk to station line -- completed direct.
- Reference to directory by attendant.
- Miscellaneous calls.

b. Coefficients.

An approved coefficient table for converting busy hour calls into units, entitled "Coefficients for Equating Traffic," is shown in table I, paragraph 60.

c. Switchboard Position Requirements.

After determining the busy hour units, determine position requirements by dividing the busy hour units by the proper approved position engineering loads as shown in table 7, paragraph 60. In general, a fractional reading of 0.3 or more will indicate an additional position. Based on current traffic counts, determine units-per-station-line (or station), an overall-coefficient, and calls-per-station-line (or station). Then apply these data to the estimated ultimate station line (or station) requirements in determining ultimate unit requirements. In this connection, however, it may be necessary to modify the basic call data before determining ultimate requirements to account for possible changes in the nature of the activities of the installation.

d. Central Office Exchange Trunks and Tie Lines.

The number of central office exchange trunks should be sufficient in number to carry the two-way traffic between the PBX and the central office exchange. Determination of the number of trunks required is based on the number of busy hour calls, outward and inward, and the average holding times of such

calls. The number of trunks required may then be determined by converting the actual call counts into hundred call seconds (CCS) and reading the results from the applicable capacity table in paragraph 60. Ordinarily all central office exchange trunks should be included in one two-way group. There may be cases, however, at the larger PBX's where the size of the group or the nature of the particular installation will indicate the desirability of two separate one-way groups, one for outgoing and one for incoming traffic; or a one-way group for outgoing and a regular two-way group used mainly for incoming traffic, but available also for outgoing traffic.

e. Switchboard Face Equipment.

A complete face equipment schematic should be available to the traffic engineer. Both the present and ultimate requirements should be specified for all groups of lines and trunks appearing on the face of the switchboard.

f. Example of Manual Study.

An example showing a suggested presentation of basic traffic data and engineered equipment requirements for a manual PBX switchboard is given in paragraph 61.

58. STEP-BY-STEP DIAL SYSTEM

a. Basic Traffic Data.

- (1) General. Basic traffic data for a step-by-step dial PBX system, where an addition or reduction of telephone facilities is anticipated, should be prepared in accordance with paragraph 57a(1) for a manual PBX system.
- (2) Switchboard (Attendant Cabinet) Traffic Counts. Counts of switchboard calls should be taken in general as provided for manual PBX switchboard positions in paragraph 57a(2).
- (3) Equipment Traffic Counts and Holding Times. In general, traffic counts of all dial equipment should be taken hourly, 0800 to 1800 and total day, for two normal week days. In some instances it may suffice to record only the known morning and afternoon busy hours. Peg count registers, where provided, should be tested before taking the record. All switch counts should be reported in the form of hundred call seconds (CCS). The more common equipments for which counts are required for engineering purposes are:

(a) Line finders:

Switch count by groups.
Peg count by groups.
ATB registrations by groups.
Overflow registrations by groups.

(b) Line switches:

Switch count by groups.
Peg count by groups.
ATB registrations by groups.
Overflow registrations by groups.

(c) Second selectors: switch groups by count off first selector levels.

(d) Automatic tie lines:

Automatic to automatic, 2-way (incoming selector switch count taken simultaneously at both ends).
Automatic to automatic, 1-way (incoming selector switch count at terminating end).
Automatic to manual and manual to automatic (2-way group). (Tie line usage count, both inward and outward, taken at switchboard end.)

NOTE: Where automatic tie lines have a multiple appearance at the local dial switchboard and are equipped with busy lamps, the usage counts can be taken from the busy lamps. ATB and peg count readings should be included when they are available.

(e) Connectors:

Switch count by groups.
Peg count by groups.

NOTE: Where a jack connector type switchboard is involved and all connector switches have a busy lamp appearance at the switchboard, the usage count can be taken at the switchboard.

(f) Central office exchange trunking: ATB registrations.

(g) Line assignments:

Line finder (working lines per group, by groups).
Connectors (working lines per group, by groups).

b. Switchboard Position (Attendant Cabinet) Requirements.

The number of (attendant cabinets) switchboard positions required should be engineered in the same manner as discussed for manual switchboard positions in paragraph 57c. To obtain greater accuracy in attendant cabinet requirements, include any additional breakdown of switchboard calls, such as calls dialed by the attendant and those completed by the station line user. Also indicate the average number of pulls of the dial on calls dialed by the attendant for each type of call completed in this manner.

c. Line Finders.

Requirements for line finders should be prepared to show present and ultimate equipments. Ordinarily, line finder requirements are determined as follows:

- (1) Find the number of line finder groups required to handle a given number of working lines by dividing the total number of working station lines by the number of working station lines per group. In general, the working station lines per group depend on the type of line finder (usually 100- or 200-point) and the number of line finder terminals required for testing and for balancing traffic. Usually 2% of the terminals in each group is provided as spare for balancing purposes. In addition, two terminals in each 200-point group and one terminal in each 100-point group are required for testing. In view of these factors, for engineering purposes, the number of available working station lines per full group is 194 for 200-point and 97 for 100-point groups.
- (2) If, for example, the number of 200-point line finders required for a group of 194 station lines should be slightly greater than the CCS capacity of a group of 20 line finders (see line finder capacity table in paragraph 60), it may be more economical to reduce the number of working station lines in the group to the point where the traffic expressed in CCS will come within the capacity of 20 line finders. A comparative study should be made in such cases to determine if it would be more economical to increase the number of line finders per group, or to increase the number of groups. Consider, of course, the type and capacity of the existing equipments and the ultimate requirements. Use table 2 in paragraph 60 to determine the number of line finders required per group.
- (3) In cases where a small number of station lines remains beyond the last full group, it may be more practicable to scatter these station lines over the full group -- resulting in a slight theoretical overload -- than to engineer an additional partial group.
- (4) In those instances where it is known that the nature of an incoming or outgoing organization will definitely affect the station line calling characteristics at an installation, it may be advisable to estimate the ultimate requirements based on a recapitulation of the traffic contemplated.

d. First Selectors.

Any dial system exceeding the capacity of a two-digit system requires a first selector directly associated with each line finder for handling calls to station lines, central office exchange trunks, attendants' trunks, and dial or automatic tie lines. The number of local first selectors required is accordingly equal to the number of line finders required. The customary method for assigning trunk groups on first selector levels is as follows:

- (1) "0" level - trunk group to switchboard attendants.
- (2) "9" level - direct dial trunks or combination trunks to the central office exchange. Access to these trunks from restricted lines is prevented.
- (3) "8" level - dialing or automatic tie lines are usually assigned to this level, if such are provided to a satellite area.
- (4) Levels "2" to "7" inclusive - usually assigned to dial station lines.
- (5) "1" level - usually assigned to special second selector lines.

e. Second Selectors - Local.

Local second selectors are provided at those installations where the capacity of the first selector multiple is insufficient to care for trunks to the various dial and repeater tie line groups and to the connector groups. The number of second selectors required is determined from the CCS from the first selector levels passing through the second selector train and then by reading the trunk requirements from table 3, paragraph 60.

f. Special Second Selectors.

The majority of step-by-step systems at Army installations are equipped with special second selectors. Trunks associated with these selectors include "fire repeaters," "test desk," "wire chief," etc. It is usually unnecessary to take usage counts for trunks to the special second selectors since the number of these trunks is determined on the basis of the nature of the "code" calls rather than from volumes of calls completed to the lines concerned.

g. Connectors.

- (1) Requirements for connectors should be prepared to show present and ultimate equipments. In general, connector requirements are determined as follows:
 - (a) As a connector is directly associated with each trunk from the first selectors (or local second selectors when provided) over which calls are routed to station lines, the number of connectors required is equal to the number of such trunks required to handle the terminating station line traffic. Connector requirements are engineered in much the same manner as previously described for line finders in paragraph 58c. To determine the number of connector groups required to handle a given number of working station lines, divide the total number of working station lines by the number of working station lines per group. The number of working station lines per group depends on the type of connector, usually 100-point or 200-point, less station lines required for test purposes and for balancing traffic. For engineering purposes, the number of working station lines per group is usually the same as provided for line finders, 194 for the 200-point switch and 97 for the 100-point switch.

- (b) Assuming that the number of 200-point connectors required for a group of 194 station lines should be slightly greater than the CCS capacity of a group of 20 connectors (see connector capacity tables in paragraph 60), it may be more economical, as in the case of engineering line finder requirements, to reduce the number of working station lines in the group to the point where the traffic expressed in CCS will come within the capacity of 20 connectors. A comparative cost study should be made to determine whether it would be more economical to increase the number of connectors per group or to increase the number of connector groups. Use the appropriate capacity table in paragraph 60 to determine the number of connectors required per group.

- (2) At certain installations where a rotary hunting connector group is provided to serve a particular group of station lines, experience indicates that such connectors may be engineered in the same manner as for regular connectors, the number of connectors per group being the same as those engineered for the regular connector groups where the number of terminals per group is the same.

h. Incoming First Selectors.

An incoming first selector is required for each incoming automatic tie line to establish connection to connectors. The number of automatic tie lines is determined from the CCS read from the proper capacity table in paragraph 60.

i. Attendant Trunks from Switches.

The number of trunks from the "0" level of the first selector switches to the attendants should be determined from the group busy hour CCS modified for ultimate requirements. Use table 2, paragraph 60, to determine trunk requirements. Usually these trunks are provided in multiples of ten.

j. Central Office Exchange Trunks.

(1) The number of direct dial central office exchange trunks should be determined from the group busy hour CCS modified for ultimate requirements. Use table 3, paragraph 60, to convert the CCS into trunk requirements. Ordinarily these trunks are provided from the ninth level of the first selectors in order that calls can be dialed to the central office exchange from unrestricted lines. Calls to the central office exchange originating from restricted telephones are routed via the attendant.

(2) It is the more general practice to provide combination central office exchange trunks providing two-way service between the attendant and the central office exchange and outgoing calls dialed direct by the station user. In certain instances, however, separate groups for the attendants and the dial lines may be more economical. If combination trunks are used, traffic counts should include all outgoing dialed calls from the ninth level, outgoing calls from the attendant, and incoming calls from the central office exchange. Where a separate group of trunks is provided to handle the attendant central office exchange traffic, the trunks may be arranged to handle the one-

way only or the two-way traffic as desired. Regardless of the type of central office exchange trunk used, the requirements will be based on the number of busy hour CCS for the total traffic served by the group.

k. Subgrouping and Graded Multiple Arrangements.

Subgrouping and the use of graded multiple arrangements are dependent upon various factors, including the type of equipment, frame capacities, wiring details, and particular tables or multiple schematics used by the various manufacturers of Army-owned systems. In view of this, it is recommended that the local representative of the particular manufacturer concerned be consulted when any question arises in which there may be doubt as to the proper engineering procedure to follow in effecting the most efficient multiple arrangement.

1. Example of Step-by-Step Dial Study.

An example showing a suggested presentation of basic traffic data and engineered equipment requirements for a dial step-by-step system is given in paragraph 61.

59. MISCELLANEOUS EQUIPMENTS AND CONDITIONS

a. Traffic Registers.

- (1) Traffic registers are provided at those dial installations where it is considered that the expense of providing any or all of the various types of registers can be justified. The more common types of registers in use at Army installations are:

(a) Line finder-first selector:

ATB. One register is provided for each line finder-first selector group. It scores when all line finder-first selectors in the group are busy.

Peg count. One register is provided for each line finder-first selector group. In some systems this register scores when a line finder moves off normal. In other systems the register scores when the first selector cuts through to a trunk or other terminating point, representing a true peg count.

(b) Second Selectors: No peg count or ATB registers are provided.

(c) Connectors:

Peg Count. One register is provided for each 100 line connector group. It scores when a call terminates on a particular line. This register is not customarily provided for Army systems.

(d) Trunk Groups: (Outgoing trunks or tie lines from dial equipment).

1. Central office trunks - direct dial.

ATB. One register is provided for each group of ten or less trunks where graded multiple is not used. It scores when all trunks, or tie lines in the group are busy.

LTB. One register is provided for each complete graded multiple sub-group. It scores when the last trunk, or tie line, in the subgroup is busy. Few installations are equipped with this type register.

2. Tie lines.

ATB. One register is usually provided for each group of 4 or more tie lines. It scores when all the tie lines in the group are busy.

- (2) ATB and LTB registers operate at all times. Peg count registers are usually operated by a switch only when needed.
- (3) All registers should be checked by the wire chief before readings are taken on peg count days.
- (4) A check should be made of the wire chief's record of test calls to insure that such calls are deleted from the totals. Test calls should be avoided during busy hour periods.

b. Restricted Service.

Restricted service usually applies to class C and D telephones which are restricted to inter- or intrapost communications and not permitted access to commercial telephone company trunks or other connections for either outgoing or incoming local and toll communications. It may be accomplished by one of several different methods.

- (1) Manual Switchboards. Restriction is accomplished by providing special identifying lamp caps associated with the designated station lines.
- (2) Dial System PBX's. In general, arrangement for restriction may be made by preventing the designated station lines from reaching the ninth level (the level preferably designated for local central office exchange direct dialing). Usually the restriction can be effected by means of minor wiring changes and mechanical adjustments.

c. Conference Equipment.

A conference calling circuit for use with manual PBX's -- or the manual switchboard of dial system PBX's -- is provided at certain Army installations. Usually the circuit consists of a group of switchboard jacks and associated apparatus arranged to permit the switchboard attendant to establish conference connections by means of regular cord circuits. The special jacks are mounted either in the extension or trunk jack space. On multiple boards one appearance of these conference jacks should be sufficient.

d. Information Desk.

At larger installations where busy hour information calls require more than the equivalent of one-half operator work time, such work is usually handled at a turret, desk, or table by means of regular station line equipment or simple wiring plans. In determining position or operator requirements, an approved method is to provide one operator for each 85 busy hour information calls.

e. Digit Absorbing Selectors.

- (1) At certain installations, such as a main post with several satellite areas, part of the subscriber numbers require a fewer number of digits than the remainder. In order to provide a uniform numbering system, digit absorbing equipment is sometimes used. This equipment eliminates the need for selectors corresponding to the ineffective digits in the subscribers' numbers that require the smaller number of effective digits.
- (2) The most common types of digit absorbing equipment are:
 - (a) Digit absorbing selectors which make selection corresponding to the second series of pulses received, the selector rising in response to the first set of pulses received and then falling back.
 - (b) Digit absorbing selectors which function as in (a) for specific digits only and function in the normal manner on other digits. In the case of the specific digits which are absorbed, the selector may be arranged to make a selection if the same digit is dialed the second time; or it may be arranged to absorb this digit repeatedly.
- (3) When projects are submitted for review, the type of digit absorbing equipment should be specified for the information of the traffic engineer.

f. Wartime Engineering Procedures for Conservation of Critical Materials.

When necessary to conserve critical wartime materials, certain arbitrary reductions are made in engineering switchboard position and dial equipment requirements.

- (1) After determining the switchboard busy hour operator work units, and before using such units to determine position requirements from table 7 in paragraph 60, reduce them by 5% where the busy hour units are 500 or less, or by 10% where the busy hour units are over 500.
- (2) In determining the quantities of dial selectors required, reduce the busy hour hundred call seconds (CCS) by 5% before applying the proper capacity table in paragraph 60, except where the traffic on peak days exceeds the average business day by more than 20%.

g. Traffic Data Supporting Project Requests.

- (1) Construction projects, including new construction, rehabilitation, or alterations of government-owned telephone systems submitted to the Chief Signal Officer for prior approval should be accompanied by adequate supporting traffic data for all equipments concerned.
- (2) Prepare traffic data in accordance with provisions prescribed in previous paragraphs, and present them in a manner similar to the examples in paragraph 61. Certain entries in the examples regarding computations, or explanatory notes, are shown for clarification purposes and obviously need not be included in the data submitted. Where, however, non-standard capacity tables or modifications of prescribed coefficients, etc., have been used because of certain unusual conditions, supporting reasons should be submitted.

60. TRAFFIC ENGINEERING TABLES

a. General.

The table of coefficients and the equipment capacity tables included in this paragraph were extracted from the standard American Telephone and Telegraph Company's traffic engineering instructions. Table 1, "Private Branch Exchange Switchboards, Base Co-efficients," was prepared from the American Telephone and Telegraph Company's "Peg Counts, Equating and Traffic Summaries," division D, section 6, table A, "Private Branch Exchange Switchboards." The item numbers in the table used do not correspond to the item numbers in the American Telephone and Telegraph Company table but have been arranged to cover those items of authorized switchboard operating work which are most generally applied to Army calls. Tables 2, 3, 4, 5, and 6 concerning equipment capacities were prepared from the American Telephone and Telegraph Company's tables in division I, section 3-h of that company's "Traffic Engineering Practices." Only those portions of the tables generally applicable to Army systems have been included.

b. Summary of Traffic Engineering Tables.

<u>ITEM OF EQUIPMENT</u>	<u>DIAL</u>	<u>TABLE NO.</u>	<u>PAGE</u>
Switchboard Base Coefficients.....		1	60
Line Finders - First Selectors.....		2	61
Operator First Selectors.....		3	61
Local Second Selectors.....		3	61
Connectors - First Selectors to Conn.....		5	62
Connectors - Second Selectors to Conn.....		6	62
Trunks to Switchboard Attendant ("O" Level).....		2	61
<u>MANUAL</u>			
Trunks to or from Central Office Exchange.....		3	61
Trunks - Long Haul.....		4	61
Tie Line.....		3	61
Tie Line - Long Haul.....		4	61
Trunks to Satellite Systems.....		3	61
Switchboard Positions.....		7	63
Switchboard Cords.....		2	61

c. Table 1: Private Branch Exchange Switchboards Base Coefficients and Modification Factors.

<u>Items</u>	<u>Type of Work</u>	<u>Coeff.</u>	<u>See also Items</u>
BASE COEFFICIENTS			
1.	PBX station line to PBX station line	.90	10, 11, 14, 15
2.	PBX station line or tie line to tie line	.90	10, 11, 13 - 15
3.	Incoming to PBX station line	1.15	10, 11, 12, 13
	Outgoing to Manual Central Office		
4.	Attendant passes call	1.60	13 - 15
5.	PBX station user passes call	.90	13 - 15
	Outgoing to Dial Central Office		
6.	Attendant dials (4 pulls)	1.50	10, 13 - 15
7.	PBX station user dials	.90	13 - 15
8.	PBX station line to toll or L.D.	4.00	9, 13 - 15
			<u>To be added to</u>
MODIFICATION FACTORS			
9.	Receiving time and charges - personal calls only	3.00	8
10.	Each additional pull on dial calls	.08	1 - 3, 6
11.	Reference to PBX directory by attendant	1.30	1 - 3
			<u>To be deducted from</u>
12.	Machine ringing	.07	3
13.	Individual busy signals or idle trunk indicating modification for multiple PBX station line or trunk lamp appearances	.05	2 - 8
			<u>Coeff. to be multiplied by factor</u>
14.	Modification factor - 2 appearances	.94	1, 2, 4 - 8
15.	Modification factor - more than 2 appearances	.91	1, 2, 4 - 8

NOTE 1: A coefficient of 1.50 may be used for items of miscellaneous authorized work (such as local assistance calls terminating at the switchboard, intercepted calls, etc.) performed by the switchboard attendant but not specifically covered in the coefficients, should this coefficient more adequately cover the attendant's work time than items 1 or 3. The use of items 1 or 3, depending on the point of origin of the call, is suggested in the explanatory notes to the corresponding items on the American Telephone and Telegraph Company's standard table referred to in the introduction to this section.

NOTE 2: All toll calls -- "A" board and toll board -- should be equated using the "PBX station line to toll or L. D." coefficient, item 8. This coefficient should be applied to each initial attempt and to each subsequent attempt initiated by the PBX station user. Subsequent attempts initiated by the toll operator will be tabulated and equated with other incoming to PBX station line calls, using the coefficient, "Incoming to PBX station line," item 3. Transfers from one PBX station line to another should be equated as incoming calls, using the coefficient, "Incoming to PBX station line," item 2.

NOTE 3: For each digit less than the number specified in any coefficient, subtract the allowance shown in item 10.

d. Tables 2 - 4: Trunk Capacity Tables

Hundred Call Seconds at Various Service Levels

Switches or Trunks	Table 2 (P.01) CCS	Table 3 (P.02) CCS	Table 4 (P.04) CCS	(Continuation)		
				Switches or Trunks	Table 2 CCS	Table 3 CCS
1	.36	.72	1.44	46	1142	1194
2	5.36	7.9	11.52	47	1171	1225
3	15.7	20.5	27.	48	1201	1255
4	29.6	36.7	45.7	49	1231	1286
5	46.1	55.8	66.6	50	1261	1317
6	64.4	76.0	89.3	51	1291	1349
7	83.9	96.8	112.3	52	1322	1380
8	105	119	137	53	1352	1410
9	126	142	162	53	1382	1441
10	149	166	188	55	1412	1472
11	172	191	214	56	1443	1503
12	195	216	240	57	1473	1534
13	220	241	267	58	1504	1565
14	244	267	295	59	1534	1596
15	269	293	323	60	1565	1627
16	294	320	350	61	1595	1659
17	320	347	378	62	1626	1690
18	346	374	407	63	1657	1722
19	373	401	435	64	1687	1752
20	399	429	464	65	1718	1784
21	426	458	493	66	1749	1816
22	453	486	523	67	1780	1847
23	480	514	552	68	1811	1878
24	507	542	582	69	1842	1910
25	535	570	611	70	1873	1941
26	562	599		71	1904	1973
27	590	627		72	1935	2004
28	618	656		73	1966	2036
29	647	685		74	1997	2067
30	675	715		75	2028	2099
31	703	744		76	2059	2130
32	732	773		77	2091	2162
33	760	803		78	2122	2194
34	789	833		79	2153	2226
35	818	862		80	2184	2258
36	847	892		81	2215	2290
37	876	922		82	2247	2321
38	905	951		83	2278	2354
39	935	982		84	2310	2386
40	964	1012		85	2341	2418
41	993	1042		86	2373	2451
42	1023	1072		87	2404	2483
43	1052	1103		88	2436	2515
44	1082	1133		89	2467	2548
45	1112	1164		90	2499	2579

NOTE: In general, use next lower number for fractional requirements.

e. Tables 5, 6: Dial PBX Selector Multiple Tables

TABLE 5
(P.04)

First Selectors to Connectors - CCS Connector Capacity

No. Conn. Per Group	TOTAL FIRST SELECTORS						
	120	80	60	50	40	30	20
10	190	192	194	196	199	205	220
11	211	213	215	216	220	229	242
12	233	236	239	240	245	255	273
13	255	259	262	264	270	282	306
14	277	281	285	288	295	309	340
15	299	303	308	312	320	338	376
16	321	325	331	336	345	368	415
17	343	347	355	360	370	398	457
18	365	369	379	384	396	428	503
19	387	392	403	408	423	460	555
20	409	414	427	434	450	494	

NOTE: For requirements of less than 10 connectors, use TABLE 4.

TABLE 6
(P.02)
Second Selectors
to Connectors
CCS Capacity Table

No. Conn. Per Group	CCS
10	166
11	187
12	207
13	227
14	247
15	267
16	287
17	306
18	326
19	345
20	365

NOTE: For requirements of less than 10 connectors use TABLE 3

NOTE: In general, use next lower number for fractional requirements.

f. Table 7: PBX Switchboard Position Loads.

Work Units	Positions	Work Units Per Position
0-150	1	150
151-400	2	200
401-660	3	220
661-900	4	225
901-1150	5	230
1151-1380	6	230
1381-1610	7	230
1611-1840	8	230
1841-2070	9	230
2071-2300	10	230
2301-2530	11	230
over 2530	work units ÷ 245	245

61. EXAMPLES OF MANUAL AND DIAL STUDIES

Included in this paragraph are examples of traffic engineering studies for a manual and a step-by-step dial system. These examples are shown for the purpose of presenting the various steps necessary to determine present and ultimate equipment requirements from the accumulation of the basic traffic data to the final Traffic Engineering Results Summary. It is assumed that the traffic engineer is familiar with, or has been advised of the nature and characteristics of the installation concerned and also has available necessary equipment drawings and specifications of the particular system; floor plan layouts; size and cabling arrangement of frames, racks, and switchboards; and the size of the present and ultimate power plant required. The traffic engineer in computing the various amounts of equipments required should carefully consider particular conditions encountered in each case in order to determine the best plan from both a traffic and plant viewpoint. This may involve comparative cost studies usually in conjunction with the equipment or plant engineer. If special conditions prevail at any particular installation, it is suggested that the matter be reviewed with the manufacturer of the system concerned.

a. Example of Manual PBX Study (3 Positions - 2 Appearances).

SWITCHBOARD TRAFFIC DATA

<u>CALL COUNTS</u>	<u>First Day</u> <u>1000-1100</u>	<u>Second Day</u> <u>1000-1100</u>	<u>Avg</u> <u>B.H.</u>	<u>%</u> <u>Dist.</u>	<u>Average</u> <u>Holding</u> <u>Time</u>
Sta. line to sta. line	512	581	547	72.8	
Tie line					
Outgoing	18	23	21	2.8	105"
Incoming	21	17	19	2.5	90"
Sta. line to trunk					
Local	39	41	40	5.3	150"
Toll & L. D.	5	3	4	0.5	149"
Trunk to sta. line					
Completed direct	105	130	117	15.6	157"
Referred to dety (included above)	(12)	(19)	(15)		
Miscellaneous calls	3	5	4	0.5	
TOTAL	703	800	752		
<u>CORD COUNTS - 2-min Intervals</u>	568	682	625		

SWITCHBOARD TRUNK GROUPS

	<u>Calls</u>	<u>Call Rate</u>	<u>H. T.</u>
C. O. exchange tks (15)	161 ÷ 210 =	.76	154"
Tie line (4)	40 ÷ 210 =	.19	97"

STATION LINES IN SERVICE AT TIME OF STUDY.....210

ESTIMATED FUTURE REQUIREMENTS.....280

SWITCHBOARD POSITION REQUIREMENTS

<u>TYPE CALL</u>	(Avg. B. H) <u>No. Calls</u>	<u>Coefficient</u>	<u>Units</u>
Sta. line to Sta. line	547	.85	465
Tie line			
Outgoing	21	.80	17
Incoming	19	1.15	22
Sta. line to trunk			
Local	40	.80	32
Toll & L. D.	4	3.71	15
Trunk to Sta. line			
Completed direct	117	1.15	135
Referred to dcty (included above)	(15)	1.30	20
Miscellaneous calls	4	1.50	6
TOTAL	752		712

Overall coefficient.....0.95

B. H. calls per sta. line.....3.58

Units per sta. line.....3.39

	<u>PROPOSED</u>
Working sta. lines	280
B.H. calls per line	3.58
B.H. calls	1002
Overall coefficient	0.95
Units (proposed)	952
Units less 10%	857
Positions Required	4

<u>Derivation of Coefficients</u>	<u>Base Coef.</u>	<u>Weighted Coef.</u>
Sta. line to sta. line	.90 x .94	.85
Tie line - OTG	.90 x .94 - .05	.80
INC	1.15	1.15
Sta. line to trunk		
Local	.90 x .94 - .05	.80
Toll & L. D.	4.00 x .94 - .05	3.71
Trunk to sta. line		
Completed direct	1.15	1.15
Referred to dcty	1.30	1.30
Miscellaneous calls	1.50	1.50

SWITCHBOARD TRUNK REQUIREMENTS

	<u>Call Rate</u>	<u>Calls</u>	<u>H.T.</u>	<u>CCS</u>	<u>Table No. (par. 60)</u>	<u>Tks Req</u>
C. O. exchange tks.	.76 x 280 =	213	154"	328	3	16
Tie lines	.19 x 280 =	53	97"	51	3	5

SWITCHBOARD CORD PAIR REQUIREMENTS

Cord pair usage counts $\frac{625 \times (2 \times 60)}{100} = 750 \text{ CCS} \div 210 \text{ sta. lines} = 3.57 \text{ CCS/Sta. Line}$

$3.57 \text{ CCS} \times 280 \text{ sta. lines} = 1000 \text{ CCS} = 41 \text{ cord prs. req. (table 2, par. 60d)}$

$41 \text{ cord pairs} \div 4 \text{ positions} = 11 \text{ cord prs. req. per position}$

NOTE: Cord pair requirements are determined primarily for checking purposes. In general, no addition or reduction will be made in the number of cord pairs installed.

TRAFFIC ENGINEERING RESULTS SUMMARY

<u>Equipment</u>	<u>Present</u>	<u>Proposed</u>	<u>Difference</u>
Line equipments	210	280	+70
Switchboard positions	3	4	+ 1
C. O. exchange trunks	15	16	+ 1
Tie lines	4	5	+ 1
Fire reporting lines	3	3	-

CAMP BLANK
SWITCHBOARD FACE EQUIPMENT

1			2		
3 Fire Tks.			3 Fire Tks.		
0 9			0 9		
0	100	200	0		
Sta. Lines	Sta. Lines	Sta. Lines	Sta. Lines		
99	199	299	99		
5 C.O.	10 C.O.	4 Tie Lines	5 C.O.		
0 Tks. 9	10 Tks. 19	0 9	0 Tks 9		

17 Cord Pairs Per Position

No. of positions -- installed 3 -- working 3
 Central office exchange trunks -- busy indication -- flat rate
 Manual tie lines -- busy indication
 Three panel complete multiple appearance
 Two appearances all lines and trunks

b. Example of Dial PBX Study (3 Positions - 2 Appearances).

SWITCHBOARD TRAFFIC DATA

<u>CALL COUNTS</u>	<u>First Day</u> <u>1500-1600</u>	<u>Second Day</u> <u>1500-1600</u>	<u>Avg.</u> <u>B.H.</u>	<u>%</u> <u>Dist</u>	<u>Avg.</u> <u>Hold</u> <u>Time</u>
Sta. line to sta. line					
Tie line					
Outgoing	17	18	18	4.1	88"
Incoming	19	18	18	4.1	102"
Sta. line to trunk					
Local	2	1	2	.5	
Toll & L.D.	13	9	11	2.5	130"
Trunk to sta. line					
Completed direct	391	322	357	81.1	154"
Referred to dety (not incl)	11	7	9	2.0	
Miscellaneous calls	29	20	25	5.7	
TOTAL	482	395	440	100.0	

OVERALL CORD COUNTS

(2-min intervals) 411 395 403

SWITCHBOARD TRUNK GROUPS

(Usage counts - 2-min intervals)

*Combination C. O. exchange			
tks. (20)	351	321	336
Manual C.O. ex. tks. (6)	63	51	57
Toll trunks (3)	17	19	18
"O" Level (10)	72	60	66
Tie lines (5)	28	21	24
*Includes "9" level counts			

STATION LINES IN SERVICE AT TIME OF STUDY.....857

ESTIMATED FUTURE REQUIREMENTS.....580

Dial PBX Study (Contd)

DIAL EQUIPMENT DATA

<u>LINE FINDERS (200-point)</u>	<u>First Day</u>	<u>Second Day</u>	<u>Avg.</u>
<u>Usage Counts - 2-min intervals</u>	<u>0900-1000</u>	<u>0900-1000</u>	<u>B.H.</u>
2100-2200 Group	314	286	
3100-3200 "	304	269	
4100-4200 "	267	244	
5100-5200 "	284	296	
6100-6200 "	276	248	
TOTAL	1445	1343	1394

Call Registrations

2100-2200 Group	604	540	
3100-3200 "	615	582	
4100-4200 "	513	554	
5100-5200 "	538	534	
6100-6200 "	433	531	
TOTAL	2703	2741	2722

A.T.B. Registrations

2100-2200 Group	3	-	
3100-3200 "	1	1	
4100-4200 "	-	-	
5100-5200 "	-	-	
6100-6200 "	-	-	

Overflow Registrations (Record if Registers are Provided)

Dial PBX Study (Contd)

DIAL EQUIPMENT DATA (Contd)

<u>CONNECTORS (200-point)</u> (Usage Counts - 2-min intervals)	<u>First Day</u> <u>0900-1000</u>	<u>Second Day</u> <u>0900-1000</u>	<u>Avg</u> <u>B.H.</u>
2100-2200 Group	344	309	
3100-3200 "	331	271	
4100-4200 "	218	197	
5100-5200 "	258	288	
6100-6200 "	262	268	
TOTAL	1413	1333	1373

C. O. EXCHANGE TRUNKS

ATB Registrations	4	-	2
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LINE ASSIGNMENT

<u>Group</u>	<u>L. F. Terms</u>	<u>Conn Terms</u>
2100-2200	176	176
3100-3200	175	175
4100-4200	174	174
5100-5200	172	172
6100-6200	160	160
TOTAL	857	857

SWITCHBOARD POSITION REQUIREMENTS

<u>TYPE CALL</u>	<u>No. Calls</u>	<u>*Coefficient</u>	<u>Units</u>
Sta. line to sta. line	0	0	0
Tie line			
Outgoing	18	.80	14
Incoming	18	1.19	21
Sta. line to trunk			
Local - user dials	2	.80	2
Toll & L. D.	11	3.71	41
Trunk to sta. line			
Completed direct	357	1.19	425
Referred to dcty (not incl)	9	2.49	22
Miscellaneous calls	25	1.50	38
TOTAL	440		563

Overall coefficient.....1.28

B. H. calls per sta. line.....0.51

Units per sta. line.....0.66

	<u>PROPOSED</u>
Working sta. lines	580
B. H. calls per sta. line	0.51
B. H. calls	296
Overall coefficient	1.28
Units	383
Units less 5%	364
Positions Required	2

<u>*Derivation of Coefficients</u>	<u>Base Coef.</u>	<u>Weighted Coef.</u>
Tie line - OTG	.90 x .94 -.05	.80
INC	1.15 + (2x.08) -.07-.05	1.19
Sta. line to trunk		
Local	.90 x .94 -.05	.80
Toll & L. D.	4.00 x .94 -.05	3.71
Trunk to sta. line		
Completed direct	1.15 + (2x.08) -.07-.05	1.19
Referred to dcty	1.15 + (2x.08) -.07-.05 + 1.30	2.49
Miscellaneous calls	1.50	1.50

SWITCHBOARD TRUNK REQUIREMENTS

(Based on Usage Counts - 2-Min Intervals)

	Count	PRESENT		PROPOSED		
		Total CCS	CCS Per Sta. Line	Total CCS	Table Par 60	No. Tks. Required
Combination C. O. ex tks (20)	$\frac{336 \times (2 \times 60)}{100}$	403	.471	273	3	14
Manual C. O. ex tks (6)	57 "	68	.079	46	3	4
Toll Trunks (3)	18 "	22	.026	15	4	2
"O" level tks (10)	66 "	79	.092	53	2	5
Tie lines (5)	24 "	29	.034	20	3	3

SWITCHBOARD CORD PAIR REQUIREMENTS

Cord pair usage counts $\frac{403 \times (2 \times 60)}{100} = 484 \text{ CCS} \div 857 \text{ sta. lines} = 0.56 \text{ CCS per sta. line}$

$0.56 \text{ CCS} \times 580 \text{ sta. lines} = 325 \text{ CCS} = 17 \text{ cord pairs req. (table 2, par 60d).}$
 $17 \text{ cord prs} \div 2 \text{ positions} = 9 \text{ cord pairs req. per position.}$

NOTE: Cord pair requirements are determined primarily for checking purposes. In general, no addition or reduction will be made in the number of cord pairs installed.

DIAL EQUIPMENT REQUIREMENTSLINE FINDERS

Present Station Lines - 857

B. H. usage counts $\frac{1394 \times (2 \times 60)}{100} = 1673 \text{ CCS}$ (5% reduction not used in this example as it is assumed that the traffic on peak days exceeds the average business day by more than 20%).

$1673 \text{ CCS} \div 857 \text{ sta. lines} = 1.95 \text{ CCS per sta. line}$

Station lines per group (available working sta. lines for engineering purposes) 194.

$194 \times 1.95 = 378 \text{ CCS capacity per L. F. group}$

$378 \text{ CCS (table 2, par 60d)} = 19 \text{ line finders per group.}$

Proposed Station Lines - 580

$580 \div 194 \text{ sta lines per group} = 2 \text{ groups of } 194 \text{ sta. lines plus } 192 \text{ sta. lines}$

$192 \times 1.95 \text{ (CCS per sta. line)} = 374 \text{ CCS (table 2)} = 19 \text{ line finders}$

Proposed line finders required, therefore, are 3 groups of 19 L. F. each = 57.

Dial PBX Study (Contd)

NOTE: In the above example, the CCS per group were within the capacity of 20 line finders (table 2, par. 60d). Assuming that the frame capacity in this example is 20 line finders per frame and that the developed CCS per group exceeded the capacity of 20 line finders, the equipments required might better be engineered as follows:

Assumed CCS per sta. line = 2.25
Capacity of 20 L. F. (table 2, par. 60d) = 399 CCS
 $399 \text{ CCS} \div 2.25 \text{ CCS per sta. line} = 177 \text{ sta. lines, capacity per group}$
 $580 \text{ sta. lines} \div 177 \text{ sta. lines per group} = 3 \text{ groups of 20 L. F. each}$
plus 49 sta. lines
 $49 \text{ sta. lines} \times 2.25 \text{ CCS} = 110 \text{ CCS}$
 $110 \text{ CCS (table 2, par. 60d)} = 8 \text{ line finders}$
Line finders required, therefore, would be:

3 groups of 20 L. F. each	60
1 group of 8 L. F.	8
TOTAL 4 groups	68

DIAL EQUIPMENT REQUIREMENTS (CONTD)

CONNECTORS

Present Station Lines - 857

B. H. usage counts $\frac{1373 \times (2 \times 60)}{100} = 1648 \text{ CCS}$ (5% reduction not used in this

example as it is assumed that the traffic on peak days exceeds the average business day by more than 20%)

$1648 \text{ CCS} \div 857 \text{ sta. lines} = 1.92 \text{ CCS per sta. line}$

Sta. lines per group (available working sta. lines for engineering purposes)
194

$194 \times 1.92 = 372 \text{ CCS per group}$

$372 \text{ CCS (table 5, par. 60e)} = 17 \text{ connectors per group}$

Proposed Station Lines - 580

$580 \div 194 \text{ sta. lines per group} = 2 \text{ groups of 194 sta. lines plus 192 sta. lines}$

$192 \times 1.92 \text{ (CCS per sta. line)} = 369 \text{ CCS (table 5)} = 17 \text{ connectors}$

Proposed connectors required therefore are 3 groups of 17 connectors each
= 51.

NOTE: Should the CCS capacity developed exceed the capacity of 20 connectors, the requirements should be engineered in the same manner as shown for line finders under similar conditions.

Dial PBX Study (Contd)

TRAFFIC ENGINEERING RESULTS SUMMARY

<u>Equipments</u>	<u>Present</u>	<u>Proposed</u>	<u>Excess</u>
Line equipments	900	600	300
Line finder groups (200 ft.)	5	3	2
Line finders per group	20	19	1
Line finders (total)	100	57	43
First selectors	100	57	43
Connector group	5	3	2
Connectors per group	20	17	3
Connectors (total)	100	51	49
Special second selectors	3	3	-
Combination C. O. trunks	20	14	6
Manual C. O. trunks	6	4	2
Toll trunks	3	2	1
"O" level trunks	10	5	5
Tie lines	5	3	2
Fire reporting lines	5	5	-
Fire repeaters	2	2	-
Test desk	1	1	-
Attendant cabinets	3	2	1

CAMP BLANK

SWITCHBOARD FACE EQUIPMENT

Connector Jack Multiple	61				5 Fire Tks.	
	62	1	20	0	9	
	41			3	Toll Tks.	
	42	1	20	0	9	
	21	1 Lp Busy	20	31	1	20
	22			32		
		0	9		6 Man.C.O.Tks	
			5 Tie Lines		0	9
			0	9		
			10	CombC.O.Tks		
			0	9		
			10	CombC.O.Tks		
			0	9		
			10	"0"Level Tks		
15 Cord Prs. Per Position						

No. of positions: installed - 3, working - 3

Central office exchange trunks -- busy indication -- flat rate

Toll trunks 3

Dial combination 20

Manual 6

Tie lines 5 -- busy indication -- flat rate

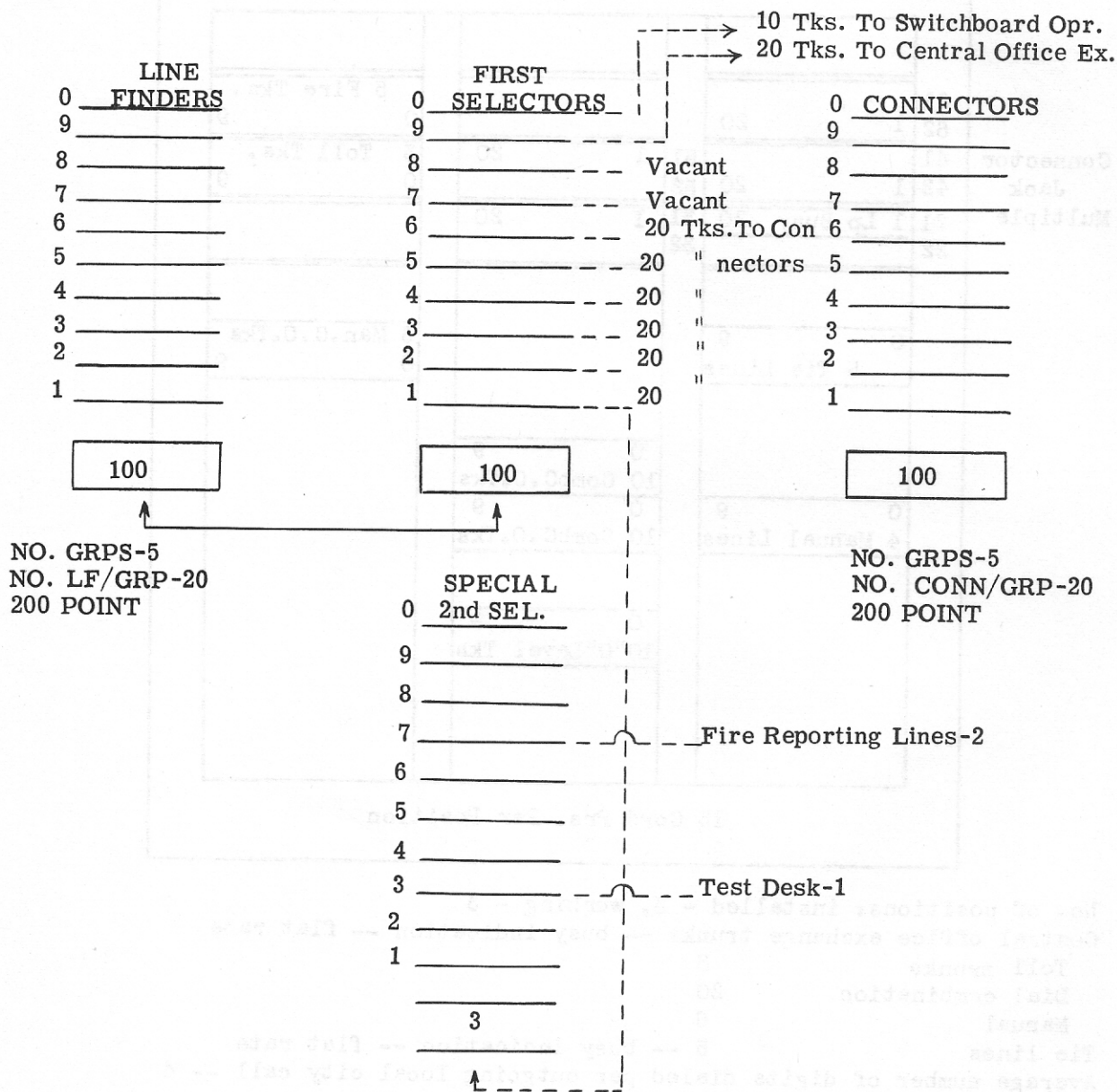
Average number of digits dialed per outgoing local city call -- 4

"0" level attendant tks -- busy indication

Connector jack multiple -- busy indication

Each position is in complete multiple except fire trunks which appear only in position 1. Two appearances of each line.

CAMP BLANK TRUNKING SCHEMATIC



NOTE: CLASS "C" SUBSCRIBERS RESTRICTED FROM LEVEL "9"

TELETYPEWRITER CAPACITY TABLE
POINT TO POINT CHANNELS - FIXED NETWORKS

60-Speed - Cap. in Gps.			Opn. Hrs.	75-Speed - Cap. in Gps.			Opn. Hrs.	100-Speed - Cap. in Gps.			Keyboard		Multi-Point		
Tape: Semi-Auto		Tape: Full-Auto		Tape: Semi-Auto		Tape: Full-Auto		Tape: Semi-Auto		Tape: Full-Auto			Semi-Auto. - H-2		
H-1	H-2	H-1		H-1	H-2	H-1		H-1	H-2	H-1	H-1	H-2	Average Hour Groups	No. of Pts.	Busy Hour Groups
50,400	43,200	52,800	24	62,400	52,800	67,200	24	84,000	72,000	88,800	36,000	26,400	60-Speed		
48,300	41,400	50,600	23	59,800	50,600	64,400	23	80,500	69,000	85,100	34,500	25,300	1,800	2	2,400
46,200	39,600	48,400	22	57,200	48,400	61,600	22	77,000	66,000	81,400	33,000	24,200	1,710	3	2,280
44,100	37,800	46,200	21	54,600	46,200	58,800	21	73,500	63,000	77,700	31,500	23,100	1,620	4	2,160
													1,530	5	2,040
42,000	36,000	44,000	20	52,000	44,000	56,000	20	70,000	60,000	74,000	30,000	22,000	1,440	6	1,920
39,900	34,200	41,800	19	49,400	41,800	53,200	19	66,500	57,000	70,300	28,500	20,900			
37,800	32,400	39,600	18	46,800	39,600	50,400	18	63,000	54,000	66,600	27,000	19,800			
35,700	30,600	37,400	17	44,200	37,400	47,600	17	59,500	51,000	62,900	25,500	18,700			
33,600	28,800	35,200	16	41,600	35,200	44,800	16	56,000	48,000	59,200	24,000	17,600	75-Speed		
31,500	27,000	33,000	15	39,000	33,000	42,000	15	52,500	45,000	55,500	22,500	16,500	2,200	2	3,000
29,400	25,200	30,800	14	36,400	30,800	39,200	14	49,000	42,000	51,800	21,000	15,400	2,090	3	2,850
27,300	23,400	28,600	13	33,800	28,600	36,400	13	45,500	39,000	48,100	19,500	14,300	1,980	4	2,700
													1,870	5	2,550
25,200	21,600	26,400	12	31,200	26,400	33,600	12	42,000	36,000	44,400	18,000	13,200	1,760	6	2,400
23,100	19,800	24,200	11	28,600	24,200	30,800	11	38,500	33,000	40,700	16,500	12,100			
21,000	18,000	22,000	10	26,000	22,000	28,000	10	35,000	30,000	37,000	15,000	11,000			
18,900	16,200	19,800	9	23,400	19,800	25,200	9	31,500	27,000	33,300	13,500	9,900			
16,800	14,400	17,600	8	20,800	17,600	22,400	8	28,000	24,000	29,600	12,000	8,800	100-Speed		
14,700	12,600	15,400	7	18,200	15,400	19,600	7	24,500	21,000	25,900	10,500	7,700	3,000	2	4,000
12,600	10,800	13,200	6	15,600	13,200	16,800	6	21,000	18,000	22,200	9,000	6,600	2,850	3	3,800
10,500	9,000	11,000	5	13,000	11,000	14,000	5	17,500	15,000	18,500	7,500	5,500	2,700	4	3,600
													2,550	5	3,400
8,400	7,200	8,800	4	10,400	8,800	11,200	4	14,000	12,000	14,800	6,000	4,400	2,400	6	3,200
6,300	5,400	6,600	3	7,800	6,600	8,400	3	10,500	9,000	11,100	4,500	3,300			
4,200	3,600	4,400	2	5,200	4,400	5,600	2	7,000	6,000	7,400	3,000	2,200			
2,100	1,800	2,200	1	2,600	2,200	2,800	1	3,500	3,000	3,700	1,500	1,100			
3,000	2,400	3,200	BH*	3,700	3,000	4,000	BH*	5,000	4,000	5,400	2,000	1,500			

H-1 = FDX 1-way, or $\frac{1}{2}$ DX send only.
H-2 = $\frac{1}{2}$ DX send and receive.

*Criteria to be used when engineering on the busy hour traffic load. The busy hour figure is applicable to circuit capability for each hour, for engineering studies.

NOTE: Adjust operating hours to channel availability.

From Standard Procedure ACCM 4-1, approved 21 November 1955.

TELETYPEWRITER CAPACITY TABLE, POINT TO POINT CHANNELS - FIXED NETWORKS
APPENDIX I