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Building Industry Consulting Service

DESIGN HANDBOOK

GTE

Switching and Telephone Products

Building Industry Consulting Service

DESIGN
HANDBOOK

FOREWORD

This handbook is prepared to assist the Building Industry Consultant (BIC) in planning communications requirements for his building projects.

This handbook is designed to be used in conjunction with the Building Industry Consulting Service Telephone Standards Handbook (CHB-155).

The information in this handbook is not intended to supersede national, state, or municipal regulations. When such regulations exist, the Building Industry Consultant is expected to familiarize himself with them and see that they are observed.

This handbook contains current information used by GTE employees. This information may change or may not be applicable in a specific situation, and so is recommended as suggested procedures only. GTE hereby disclaims any responsibility and/or liability for any consequential or inconsequential damage that may result from the use of such information.

Any suggestions, comments, or recommendations regarding this handbook should be transmitted to: GTE Automatic Electric, GTE Practices Manager, Department 431, Tube Station C-1, 400 North Wolf Road, Northlake, Illinois 60164.

CONTENTS

1. GENERAL INFORMATION

1. GENERAL

1.01 It is the responsibility of the Building Industry Consultant (BIC), with the cooperation of the other departments in the telephone company, to design the in-building facilities and review the design with the building owner or architect.

1.02 It is the objective of the BIC to provide the building owner and the occupant with the most economical and flexible arrangement for the provision of initial and future communication services. Well-planned facilities for both present and future needs designed into buildings during initial construction or major alterations will pay dividends throughout the life of the building.

1.03 It is the responsibility of the BIC to maintain the necessary contacts during construction of the building to ascertain any changes in the plan and their effect on telephone company current and future installations. In addition, it is also the responsibility of the BIC to notify and coordinate all such changes with the affected telephone company department. Should a problem created by the in-building supporting structures arise during the installation of the telephone company facilities, the BIC will coordinate the rearrangements or revisions.

2. TELEPHONE FACILITIES DESIGN

2.01 In preplanning telephone facilities, space should be provided for the following:

(a) Service entrance.
(b) Main terminal or equipment room.
(c) Riser system.
(d) Floor closets.
(e) Wiring distribution.
(f) Service fittings.
(g) Power and lighting.
(h) Attendant and reception area.

2.02 This handbook provides detailed guidelines for preparing a communications proposal covering the following:

(a) Floor closets.
(b) Wiring distribution.
(c) Riser system.
(d) Main terminal or equipment room.
(e) Service entrance.

2.03 The sequence of events in designing the communications facilities follows:

(a) Consult with the building industry representatives for the project.
(b) Advise the appropriate telephone company departments about the project.
(c) Determine the total floor area of the building.
(d) Determine the usable floor area on each floor of the building.
(e) Determine the type and location of the closets on each floor.
(f) Design the wiring distribution system.
(g) Design the riser system.
(h) Design the closet layout.
(i) Design the main terminal or equipment room.
(j) Design the entrance facilities.
(k) Prepare a Communications Proposal or Specification, and be prepared to defend the design.
(l) Make periodic inspections of the building to verify that the conditions of the specification are being adhered to.

3. BUILDING CLASSIFICATIONS

3.01 It is helpful in designing telephone facilities in buildings to classify buildings in general categories based on their type of usage. Reference is made to these classifications in related sections covering the design of housings and cable systems.

3.02 Office Buildings. This is a broad term covering buildings with a relatively high telephone density. Such buildings may include those where the greater part of available floor space may be used for persons engaged in executive, supervisory, or clerical activities. Extensive and changing communications requirements are characteristic of this type of building; therefore, a sufficiently flexible building cable arrangement is desirable to minimize future cable rearrangements.

(a) Financial office buildings are those occupied by brokerage, banking, insurance executive office, etc. This type of building exists mostly in larger metropolitan areas and develops the highest station density due to the nature of business conducted by the tenants. Because of the relatively high floor space rental charges, the number of tenants or employees per unit exceeds that of other types of office buildings.

(b) Commercial business office buildings that house sales agencies and clerical forces with showrooms or salesrooms develop a lower station density than financial buildings.

(c) Financial and commerical business offices are often combined into a large building whose station requirements fall between buildings of either of these two classifications. The combination office building often houses executives and clerical forces of large industrial concerns, public utilities, etc. This is usually the highest usage building found in smaller cities.

3.03 Loft Buildings. This is a term given to types of buildings in which the greater part of the floor areas are used for display, storage, or manufacturing. Such buildings may have sections of floor developed for office use. This type of building generally requires a building cable system, but terminal requirements are limited since station density usually is not high. Since loft building telephone service does not remain fixed for extended periods of time, the principles of building cable design follow those applicable to office buildings. Department stores form a special class of loft building and require special consideration. Generally, these buildings are served by a PABX usually located on an upper floor. Station density is not high, but flexibility is important due to the frequent relocation of departments, order boards, offices, etc.

3.04 Public buildings often have distinctive features that warrant special attention. In general, the principles of building cable design for office buildings and loft buildings are applicable. Many government buildings resemble commercial office buildings in communication requirements. Auditoriums, railroad and steamship terminals, and especially airports and air terminals require extensive facilities for private lines, teletypewriters, or other leased facilities in addition to normal telephone service. Requirements for coin telephone service are high in these types of buildings.

3.05 Professional buildings are apartment-type buildings used extensively to house persons engaged in professional occupations such as medical doctors, dentists, etc. These buildings are more subject to rearrangements to suit the tenant than regular apartment buildings and usually have a greater telephone service requirement. Intercommunication and special services are often required. Because of these conditions, it is desirable to be more liberal in the building cable design than for residential apartment buildings.

3.06 Hotels and hospital buildings are similar in construction in that both have room telephone requirements and sections of lower floors are given over to offices and lobby areas. The initial service to rooms is fairly permanent. The areas used for administrative purposes should be considered similar to an office building when planning the building cable system. In many instances, hotels require a large number of special services for conventions, meetings, special radio and television broadcasts, etc.

3.07 Residential apartment and condominium buildings are the most numerous type of residential building requiring a building cable system. The maximum telephone requirements are defined by the number of apartments, and there is little probability of future cable or wiring rearrangements. There is little need for flexibility in the building cable design. An economic balance should be obtained in cable and station wiring costs.

2. CLOSETS

1. GENERAL

1.01 A closet is the facility for housing station relay circuits, terminals and cross-connections.

1.02 Adequate and proper design of closets offers several advantages to the building owner, tenants, and the telephone company. These advantages are as follows:

(a) Improves overall office appearance.
(b) Reduces noise.
(c) Allows telephone company personnel to work during normal business hours with minimal inconvenience to tenants.
(d) Promotes optimum use of space, particularly when centrally located key telephone equipment can be shared among various tenants.
(e) Increases the reliability of communication services.
(f) Provides a more flexible system which increases the variety of tenants attracted to the building.

1.03 A closet is defined either by its function or by its size.

(a) An apparatus closet is designed to contain cables, cross-connecting terminals, and key telephone apparatus. This closet may or may not have riser cables through it.
(b) A satellite closet (or terminal) contains the cross-connections necessary to terminate station cables and tie cable pairs from an apparatus closet. It does not contain any key telephone apparatus, and it is normally fed from an apparatus closet or equipment room.
(c) A closet is a walk-in closet when it is 4 feet or more deep (Figure 2-1).
(d) A closet is a shallow closet when its depth varies from 18 inches to 30 inches (Figure 2-2).

2. CONSIDERATIONS

2.01 An apparatus closet may house the key telephone equipment and apparatus to serve a floor area of as much as 20,000 square feet provided that:

(a) It serves only telephones on the same floor.
(b) Station cables and wires serving only 10,000 square feet are fed directly from the apparatus closet.
(c) Satellite closets or terminals are provided and used to feed the station cables and wires for the other 10,000 square feet.

2.02 Each satellite closet or terminal may serve a maximum floor area of 5,000 square feet.

2.03 Closet space assigned for telephone equipment and terminations shall have the following requirements:

(a) The closets shall have adequate access for telephone company employees.
(b) The closets shall be free from the danger of flooding.
(c) The walls, floor, and ceiling of the closet shall be treated to eliminate dust.
(d) The closets shall be free from false ceilings.
(e) The closets shall have 3/4-inch by 8-foot high plywood backboard on the walls, which is rigidly affixed and capable of supporting the weight of relay strips and circuit units, terminals, etc.
(f) The closets shall have overhead lighting, normally 8 feet 6 inches above the finished floor.
(g) The doorway(s) shall be a minimum of 2 feet 6 inches wide and 6 feet 8 inches high without a doorsill or centerpost. The doors shall be hinged to open outward or slide side to side and be removable.
(h) Preferably, the closet is not to be located adjacent to duplicating-type equipment.
(i) When ceiling distribution systems are to be used, the closet shall have adequate conduit or openings through beams or other obstructions into the accessible ceiling space to permit the placing of wires and cables.

2.04 Where possible, the wall space for terminations in both apparatus and satellite closets should be designed on one continuous wall. Corners necessitate 6 to 8 inches of lost space on each of the walls.

2.05 The apparatus closets should be equipped with 110-volt ac duplex receptacles separately fused at 15 or 20 amperes. The rule of thumb is to provide one receptacle for each 8,000 square feet of usable floor area served from the closet.

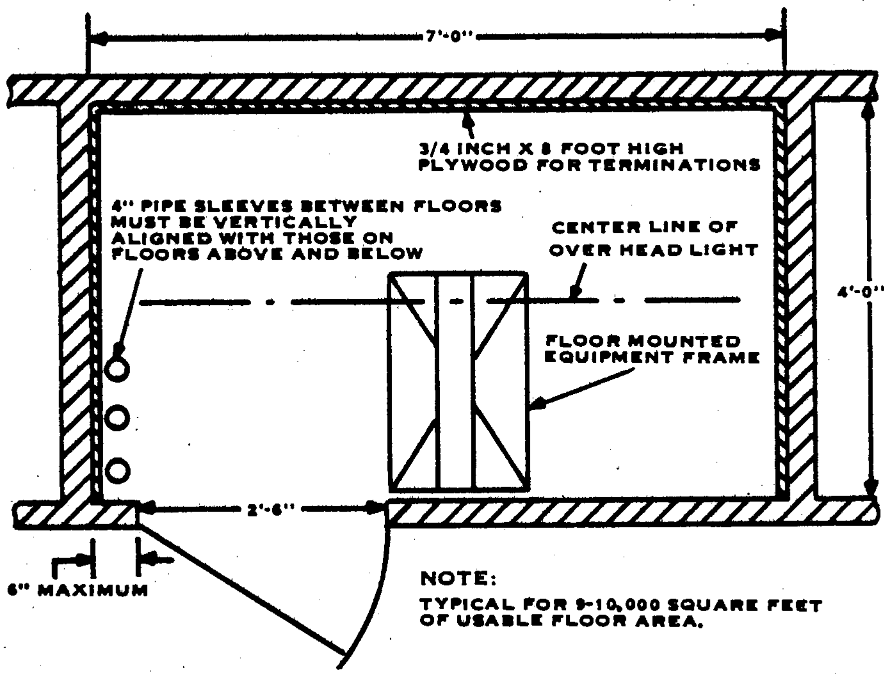


Figure 2-1. Walk-In Closet.

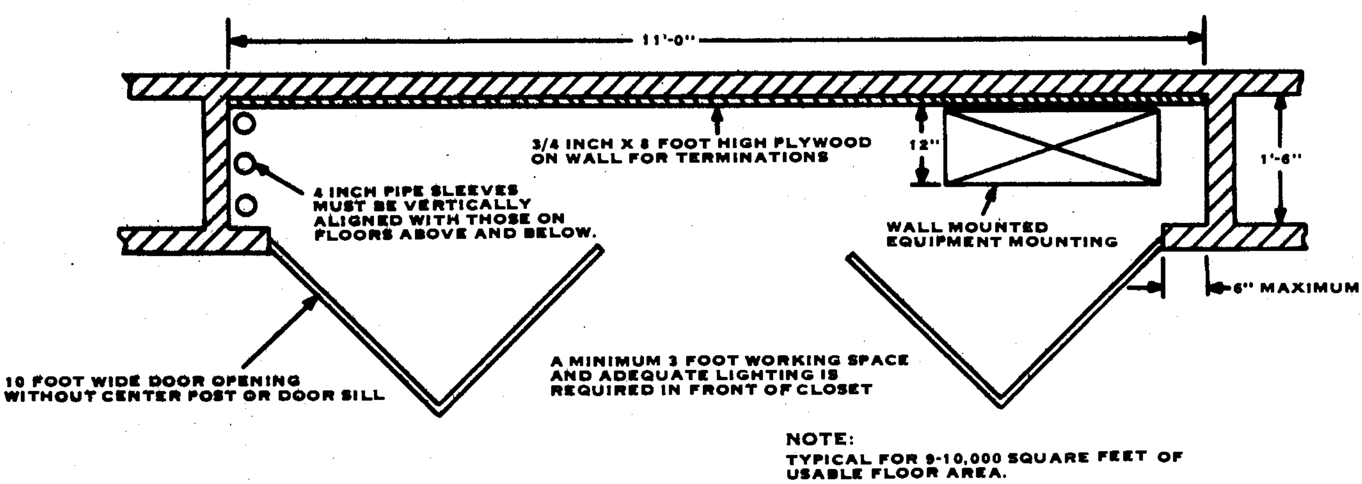


Figure 2-2. Shallow Closet (Wall-Mounted Equipment).

3. DETERMINATION OF NUMBER AND LOCATION

3.01 Physical conditions within the building frequently dictate the number, location, and type of closets. In general, it is desirable to have one apparatus closet for each 10,000 square feet of usable floor area. It has been found in practice that beyond this size, the problems created by the number of cross-connections required tend to offset any advantage gained from centralization of key telephone apparatus, etc.

3.02 Closets should be located to optimize the feed to underfloor raceway or ceiling raceway systems. As a general rule, closets located on the corners of the core area, or as close as possible to the corners, provide the best layout conditions.

3.03 Referring to a typical plan for floors (Figure 2-3), it is calculated that there is 29,600 square feet of usable floor space. On the basis of one closet per 10,000 square feet, this would indicate that a minimum of three closets is required. One closet on each corner of the core area would provide an optimum layout for the floor.

4. SIZE CALCULATION

4.01 In calculating the size of the closets, the first step is to determine the ultimate use of the closet. The closet associated with a riser system is usually an apparatus closet. When designing the building cable system, the number of satellite closets should be kept to a minimum. While this may increase the length of some of the key telephone cables, the number of cross-connections which must be made will be reduced.

4.02 Both apparatus and satellite closets must be large enough to accommodate the terminals required to terminate the station cables and the building cable pairs. Also, apparatus closets must be large enough to contain the key telephone apparatus. Another space requirement in closets is the provision of room for splicing the lateral cables from each floor to the main riser cables.

4.03 The planning of each closet should be based on the use of colored backboards equipped with 66-type connecting blocks or color-coded cross-connect systems. The backboards and cross-connect systems have a color identity so that there is a standardization of use. At any location, the colors have the following meanings:

(a) Green - toward central office
(b) Blue - to and from customer
(c) Red - to and from key telephone equipment
(d) Purple - to and from PABX equipment (in the U.S.A.)
(e) White - to and from PABX equipment (in Canada)
(f) Yellow - to and from special services

4.04 The space required in an apparatus or satellite closet for terminations is determined by the following parameters:

(a) The square feet of usable floor space per station.
(b) The average number of stations per line.
(c) The ratio of large key telephones (10 to 60 pushbutton key telephones) to key telephone sets.
(d) The size of the station cable terminated in the blue field for each key telephone set served directly from the closet.
(e) The size of the station cable terminated in the blue field for each large key telephone set directly served from the closet.
(f) The number of stations able to be terminated in the blue field on a blue backboard or a cross-connect system connector mount.
(g) The number of lines able to be terminated in the red field on a red backboard or a connector mount.
(h) In an apparatus closet, additional pairs are to be terminated in the blue field for tie cables to other apparatus closets and satellite closets.

Sample Calculation

4.05 On the sample floor (Figure 2-3), space has been allocated for three apparatus closets and a satellite closet near the four corners of the core area.

4.06 The floor area is divided into four zones, each one associated with a closet. Closet 1 is an apparatus closet and will serve zone 1 which has an area of 7,100 square feet of usable floor space. Closet 2 is the satellite closet which will serve zone 2 with an area of 7,100 square feet. Closets 3 and 4 are apparatus closets, and each will serve a zone of 7,700 square feet.

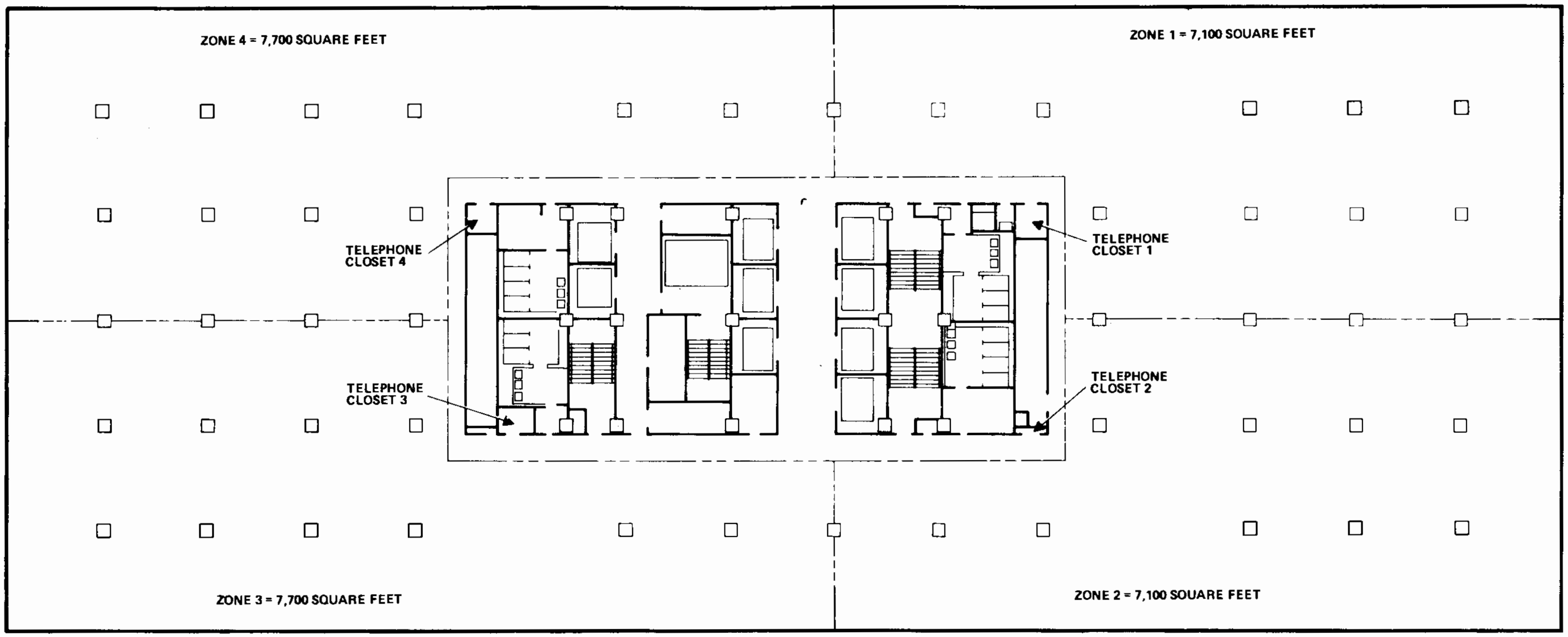


Figure 2-3. Typical Floor Plan Divided into Zones.

4.07 The key telephone apparatus for zone 2 will have to be placed in the other closets. Closets 1 and 3 will serve best, and Table 2-1 shows the breakdown of the floor area for key telephone apparatus purposes.

4.08 The required size of the apparatus closet is primarily determined by the quantity of terminations and key telephone apparatus; also, other factors must be considered. For our calculation purposes, the floor will be served by a multiple riser system with a riser in each of the apparatus closets.

4.09 The size of the terminating area is determined as follows:

(a) BLUE FIELD - Table 2 provides the procedure for determining the size of the blue field in an apparatus closet. The table also shows the calculations for the closets on the sample floor. Table 2-2a provides the procedure when blue backboards with 66-type connecting blocks are used. Table 2-2b provides the procedure when cross-connect systems are used.

(b) RED FIELD - Table 2-3 provides the procedure for determining the size of the red field in an apparatus closet. The table also shows the calculation for the closets on the sample floor. Table 2-3a provides the procedure when red backboards with 66-type connecting blocks are used. Table 2-3b provides the procedure when cross-connect systems are used.

(c) GREEN FIELD - Table 2-4 provides the procedure for determining the size of the green field. Table 2-4a provides the procedure when green blackboards with 66-type connecting blocks are used. Table 2-4b provides the procedure when cross-connect systems are used. Since the area served by an apparatus closet should be limited to 10,000 square feet, the maximum number of green backboards or mounts would be two. As a practical recommendation, it is suggested that two be placed at all times.

(d) YELLOW FIELD - Normally, the special requirements are not known at the time of planning for telephone company use. However, it is standard procedure to allow at least one yellow backboard or mount for special service terminations.

(e) PURPLE FIELD - The purple field is calculated in the same manner as the blue field.

Table 2-1. Breakdown of Usable Floor Area.

CLOSET	SQUARE FOOTAGE
1	7100 + 3600* = 10,700
2	7100
3	7700 + 3500* = 11,200
4	7700

*Assumes that key telephone apparatus for zone 2 is split between closets 1 and 3.

4.10 Sufficient space must be allocated in the apparatus closets to mount the key telephone apparatus. Table 2-5 indicates the space usually required for the apparatus.

4.11 Based on the calculations in Tables 2-2, 2-3, 2-4, and 2-5, the amount of wall space required in the closets may now be calculated. Table 2-6 shows the amount of wall space required in closets when backboards are used. The amount of wall space required in closets when cross-connect systems are used can be figured in the same manner.

4.12 The terminals and apparatus must be correctly placed in the closets. This introduces additional requirements for walk-in closets.

(a) Minimum depth of 3 feet if only one wall is used.

(b) Minimum depth of 4 feet if two adjacent or opposite walls are used for apparatus mountings.

(c) Minimum depth of 5 feet if two opposite walls and common adjacent wall are used for apparatus mountings.

4.13 Some general rules that apply in planning the interior arrangement of closets:

(a) Cable entrances (riser) should be on the left.

(b) Terminations are in the center starting from the left (right of the riser) and working around to the right.

(c) Key telephone apparatus should be to the right of the terminations.

Table 2-2. Procedure for Calculating Size of Blue Field in Apparatus Closets.
Table 2-2a. Procedure Used When Blue Backboards Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of stations: floor area/100 (Note 1).	7100/100 = 71	7700/100 = 77	7700/100 = 77
2. Calculate number of large key telephones required: number of stations/20 (Note 2).	71/20 = 4	77/20 = 4	77/20 = 4
3. Calculate number of pairs required for large key telephone sets: number of large key telephone sets x 75 (Note 3).	4 x 75 = 300	4 x 75 = 300	4 x 75 = 300
4. Calculate number of key telephones required: stations — large key telephone sets.	71 – 4 = 67	77 – 4 = 73	77 – 4 = 73
5. Calculate number of pairs required for key telephones: number of key telephones x 25 (Note 4).	67 x 25 = 1675	73 x 25 = 1825	73 x 25 = 1825
6. Calculate number of pairs required for stations: add step 3 to step 5.	300 + 1675 = 1975	300 + 1825 = 2125	300 + 1825 = 2125
7. Calculate number of pairs required in tie cables between apparatus closet and satellite closet. See paragraph 4.22 for method of calculation.	200	200	
8. Calculate number of pairs required for tie cables between apparatus closets: sum of stations served by each closet x 0.15 x 4 (Note 5).	Between closet 1 and closet 4: (71 + 77) x 0.15 x 4 = 89 or 100	Between closet 3 and closet 4: (77 + 77) x 0.15 x 4 = 92 or 100	Terminations required to terminate cables from closets 1 and 3 = 200 pairs.
9. Calculate total number of pairs required in the blue field: add results of steps 6, 7, and 8.	1975 + 200 + 100 = 2275	2125 + 200 + 100 = 2425	2125 + 200 = 2325
10. Calculate number of blue backboards required: total number of pairs required in blue field/400 (Note 6).	2275/400 = 6	2425/400 = 7	2325/400 = 6

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. Assumes a ratio of 1 large key telephone for each 20 stations.
3. Assumed to be the average number of pairs required per large key telephone.
4. Assumed to be the number of pairs required per key telephone.
5. Assumes that 15% of stations served by each apparatus closet must be tied to key telephone apparatus in adjacent apparatus closet.
6. Assumes that 400 pairs can be terminated on a blue backboard.

Table 2-2. Procedure for Calculating Size of Blue Field in Apparatus Closets.
Table 2-2b. Procedure Used When Cross-Connect Systems Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of stations: floor area/100 (Note 1).	7100/100 = 71	7700/100 = 77	7700/100 = 77
2. Calculate number of large key telephones required: number of stations/20 (Note 2).	71/20 = 4	77/20 = 4	77/20 = 4
3. Calculate number of pairs required for large key telephone sets: number of large key telephone sets x 75 (Note 3).	4 x 75 = 300	4 x 75 = 300	4 x 75 = 300
4. Calculate number of key telephones required: stations — large key telephone sets.	71 – 4 = 67	77 – 4 = 73	77 – 4 = 73
5. Calculate number of pairs required for key telephone sets: number of key telephones x 25 (Note 4).	67 x 25 = 1675	73 x 25 = 1825	73 x 25 = 1825
6. Calculate number of pairs required for stations: add step 3 to step 5.	300 + 1675 = 1975	300 + 1825 = 2125	300 + 1825 = 2125
7. Calculate number of pairs required in tie cables between apparatus closet and satellite closet. See paragraph 4.22 for method of calculation.	200	200	
8. Calculate number of pairs required for tie cables between apparatus closets: sum of stations served by each closet 0.15 x 4 (Note 5).	Between closet 1 and closet 4: (71 + 77) x 0.15 x 4 = 89 pairs (or 100 pairs)	Between closet 3 and closet 4: (77 + 77) x 0.15 x 4 = 92 pairs (or 100 pairs)	Terminations required to terminate cables from closets 1 and 3 = 200 pairs.
9. Calculate total number of pairs required in the blue field: add results of steps 6, 7, and 8.	1975 + 200 + 100 = 2275	2125 + 200 + 100 = 2425	2125 + 200 = 2325
10. Calculate number of connectors required in blue field: number of pairs required/25 (Note 6).	2275/25 = 91	2425/25 = 97	2325/25 = 93
11. Calculate number of mounts required: number of connectors/10 (Note 7).	91/10 = 10	97/10 = 10	93/10 = 10

Table 2-2. Procedure for Calculating Size of Blue Field in Apparatus Closets (Continued).
Table 2-2b. Procedure Used When Cross-Connect Systems Are Used (Continued).

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. Assumes a ratio of 1 large key telephone for each 20 stations.
3. Assumed to be the average number of pairs required per large key telephone set.
4. Assumed to be the number of pairs required per key telephone set.
5. Assumes that 15% of stations served by each apparatus closet must be tied to key telephone apparatus in adjacent apparatus closet.
6. Assumes that 25 pairs can be terminated on a connector.
7. Assumes that 10 connectors can be mounted on a mount.

Table 2-3. Procedure for Calculating Size of Red Field in Apparatus Closets.
Table 2-3a. Procedure Used When Red Backboards Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of stations: floor area/100 (Note 1).	$\frac{7100 + 3600}{100} = 107$	$\frac{7700 + 3500}{100} = 112$	$\frac{7700}{100} = 77$
2. Calculate number of lines required: number of stations/1 (Note 2).	107/1 = 107	112/1 = 112	77/1 = 77
3. Calculate number of red backboards required to terminate the lines: lines/20 (Note 3).	107/20 = 6	112/20 = 6	77/20 = 4
4. Calculate number of red backboards required to terminate the tie cables from the other apparatus closets: number of pairs in tie cables/100 (Note 4). Number of pairs in tie cables is found in Table 2-2a.	100/100 = 1	100/100 = 1	200/100 = 2
5. Calculate total number of red backboards required: sum of steps 3 and 4.	6 + 1 = 7	6 + 1 = 7	4 + 2 = 6

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. Assumes a ratio of one station per line.
3. Assumes that 20 lines can be terminated on a red backboard.
4. Assumes that 100 pairs can be terminated on a red backboard.

Table 2-3. Procedure for Calculating Size of Red Field in Apparatus Closets.
Table 2-3b. Procedure Used When Cross-Connect Systems Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of stations: floor area/100 (Note 1).	$\frac{7100 + 3600}{100} = 107$	$\frac{7700 + 3500}{100} = 112$	$\frac{7700}{100} = 77$
2. Calculate number of lines required: number of stations/1 (Note 2).	107/1 = 107	112/1 = 112	77/1 = 77
3. Calculate number of connectors required to terminate lines: lines/5 (Note 3).	107/5 = 22	112/5 = 23	77/5 = 16
4. Calculate number of connectors required to terminate the tie cables from the other apparatus closets: number of pairs in the tie cables/5 (Note 3). Number of pairs in tie cables is found in Table 2-2b.	100/5 = 20	100/5 = 20	200/5 = 40
5. Calculate total number of connectors required: sum of steps 3 and 4.	22 + 20 = 42	23 + 20 = 43	16 + 40 = 56
6. Calculate number of mounts required: number of connectors/10 (Note 4).	42/10 = 5	43/10 = 5	56/10 = 6

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. Assumes a ratio of one station per line.
3. Assumes that five pairs can terminate on a connector.
4. Assumes that 10 connectors can be mounted on a mount.

Table 2-4. Procedure for Calculating Size of Green Field in Apparatus Closets.
Table 2-4a. Procedure Used When Green Backboards Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of pairs required: floor area x 15/1000 (Note 1).	7100 + 3600 = 10,700 10700 x 0.015 = 161	7700 + 3500 = 11,200 11200 x 0.015 = 168	7700 x 0.015 = 116
2. Calculate number of green backboards required: pairs/200 (Note 2).	161/200 = 1	168/200 = 1	116/200 = 1

NOTES:

1. Assumes 15 pairs are required per 1,000 square feet of floor area served.
2. Assumes that 200 pairs can be terminated on a green backboard.

Table 2-4. Procedure For Calculating Size of Green Field in Apparatus Closets.
Table 2-4b. Procedure Used When Cross-Connect Systems Are Used.

STEPS	CLOSET 1	CLOSET 3	CLOSET 4
1. Calculate number of pairs required: floor area x 15/1000 (Note 1).	7100 + 3600 = 10700 10700 x 0.015 = 161	7700 + 3500 = 11200 11200 x 0.015 = 168	7700 x 0.015 = 116
2. Calculate number of connectors required: pairs/25 (Note 2).	161/25 = 7	168/25 = 7	116/25 = 5
3. Calculate number of mounts required: connectors/10 (Note 3).	7/10 = 1	7/10 = 1	5/10 = 1

NOTES:

1. Assumes 15 pairs are required per 1,000 square feet of floor area served.
2. Assumes that 25 pairs can be terminated on a connector.
3. Assumes that 10 connectors can be mounted on a mount.

Table 2-5. Wall Space Requirements for Key Telephone Apparatus.

FLOOR AREA SERVED (SQ. FT.)	NUMBER OF APPARATUS	WALL SPACE REQUIRED
Up to 18,000	1	4 feet
18,000 to 36,000	2	8 feet

Table 2-6. Minimum Wall Space Required for Apparatus Closets.

EQUIPMENT REQUIRED	CLOSET 1		CLOSET 3		CLOSET 4	
	NO. OF UNITS REQUIRED	WALL SPACE	NO. OF UNITS REQUIRED	WALL SPACE	NO. OF UNITS REQUIRED	WALL SPACE
Yellow Backboards (8.5 in. wide, 20 in. high)	1	8.5 in.	1	8.5 in.	1	8.5 in.
Green Backboards (8.5 in. wide, 20 in. high)	1	8.5 in.	1	8.5 in.	1	8.5 in.
Blue Backboards (17 in. wide, 20 in. high)	6	102 in.	7	119 in.	6	102 in.
Red Backboards (17 in. wide, 20 in. high)	7	119 in. (7 x 17)	7	119 in. (7 x 17)	6	102 in. (6 x 17)
Key Telephone Apparatus	1	48 in.	1	48 in.	1	48 in.
Minimum Wall Space Required (does not include space for splicing, working space, and space lost due to room configuration).		175.5 in. (14 ft. 7.5 in.)		175.5 in. (14 ft. 7.5 in.)		158.5 in. (13 ft. 2.5 in.)

SPCL
CO
STA
KEY
PURPLE
PBX

4.14 Having determined the minimum wall space required for the apparatus closets, the adequacy of the space available must be examined.

4.15 It must be recalled that linear feet of wall space will vary, dependant on the configuration of the wall space and equipment. If corners are involved, lost wall space is experienced at the corner locations. Working space should also be considered, especially where the terminations or apparatus abut a wall. See Figure 2-4 for the information that must be taken into account. It is recommended not to mix red and blue fields in the same horizontal line; however, this may be impossible at times.

4.16 From Table 2-6 it can be determined that closet 4 has a minimum wallspace requirement of 158.5 inches, and closets 1 and 3 have a requirement of 175.5 inches. Taking inches into consideration the additional space required for lost space, working room, splicing and space for riser cables, it is a necessity to have at least 18 feet of wall space if rooms are to be used, or 15 feet if there is a continuous wall.

4.17 A room 6 feet by 5 feet 6 inches has been allocated for apparatus closet 1. This appears to be adequate for backboards if laid out as shown in Figure 2-5a. Figure 2-5b shows a layout if a cross-connect system is used.

4.18 A 5-foot by 7-foot room was provided for apparatus closet 3. This room could be laid out as shown in Figure 2-6a if backboards are used, or as shown in Figure 2-6b if a cross-connect system is used.

4.19 A 5 foot by 5 foot 6 inch room was allocated for apparatus closet 4. One 5-foot wall is lost entirely for installation of the key telephone apparatus. The space provided in the room is quite adequate for backboards if laid out as shown in Figure 2-7a. If a cross-connect system is used, it may be laid out as shown in Figure 2-7b.

4.20 Satellite closet 2 needs only two fields, the red field for terminating the cables from the apparatus closets, and the blue field for terminating station cables.

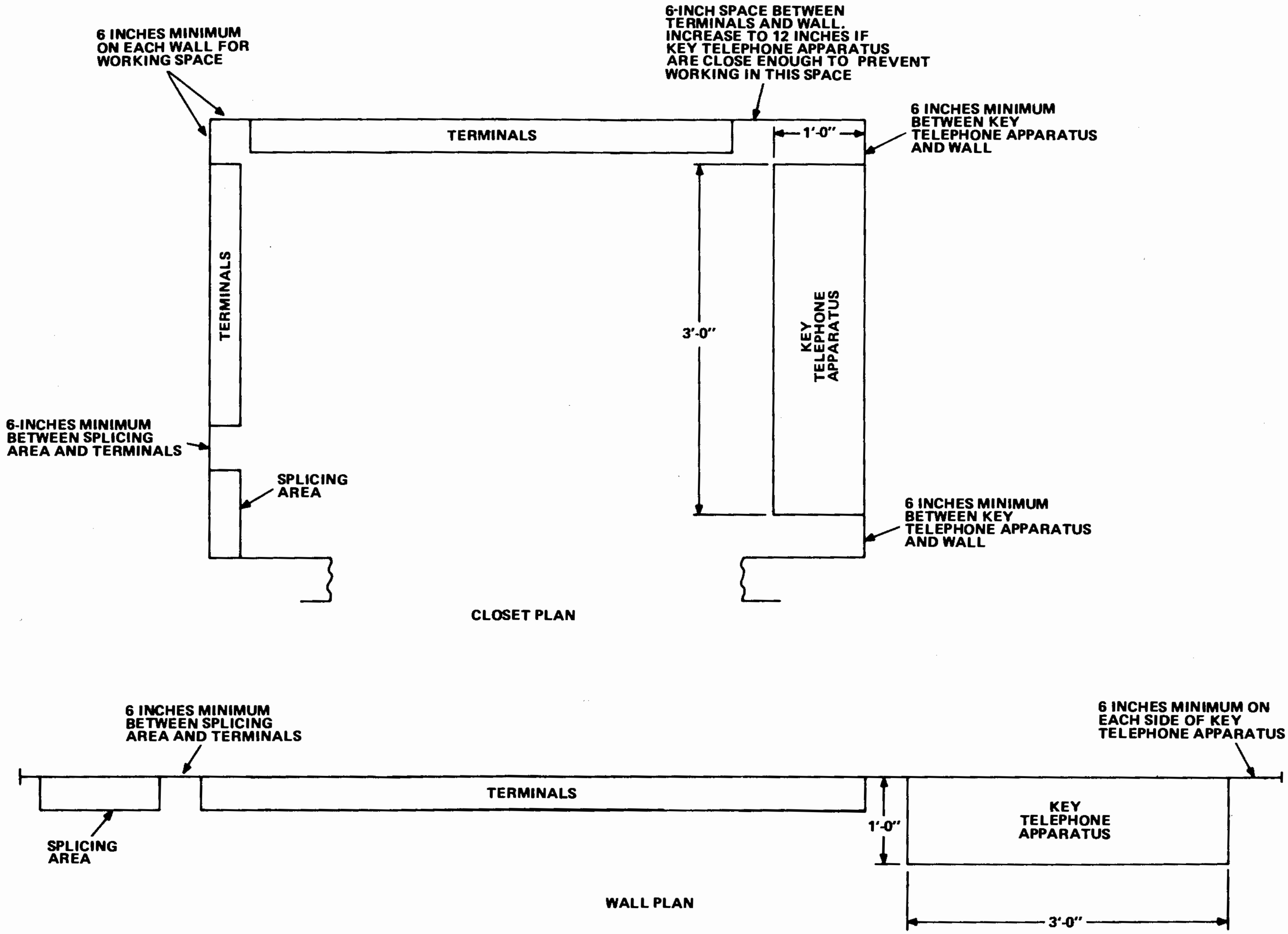


Figure 2-4. Plan Indicating Lost Space.

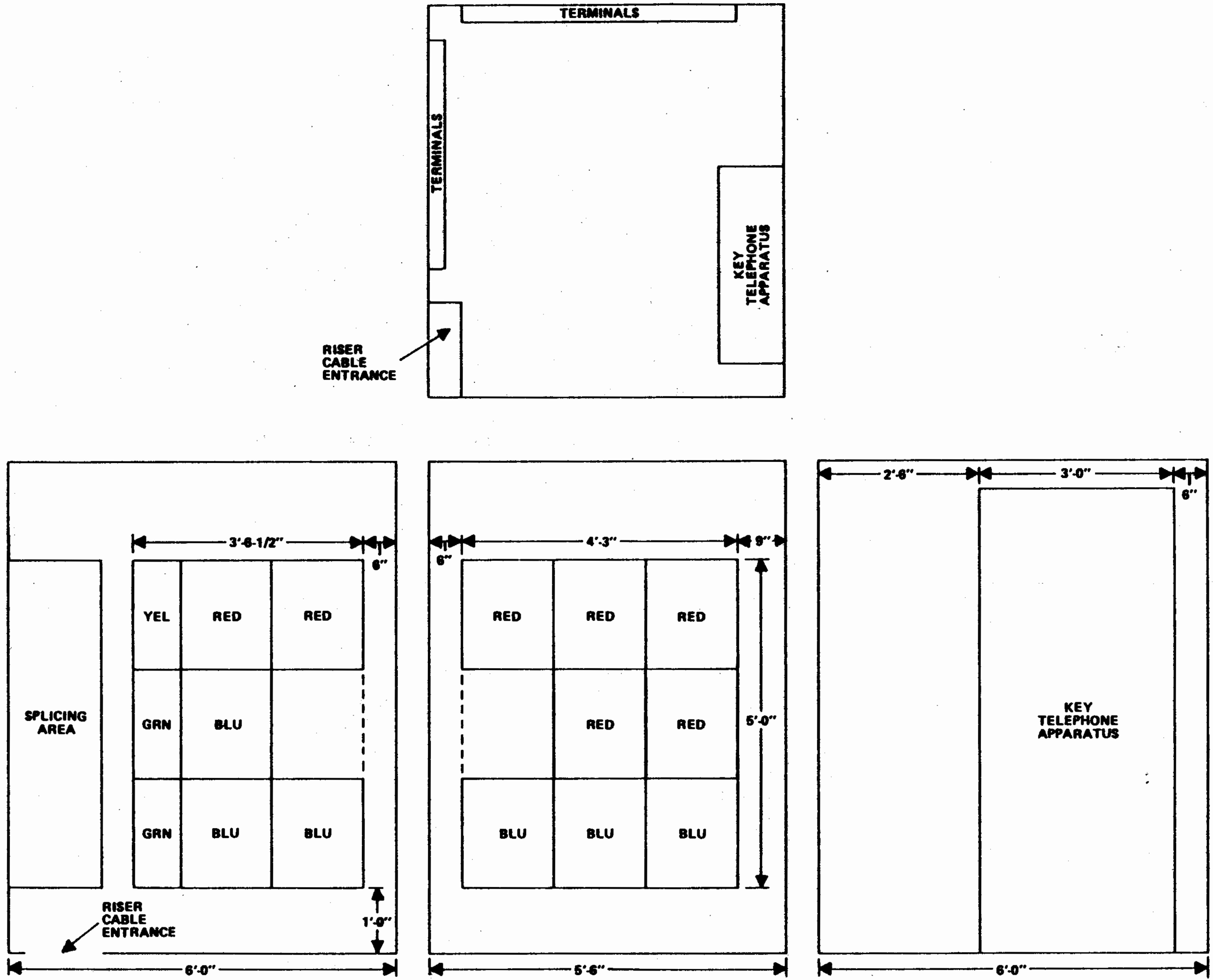


Figure 2-5a. When Backboards Are Used.

Figure 2-5. Profile and Plan Views for Apparatus Closet 1.

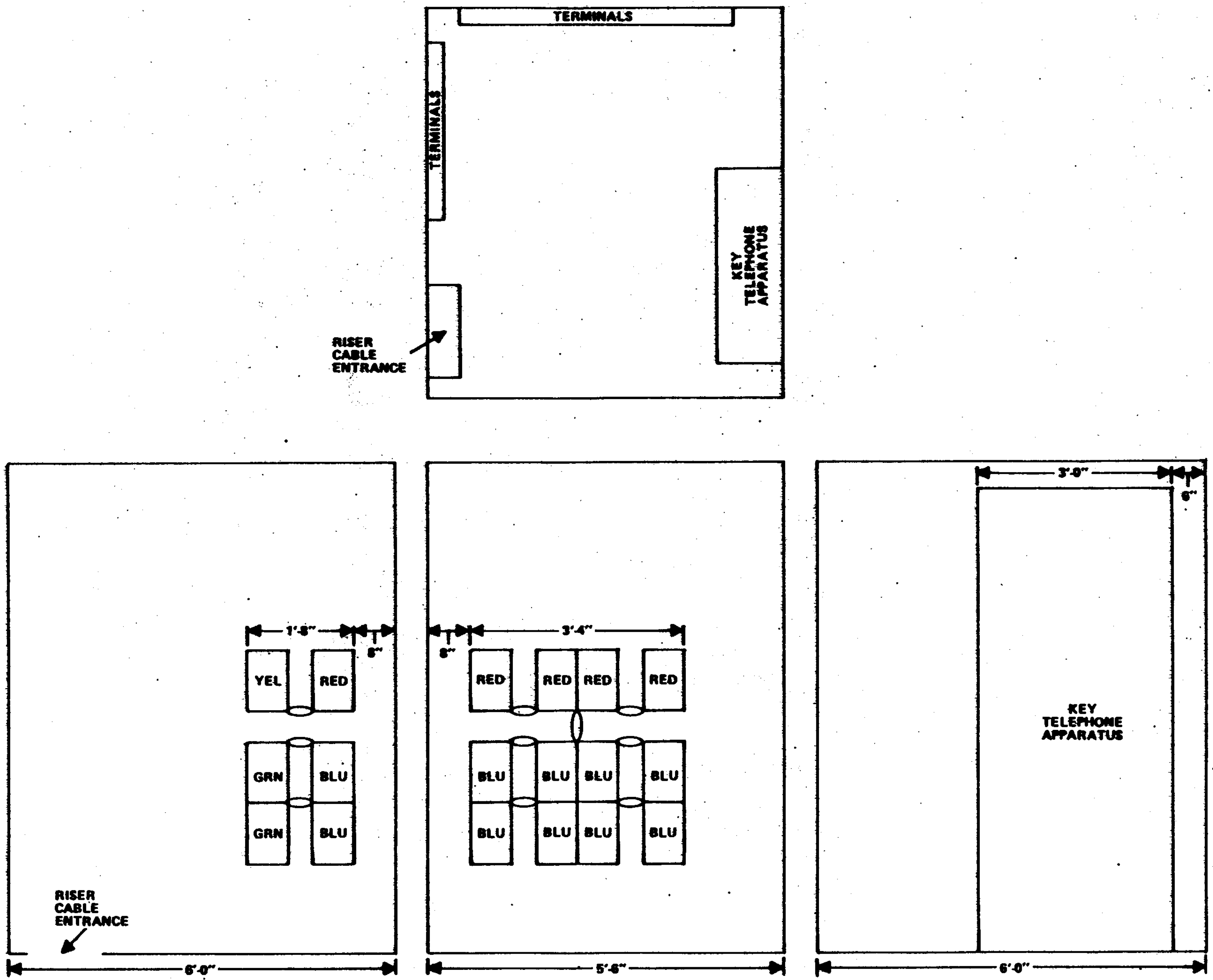


Figure 2-5b. When Cross-Connect Systems Are Used.

Figure 2-5. Profile and Plan Views For Apparatus Closet 1 (Continued).

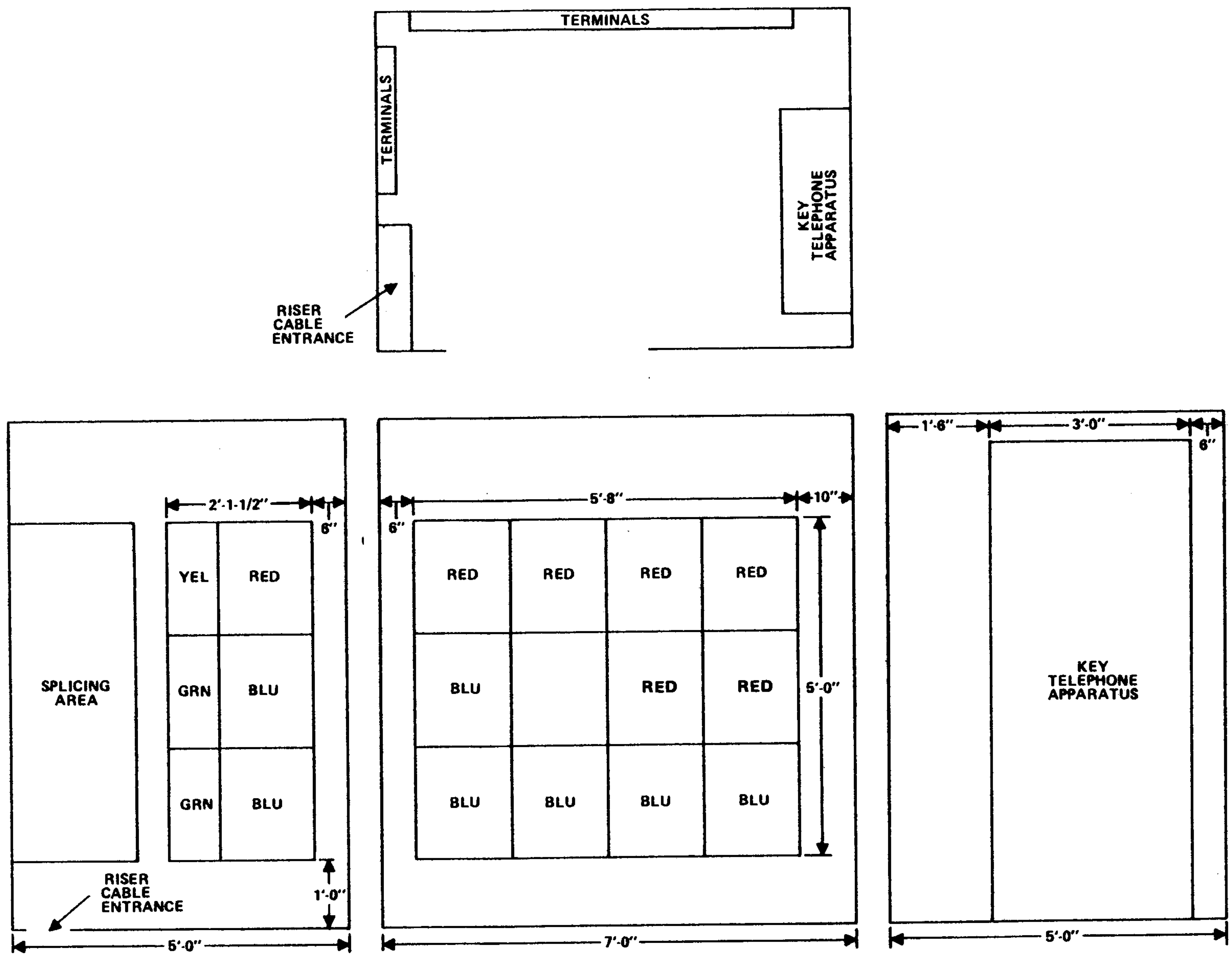


Figure 2-6a. When Backboards Are Used.

Figure 2-6. Profile and Plan Views for Apparatus Closet 3.

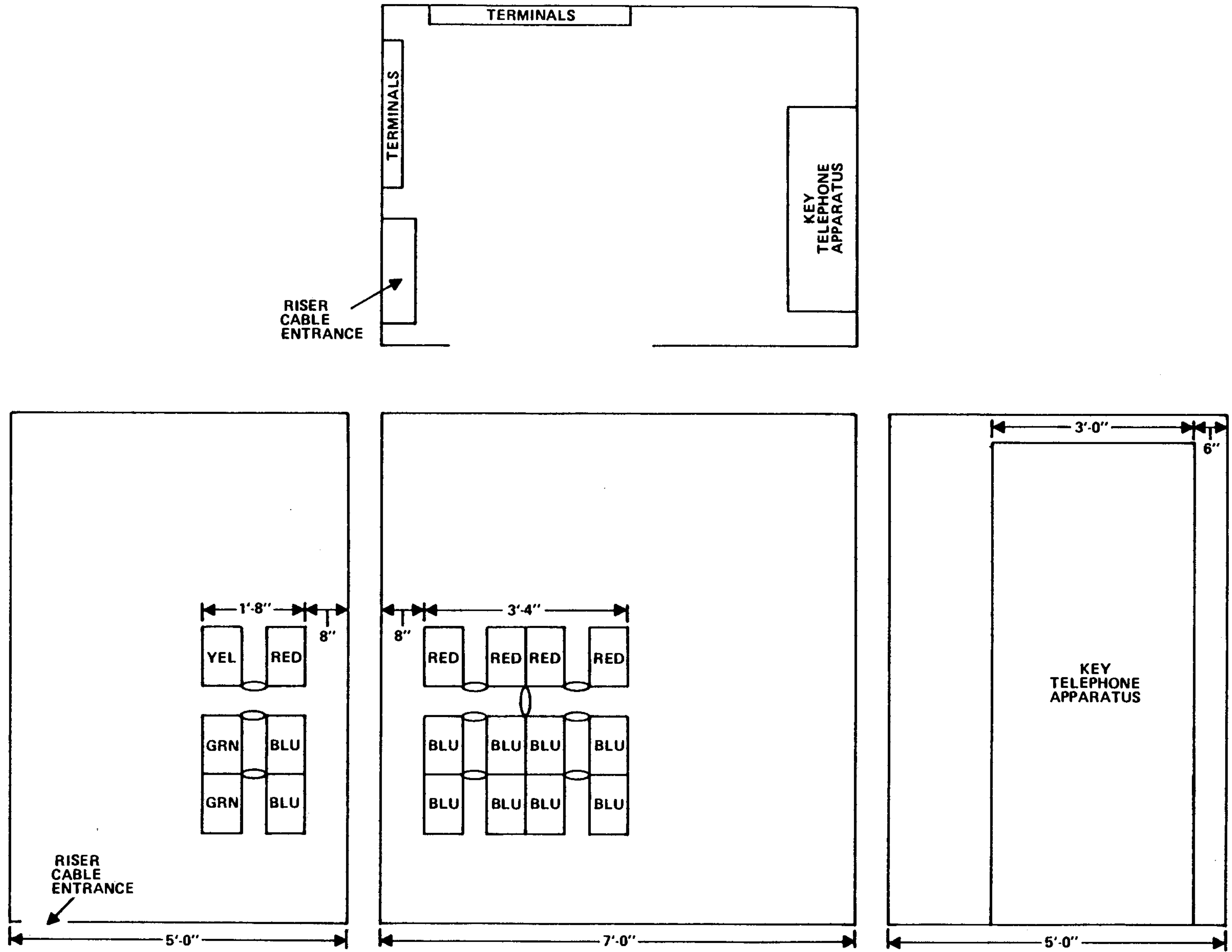


Figure 2-6b. When Cross-Connect Systems Are Used.

Figure 2-6. Profile and Plan Views for Apparatus Closet 3 (Continued).

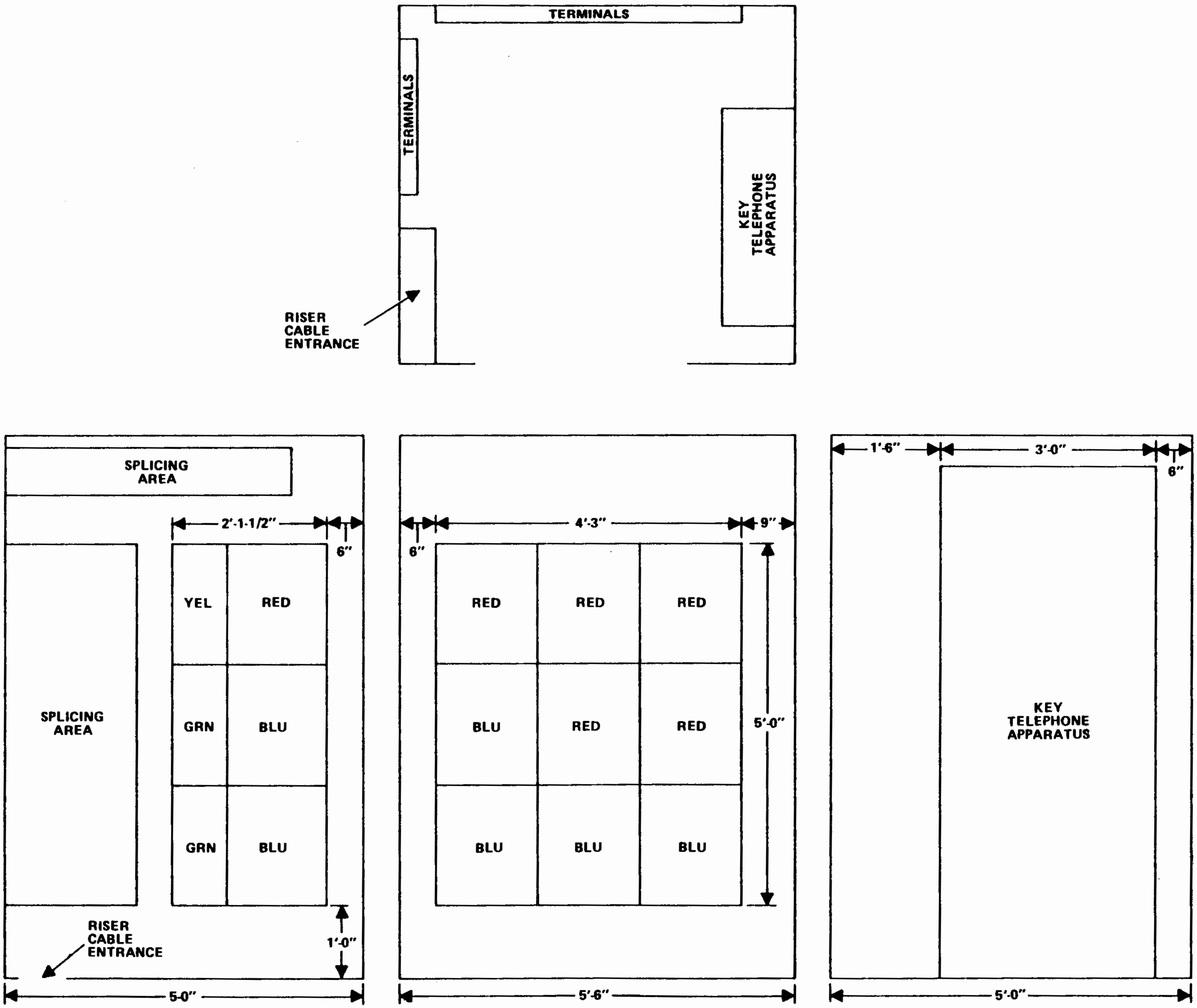


Figure 2-7a. When Backboards Are Used.

Figure 2-7. Profile and Plan Views for Apparatus Closet 4.

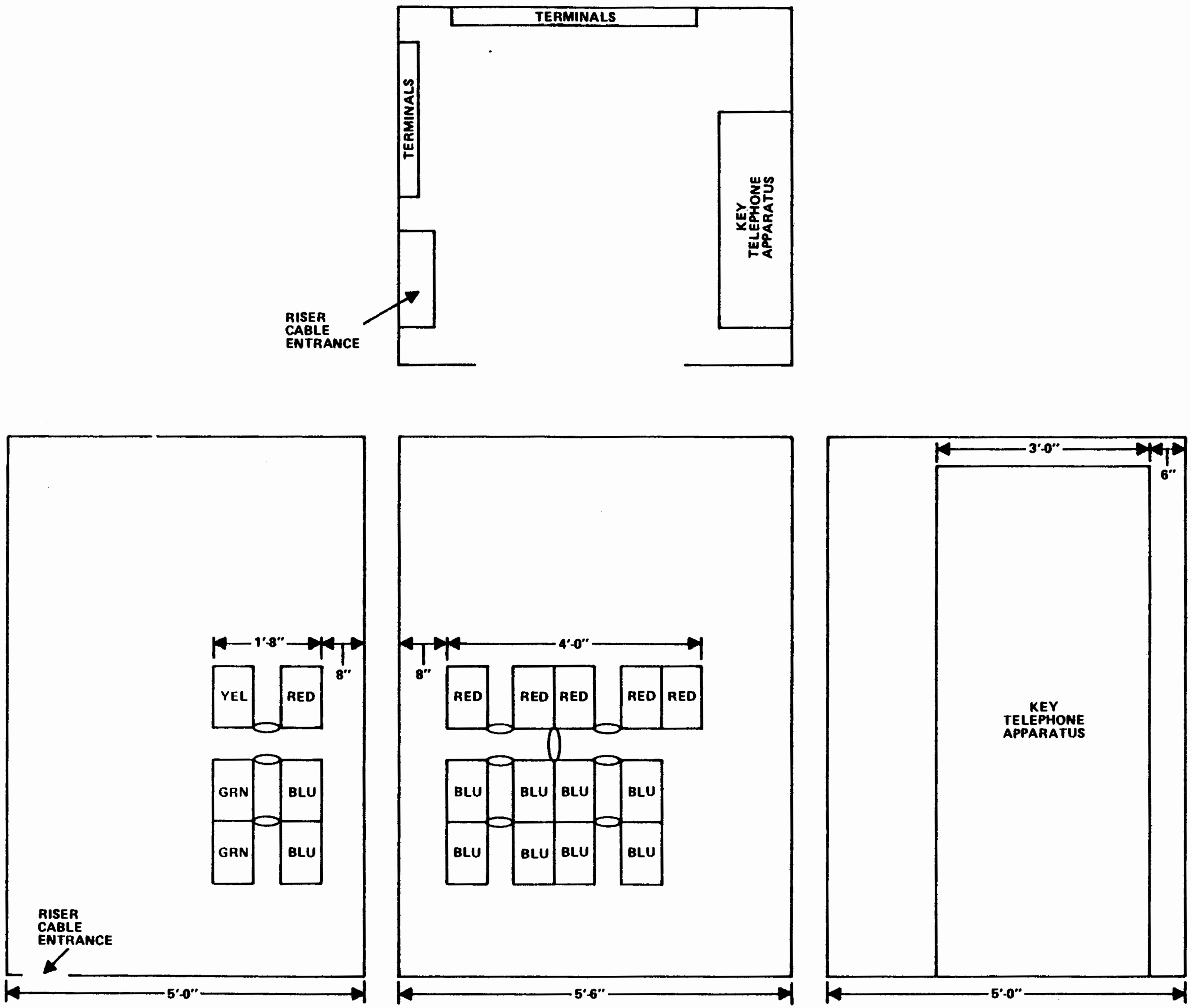


Figure 27b. When Cross-Connect Systems Are Used.

Figure 2-7. Profile and Plan Views for Apparatus Closet 4 (Continued).

4.21 The blue field requirement is calculated as in Table 2-2. Based on 67 key telephone sets and 4 large key telephone sets, there is a requirement for 1,975 pairs or 5 blue backboards or 8 mounts.

4.22 Table 2-7 gives the procedure for calculating the red field for satellite closets. From the computations in Table 2-7, 312 pairs are to be terminated which required four red backboards. These pairs are to be cabled to the apparatus closets. Since the load was arbitrarily divided between apparatus closets 1 and 3, 156 pairs are required between closet 2 and each of apparatus closets 1 and 3. In practice, it would be logical to place a 200-pair cable between the closets. This would also provide flexibility in the grouping of key telephones in zone 2.

4.23 There is now sufficient information on hand to check the size of closet 2 for adequacy, and show a typical layout (Figure 2-8).

4.24 Minimum wall space and backboard requirements for various floor areas from 1,000 to 6,000 square feet are shown in Table 2-8. The requirements for those situations above 6,000 feet are not given since the recommended serving area of a satellite closet is a maximum of 5,000 square feet. It is expected that cases in excess of this parameter will be held to a minimum.

5. CLOSETS IN HOTELS, MOTELS, AND APARTMENTS

5.01 The size and design of terminals discussed previously have been based on the use of key-type telephones at each station. The size of the closets or terminals used to serve individual apartments or rooms in hotels or motels is not necessarily based on the same situation. The normal requirement for apartments and rooms in hotels and motels is two pairs per unit. Within some areas of some buildings, there may be a requirement for as many as six pairs per unit. No space is usually required for key telephone apparatus. The exception to this is those buildings or parts of buildings requiring large amounts of telephone service.

5.02 Terminal space in most uses is based on the following:

(a) Space required to terminate the riser pairs.
(b) Space required to terminate all of the station wiring or cable from the various rooms or apartments.
(c) Space required for power for those telephone sets requiring lights.
(d) Space required for splices.

5.03 For economy reasons, it is recommended that the design of the terminals be based on the following:

(a) Exclusive riser cable pairs to each terminal (no multipling of pairs).
(b) Termination of all pairs.

5.04 Two methods of terminating cable are commonly used. They are as follows (Figure 2-9):

(a) Method A: Riser pairs and station pairs terminate on the same block so that no cross connections are required to establish a connection through to the main terminal.
(b) Method B: Riser pairs terminate on one set of blocks, and all station wiring on a second set. All connections to the main entrance terminal are established by means of cross-connections in the terminal.

5.05 The advantages of Method A are as follows:

(a) Space required for terminals is smaller.
(b) The elimination of cross-connections in terminals except the main entrance terminal.
(c) The installer is required only to know the location of the main entrance terminal.

5.06 The advantages of Method B are as follows:

(a) Riser cables can be smaller.
(b) In the case of troubleshooting, pairs can be opened more conveniently at the terminal.

Table 2-7. Procedure for Calculating Size of Red Field in Satellite Closets.
Table 2-7a. Procedure Used When Backboards Are Used.

STEPS	CLOSET 2
1. Calculate number of stations: floor area/100 (Note 1).	7100/100 = 71
2. Calculate number of pairs required for telephones: number of stations x 4 (Note 2).	71 x 4 = 284
3. Calculate number of pairs for miscellaneous use: percentage of step 2. (Note 3).	284 x 0.10 = 28
4. Calculate total number of pairs required: add steps 2 and 3.	284 + 28 = 312
5. Calculate number of red backboards required: total number of pairs required/100 (Note 4).	312/100 = 4

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. Assumes key telephone sets are used with each set requiring four leads.
3. For this example, 10 percent is assumed.
4. Assumes that 100 pairs can be terminated on a red backboard.

Table 2-7. Procedure for Calculating Size of Red Field in Satellite Closets.
Table 2-7b. Procedure Used When Cross-Connect Systems Are Used.

STEPS	CLOSET 2
1. Calculate number of stations: floor area/100 (Note 1).	7100/100 = 71
2. Calculate number for miscellaneous use: percentage of step 1 (Note 2).	71 x 0.10 = 7
3. Calculate total number: add steps 1 and 2.	71 + 7 = 78
4. Calculate number of connectors required: total number required/5 (Note 3).	78/5 = 16
5. Calculate number of mounts required: connectors/10 (Note 4).	16/10 = 2

NOTES:

1. Assumes one station per 100 square feet of usable floor area.
2. For this example, 10 percent is assumed.
3. Assumes that 5 stations can be terminated on a connector.
4. Assumes that 10 connectors can be mounted on a mount.

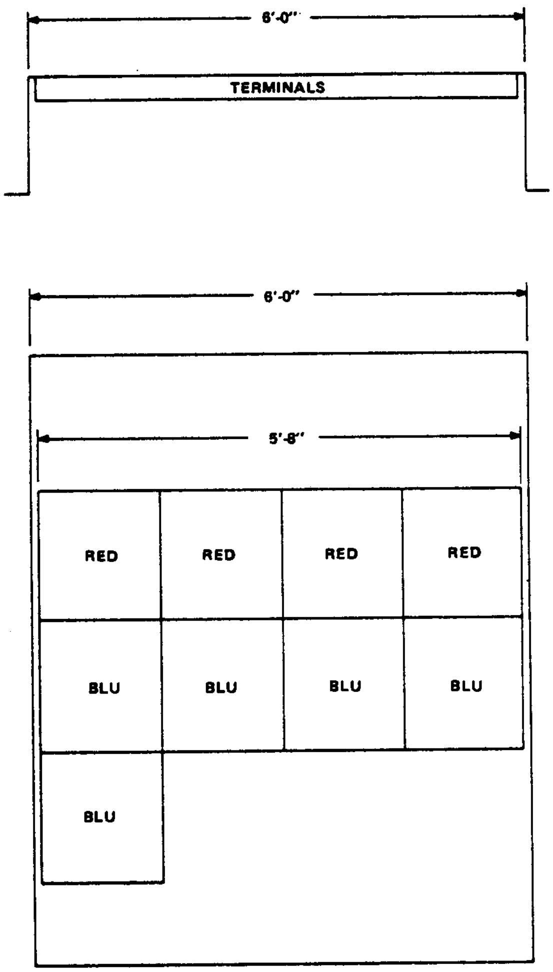


Figure 2-8a. When Backboards Are Used.

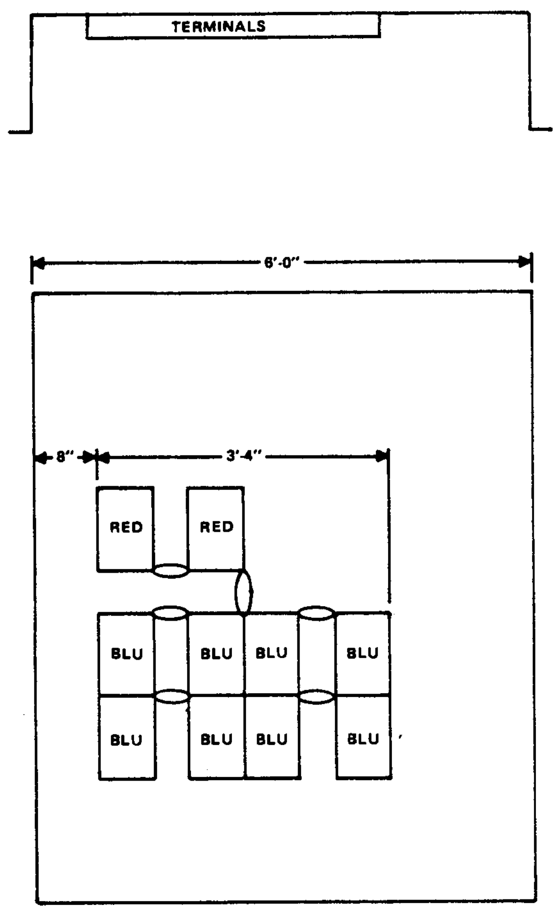


Figure 2-8b. When Cross-Connect Systems Are Used.

Figure 2-8. Profile and Plan Views for Satellite Closet 2.

Table 2-8. Backboard Requirements and Sizes of Closets for Satellite Closets.

AREA SERVED (SQ. FT.)	NUMBER OF STATIONS	TIE CABLE PAIRS (NOTE 1)	BACKBOARDS REQUIRED		LENGTH OF SHALLOW CLOSET
			RED	BLUE	
1,000	10	50	1	1	1 ft. 6 in. (Note 2)
2,000	20	100	1	2	1 ft. 6 in. (Note 2)
3,000	30	150	2	3	3 ft.
4,000	40	200	2	4	3 ft.
5,000	50	300	3	5	4 ft. 6 in.
6,000	60	300	3	5	4 ft. 6 in.

NOTES:

1. The size of the cable recommended will be adequate to serve the average condition found in the field. Any particular area that has an unusually high density, will require a larger size cable, more terminals, and a larger closet.
2. This will probably be a flush-type cabinet. Adjust measurement to standard cabinet available.

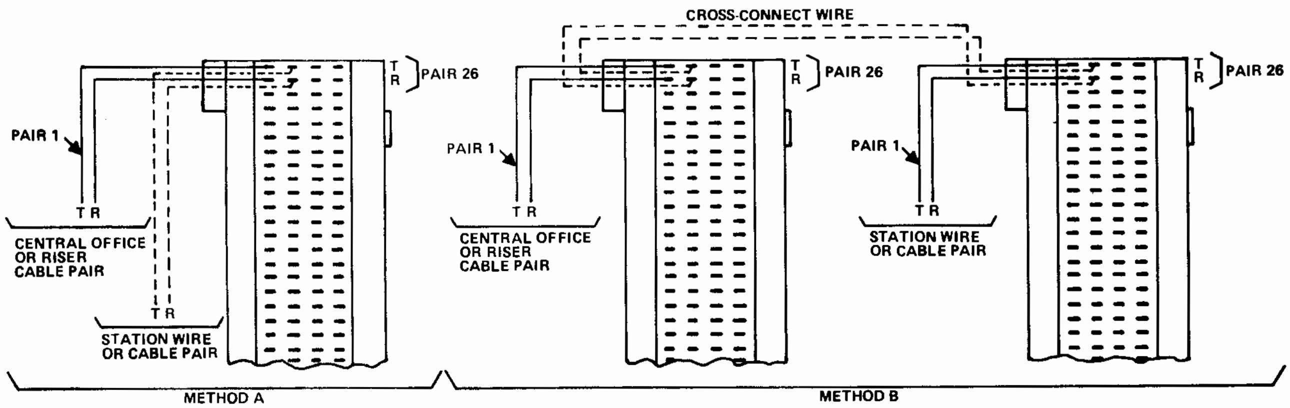


Figure 2-9. Method of Terminating Cable.

1. GENERAL

1.01 This section provides information on wiring distribution design. Wiring distribution is one of the elements in providing a communications system in a building.

2. CONSIDERATIONS

2.01 Wiring distribution systems are the facilities for housing the wire (cables) to be placed between the apparatus (or satellite) closet and the desired telephone set location.

2.02 The distribution system is designed after the apparatus and/or satellite closet(s) have been located for the floor.

2.03 The design and capacity of distribution systems shall have a built-in flexibility in the initial design to anticipate the movement and growth needs of the tenant(s).

2.04 There are five main types of wiring distribution systems:

(a) Underfloor duct.
(b) Cellular floor.
(c) Unlimited access (raised) floor.
(d) Ceiling.
(e) Perimeter raceway and other miscellaneous conduit systems.

2.05 Some buildings may require a combination of underfloor, cellular, and conduit distribution. An example of this is a hotel that may require an underfloor system to serve the office and service areas, and a conduit system to serve telephones at remote or isolated locations.

3. UNDERFLOOR DUCT

3.01 Underfloor duct systems consist of distribution ducts and feeder (header) ducts. The underfloor duct systems may be designed into a one- or two-level system, depending on the floor structure (Figures 3-1 and 3-2).

Distribution Duct

3.02 The distribution duct is available in standard sizes with cross-sectional area varying from 3.3 to 3.9 square inches. It is also available in "large sizes" with a cross-sectional area varying from 7.6 to 8.9 square inches (Figure 3-3). When preparing the underfloor duct design, the points to be considered are as follows:

(a) The underfloor duct should be provided with preset inserts spaced at regular intervals to accommodate the standard connector-ended cable.
(b) Installation with insert markers should be at 50-foot intervals (approximately). This provides installation and service groups with run location information.
(c) Installation should be between building module lines.
(d) A single run of distribution duct should be located within 18 inches of the outside wall. This provides service for credenzas that are common in prime private office locations.

Feeder (Header) Ducts

3.03 An enclosed feeder (header) duct is a large blank (no inserts) duct that is installed with junction boxes (Figure 3-2). Junction boxes should be provided where feeder (header) ducts and distribution ducts intersect. They are also required at all horizontal 90-degree floor bends in feeder (header) ducts, or the duct capacity should be reduced by 25 percent. Junction boxes shall have a handhole opening and an opening between the upper and lower level, with a 5-inch minimum diameter, to permit ease of inserting hands and bending cables. Conduit should not be designed for use between the distribution duct and the terminal closet in lieu of a feeder (header) duct, nor to supplement the feeder capacity of the system. A typical feeder (header) duct has a cross-sectional area of from 7.6 to 8.9 square inches and can theoretically serve a floor area of up to 800 square feet.

3.04 The advantages of an underfloor duct system are as follows:

(a) Mechanical protection is provided for cables. This leads to reduced interruption of service caused by mechanical damage by other workmen.
(b) Electrical interference is reduced.
(c) New or rearranged requirements are easily provided.
(d) Flexibility of office layout is facilitated.

(e) Security from wiretapping is increased.
(f) Customer's premises appearance is improved.
(g) Safety hazards are reduced.
(h) Connecting devices between the telephone set and cable are concealed in the service fitting.

3.05 The disadvantages of an underfloor duct system are as follows:

(a) Initial cost must be spent before floor space is occupied.
(b) Junction boxes or trench duct must be made accessible even when covered with carpets.
(c) Openings for service fittings necessitate special treatment in carpeted areas.
(d) Junction boxes are sometimes too small to permit inserting hands and bending the cables.
(e) Wiring must be fished through floor ducts, whereas it may be laid into trenches and trays.

4. CELLULAR FLOOR SYSTEM

4.01 Cellular floor systems are comprised of two distinct components: distribution cells and feeder (header) duct. Depending on the floor structure, the distribution cells may be constructed of steel or concrete. In both cases, enclosed header duct or trench header may be used to feed the system from the terminal closet.

4.02 The capacity requirements of both cells and headers for communications in a cellular floor system are the same as those for the underfloor duct systems. A cellular floor has a multiple function:

(a) It serves as the structural floor.
(b) It acts as a distribution system for communication and power.

The layout of the distribution system and the design of the structural floor and its supporting members are necessarily integrated. This multiple function leads to economy for the total structure. When considering the use of cellular steel floor, one level of the two-level system is provided by the cells in the floor deck. It is only necessary, therefore, to add the feeder or header ducts. A typical arrangement is shown in Figure 3-4. Figure 3-5 shows four typical cellular floor units.

4.03 The advantages of a cellular floor system are as follows:

(a) The advantages of an underfloor duct system (paragraph 3.04).
(b) Access can be had on 3-inch spacing along the cell.
(c) Above normal capacity can be achieved.

4.04 The disadvantages of a cellular floor system are as follows:

(a) The disadvantages of an underfloor duct system (paragraph 3.05).
(b) The concrete floor has to be drilled to place afterset inserts. This is very expensive.
(c) Cellular floor is primarily a structural member, and therefore is installed by iron or concrete workmen. They may not be conscious of the dual purpose of the floor and cause problems by passing sleeves or holes through cells; not leveling and aligning the cells; by permitting concrete to enter the cells; or by placing hangers, pins, and/or conduit over the top of or into the cells.

Trench Duct

4.05 Trench duct is a specially manufactured metallic trough placed flush with the finished floor (Figure 3-6). It is normally used as header or feeder duct for cellular floor systems or underfloor distribution systems. It shall be equipped with removable 1/4-inch flat steel cover plates for its entire length. Each cover shall overlay a rabbet on the adjacent cover and not weigh more than 65 pounds. The cover shall be equipped with tile trim to prevent damage to surrounding tiles. The covers of the trench duct are to be removed by the building owner, and where the trench has two or more compartments (communications and power), a dividing partition must be supplied. The divider shall support the weight of the cover. The interconnect between trench and distribution duct or cell shall be a minimum 2-1/2 inch by 5-inch opening; the minimum usable depth shall be 1-1/4 inches. Regardless of actual depth, the maximum usable depth for telephone service should be considered as 2-1/2 inches. Trench duct should not be a first choice in normal design.

4.06 The advantages of a trench feeder are as follows:

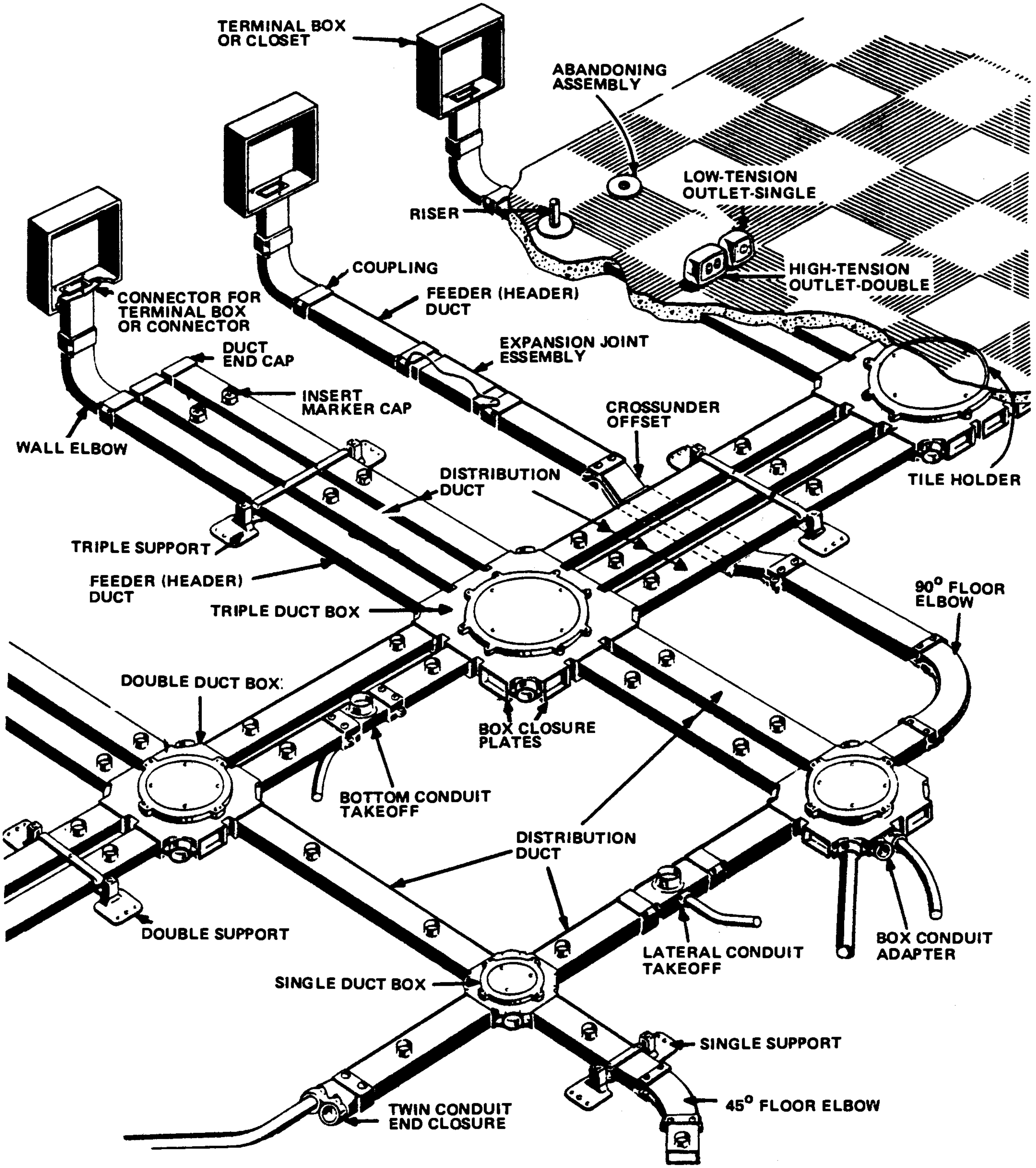


Figure 3-1. Single-Level Duct System.

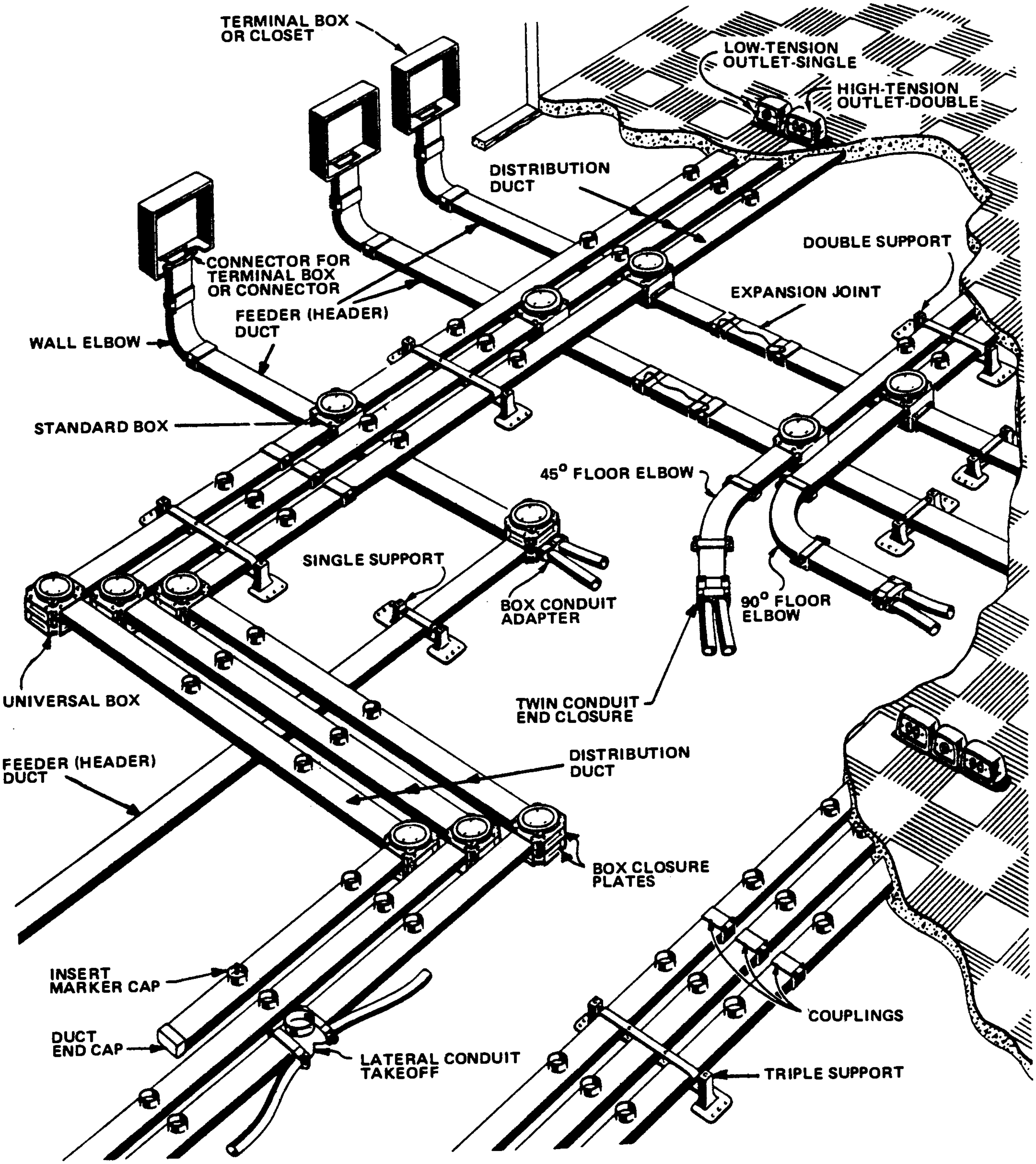
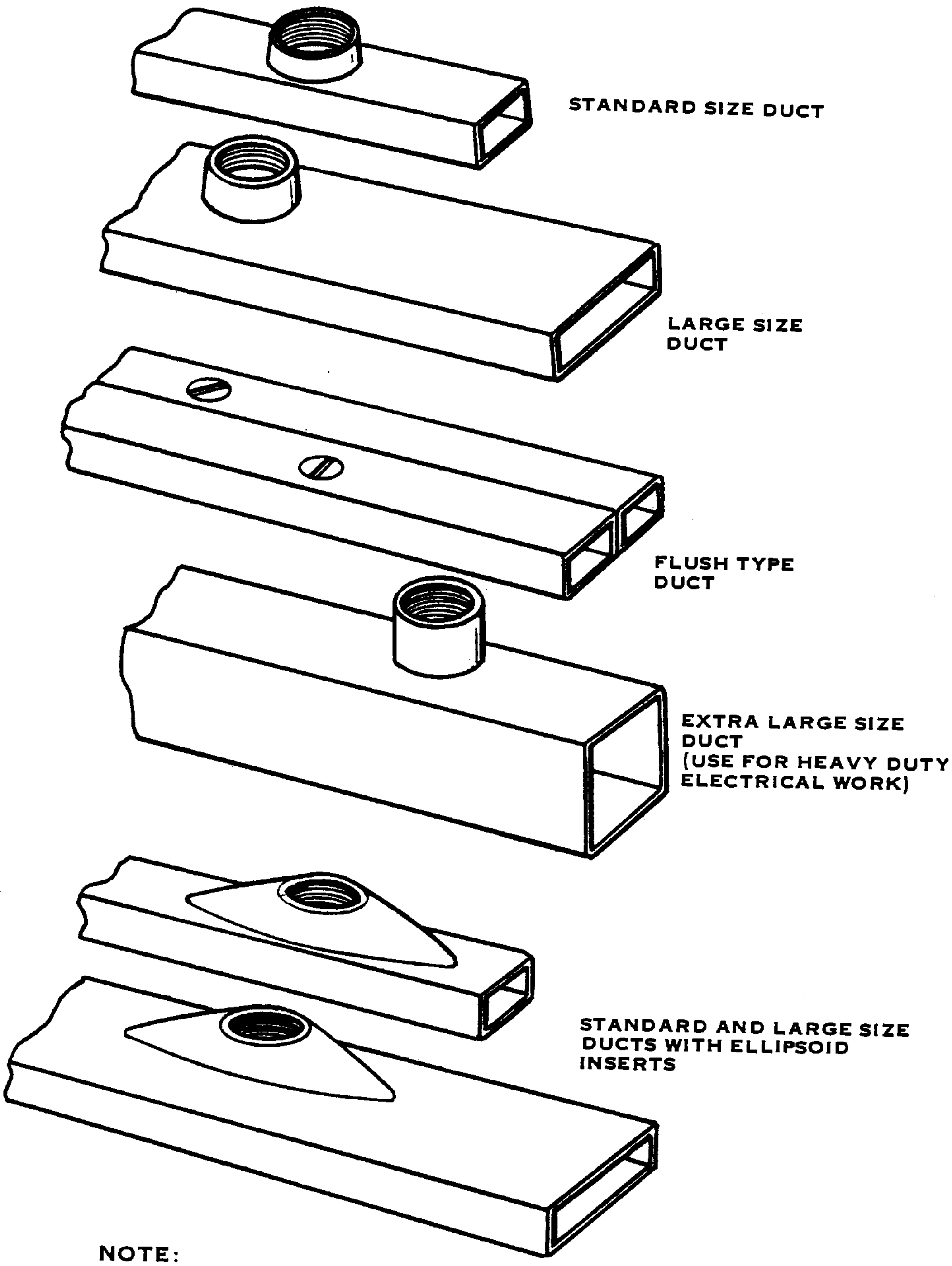


Figure 3-2. Two-Level Duct System.



NOTE:
THE DUCTS SHOWN ARE ALL AVAILABLE WITHOUT INSERTS SO THAT THEY MAY ALSO BE USED AS FEEDER DUCTS.

Figure 3-3. Distribution Ducts.

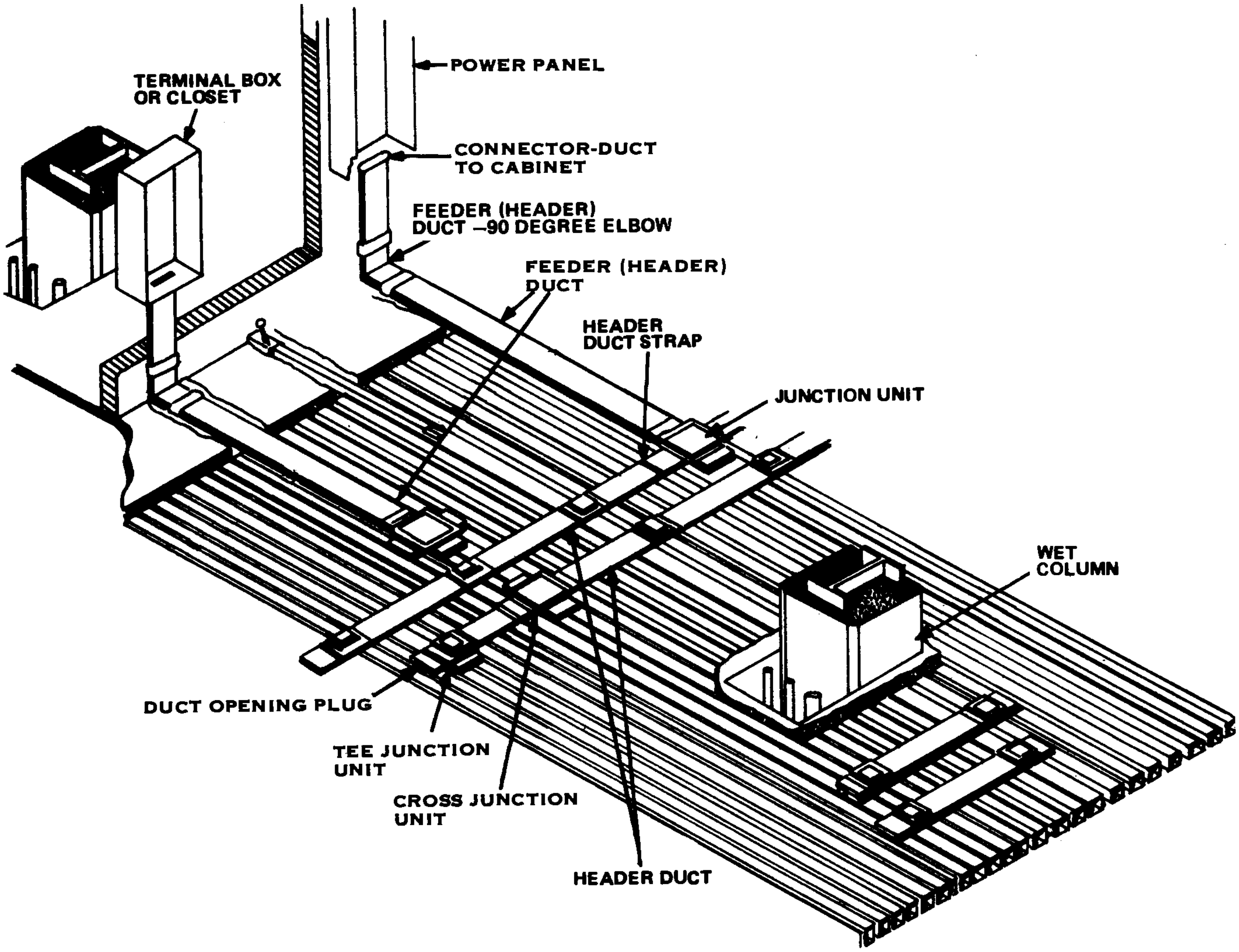


Figure 3-4. Cellular Floor System Layout.

(a) It is possible to lay large cables or large quantities of smaller cables in place.

(b) In new installations, cables can be placed significantly faster than with other systems.

4.07 The disadvantages of a trench feeder are as follows:

(a) The trench feeder is difficult to level with surrounding floor area. It is very predominant when placed between beams on a cellular metal floor and where the deck sags during the concrete pour.

(b) The cracks along the side of the covers permit dirt, wax, etc to enter making the cover difficult to remove.

(c) The fastening down screws often used to pull the cover down and to make it level also cause warping. The screws are often not replaced when the cover is removed and reinstalled.

(d) Wide covers provide a springy sensation when walking on them.

(e) It acts as a sounding board.

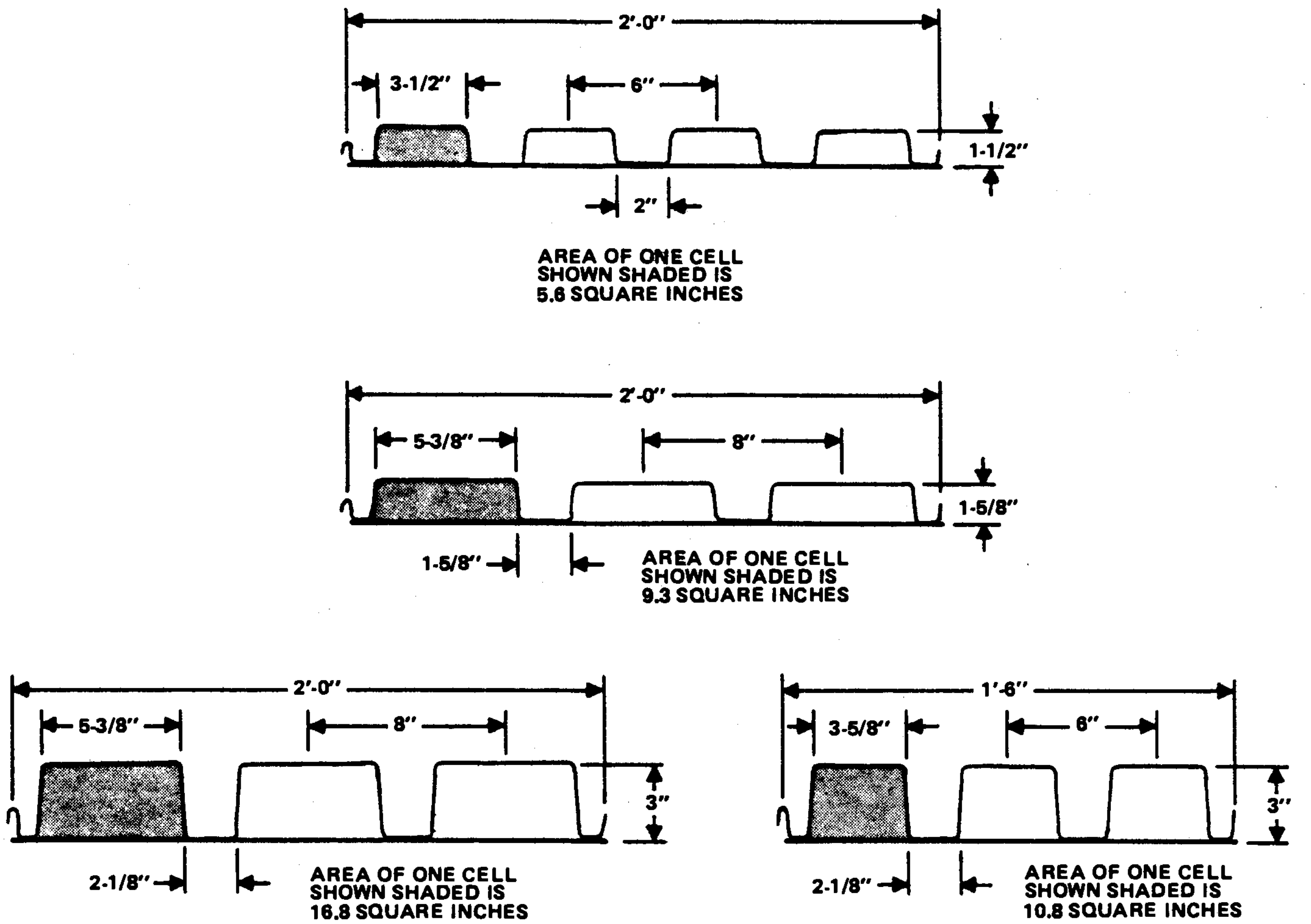
(f) When all the covers are removed, it is a hazard or inconvenience to customers.

(g) It is a problem to remove covers when they are covered with carpets.

(h) Usually more expensive to install than an express header system.

(i) Floor tiles chip, crack or come off the covers.

(j) It is very difficult to fish unless it is provided with compartments 6 to 8 inches wide.



NOTE:

OVERALL WIDTHS AND CELL SPACINGS ARE STANDARD. PROFILE DIMENSIONS MAY VARY SLIGHTLY, DEPENDING ON THE MANUFACTURER.

Figure 3-5. Commonly Used Cellular Floor Decks.

5. UNLIMITED ACCESS FLOOR

5.01 Unlimited access floor is a floor superimposed upon an existing area, providing unlimited accessible space under the floor. This is also called a raised floor. It has long been used for computer rooms and office space. The floor consists of a series of square modules of die-cast aluminum plates interlocking into and resting upon cast aluminum locking pedestals, with substantial steel footings resting upon the subfloor. Each plate provides an 18-1/4 inch square module and can contain an 18-inch by 18-inch tile or be covered with carpeting (Figure 3-7).

5.02 The advantages of the unlimited access (raised) floor system are as follows:

(a) The advantages of the underfloor duct system.

(b) The advantages of the cellular floor system.

(c) It is completely flexible and convenient. The cable can be laid in or fished into place and dedicated to a specific area.

(d) It is aesthetically acceptable to general office decor.

(e) It is safe and not time consuming during installations.

(f) It provides a capacity that is more than adequate for present and future needs.

(g) There is total accessibility across the entire floor.

(h) The floor can be compartmentalized for fireproofing purposes.

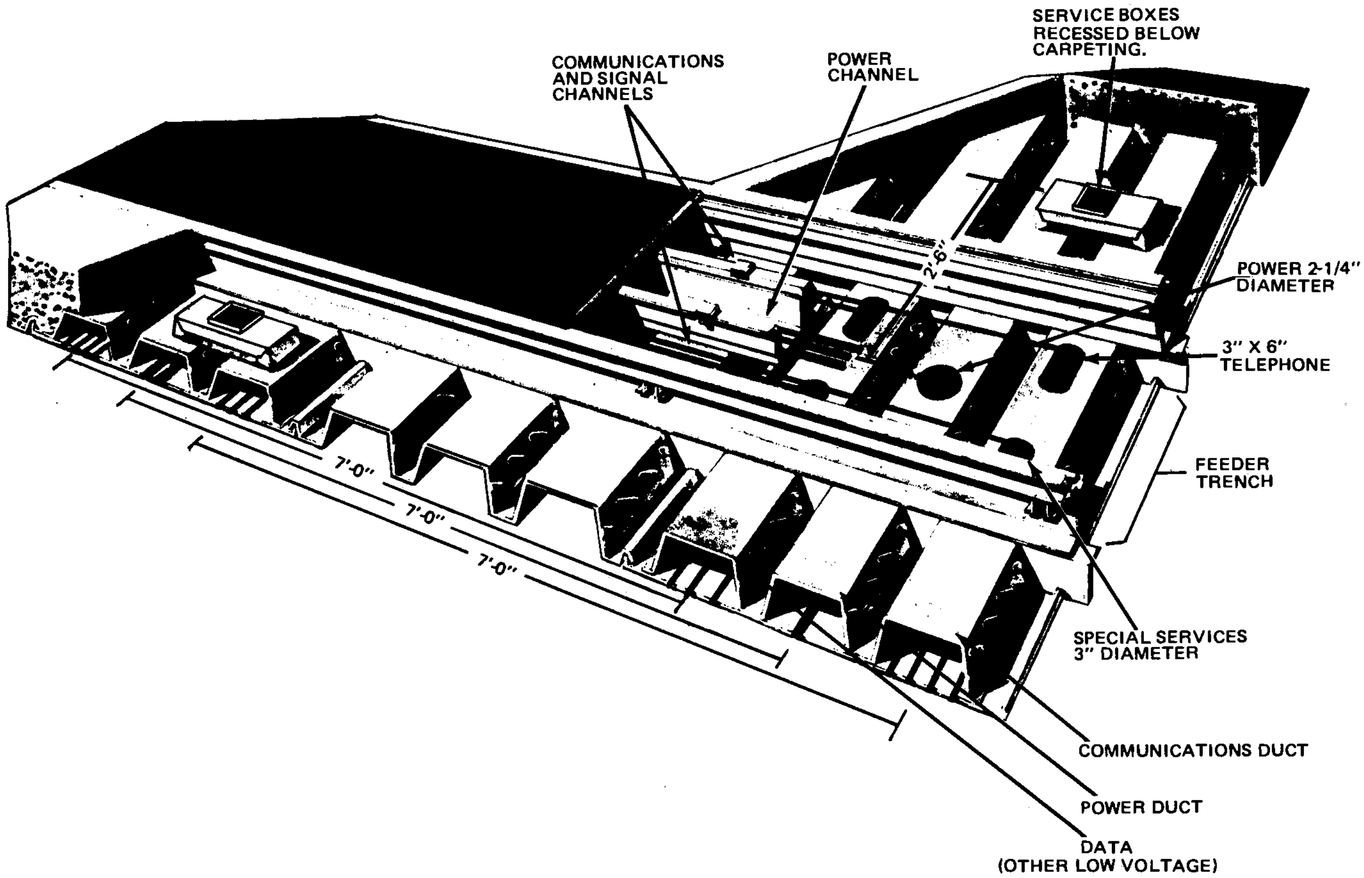


Figure 3-6. Trench Header Duct with a Cellular Floor System.

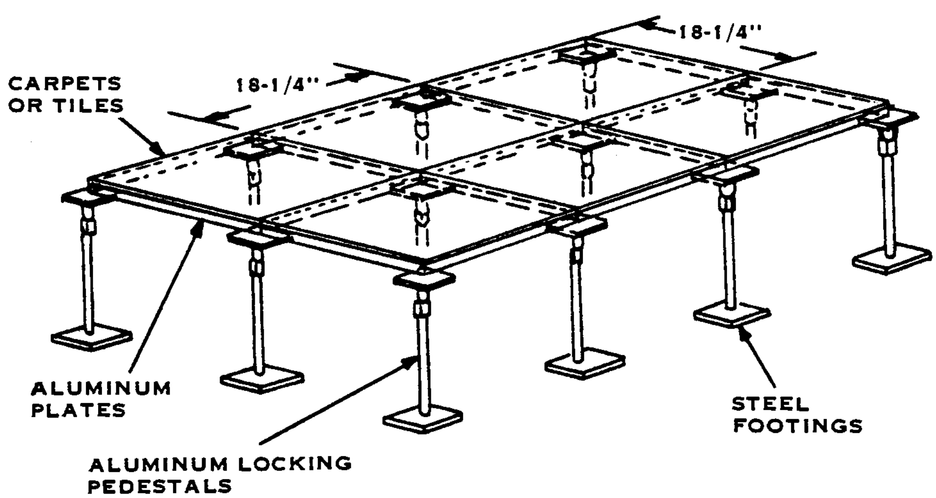


Figure 3-7. Unlimited Access Floor.

5.03 The disadvantages of the unlimited access floor system are the sounding board effect and the initial cost. The cost can be delayed until the initial tenant occupies the space. The initial cost may be higher than the other systems.

6. CEILING DISTRIBUTION SYSTEMS

6.01 There are three types of ceiling distribution systems:

(a) Poke-through.
(b) Zone distribution using conduit.
(c) Grid distribution.

Poke-Through System

6.02 In the poke-through system, the cables or wires are placed within the ceiling space and are poked up through the fire-resistant floor structure to the office above. This system is not recommended, and all efforts should be made to discourage its use.

6.03 The poke-through system has disadvantages to the telephone company and to the building owner or tenant. The disadvantages are as follows:

(a) To the telephone company:

- (1) Additional time is required in coordinating with structural engineers to select locations for holes.
- (2) There may be an inability to penetrate the floors in certain areas such as over beams, column caps, etc.
- (3) Occupants on the lower floor may refuse to allow disturbance by workmen who are providing service to tenants on the floor above.

(b) To the building owner and/or tenant.

- (1) Cost of both the hole and the afterset fitting.
- (2) Structural damage is caused by drilling the holes.
- (3) Passage of liquids, gases, dirt, etc to floors below and into the air conditioning system.
- (4) Expenses of removing and replacing ceiling tiles, overtime work, and drilling holes.
- (5) Possibility of having exposed cables in locations where drilling is not possible.
- (6) Service interruptions.
- (7) Disruption of employees due to noise of core drilling and/or telephone company employees working over desks on stepladders, etc.
- (8) Potential accident hazards during the work.
- (9) The holes can act as a chimney for any gases or odors especially in the case of a fire.
- (10) There is a reduction in the fire-resistant qualities of the floor.
- (11) The holes can allow drainage of water, etc, onto lower floor areas during fire-fighting operations on upper floors.

Zone Distribution

6.04 In a zone distribution system, the cables and wires are placed in conduit within the ceiling space and are brought down to the terminal locations using utility poles or conduits to receptacle boxes. Figure 3-8 shows a typical zone distribution system. This system is recommended under the following conditions:

(a) The opening and closing of the ceiling is the responsibility of the building owner or tenant.
(b) The building owner or tenant shall be fully responsible for all damage, injury and inconvenience to parties that may result.

6.05 Some advantages of a ceiling distribution system are as follows:

(a) It provides an alternative method of concealing the majority of wiring.
(b) For the most part, the initial cost of a ceiling system can be delayed until the floor space is rented.
(c) It provides a flexible means of distributing the cables and wires to desk locations and avoids exposed wire.
(d) Cable lengths are kept to a minimum.
(e) Cable can be dedicated to serve a specific floor area and reused time and time again.
(f) A telephone set can be relocated short distances without replacing cables.

(g) When 3 inches of clear space is provided between electrical and mechanical services and the T rails, there is adequate space to place wires and cables throughout the floor area.
(h) When the zone system is used, additional wires and cables can be easily placed with a minimum of inconvenience.
(i) The initial cables and wire requirements can be quickly and easily placed to approximate locations before a ceiling is installed.

6.06 Some disadvantages of a ceiling distribution system are as follows:

(a) There is sometimes inadequate clearance (less than 3 inches) under air conditioning ducts, electrical boxes, lighting fixtures, or over some types of luminous ceilings.
(b) Complete inaccessibility over plaster or spline ceilings and sealed air plenums.
(c) It lends itself to wire tapping and bugging of the area.
(d) Noise interference can be picked up from electrical fixtures or wiring.
(e) There is a possibility of electrical hazards.
(f) There is a possibility of interruption of telephone service caused by other tradesmen working in the ceiling area.
(g) There is a possibility of forced future relocation.
(h) The aesthetics of an office may be affected by a required utility pole.
(i) Damage to the ceiling is possible due to movement of utility poles. The repair of the ceiling may cause a patchwork effect in the ceiling.
(j) Ceiling tiles may droop due to the weight of the cables.
(k) The occupant must provide workmen to remove ceiling tiles when requested. This causes delays in servicing.
(l) Dirt and debris may be deposited on surrounding furniture during the removal/replacing procedure for ceiling tiles.
(m) There is an accident hazard and work interruption to surrounding office employees when workmen are working on ladders during normal working hours.
(n) There may be a loss in telephone company time waiting for ceilings to be opened by the owner.

Grid System

6.07 A ceiling grid system is similar to an underfloor distribution system in that it consists of header ducts and distribution ducts mounted in the ceiling space. Figure 3-9 shows a ceiling grid system. The wires or cables are brought down from the distribution ducts by using telephone takeoff fittings and utility poles or conduits.

6.08 The wires or cables can be laid into this duct with removal of the ceiling tiles; and they can be fished through the duct if and when desired, such as across nonremovable ceiling areas. A completely accessible system can be more efficiently used than a sealed system such as floor duct because virtually any point of interference, congestion, etc., along the raceway can be located, accessed, and rectified at anytime.

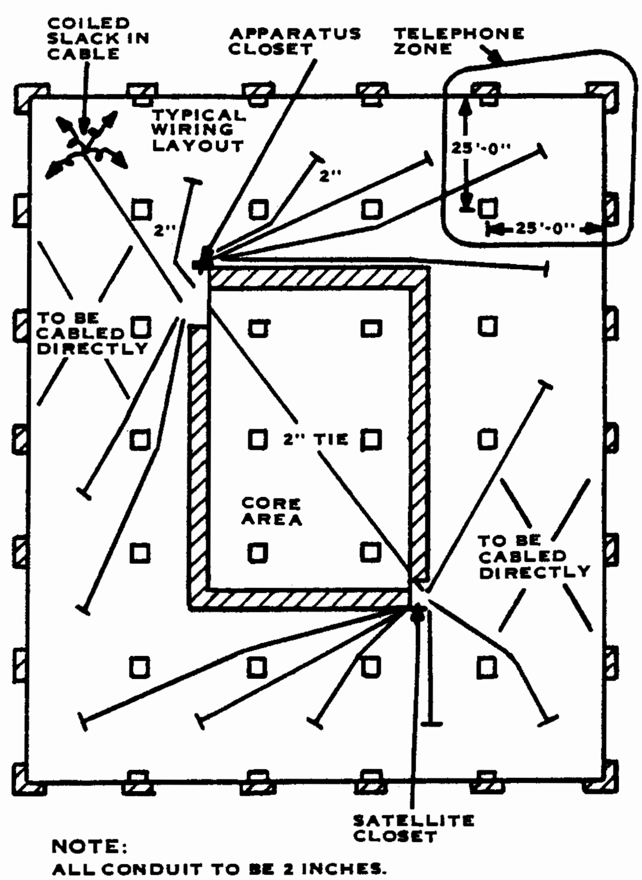


Figure 3-8. Ceiling Distribution System.

7. MISCELLANEOUS SYSTEMS

Underfloor Conduit

7.01 An underfloor conduit system consists of a number of conduits radiating from an apparatus or satellite closet to potential telephone locations in the floor, walls, or columns of a building as shown in Figure 3-10. If a sufficient number of outlets are installed at frequent intervals, the underfloor conduit system will furnish a suitable housing arrangement for relatively small buildings having need for few telephones in the open room spaces. To provide for adequate wiring capacity, the conduit that extends from the terminal or closet generally should not serve more than three outlets in offices, stores, exhibition rooms, markets, etc. Since business services are usually connected to a key telephone system, conduit for the inside wiring cable from the key telephone apparatus equipment to the potential key telephone should be recommended.

7.02 The advantage of an underfloor conduit system is the low initial cost for areas of low station density, particularly where the station locations are definitely established as in markets, information desks, etc.

7.03 The disadvantage of an underfloor conduit system is its limited flexibility. If the desks or tables are not located over floor outlets or adjacent to wall outlets, exposed wiring will be required from the outlet to the desk or table.

"Peirce Wye" Conduit System

7.04 The "Peirce Wye" conduit system is recommended for postwiring various types of buildings to preselected locations. The type of building is

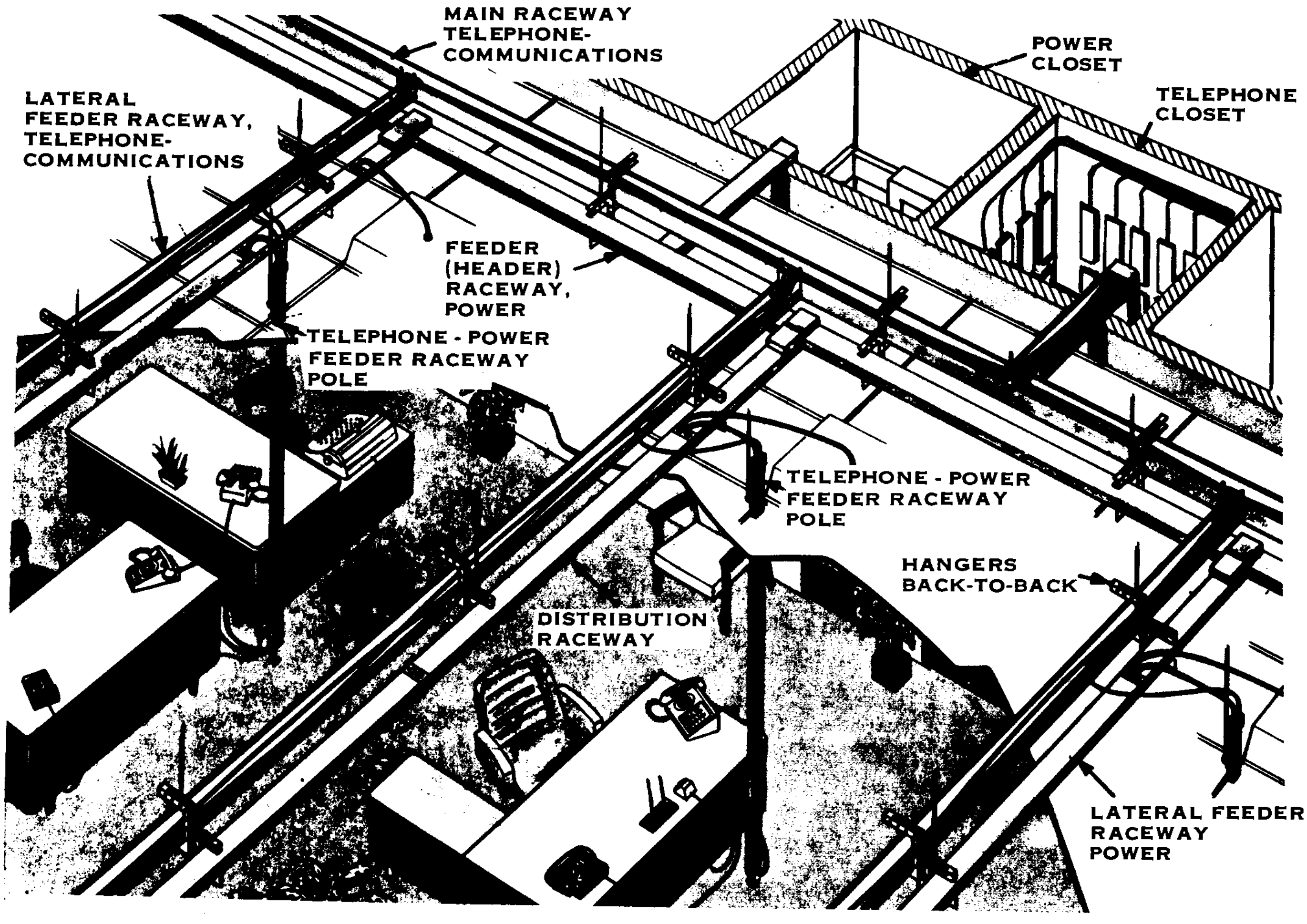


Figure 3-9. Ceiling Grid Distribution System.

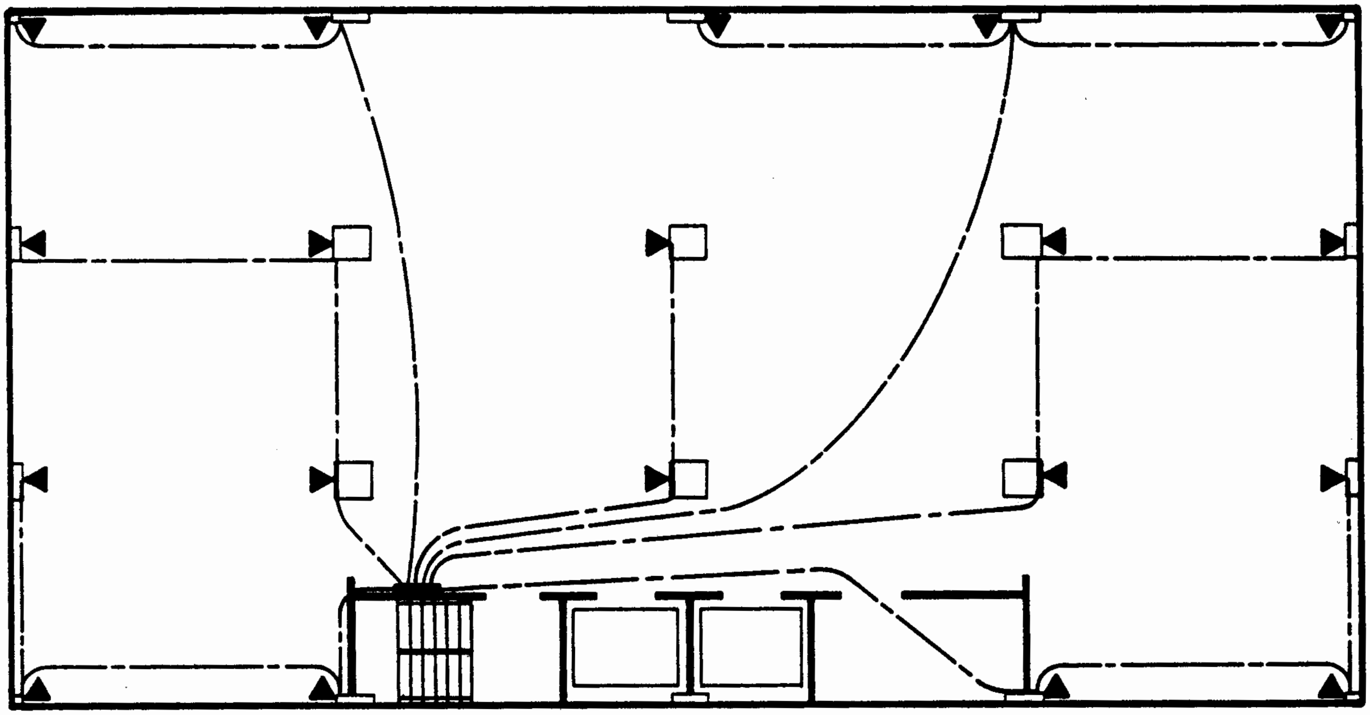


Figure 3-10. Underfloor Conduit System.

particularly the slab-on-grade type of construction used for motels, townhouses, apartments, small shopping centers, and industrial malls. This conduit system may also be used to serve trailer parks and permanent marinas. Figure 3-11 shows the "Peirce Wye" system.

7.05 A Wye coupling is employed in lieu of a pull box to permit one-way wiring to a common termination point. It eliminates looping of wiring which results in savings to the owner and telephone company. It also saves encroachment on the premises of other customers on maintenance calls.

Perimeter Raceway

7.06 Perimeter raceways (either communication or combination communication and commercial power) can be placed around the perimeter of rooms or offices, provided that all telephones can be served from the wall areas. This system is designed for small offices or commercial work areas. Figure 3-12 shows a perimeter raceway system. The raceway may be mounted either at baseboard height or at desk height.

8. DESIGN PROCEDURES

8.01 This part provides design information for various possible designs for the same floor plan. Figure 3-13 shows one-half of the floor plan of the sample building.

Underfloor Duct

8.02 Figure 3-14 shows a possible design of an underfloor duct distribution system for the sample building. The procedure for designing this system is explained in the following paragraphs.

8.03 An underfloor duct system is designed as follows.

(a) Calculate the total usable floor area.
(b) Divide the area by 100 to obtain the required total cross-sectional area in square inches of the feeder ducts required for the floor.
(c) Divide the total required duct cross-sectional area by the cross-sectional area of one feeder duct to obtain the required minimum number of feeder ducts. More feeder ducts may be required depending on the configu-

ration of the floor plan and the location of the closet.

(d) Select a distribution duct spacing. The general rule is to run the distribution ducts parallel to the longest axis of the building. In the majority of the cases, this is the most economical layout. The ducts should fall between the module lines. The normal spacing is at 5-6 foot intervals. A distribution duct is usually placed 12 to 18 inches from the outside walls.

(e) Divide the floor area into zones. A zone should be in the range of 5,000 to 10,000 square feet.

(f) Divide the zones into strips equal in width to the spacing of the distribution ducts.

(g) Compute the allowable length of the distribution duct based on the general rule of 1 square inch of cross sectional duct area per 100 square feet of usable space.

$$\frac{100 \times \text{area of 1 duct}}{\text{spacing of ducts}} = \text{allowable length of duct}$$

(h) If the allowable length is less than the distance from the end of the distribution duct to the feeder duct, the design is substandard. In Figure 3-14, it can be seen that the length to the right of the closets requires that the large 9-inch duct be used, and that this is within the standard.

8.04 The feeder ducts are allocated to the distribution ducts as follows:

(a) Write down the number of feeder ducts required to serve that floor area.

(b) Write down the number of distribution ducts to be served.

(c) The solution rests with using a high common denominator so that the resultants are either: 1 to 1, 1 to 2, 1 to 3, 2 to 3, or as a last resort, 3 to 4.

(d) If the resultant does not meet the above, deduct 1, 2, or 3 from the number of distribution ducts (step b), and then repeat step c. In this case, the ducts deducted shall be treated as a separate unit served by additional feeder(s).

(e) In some cases, it may be necessary to round off the number of feeder ducts (step a) to an even number.

(f) If the number of feeder and distribution ducts are nearly equal, it is usually more economical to increase the number of required feeder ducts so that they are equal.

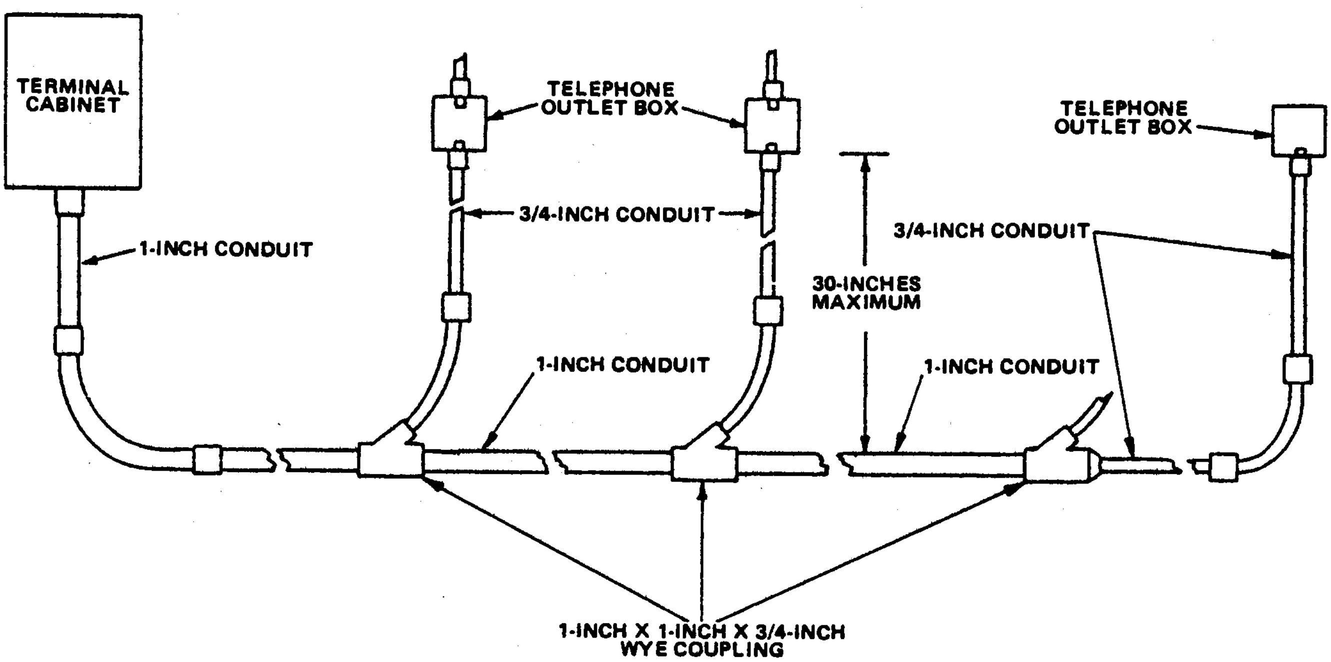


Figure 3-11. "Peirce Wye" Conduit System.

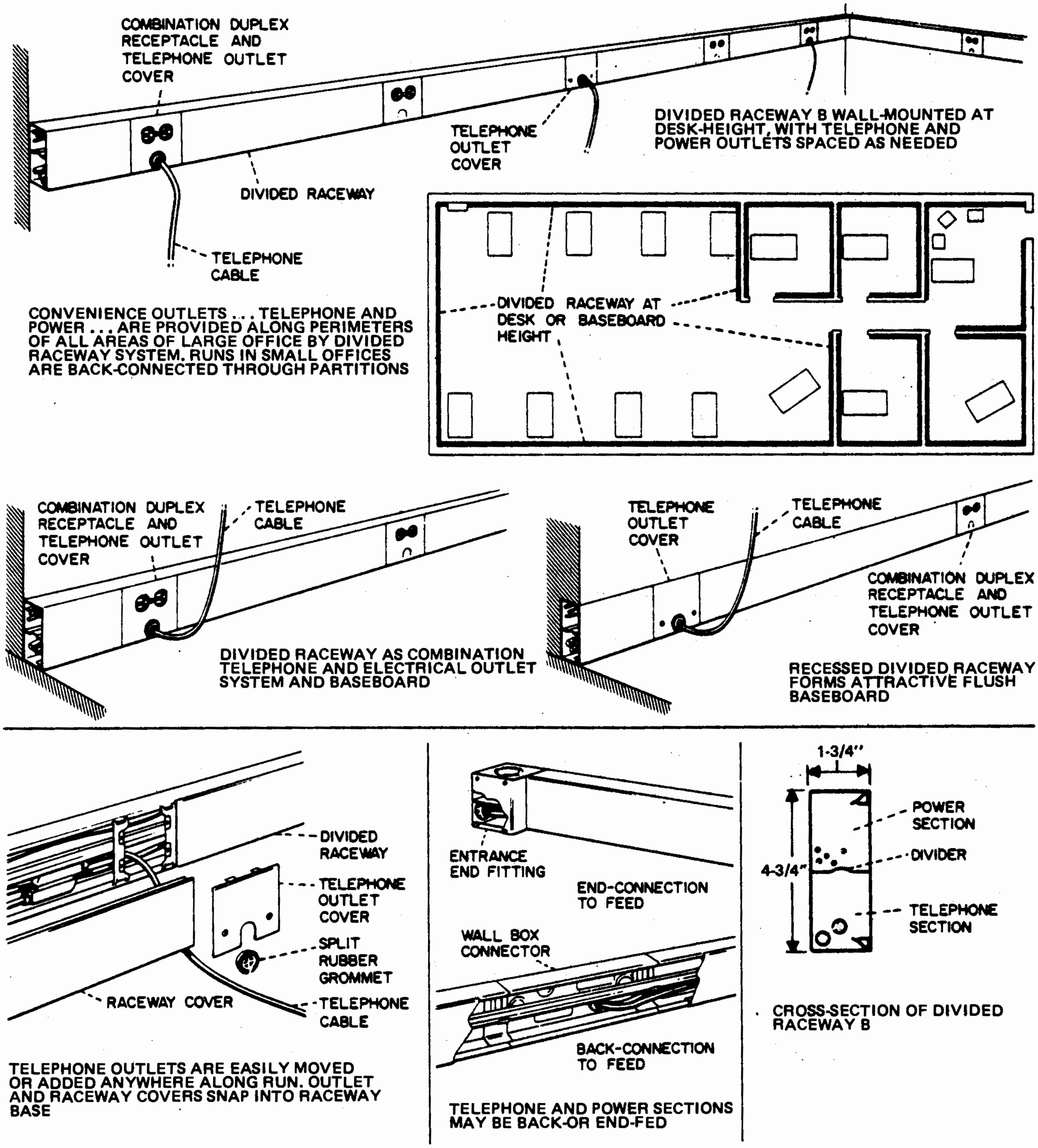


Figure 3-12. Perimeter Raceway System.

(g) Where the number of feeders is greater than the number of distribution ducts, perform the following:

(1) Provide one or two feeders to serve each distribution duct.

(2) Allocate the remainder as in steps c, d and e.

8.05 The inserts can be either preset or afterset. The inserts should be a nominal 2 inches inside diameter with a recommended height of 1 inch. Normally, it is more economical to use preset inserts. Insert spacing should be simple divisions of the building module. Consider a 5-foot module spacing, where the insert spacing could be 60/2 = 30-inch spacing (this is too long), 60/3 = 20-inch spacing (good), 60/4 = 15-inch spacing (better) or 60/5 = 12-inch spacing (very good but likely too expensive). Spacing of 15 to 20 inches is the recommended spacing with the inserts equidistant from the module lines.

8.06 Underfloor duct can be incorporated in the structural slab, or in the fill placed on top of the slab. If the duct system is incorporated into the fill, the fill must be 2-3/4 inches thick for a single-level system or 4-1/4 inches thick for a two-level system except where the feeder duct is depressed into the slab. When the duct is incorporated into the slab, the slab must be 5 inches thick for a single-level system or 7 inches thick for a two-level system unless the feeder beam concept is used.

8.07 The use of fill to enclose an underfloor system has the following advantages:

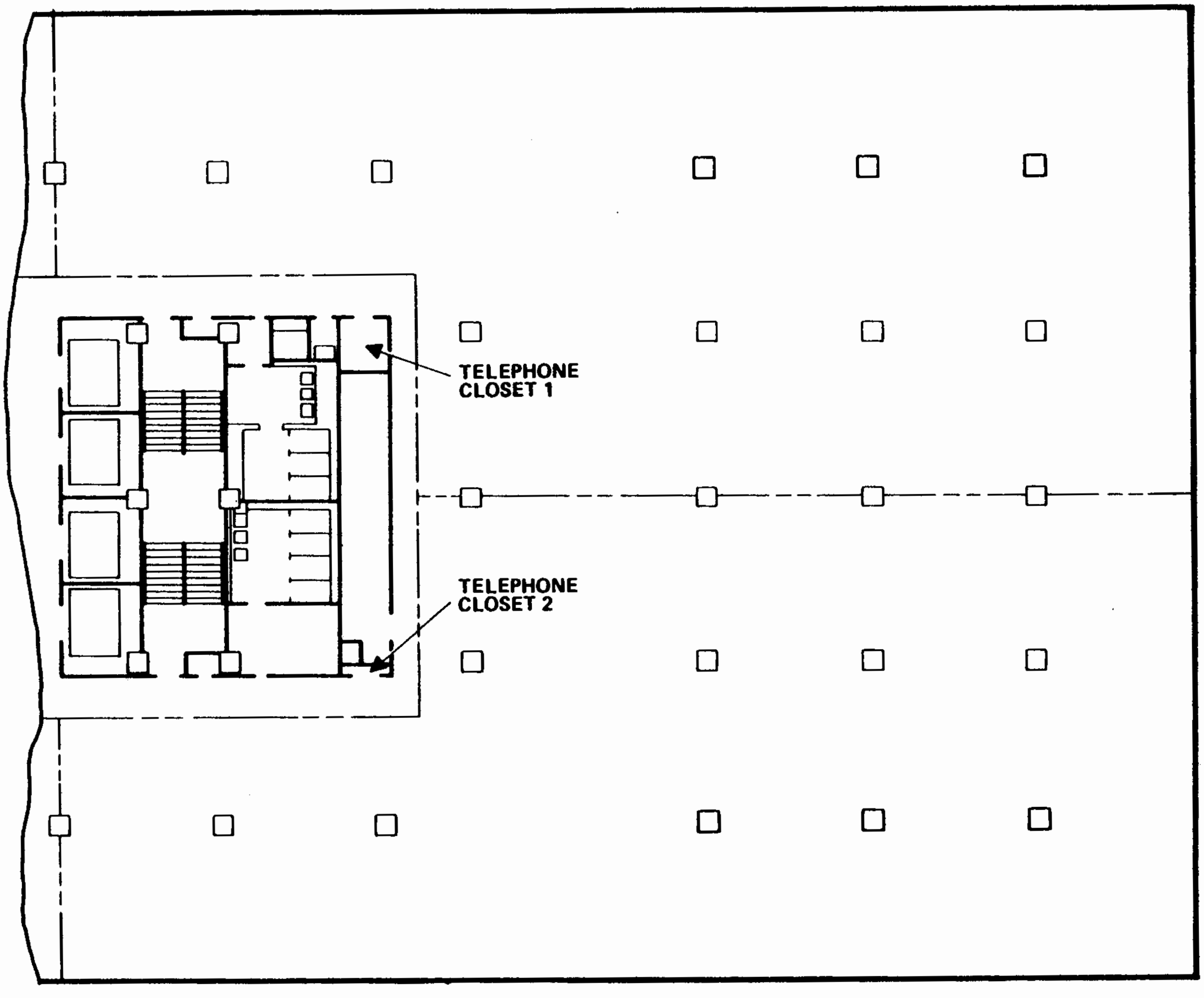


Figure 3-13. Sample Building Floor Plan (One-Half Floor).

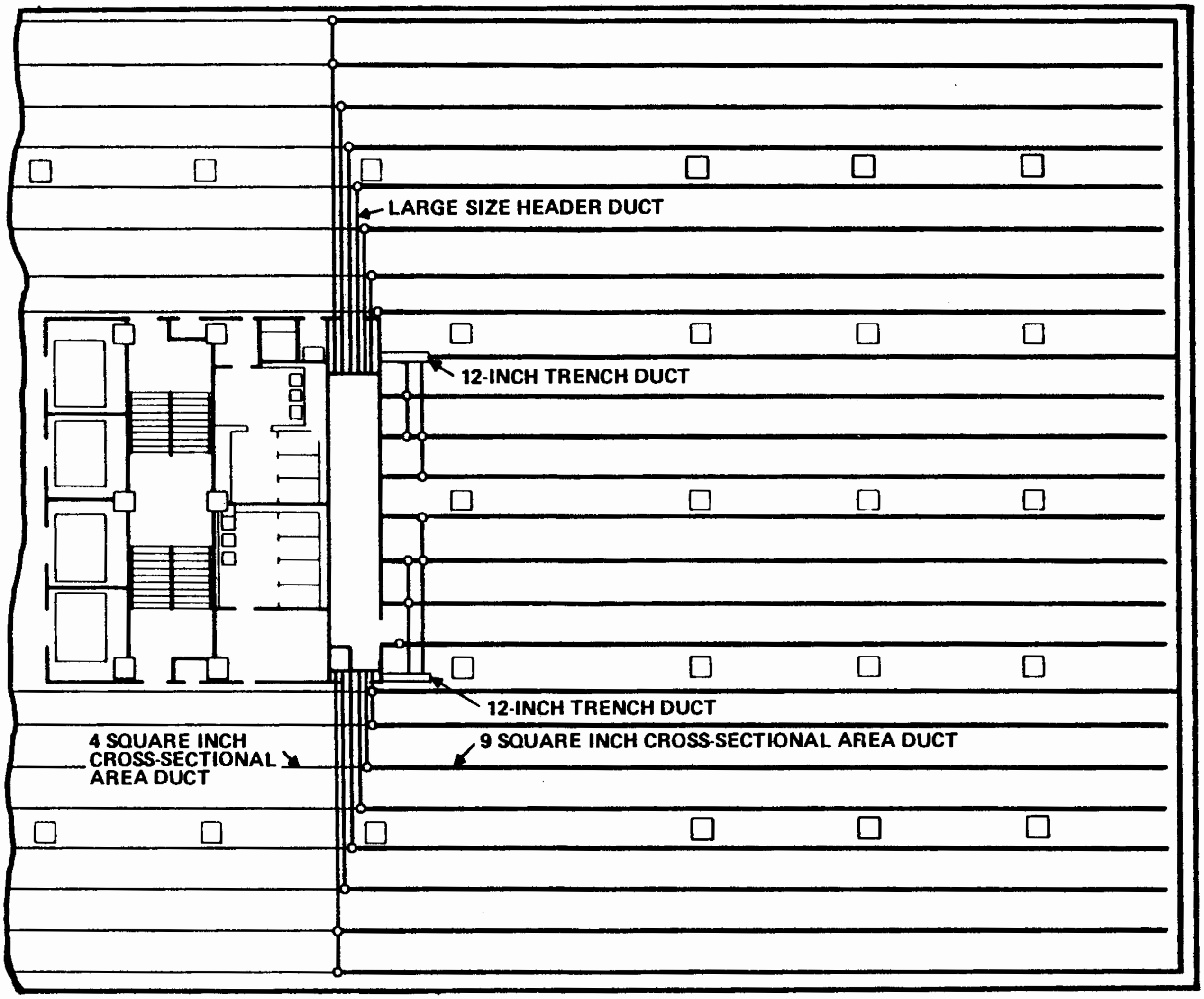


Figure 3-14. Typical Underfloor Duct System Design.

(a) The type of floor system used is independent of the underfloor system design.
(b) Ducts can be placed in any direction.
(c) The extra slab thickness adds to the fire resistance. The five-inch minimum thickness required for ducts probably will provide a two-hour fire-resistance rating.
(d) Many contractors prefer a fill to relieve them of close tolerances in finishing the slab. It also eliminates construction sequence difficulties.

8.08 The disadvantages of using a fill are as follows:

(a) Additional dead weight is added to the structure, increasing foundation loads.
(b) The additional material contributes nothing to the strength of the floor.
(c) The height of the building is increased because of additional floor thickness.
(d) Fill placement is an extra construction operation. An inch of fill costs more than an extra inch of monolithic construction. The cost of the wire mesh in the fill must be considered.

8.09 If the ducts can be included in the structural floor system, the weight of the structure is reduced and a shallower but stiffer floor system results at a lower cost.

Cellular Floor

8.10 The following paragraphs should assist the designer to exploit the attributes of a cellular floor system and achieve economy and flexibility.

8.11 Figure 3-15 shows a possible design of a cellular floor distribution system for the sample building.

8.12 The capacity requirements of both cells and headers for communications in a cellular floor system are the same as those for the underfloor duct systems.

8.13 A cellular steel floor has a multiple function:

(a) It serves as the structural floor.

(b) It provides the distribution ducts for communications systems and power.

The layout of the distribution system and the design of the structural floor and its supporting members are necessarily integrated. This multiple function leads to economy of total structure and the building.

8.14 The details of a structural approach and the economics to be derived have been studied. These studies have found that the capacity of the distribution systems required is one of the first decisions to be made. The capacity required is directly related to the building function. It is, therefore, a basic decision of the builder/owner.

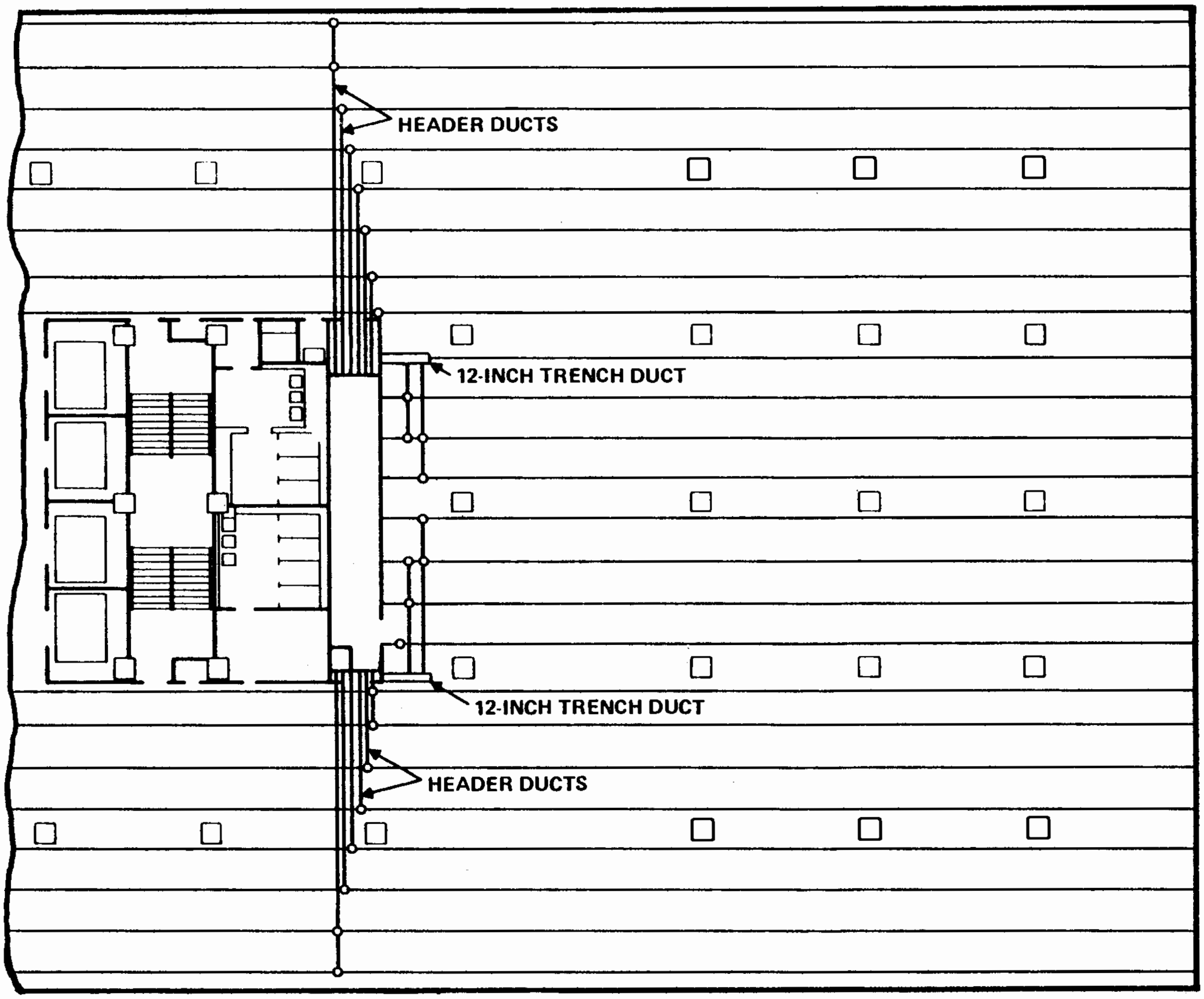


Figure 3-15. Typical Cellular Floor System Design.

8.15 When considering the use of the cellular steel floor, one of the two levels has been provided by the cells in the floor deck. It is only necessary to add the feeder ducts.

8.16 In the designing process, the structural engineer should carefully choose the location of the feeder ducts because they may jeopardize the structural system.

8.17 When designing a system, it is necessary to consider the following:

(a) The area of cell required.
(b) The size of the cells.
(c) The frequency and location of the cells.

Zone Ceiling Distribution

8.18 Figure 3-16 shows a possible design of a zone ceiling distribution system for the sample building.

8.19 A zone ceiling distribution system should be carefully planned by the architect, consulting engineer, and/or owner to allow for all the services to be placed within it.

8.20 The design should provide a suitable method for supporting telephone station cables from the terminal to each floor area zone.

8.21 The size and depth of structural beams, column caps, and mechanical services should be considered to obtain a minimum of 3 inches of clear vertical space for wires and cables. Cables should not be on or against any light fixture.

8.22 The ceiling tiles selected should be easily removable such as a lay-in type on single or double "T" rails. Locking-type ceiling tiles, which are not readily movable, will probably require a conduit system.

8.23 The "T" rails must be rigidly installed and braced to overcome movement in both the vertical and horizontal directions.

8.24 Where a false ceiling is used as an air plenum, no cable of a combustible nature may be used in this place without metallic raceway protection. Cables listed by a nationally recognized testing laboratory as having adequate fire resistance and low smoke-producing characteristics may be permitted by local codes.

8.25 The floor area to be defined as a telephone zone should normally consist of not more than 400 to 600 square feet, in order to limit the length of individual cables/conduits from the center of the zone to serve each desk location.

8.26 To feed the telephone zone, the building owner should be asked to install a continuous length of 2-inch conduit in the ceiling space, properly supported to permit the pulling in of cables. This conduit should extend from the nearest telephone closet or terminal and be terminated at the midpoint of each telephone zone.

8.27 For floor areas where the 2-inch conduit to the telephone zones is not available, and where a number of inside wiring cables are to be placed loosely in the ceiling, adequate cable trays or open-top cable supports (J-hooks) are required. These J-hooks shall be located on 5-foot centers and must be provided by the building owner to avoid damage to the ceilings because of the cable weight.

8.28 If no supporting structures can be obtained, the cables can be placed directly on the "T" bars providing that they do not exceed the following:

(a) Inside wires and cables not exceeding a total of 500 pairs may be placed within a 4-foot section of the ceiling "T" bars.
(b) Inside wires and cables should be placed as close as possible to the hangar wires.

Grid Distribution

8.29 Figure 3-17 shows a possible design of a ceiling grid distribution system for the building.

8.30 A grid system is designed as follows:

(a) The location of the distribution ducts should be determined and spaced approximately 20 feet apart and parallel to the closets.
(b) Calculate the floor area to be served by each run of distribution duct. Spacing times the distance of the run equals floor area served.
(c) Compute the allowable length of the distribution duct based on the requirement of 1/2 square inch of cross-sectional area of duct per 100 square feet of usable space.

$$\frac{200 \times \text{area of duct}}{\text{spacing of ducts}} = \text{allowable length of duct}$$

NOTE: A reenterable overhead raceway of 16 square inches of cross-sectional area will serve at lease 3,200 square feet of usable floor area because it can contain at least 32 of the standard 25-pair station cables.

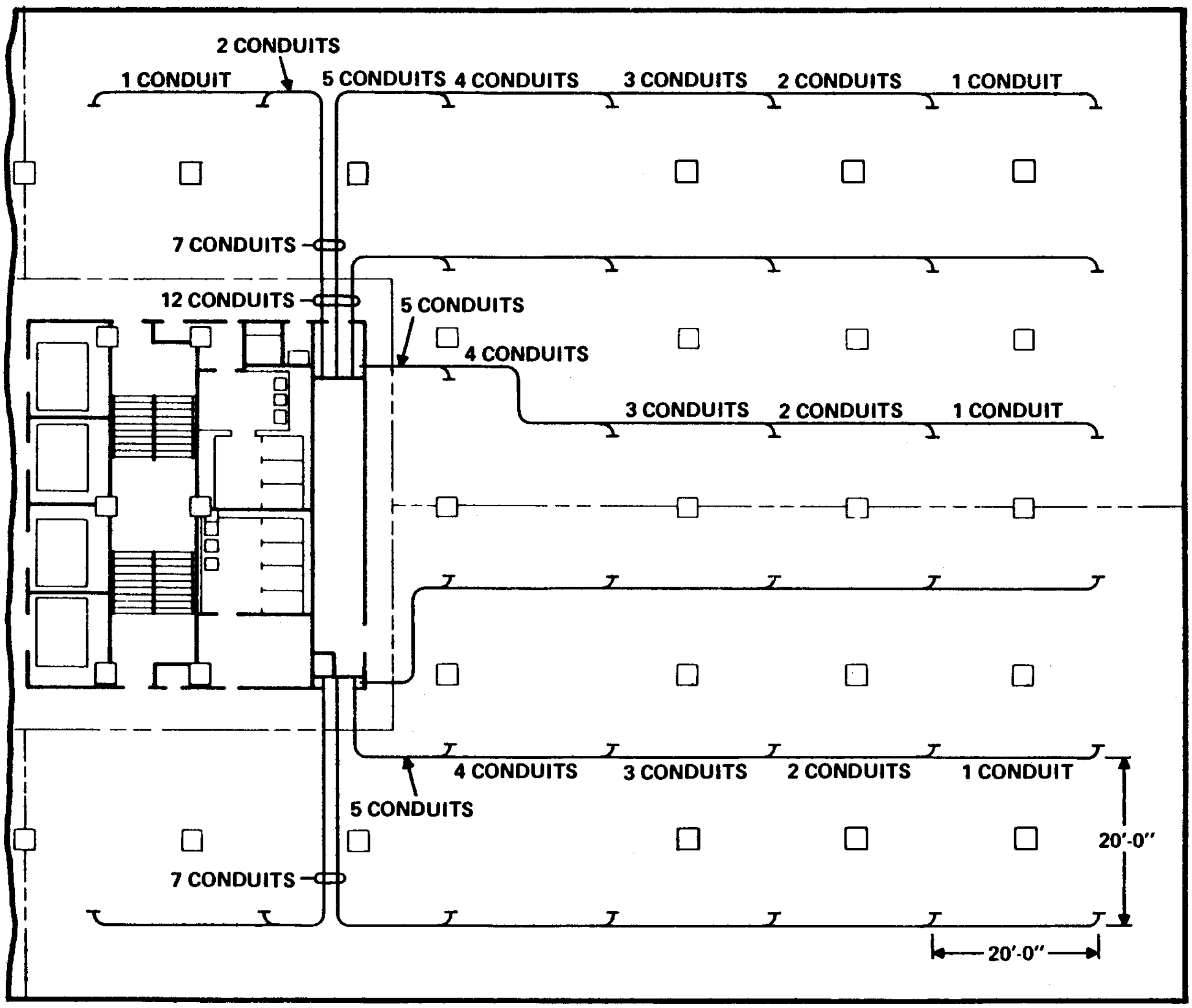
(d) Select the floor area to be served directly from the closet, and calculate the floor area.

(e) Determine the number of feeder ducts required to serve the area.

$$\frac{\text{floor area}}{\text{area of duct} \times 200} = \text{number of feeder ducts required}$$

(f) Allocate the feeder ducts with the distribution ducts in a 1:1, 1:2, 1:3, or 1:4 ratio as required to efficiently match their capacities.

(g) Note that individual cables/conduits are necessary from the distribution duct to the top of each utility pole or partition wall as required.



NOTE:
ALL CONDUIT IS 2-INCH DIAMETER.

Figure 3-16. Typical Ceiling Zone Distribution System Design.

Conduit

8.31 All conduits should be rigidly installed, adequately supported, and properly reamed at both ends. Sections of conduit should be joined with approved couplings and conduit terminations in outlet boxes, pull boxes, etc., should be made with approved fittings.

8.32 Terminate metallic conduits using insulated metallic bushings.

8.33 The conduits should be run in the shortest straight runs whenever possible. Usually, they should be placed parallel to building bay lines. No section of conduit should run longer than 100 feet or contain more than two 90-degree bends unless pull boxes are placed.

8.34 When a conduit run is more than 100 feet or contains more than two 90-degree bends or contains a reverse bend, pull boxes shall be provided and installed.

8.35 Bends in conduits, and particularly in conduits larger than 2 inches in diameter, should be long sweep radius bends whenever it is possible and practical. However, in no instance should the inside radius of a bend be less than six times the internal diameter of the conduit. For conduits 2-1/2 inches and larger, when it is known that cables with a combination steel tape or lead sheath may be placed in them, the bend should be 10 times the internal diameter.

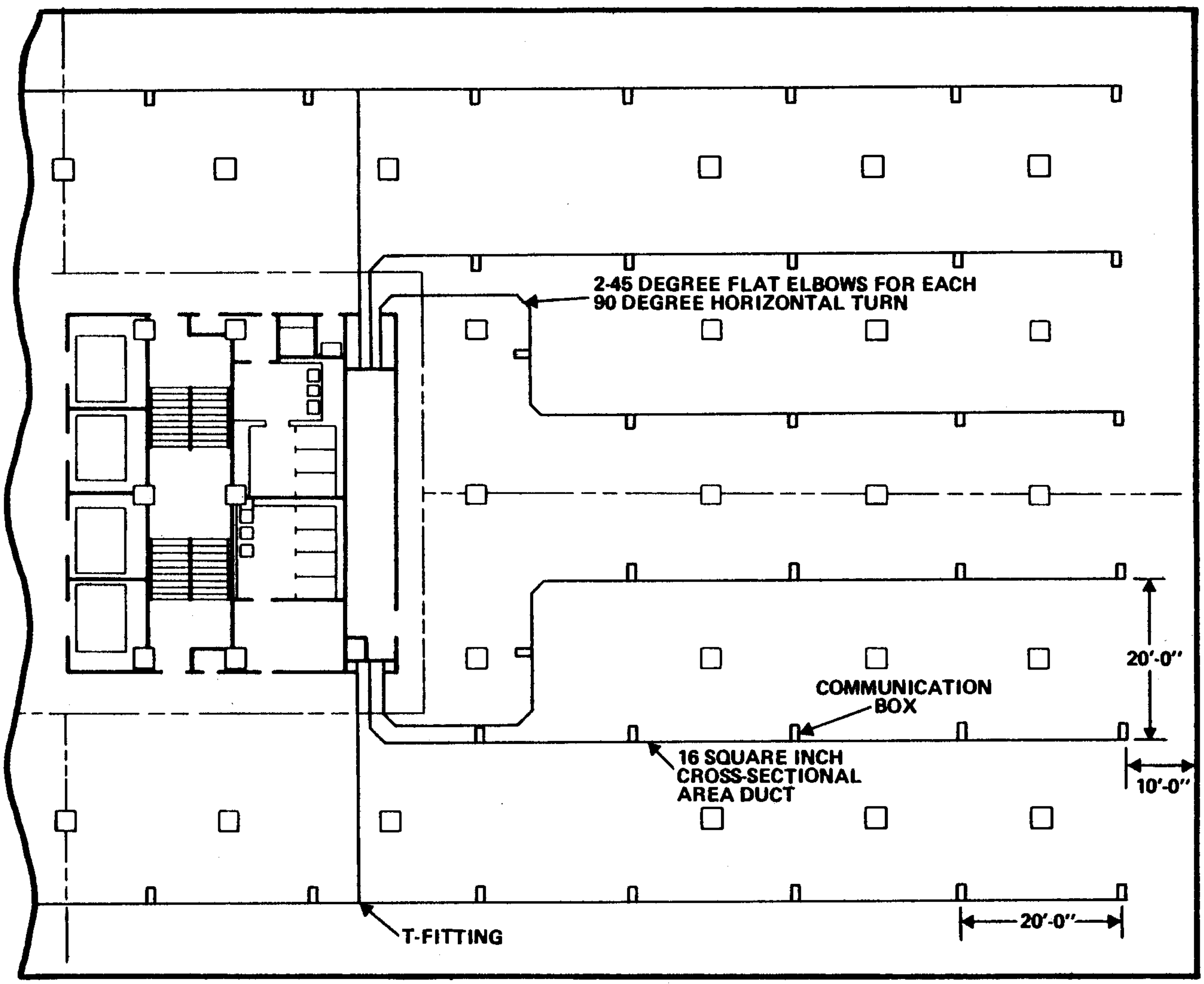


Figure 3-17. Typical Ceiling Raceway Distribution System Design.

8.36 Consider accepting a third bend in the conduit without derating the capacity providing the following conditions exist:

(a) The run is not too long.
(b) One of the bends must be located within 3 feet of the end where the cable reel will be set up.

This can only be considered when a cable-placing operation can be used by pushing the cable into and around the first bend while pulling the cable around the other two bends.

8.37 Aluminum conduit should not be used in sizes greater than 2 inches.

8.38 PVC conduit should not be placed in the floor slab.

8.39 Conduits shall not be placed on top of activated cells of a cellular floor nor run crosswise to the cells.

8.40 Conduits entering telephone closets should have bushings and should terminate as close as possible near the wall through which the conduits enter. Where possible, the ceiling level should be higher than that of the office space, thereby eliminating a bend in the conduit.

8.41 A pull wire equivalent to No. 12 AWG shall be left in all conduit runs exceeding 100 feet in total length.

8.42 Conduits should not be placed over or run adjacent to boilers, incinerators, hot water and steam lines, and through areas in which flammable material may be stored.

9. MISCELLANEOUS DATA

9.01 For the approximate size of available raceways under the floor and the "design fill" of wires or cables recommended to be placed in them, refer to Table 3-1. It is important to note that the practical capacity of a duct is much less than the perfect fill capacity. This is due to the following:

(a) The cables are usually pulled in one at a time, and since the helix is not normally removed from the cable, they will wrap around each other.
(b) It is difficult to place cables and wire when the depth of the concrete over the duct or cell is greater than 2 inches.
(c) The size of the opening or junction box may not permit adequate access to the duct.

In no case is the cross-sectional area of all conductors or cables to exceed 40 percent of the cross-sectional area of the raceway, be it a duct, a cell, or a header.

Conduit Capacities

9.02 A numerical relationship exists between conduit diameter and the number of cables that can be pulled into the conduit. The design fill of a conduit should not be more than 50 percent of perfect fill. Table 3-2 summarizes the capacities of conduits using recommended capacities based on the National Electrical Code (1978). This table also shows the maximum percentage fill of a conduit for one or more cables. Table 3-3 shows the diameter and cross-sectional area of various sizes of cables. Figure 3-18 is useful in determining conduit size when only one cable is anticipated in a conduit.

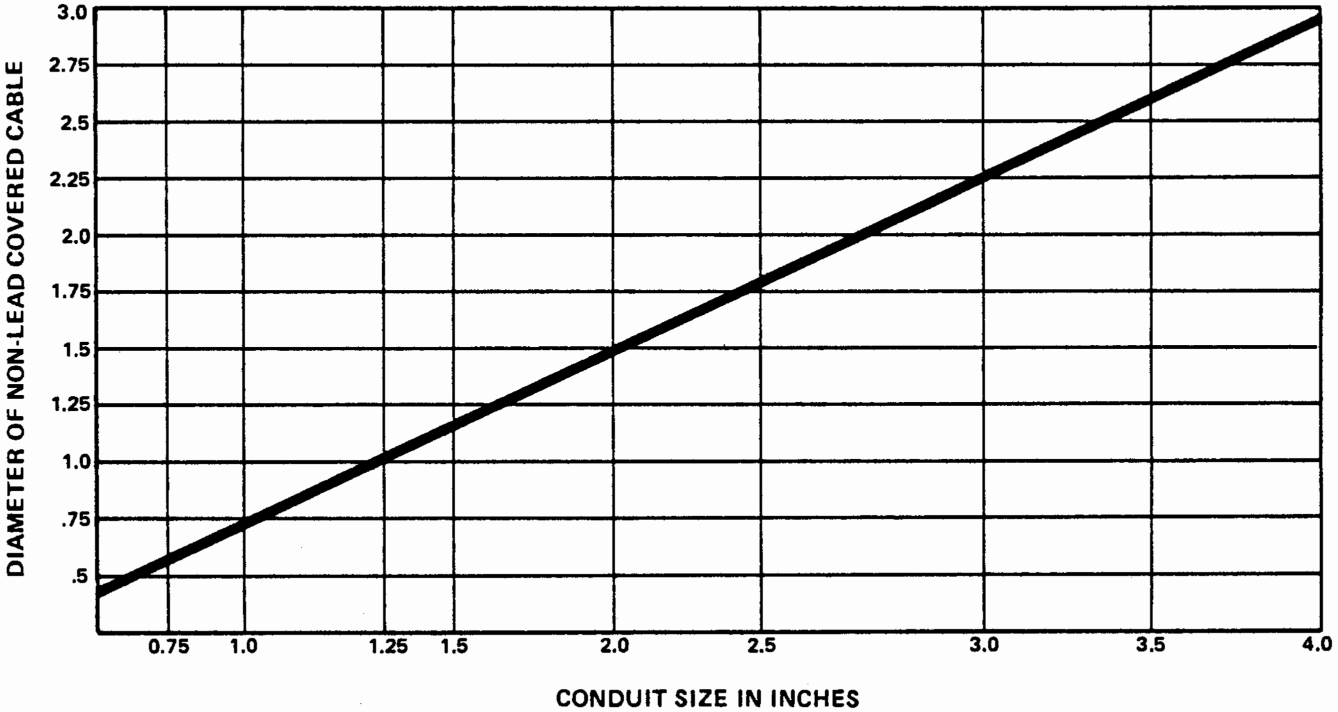


Figure 3-18. Graph Showing Recommended Conduit Size When a Single Cable Is Anticipated.

Table 3-1. Sizes for Underfloor Raceways.

RACEWAY AREA (SQ. INCHES)	CAPACITY							
	STATION WIRE	INSIDE WIRING CABLE						
	2 Pr.	6 Pr.	12 Pr.	16 Pr.	25 Pr.	50 Pr.	75 Pr.	100 Pr.
3.3	45	24	13	8	7	5	2	2
3.9	60	37	25	18	10	5	4	4
5.6	80	45	30	22	13	7	5	4
7.6	95	65	40	26	24	11	5	4
8.5	115	65	40	26	24	11	5	4
8.9	115	75	45	31	27	13	5	5
9.3	140	85	45	34	30	16	9	8
10.8	160	95	60	45	31	17	10	10
16.8	245	150	90	75	45	25	16	14

Table 3-2. Conduit Capacities and Recommended Maximum Occupancy.

CONDUIT SIZE (INCHES)	CONDUIT INSIDE DIAMETER INCHES	AREA – SQUARE INCHES								
		CONDUIT AREA $0.79D^2$ TOTAL 100%	CABLE NOT LEAD COVERED			CABLE LEAD COVERED				
			1 CABLE 53%	2 CABLES 31%	OVER 2 CABLES 40%	1 CABLE 55%	2 CABLES 30%	3 CABLES 40%	4 CABLES 30%	OVER 4 CABLES 35%
0.5	0.622	0.30	0.16	0.09	0.12	0.17	0.09	0.12	0.11	0.11
0.75	0.824	0.53	0.28	0.16	0.21	0.29	0.16	0.21	0.20	0.19
1.0	1.049	0.86	0.46	0.27	0.34	0.47	0.26	0.34	0.33	0.30
1.25	1.380	1.50	0.80	0.47	0.60	0.83	0.45	0.60	0.57	0.53
1.5	1.610	2.04	1.08	0.63	0.82	1.12	0.61	0.82	0.78	0.71
2.0	2.067	3.36	1.78	1.04	1.34	1.85	1.01	1.34	1.28	1.18
2.5	2.469	4.79	2.54	1.48	1.92	2.63	1.44	1.92	1.82	1.68
3.0	3.068	7.38	3.91	2.29	2.95	4.06	2.21	2.95	2.80	2.58
3.5	3.548	9.90	5.25	3.07	3.96	5.44	2.97	3.96	3.76	3.47
4.0	4.026	12.72	6.74	3.94	5.09	7.00	3.82	5.09	4.83	4.45
4.5	4.506	15.94	8.45	4.94	6.38	8.77	4.78	6.38	6.06	5.56
5.0	5.047	20.00	10.60	6.20	8.00	11.00	6.00	8.00	7.60	7.00
6.0	6.065	28.89	15.31	8.96	11.56	15.89	8.67	11.56	10.98	10.11

NOTE: The above permitted conduit occupancy applies to straight runs with nominal offsets equivalent to not more than two 90-degree bends.

Table 3-3. Diameter and Cross-Sectional Area of Various Sizes of Cables.

NO. OF PAIRS	26 GAUGE		24 GAUGE		22 GAUGE		19 GAUGE	
	NOMINAL OUTSIDE DIAMETER (INCHES)	NOMINAL AREA (SQ. IN.) ($0.79D^2$)	NOMINAL OUTSIDE DIAMETER (INCHES)	NOMINAL AREA (SQ. NO.) ($0.79D^2$)	NOMINAL OUTSIDE DIAMETER (INCHES)	NOMINAL AREA (SQ. NO.) ($0.79D^2$)	NOMINAL OUTSIDE DIAMETER (INCHES)	NOMINAL AREA (SQ. NO.) ($0.79D^2$)
6	–	–	–	–	0.390	0.120	0.490	0.190
12	–	–	0.~~0~~440	0.150	0.500	0.200	0.620	0.300
18	0.430	0.150	0.480	0.180	0.560	0.250	0.740	0.430
25	0.460	0.170	0.530	0.220	0.630	0.310	0.810	0.520
50	0.590	0.275	0.690	0.375	0.840	0.560	1.100	0.955
75	0.670	0.355	0.790	0.490	1.000	0.790	1.400	1.550
100	0.740	0.435	0.940	0.700	1.200	1.140	1.500	1.780
150	0.920	0.670	1.100	0.955	1.400	1.550	1.900	2.850
200	1.000	0.790	1.200	1.140	1.500	1.780	2.100	3.480
300	1.200	1.140	1.500	1.780	1.900	2.850	2.500	4.940
400	1.300	1.335	1.700	2.280	2.000	3.160	2.900	6.640
600	1.600	2.020	2.000	3.160	2.500	4.940	–	–
900	1.900	2.850	2.400	4.550	–	–	–	–

4. RISER SYSTEM

1. GENERAL

1.01 The riser system provides the facilities for bringing the cables from the main equipment room or terminal room to the various floors of the building.

1.02 The design of the riser system varies from building to building and from type of building to type of building.

1.03 The types of riser systems consist of the following:

(a) Closed riser shaft or system consisting of a series of aligned closets, usually beginning in the basement and extending throughout the building. The closets are connected by pipe sleeves, slots, or conduit through the floors (Figure 4-1).
(b) Open riser shaft or system consisting of an area where the riser cables pass from floor to floor without being enclosed in a closet (Figure 4-2). An open shaft system shall be constructed to meet the National Electrical Code and other regulatory codes that may apply.

1.04 In designing a riser system, the riser cable design must also be considered.

2. DESIGN GUIDELINES

2.01 The advantages of a riser system using sleeves are as follows:

(a) Sleeves are much more economical than conduit.
(b) Sleeves are very simple to fireproof.
(c) Sleeves are flexible in that many sizes of cables can be placed in a sleeve.
(d) The use of sleeves makes it simple to support cables in the riser system.

2.02 The disadvantages of a riser system using sleeves are as follows:

(a) Sleeves are not as flexible as floor slots.
(b) Sleeves must be vertically aligned to facilitate cable pulling.

2.03 The advantages of a riser system using slots are as follows:

(a) Slots are economical to construct.
(b) Slots are very flexible in that any combination of cable sizes can be placed in a slot.
(c) A slot requires only a small space in the closet.

2.04 The disadvantages of a riser system using slots are as follows:

(a) It is difficult to get a proper fire barrier constructed in the section of a slot that does not have cables in it.
(b) It is more difficult to support cables than with sleeves or conduit.

2.05 The advantages of a riser system using conduit are as follows:

(a) It is very simple to support cables.
(b) Conduit provides unobstructed housing for the cables.
(c) Conduit is very simple to make fire resistant.

2.06 The disadvantages of a riser system using conduit are as follows:

(a) Conduit is relatively inflexible in that only certain sizes of cable can be placed in a particular conduit.
(b) Conduit is expensive to install.
(c) Conduit requires fairly extensive planning to get the proper size of conduits to proper locations.

2.07 In high-rise buildings, the choice must be made whether to have a single riser or multiple risers.

2.08 The advantages of a single riser are:

(a) Riser cable pairs can be better utilized because all cables come to a single location.
(b) There is more flexibility in cabling.
(c) Overcomes easier the problem of restricted access between floors.

2.09 The advantages of a multiple riser are as follows:

(a) At times it is more economical to use individual riser cables to each floor than to

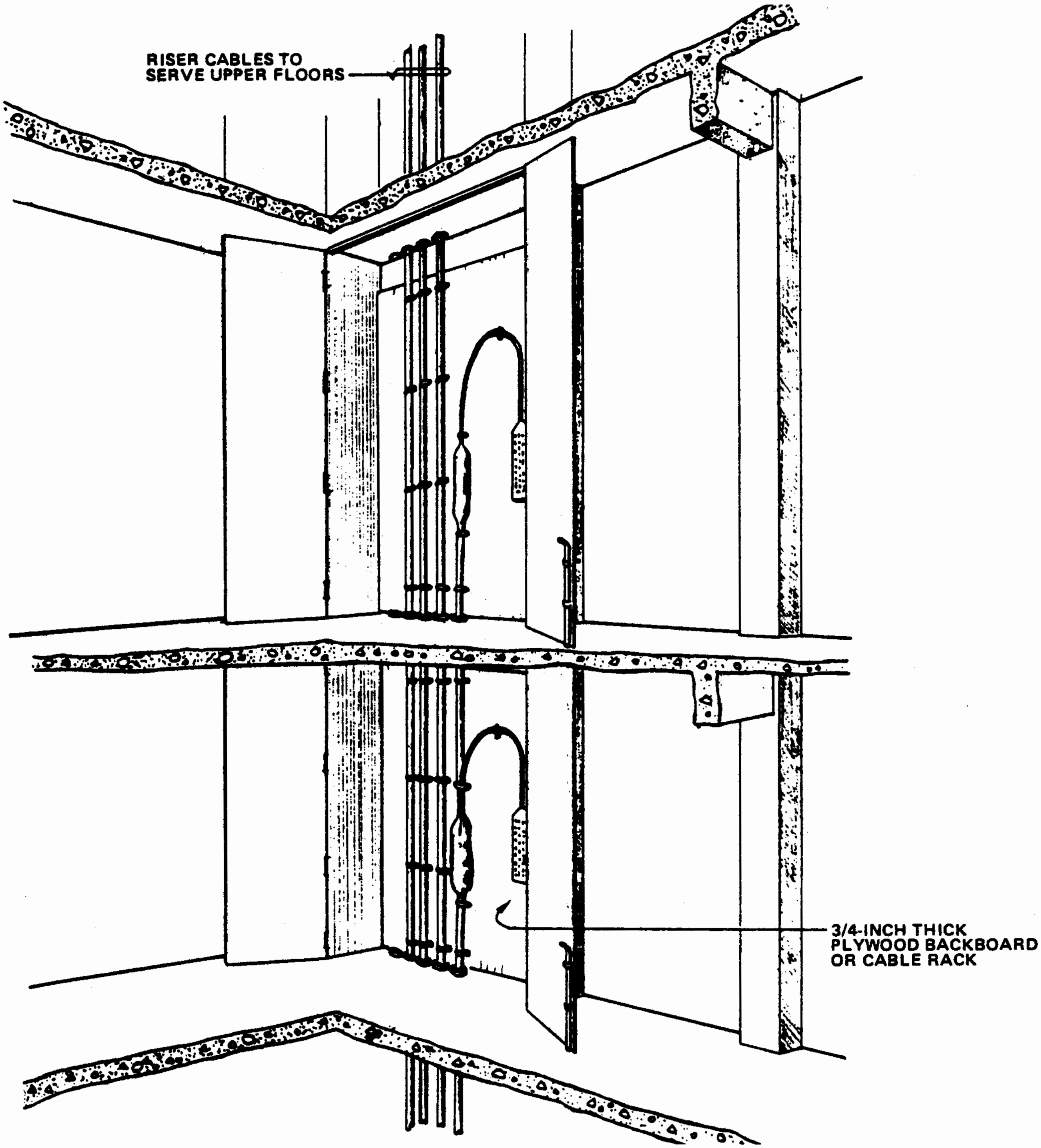


Figure 4-1. Closed Riser System.

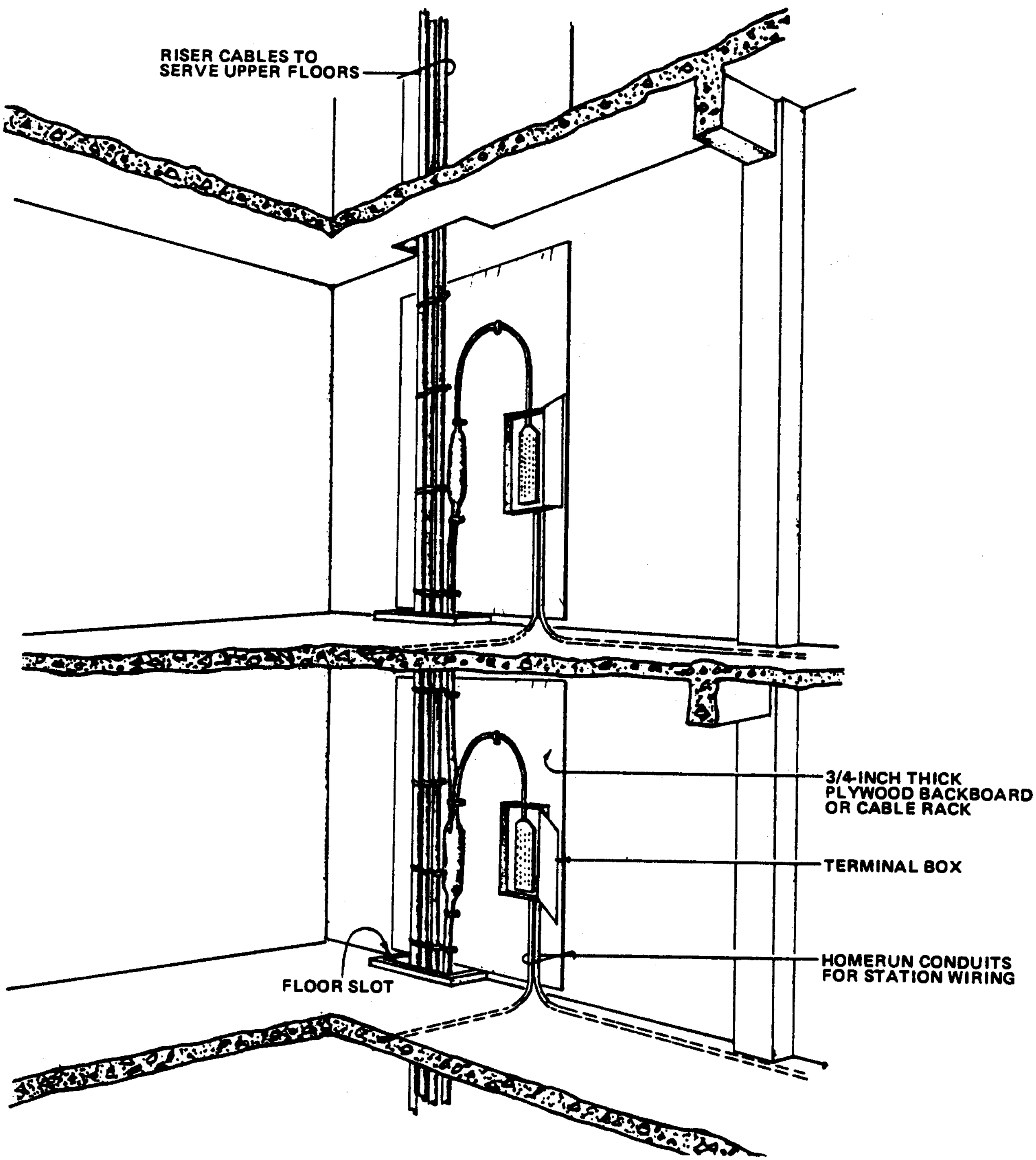


Figure 4-2. Open Riser System.

involve the splicing labor at each floor as is required with large cables.

(b) At times it is more economical in terms of cabling.

(c) Smaller riser shafts are required in each riser system.

(d) Reduces the number of tie cable pairs required between closets.

2.10 The general requirements when sleeves are used are as follows:

(a) Sleeves may be used to provide interconnection between vertically aligned closets.

(b) The minimum size for sleeves in an office building is 4 inches in diameter.

(c) For high-rise apartment buildings and other nonoffice commercial buildings, the size of the sleeve is determined by the size of the cable that is to be placed in it. Generally, the size is 2 inches in diameter or larger.

(d) The sleeves should be aligned vertically between floors to permit easy pulling-in of cables.

(e) The preferred location for sleeves is on the left wall of a closet or as close as possible to the left side of the door.

(f) The sleeves are to be placed immediately adjacent to the wall.

(g) Sleeves should not be placed in the center or close to the center of a usable wall.

(h) Sleeves are to be stubbed a minimum of 1 inch and no higher than 2 inches above the floor and the inner edge of both ends reamed.

(i) Appropriate fire barriers are to be placed around the cables in the sleeves, and unused sleeves are to be capped.

2.11 The general requirements when slots are used are as follows:

(a) Slots are generally used when the main terminal location and/or riser locations are not vertically aligned.

(b) Slots are generally unacceptable because they are difficult to fireproof.

(c) The minimum size of a slot is 4 inches by 12 inches. Table 4-1 indicates the sizes of slots for various usable floor areas.

(d) The slots are to be constructed with a curb a minimum of 1 inch in height.

(e) When the terminal location and/or riser locations are not aligned, the following may be used to tie them together:

(1) Conduit.
(2) Cable trays or racks.
(3) Strands.

2.12 The general requirements when conduit is used are as follows:

(a) Conduit is recommended in small office buildings and apartment buildings when surface mounted or recessed cabinets are used.

(b) Conduit is the first consideration to provide interconnection when riser closets are not vertically aligned.

(c) The maximum length of a conduit run depends on the following:

(1) Means of pulling the cable.
(2) Supports for the conduit.
(3) The encasement of the conduit.
(4) The size of the cable.
(5) The number of bends required in the conduit.

(d) Generally, 4-inch conduits are recommended for office buildings. For information on other sizes, see the section on Wiring Distribution Systems.

(e) The conduit should be of fire resistive material. Refer to local codes for restrictions.

(f) When conduits are required for interconnection of main terminal room and/or riser locations, the quantity of conduits required may be determined by multiplying the number of sleeves required by 0.75 and rounding off upward.

Table 4-1. Slot Sizes.

TOTAL USABLE AREA SERVED BY SHAFT IN SQUARE FEET	SIZE OF SLOT IN INCHES
Up to 250,000	4 x 12
250,000 to 600,000	6 x 18
600,000 to 1,000,000	9 x 20
1,000,000 to 1,400,000	12 x 20
1,400,000 to 2,000,000	15 x 24

2.13 Cable trays or racks should be considered when large quantities of cables are to be run horizontally between main terminal room and/or riser locations. The general requirements are as follows:

(a) The trays or racks should be adequate in width and with side rails of sufficient height to hold one layer of the proposed cables.
(b) The tray or rack should be adequately suspended by means of "L" brackets supporting one side and the bottom only to permit the laying in of cables.
(c) The bottom of the tray may be a ladder-rack type or pan type.

3. COMMERCIAL BUILDING DESIGN

3.01 The following data provides a basis for determining the size and quantity of openings through floors. Regardless of the type of opening selected, it shall be of sufficient size to accommodate the required cabling.

3.02 When providing sleeves, the rule of thumb is to provide two 4-inch sleeves for up to 50,000 square feet of usable floor space. For additional space up to 100,000 square feet, provide one additional sleeve plus one for the next unit of 100,000 square feet (or any portion thereof); see Table 4-2. For every additional 200,000 square feet, add two additional sleeves. This method permits the cable riser system to serve several floors from one cable by means of cable stubs.

3.03 The allocation of sleeves in a building with a floor area greater than 400,000 square feet can be determined in the following manner (Figure 4-3).

(a) Determine the usable square feet on each floor (in this example there are 50,000 square feet on each of 20 floors).
(b) Determine the total usable square feet to be served (1,000,000 square feet).
(c) From the information in paragraph 3.02, determine the quantity of sleeves required (12 sleeves).
(d) Starting with the top floor, descend and total each floor area until a total of 400,000 square feet has been reached. This represents "x" square feet.
(e) Through the number of floors determined in (d), place six sleeves.
(f) Continue to descend and total each floor area until the next 400,000 square feet has been reached. This represents "y" square feet.
(g) Total the area of "x" and "y" (800,000 square feet).
(h) Through these floors place 10 sleeves (floors 5 through 12).
(i) Through the remaining floors, place 12 sleeves (floors 1 through 4).

3.04 When a building is served by more than one riser system, the floor area served by each of the systems must be calculated separately. The number of sleeves required per group of floors in each of the riser systems is determined by the area they serve. The minimum number of sleeves provided on any floor in any office building having an usable floor area greater than 400,000 square feet is six.

3.05 Conduits are to be placed between apparatus and satellite closets. These conduits are to run in the shortest straight run wherever possible. No section of conduit run shall be longer than 100 feet nor contain more than two 90-degree bends unless pull boxes are placed. Bends in the conduit are to be long-sweep radius bends. However, in no instance shall the inside radius of the bend be less than 6 times the internal diameter of the conduit. A 2-inch conduit may be used between apparatus closets and satellite closets if the run is straight without bends and offsets. A 2-1/2 inch conduit shall be required for conduit runs that have one or two bends. This conduit size provides for the placing of adequately sized cables between the apparatus closets and satellite closets.

3.06 Figure 4-4 shows an ideal arrangement of the main terminal space, apparatus closets per floor, and, when required, satellite closets using a single riser design.

Table 4-2. Sleeve Requirements.

TOTAL USABLE AREA IN SQUARE FEET	NUMBER OF SLEEVES
Up to 50,000	2
50,000 to 100,000	3
100,000 to 200,000	4
200,000 to 400,000	5
For every additional 200,000	2 additional

3.07 Figure 4-5 shows a typical arrangement of the main terminal space and apparatus closets using a multiple riser design.

4. RESIDENTIAL BUILDING DESIGN

4.01 The residential building design methods may be used for high-rise apartment buildings, hotels, and hospitals.

4.02 When computing the number of riser sleeves or conduits required, it must be remembered that the cable design criterion is two cable pairs per unit without regard to usable floor space. Thus, after the number of cable pairs required has been computed, an economic study should be made to determine which method is more desirable, the single cable per floor or the multiple floors per cable. This decision affects the number of riser sleeves or conduits required.

4.03 There are three ways of providing a riser system in a residential-type building:

(a) A multiple riser system consisting of conduits serving two apartments or rooms on each floor (Figure 4-6).

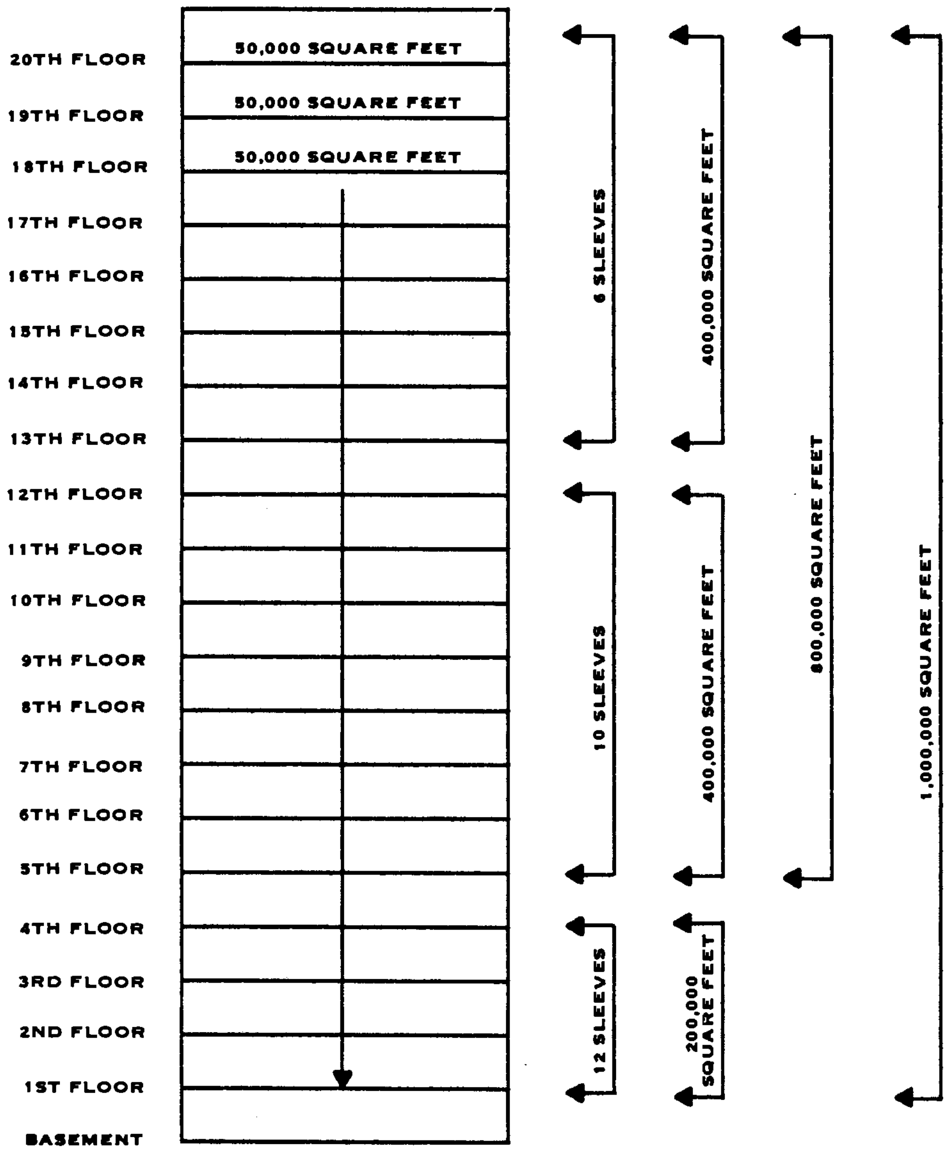


Figure 4-3. Method of Allocating Sleeves.

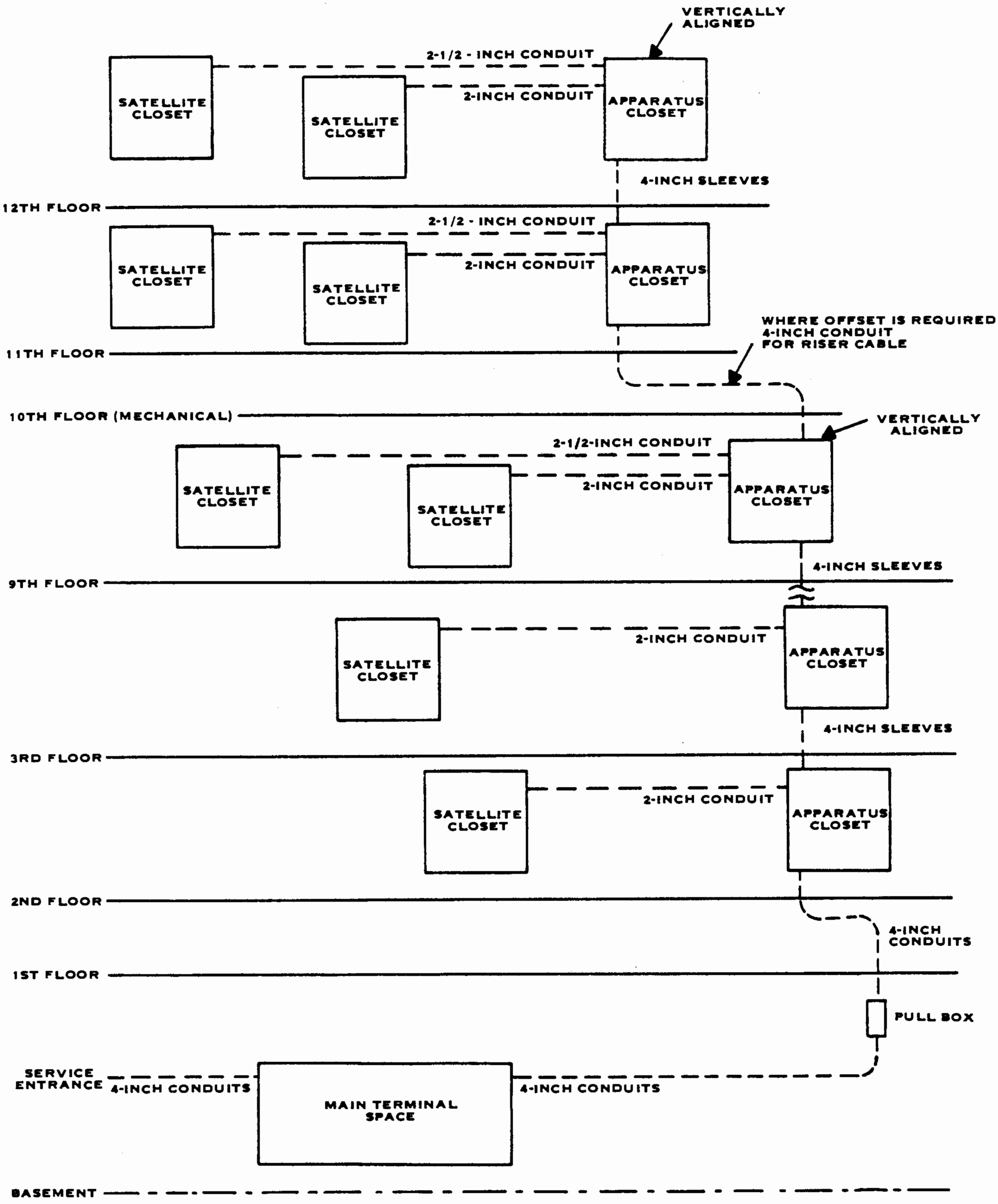


Figure 4-4. Typical Ideal Arrangement Using Single Riser System.

(b) A single riser system consisting of a vertical conduit to a distribution terminal in a cabinet or closet on each floor (Figure 4-7).

(c) A single riser system consisting of a vertical conduit to a distribution terminal in a cabinet or closet for every third floor (Figure 4-8).

4.04 Figure 4-9 shows a typical riser diagram for a small hotel.

5. CABLE DESIGN

5.01 The general rule in cable design for a commercial office building is to provide 15 pairs per 1,000 square feet of usable floor space. In a residential type of building, two pairs are provided per unit or room usually.

5.02 The riser cable can be designed as follows:

(a) Single floor per riser cable.

(b) Multiple floors per riser cable.

5.03 The recommended design is the single-floor-per-cable design, but the decision should be based on economics.

5.04 The economic factors to be considered are the following:

(a) The cost of the cable.
(b) The cost of the splices.

Normally, when the riser cable distance is short, the single-floor-per-cable design is the most economical. Over relatively long distances, the multiple-floors-per-cable design may be the most economical.

5.05 Figure 4-10 shows a single-floor-per-cable design. Figure 4-11 shows a multiple-floors-per-cable design.

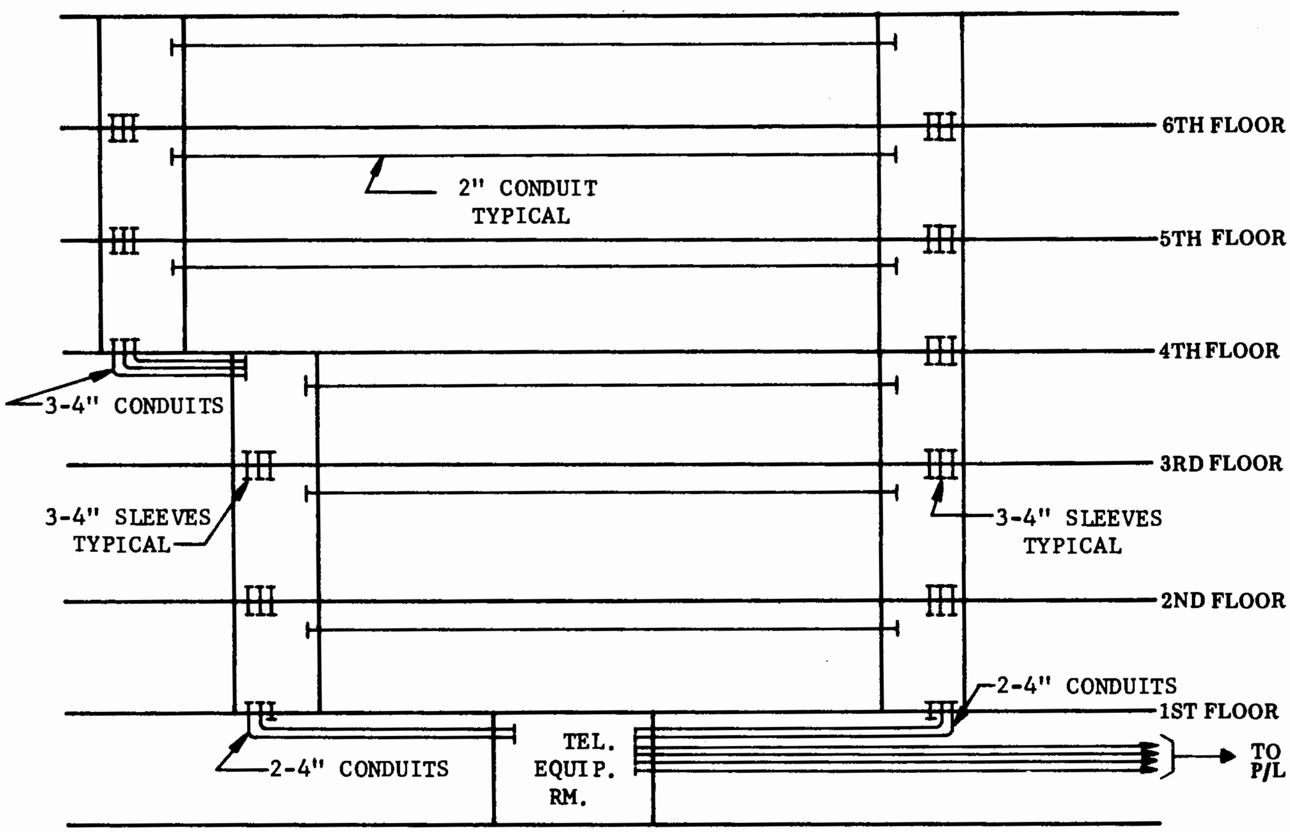


Figure 4-5. Typical Ideal Arrangement Using Multiple Riser System.

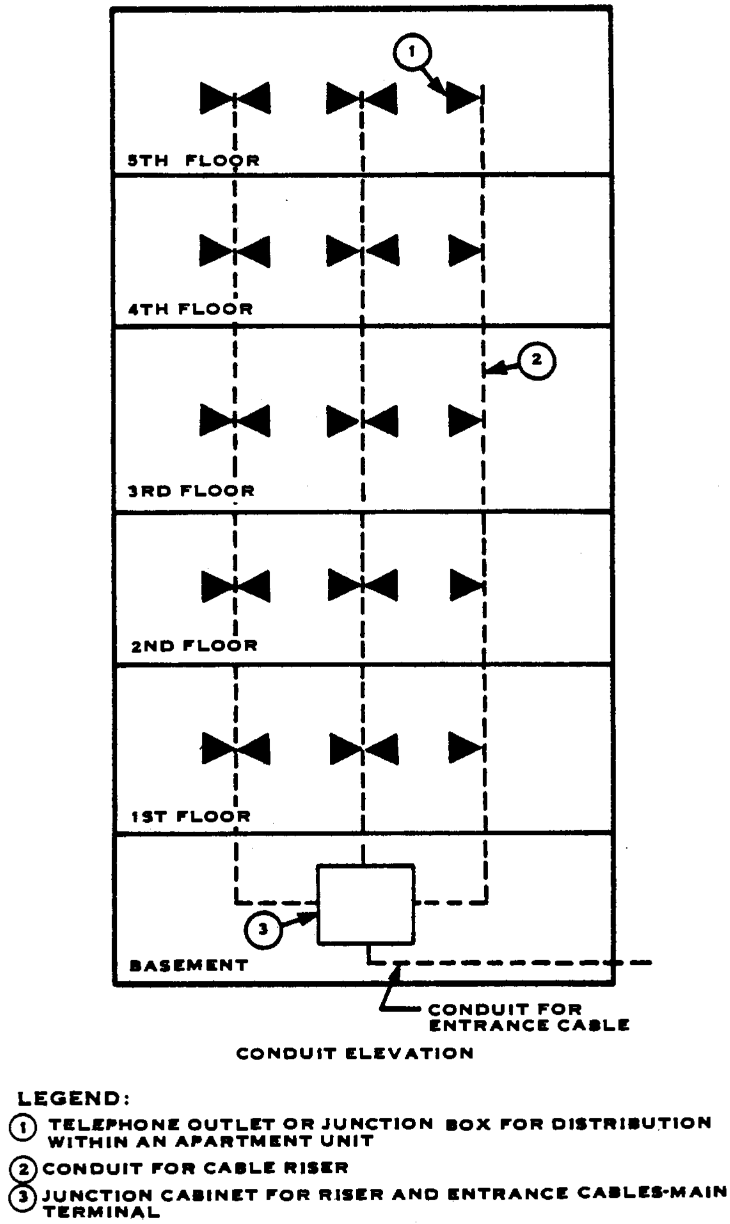
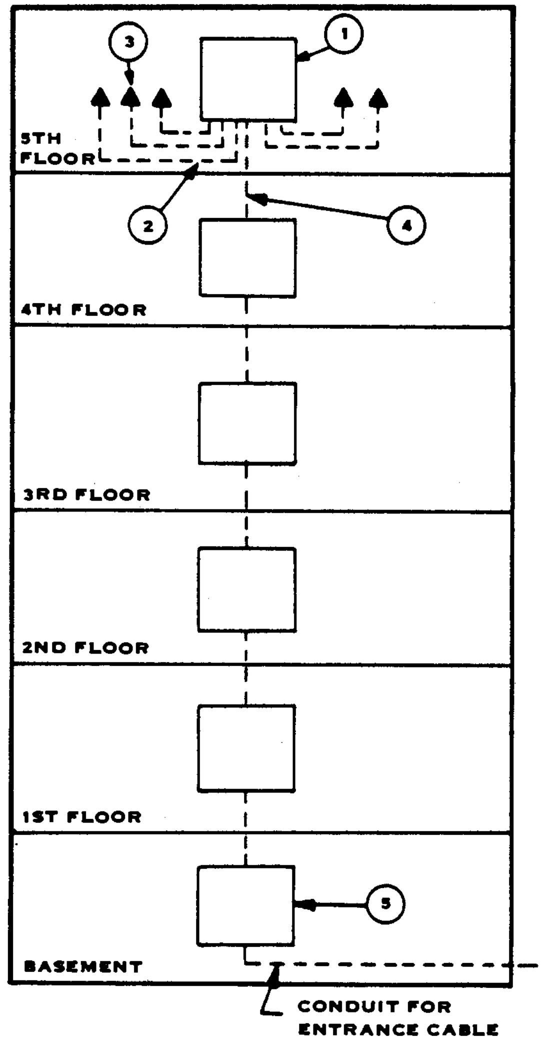


Figure 4-6. Typical Multiple Riser System in Residential-Type Building.



CONDUIT ELEVATION

LEGEND:

1. TELEPHONE CABINET OR CLOSET
2. CONDUIT FOR STATION WIRING FROM TELEPHONE CABINET TO LOCATION IN THE APARTMENT UNIT
3. TELEPHONE OUTLET OR JUNCTION BOX FOR DISTRIBUTION WITHIN AN APARTMENT UNIT
4. CONDUIT OR SLEEVE BETWEEN CABINETS FOR CABLE RISER
5. JUNCTION CABINET FOR RISER AND ENTRANCE CABLES - MAIN TERMINAL

Figure 4-7. Typical Single Riser System in Residential-Type Building Using a Distribution Terminal on Each Floor.

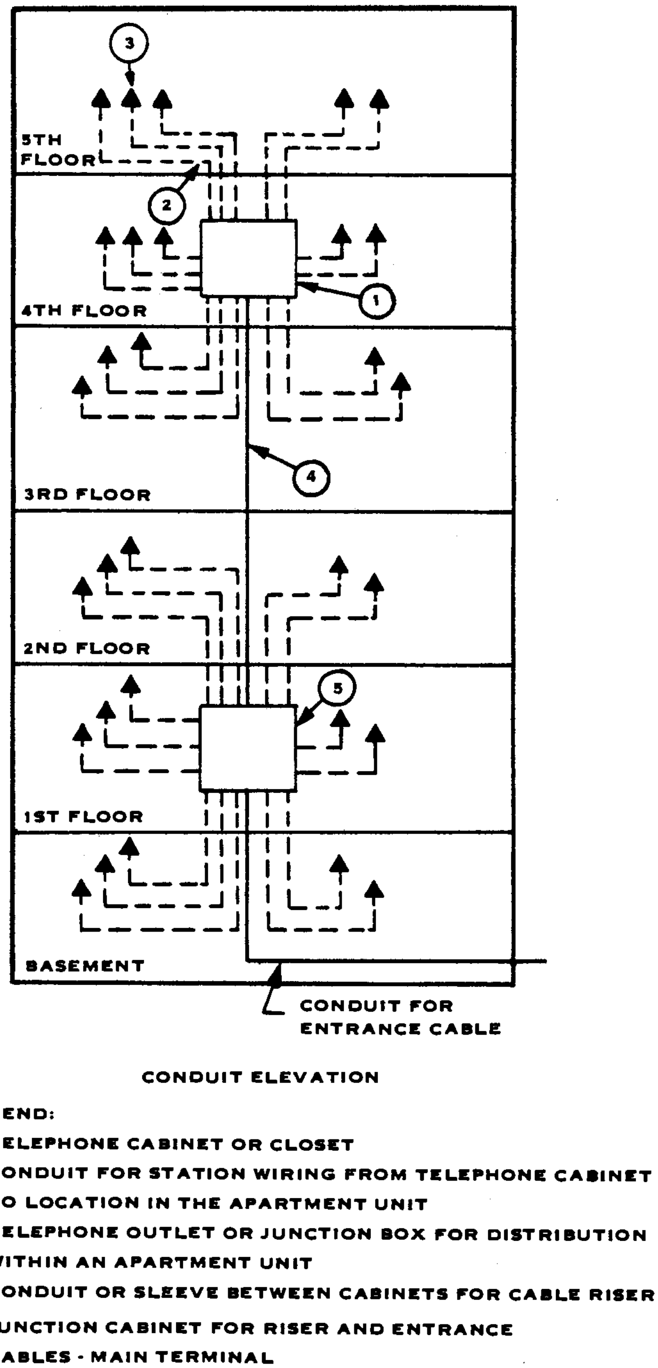
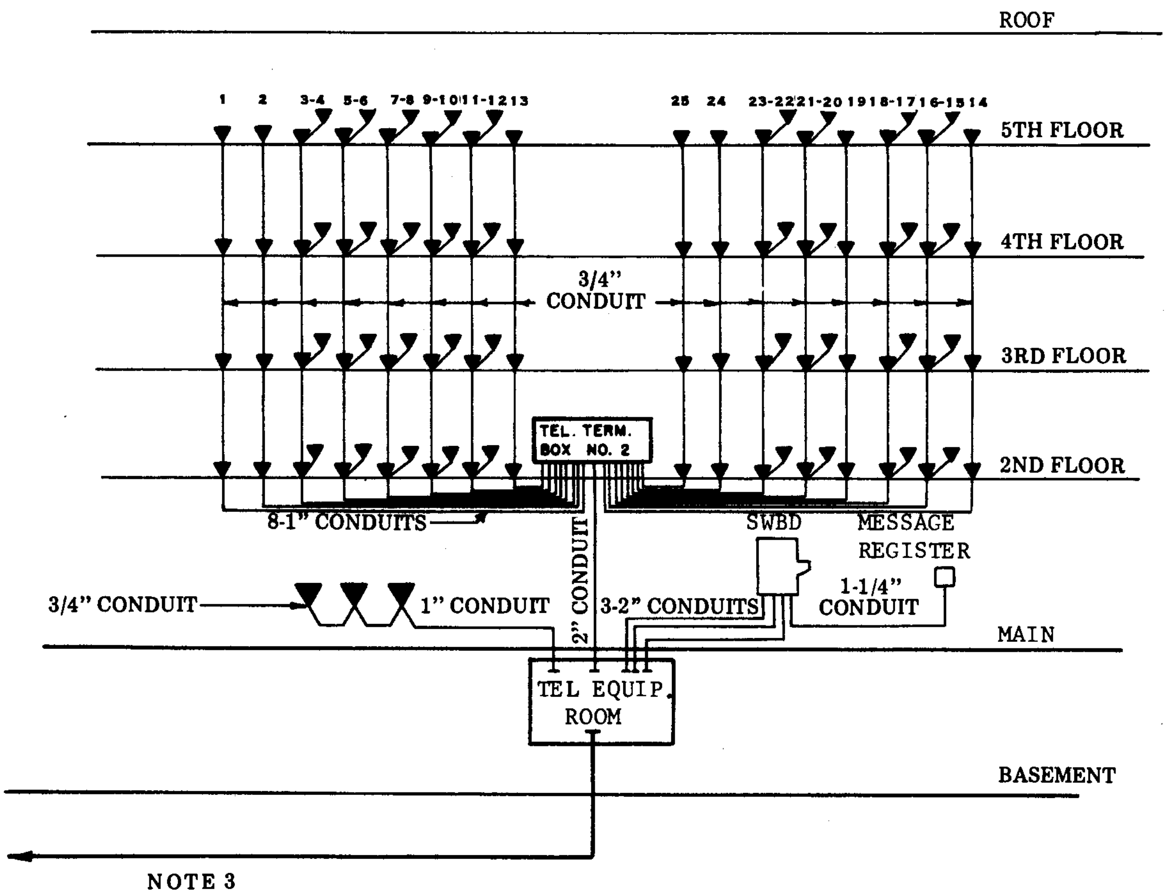


Figure 4-8. Typical Single Riser System in Residential-Type Building Using a Distribution Terminal for Three Floors.



NOTES:

1. 1" HOME RUN, 3/4" LOOP, 3 OUTLETS TO HOME RUN.
2. COIN TELEPHONES, HOUSE TELEPHONES AND TAXI TELEPHONES AT 4'-6" HEIGHT.
3. LOCATION AND SIZE OF SERVICE ENTRANCE AS DETERMINED BY TELEPHONE COMPANY.

Figure 4-9. Typical Riser Diagram for a Small Hotel.

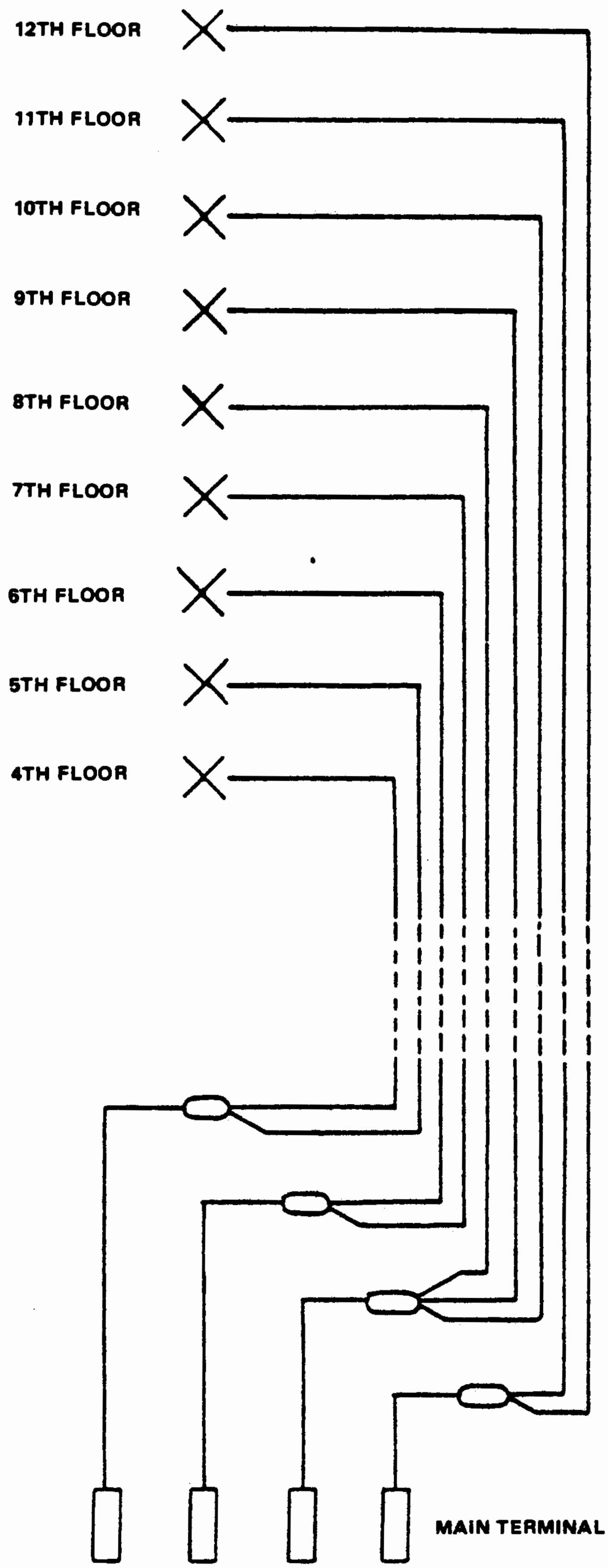


Figure 4-10. Single Floor Per Cable Design.

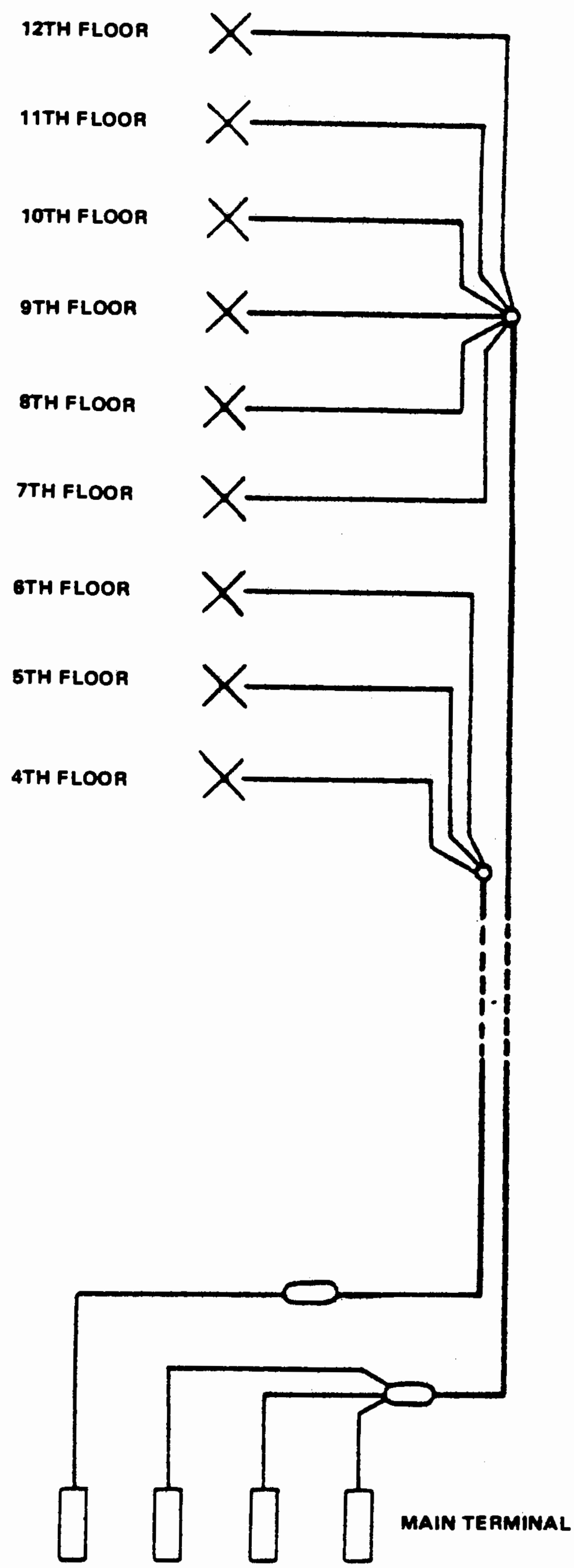


Figure 4-11. Multiple Floors Per Cable Design.

5. MAIN TERMINAL OR EQUIPMENT ROOM

1. GENERAL

1.01 The main terminal is where the incoming cables interface with the in-building cable system.

1.02 The main terminal may consist of one of the following:

(a) A panel box (terminal box) or
(b) A walk-in closet or
(c) A PABX room.

1.03 The choice of a main terminal depends on the number of incoming cable pairs, the number of in-building cable pairs, and the type of equipment required for the building.

2. COMMERCIAL BUILDING

2.01 In a commercial building, the main terminal may be any one of the three types. The number of incoming cable pairs depends upon the type and use of the building. Table 5-1 lists various types and uses of buildings and indicates the usual number of pairs provided per 1,000 square feet of usable floor space. If key telephone equipment is associated with the main terminal in a small building, a closet similar to an apparatus closet is required. If the building requires PABX service, a PABX room is required.

2.02 In small buildings having a usable floor area of up to 20,000 square feet, wall-type terminals (H-type housings with either 66M-type connecting blocks or cross-connect terminals may be used.

2.03 In buildings having usable floor area in excess of 20,000 square feet, terminals or wall- or floor-mounted terminating frames are located in a room.

2.04 If the main terminal is associated with PABX equipment, all terminations shall be made on the Main Distributing Frame (MDF) associated with the PABX equipment.

2.05 In buildings where the usable floor space exceeds 50,000 square feet, an equipment room is required.

2.06 In large, multistory buildings, it may be practical and economical to have more than one main terminal room. This could cause a reduction in the number of pairs in the riser cable system and a saving in the engineering time and rearrangement costs for buildings having large PABX installations.

Size of Main Terminal Area

2.07 When wall-mounted terminations such as the H-type housings are used, a plywood backboard 4

Table 5-1. Number of Cable Pairs Required per 1,000 Square Feet for Different Types of Buildings.

TYPE AND USE OF BUILDING	PAIRS PER 1,000 SQUARE FEET
Office	
Financial purposes only.	5 to 20
Commercial offices, small showrooms, salesrooms, etc.	5 to 10
Industrial offices, public executives, clerical forces, etc.	3 to 6
Loft	
Commercial, large display rooms.	3 to 6
Industrial and manufacturing offices, large floor areas.	2 to 4
Mercantile, department stores, wholesale houses, etc.	1
Public	
Transportation terminals.	1
Auditoriums.	1
Exhibition, convention, and sale halls.	1
Schools, museums, government buildings, large markets, etc.	1

feet by 8 feet by 3/4 inch shall be securely fastened to the wall of the allocated space. Figure 5-1 shows a typical H-type housing. Figure 5-2 shows a typical cross-connect terminal.

2.08 The sizes of main terminal rooms are based on the space requirements for the termination of the entrance cables and the building cables on the terminating frames. Table 5-2 gives the space requirements for usable floor areas from 70,000 to 1,000,000 square feet of usable floor area. The rule of thumb is to provide a room that is a minimum of 8 feet wide with 1 square foot of floor space for each unit of 2,000 square feet of usable floor space. At times, for buildings over 800,000 square feet, this may be reduced to 1 square foot for each unit of 3,000 square feet. If key telephone equipment is to be mounted in the room, extra space must be added for this equipment.

2.09 The size of a main terminal room with PABX equipment depends on the PABX equipment. Figures 5-3 through 5-10 show various typical PABX rooms.

(a) Figure 5-3 shows a typical floor plan for a GTD-120 PABX.
(b) Figure 5-4 shows a typical floor plan for two GTD-120 PABX's.
(c) Figure 5-5 shows a typical floor plan for a GTD-1000 PABX.
(d) Figure 5-6 shows a typical floor plan for a GTD-4600 Business Service Module.
(e) Figure 5-7 shows a typical floor plan for a 90-line Ericsson Type PABX.
(f) Figure 5-8 shows a typical floor plan for an AKD-741 PABX.
(g) Figure 5-9 shows a typical floor plan for an SG-1L Universal PABX.
(h) Figure 5-10 shows a typical floor plan for a FOCUS II Two-Cabinet PABX.

Design of Main Terminal

2.10 The building owner shall be responsible for providing the necessary space and environmental conditions required to house the telephone com-

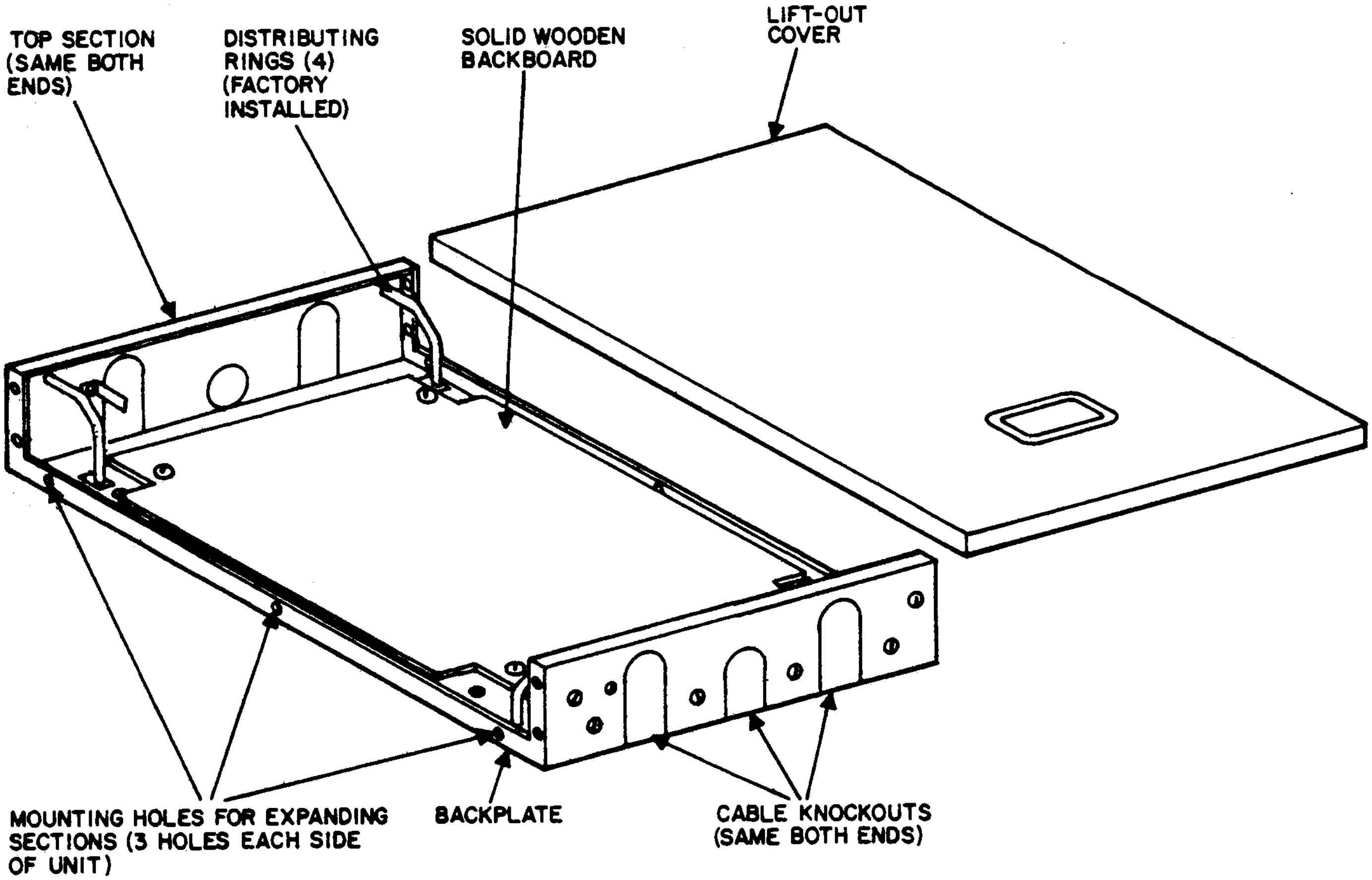


Figure 5-1. Typical H-Type Housing.

pany cable terminations and equipment. Telephone company standards shall be met in all instances.

2.11 The space allocated for the main terminal must be adequate to meet the original telephone service needs of the occupants and to provide for later installation of additional terminals for growth.

2.12 The main terminal should be located as closely as possible to the center of the riser cable distribution facilities.

2.13 Main terminals should be located where the floor space is less valuable, usually in the basement. The location should be in an area that is not subject to flooding and is easily accessible to telephone company employees 24 hours a day.

2.14 Equipment rooms must be completely finished, lighted, heated, and the doors equipped with locks before any equipment can be installed. Lighting, power, conduit or cable tray arrangements for the equipment room shall be designed for individual installations.

2.15 Two walls in the equipment room shall have 110-volt duplex convenience outlets for three-conductor plugs.

2.16 Ceiling height in the main terminal area should provide 8 foot minimum clear space. The walls of the equipment room shall extend to the regular ceiling or false ceiling.

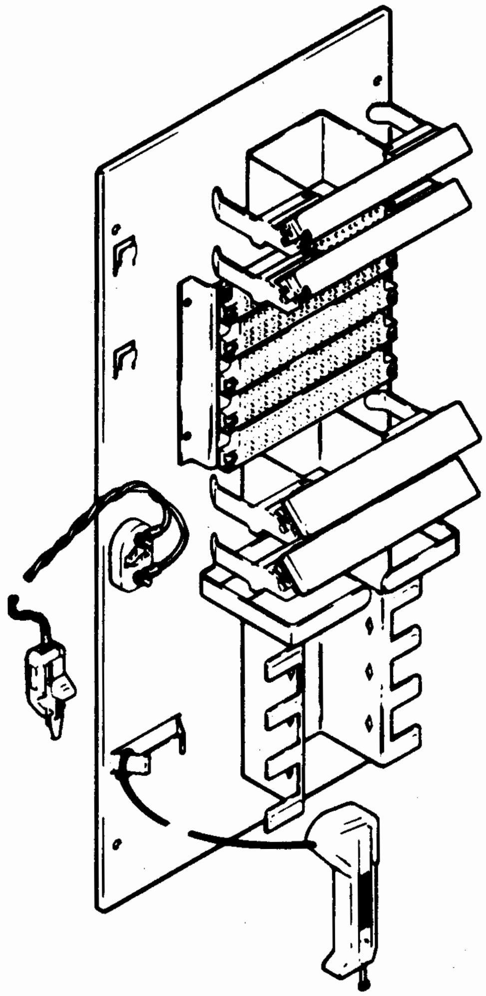


Figure 5-2. Typical Cross-Connect Terminal.

Table 5-2. Main Terminal Space Requirements.

USABLE FLOOR AREA (SQUARE FEET)	CABLE PAIRS		WALL SPACE CABLE		ROOM SIZE CABLE	
	ENTRANCE	DISTRIBUTION	EXPOSED	UNEXPOSED	EXPOSED	UNEXPOSED
70,000	700	1,050	5'6"	3'	8'x6'	8'x5'
100,000	1,000	1,500	7'	3'6"	8'x6'6"	8'x5'
200,000	2,000	3,000	12'6"	6'6"	8'x9'	8'x6'6"
300,000	3,000	4,500	17'	9'	8'x11'	8'x7'6"
400,000	4,000	6,000	23'	12'	8'x13'6"	8'x8'
500,000	5,000	7,500	29'	15'	8'x16'6"	8'x10'
600,000	6,000	9,000			8'x17'6"	8'x11'6"
700,000	7,000	10,500			8'x19'	8'x13'
800,000	8,000	12,000			8'x21'6"	8'x14'6"
900,000	9,000	13,500			8'x23'6"	8'x16'
1,000,000	10,000	15,000			8'x26'	8'x17'6"

2.17 The equipment area should be free of corrosive, explosive, or combustible gases such as ammonia, acid, oxygen, hydrogen or petroleum vapors. If this condition cannot be met, the equipment room must be pressurized by a continuous source of clean air.

2.18 Means of ventilation shall be provided for the equipment room to ensure normal office temperature and adequate filtered air. The temperature should be maintained below 80°F and above 65°F. The recommended ambient temperature is 72°F.

2.19 When electronic PABX's are used, it is mandatory that the temperature be maintained within the limits continuously and without interruption, day and night.

2.20 The relative humidity of the equipment area must be not more than 55 percent nor less than 30 percent. Equipment shall not be located in boiler rooms, washrooms, or any area where water vapor is present. If exterior windows are present, they should be weatherstripped. Steam or water pipes must not be routed above the equipment. If steam or water pipes must run through the area, they must be insulated. If the equipment is located below a lavatory, kitchen, cafeteria, or any other area where running water exists, a waterproof ceiling must be installed in the equipment area.

2.21 Sprinkler fire extinguisher systems should not be installed in equipment areas. However, when city, county, or state codes may make this unavoidable, high-temperature sprinkler heads should be specified. Fire protection in an equipment area should be provided by the proper type of fire extinguisher.

2.22 The equipment room shall not be used for storage of any material or supplies (other than telephone company communications equipment). The room shall also be kept clear of any foreign attachments that may restrict the placing of equipment on floors or walls.

2.23 Floor-loading requirements are determined by the type of terminal equipment used.

2.24 The owner shall provide a 3/4-inch conduit to an approved ground connection point or to a No. 6 AWG ground.

3. RESIDENTIAL BUILDING

3.01 Small apartment buildings are usually served by a terminal/protector in the same manner as a single family residence.

3.02 Large apartment buildings may be served by either of the following:

(a) A panel box (terminal box) or
(b) A walk-in closet.

A walk-in closet may be either a separate room reserved for telephone company use or a room shared by other utilities etc. In a shared room wall space would be required.

3.03 In large apartment buildings, the main terminal may be designed as follows:

(a) As a main terminal with station wiring leading to the individual apartments.
(b) As a main terminal with a riser system leading to other terminals with station wiring leading to the individual apartments.

3.04 In determining the size of the terminal, the following should be considered:

(a) Sufficient size should be provided to allow for two pairs of entrance cable for each apartment.
(b) Allowance should be made for some common spares.

3.05 If the building is designed to have an ENTERPHONE® Building Entrance Control System, sufficient space must be provided in the terminal room for the entrance control system equipment. Table 5-3 summarizes the space required.

3.06 The terminal should be located where the floor space is less valuable, usually in the basement. The location should be in an area that is not subject to flooding.

3.07 A 110-volt duplex convenience outlet must be provided near the terminal.

3.08 Ceiling height in the terminal area should provide an 8-foot minimum clearance.

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3.09 Sufficient lighting is to be provided in the area.

3.10 The area should be free of corrosive, explosive, or combustible gases.

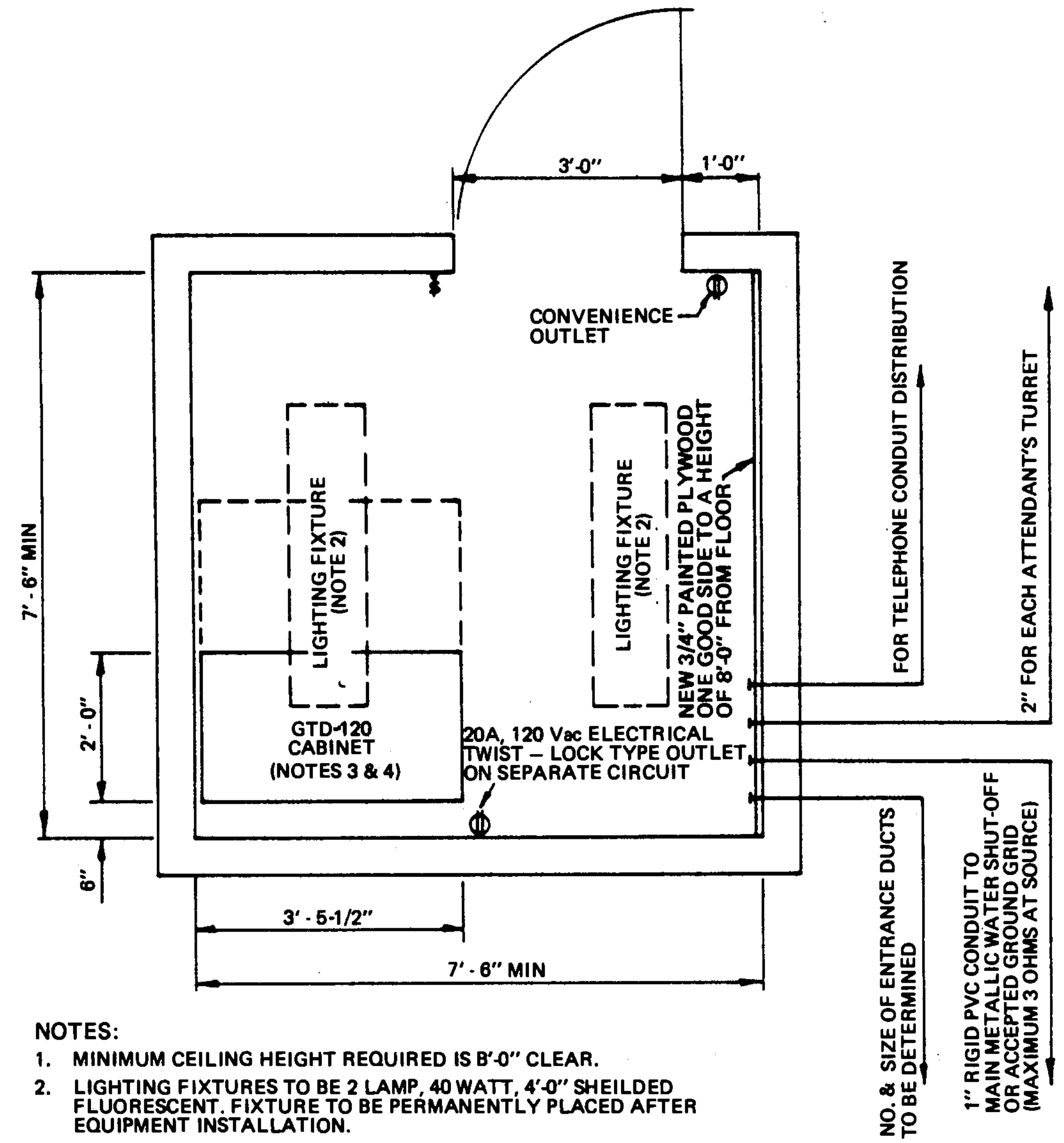
3.11 The owner shall provide a 3/4-inch conduit to an approved ground connection point.

Table 5-3. Equipment Room Space Required for ENTERPHONE Building Entry Control System.

NO. OF SUITES	PLYWOOD SIZE
1 – 25	3′6″ x 8′0″
26 – 100	6′0″ x 8′0″
101 – 200	8′0″ x 8′0″

NOTES:

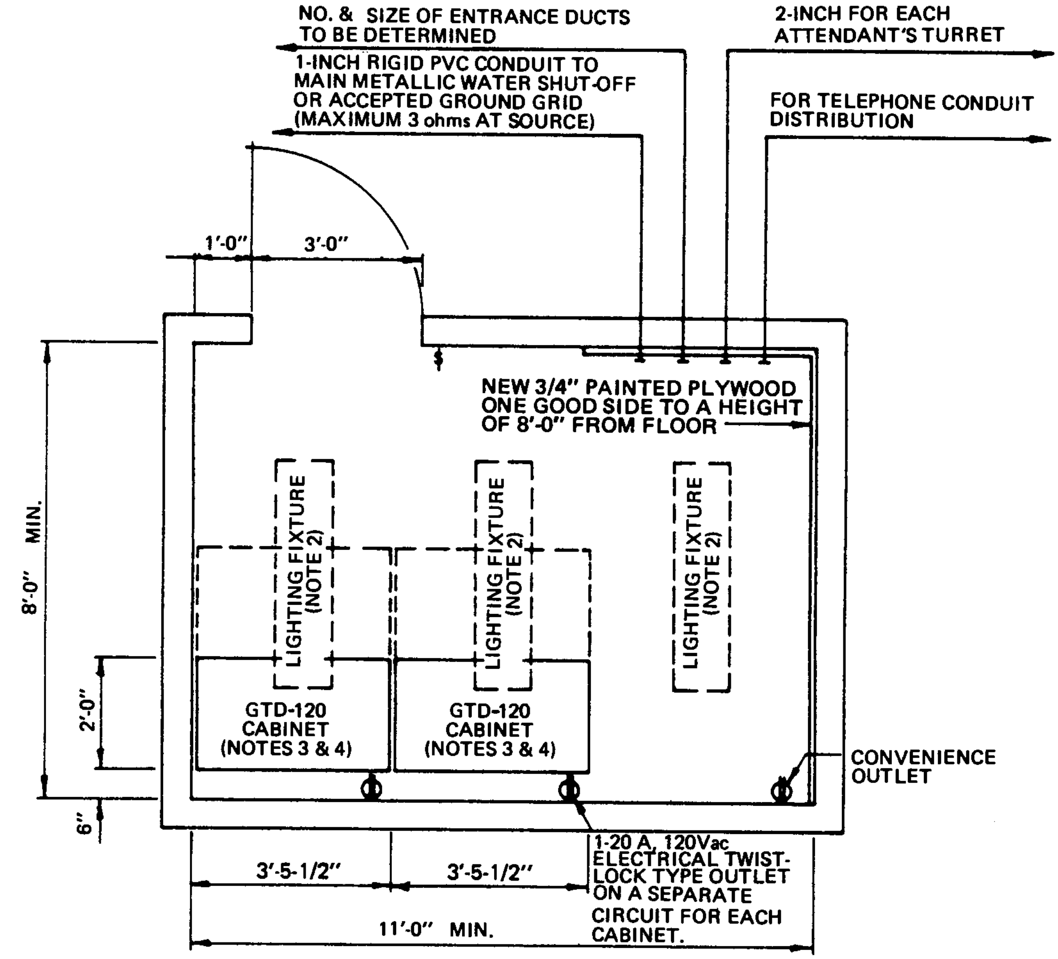
1. The common equipment module and line equipment module are approximately 18 inches deep.
2. Clear working space of 3 feet is required in front of all telephone terminal equipment. Four feet is required where telephone equipment is installed on a wall opposite to an electrical panel under 750 volts; 6 feet at more than 750 volts.
3. Allow 3 inches of clearance from the edge of plywood backboard to walls or corners. Allow 12 inches of clearance from electrical equipment installed at the corner of the room on one wall from telephone equipment or terminal boxes on the adjacent wall.



NOTES:

1. MINIMUM CEILING HEIGHT REQUIRED IS 8'-0" CLEAR.
2. LIGHTING FIXTURES TO BE 2 LAMP, 40 WATT, 4'-0" SHEILDED FLUORESCENT. FIXTURE TO BE PERMANENTLY PLACED AFTER EQUIPMENT INSTALLATION.
3. EQUIPMENT WEIGHT IS 525 LBS PER CABINET.
4. FLOOR LOADING TO BE 100 LBS/SQ. FT. DISTRIBUTED.
5. FLOOR TOLERANCE: 1/8" OVER 10'-0".
6. ADDITIONAL FLOOR SPACE NEEDED IF STANDBY POWER OR OTHER TELEPHONE FACILITIES REQUIRED.
7. GTD-120 EQUIPMENT REQUIRES ADEQUATE VENTILATION AS THERE IS A MAXIMUM DISSIPATION OF 4,950 BTU'S (1,450 WATTS) PER CABINET.

Figure 5-3. Typical Floor Plan for GTD-120 Digital PABX.



NOTES:

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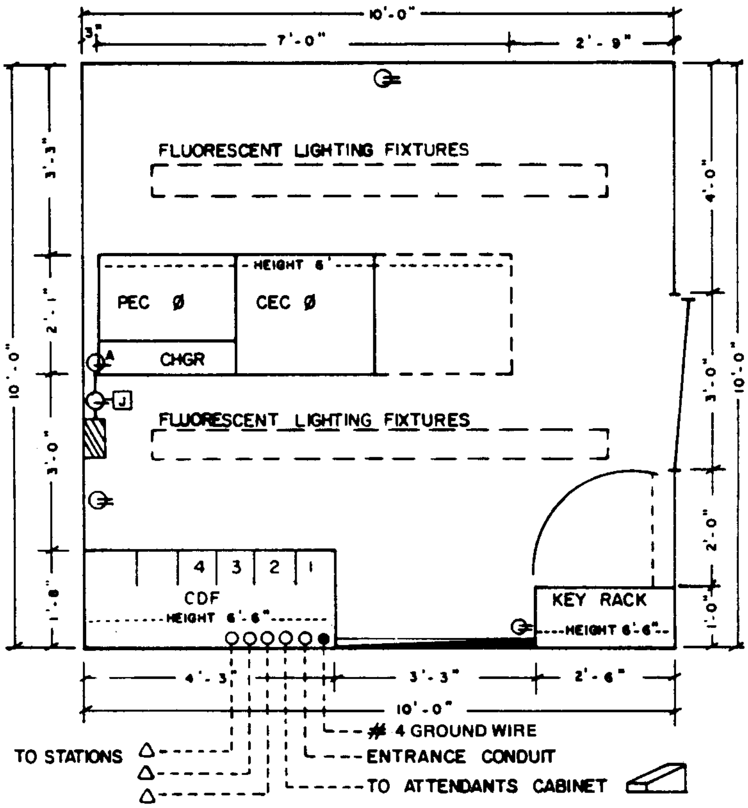
7. GTD-120 EQUIPMENT REQUIRES ADEQUATE VENTILATION AS THERE IS A MAXIMUM DISSIPATION OF 4,950 BTU'S (1,450 WATTS) PER CABINET.

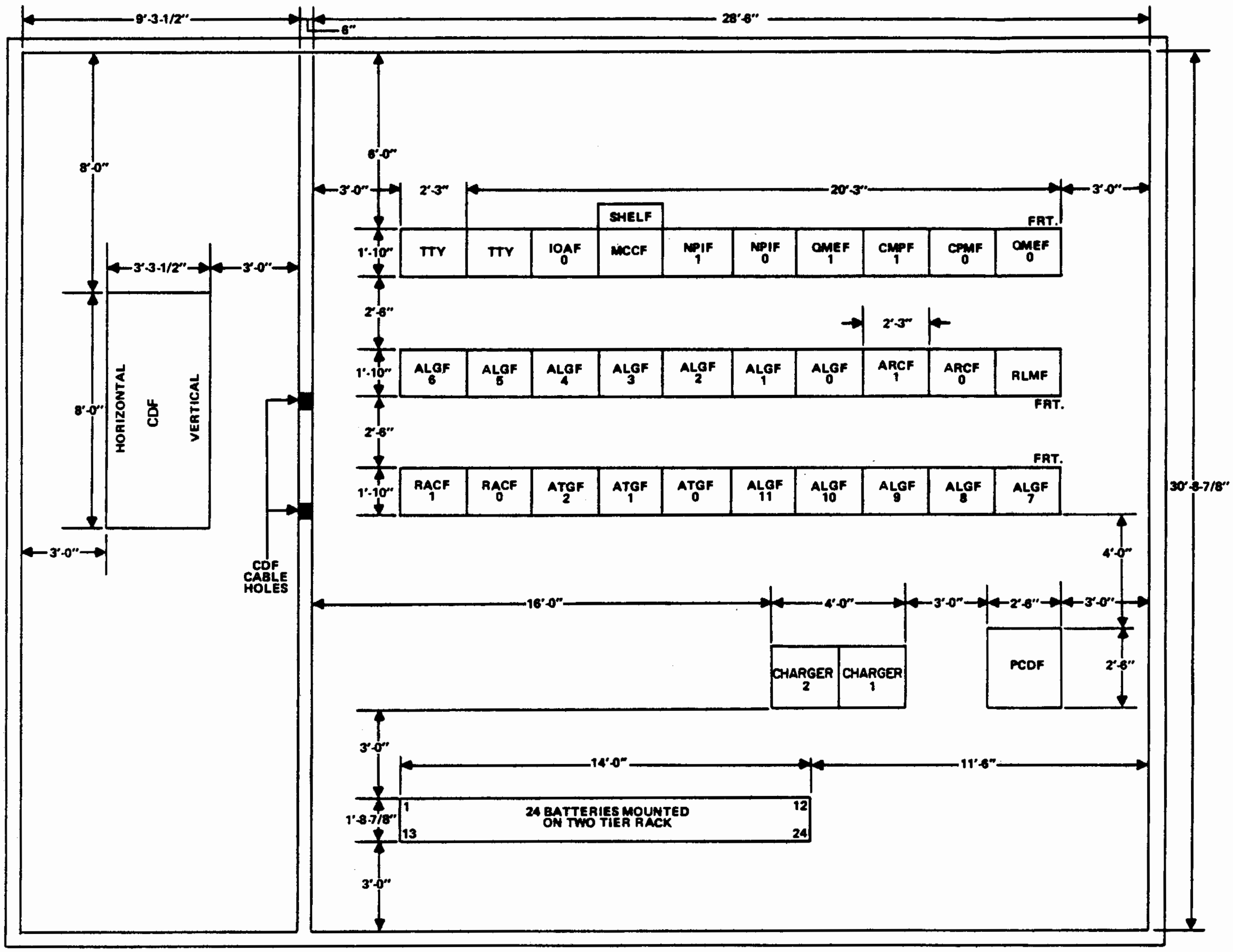
Figure 5-4. Typical Floor Plan for Two GTD-120 PABX Cabinets.



NOTES:

1. LINE CAPACITY - 256/224
2. TRUNKS - 48/64
3. TWO TURRET MAXIMUM
4. MINIMUM CEILING HEIGHT 8'
5. CONDUIT SIZE TO BE DETERMINED BY TELEPHONE COMPANY
6. EACH CHGR. REQUIRES SEPARATE 110 VOLT AC-20 AMP CIRCUIT
7. 110 VOLT AC OUTLET
8. POWER SURGE ARRESTER OUTLET
9. POWER PANEL
10. 3/4" PLYWOOD BACKBOARD
11. EQUIPMENT CABLE (TURRET) - COMMERCIAL, 1 (6 PR)
12. EQUIPMENT CABLE (CABINET) - COMMERCIAL 14 (25 PR. GROUPS)
13. BAT. & GRD. - (1 PR)

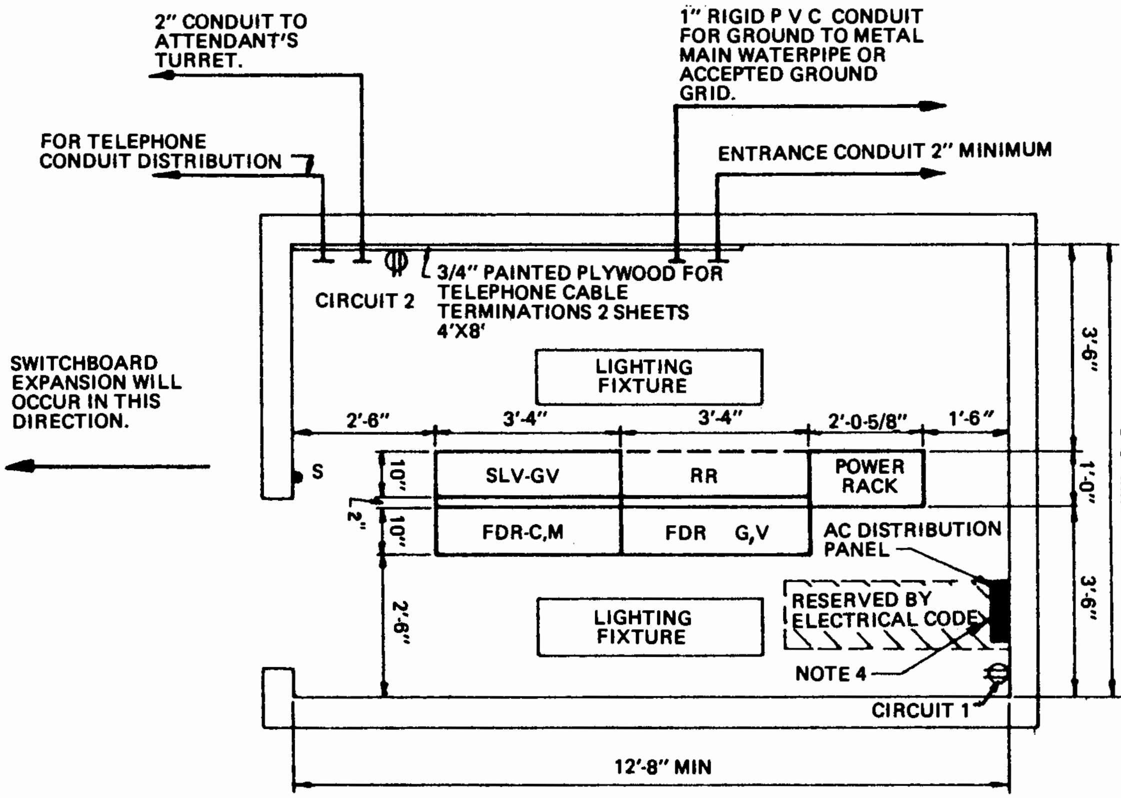
Figure 5-5. Typical Floor Plan for a GTD-1000 Digital PABX.



NOTES:

1. THE SYSTEM EQUIPMENT FRAMES ARE 8'-0" HIGH UNLESS OTHERWISE SPECIFIED.
2. CEILING HEIGHT IN CLEAR (I.E. FROM FLOOR TO BOTTOM OF LOWEST OBSTRUCTION SUCH AS BEAMS, DUCTS, LIGHT FIXTURES, ETC.) SHALL NOT BE LESS THAN 10'-6" FOR CABLE RUNWAY AND NOT LESS THAN 11'-3" FOR CABLE GRID.
3. MINIMUM FLOOR LOADING CAPACITY IS 125 POUNDS PER SQUARE FOOT FOR THE EQUIPMENT AREA AND 150 POUNDS PER SQUARE FOOT FOR THE POWER AREA.
4. THIS LAYOUT IS BASED ON 4,608 NOMINAL MAXIMUM LINES AND 576 NOMINAL MAXIMUM TRUNKS. THESE PARAMETERS REQUIRE SIX NU'S, WHICH IS MAXIMUM FOR THE SYSTEM. ANY INCREASE IN LINES WILL RESULT IN A REDUCTION OF TRUNKS AND ANY INCREASE IN TRUNKS WILL RESULT IN A REDUCTION OF LINES.
5. POWER EQUIPMENT MAY BE LOCATED ON A DIFFERENT FLOOR.

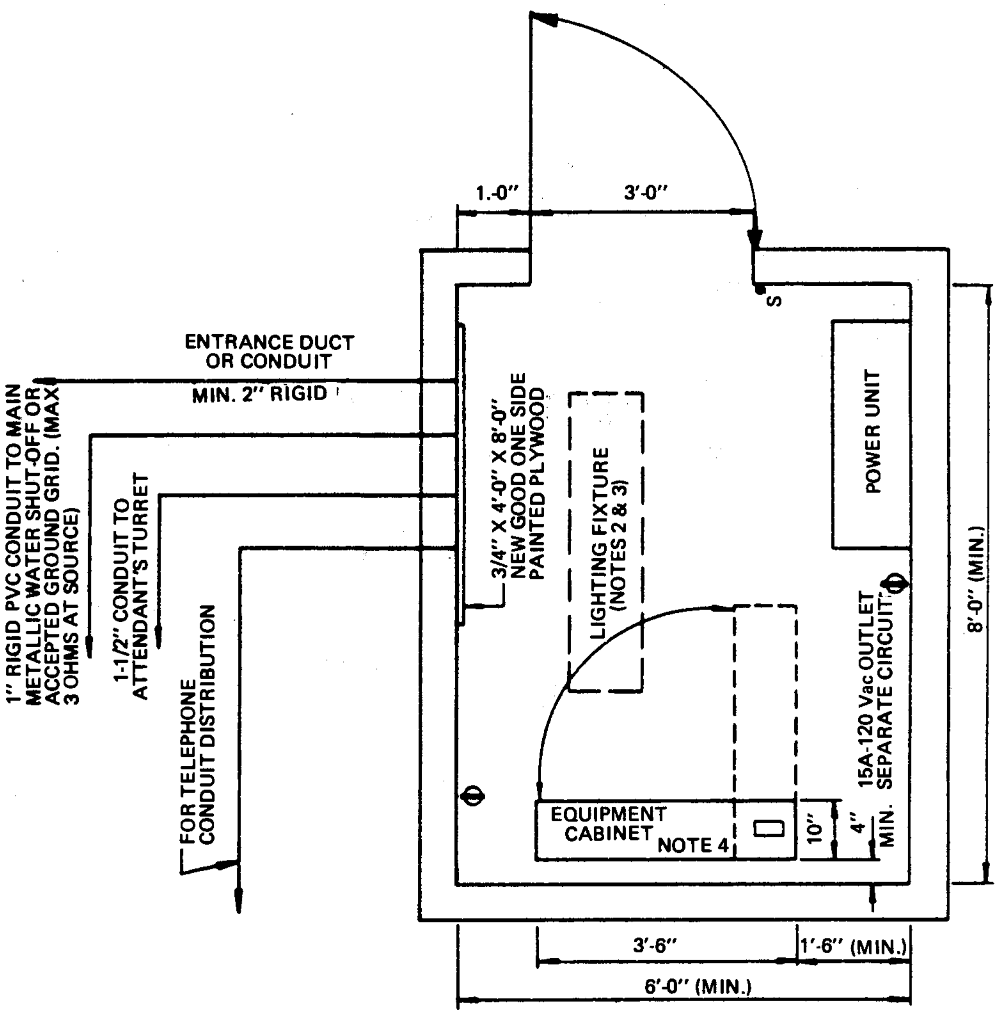
Figure 5-6. Typical Floor Plan for a GTD-4600 Digital Business Service Module.



NOTES:

1. FLOOR LOADING IS: 233 POUNDS PER SQUARE FOOT.
2. LIGHTING FIXTURES TO BE: 2 LAMP, 40 WATT, SHIELDED FLUORESCENT.
3. MINIMUM CEILING HEIGHT REQUIRED: 9"-0" CLEAR.
4. MINIMUM 50 AMP, 120/208 Vac, 3 PHASE, 4 WIRE, 6 BREAKER SURFACE MOUNTED ELECTRICAL PANEL.

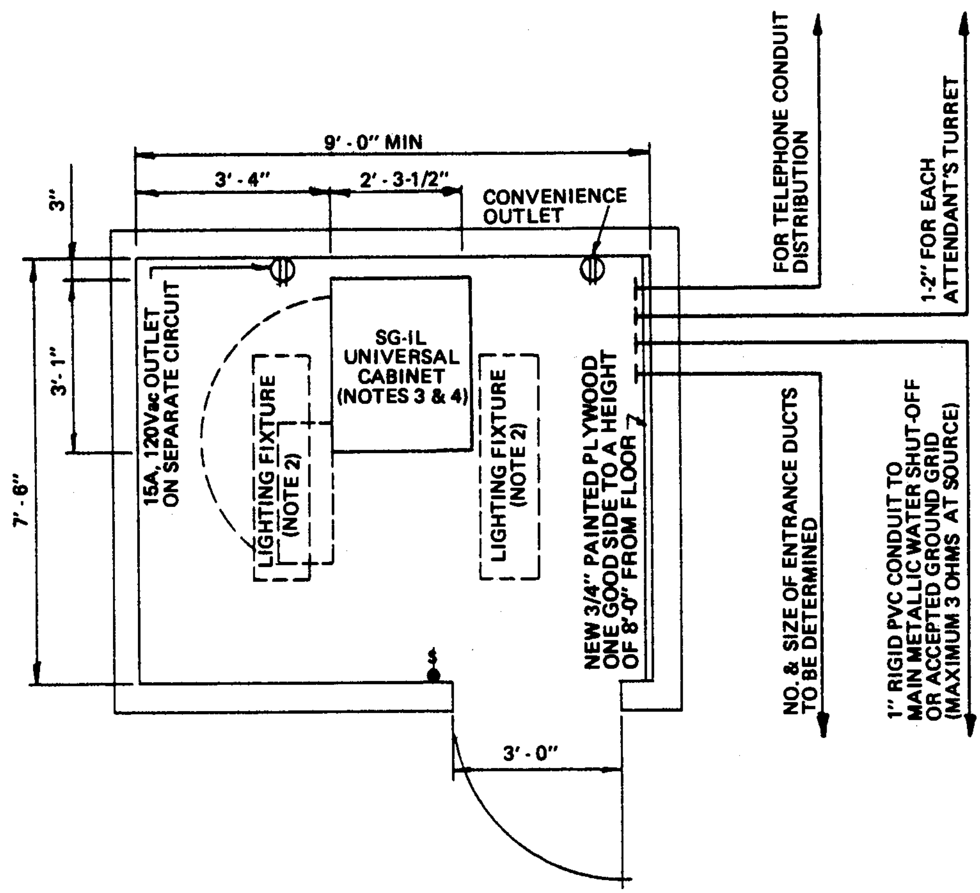
Figure 5-7. Typical Floor Plan for a 90-Line Ericsson Type PABX.



NOTES:

1. MINIMUM CEILING HEIGHT REQUIRED – 8'-6" CLEAR.
2. LIGHTING FIXTURE TO BE: 2 LAMP, 40 WATT, SHIELDED FLUORESCENT.
3. LIGHTING FIXTURE SHALL BE PERMANENTLY PLACED AFTER EQUIPMENT INSTALLATION.
4. EQUIPMENT CABINET WEIGHT IS 1,300 LBS.
5. FLOOR TOLERANCE: 1/8" OVER 10'-0".

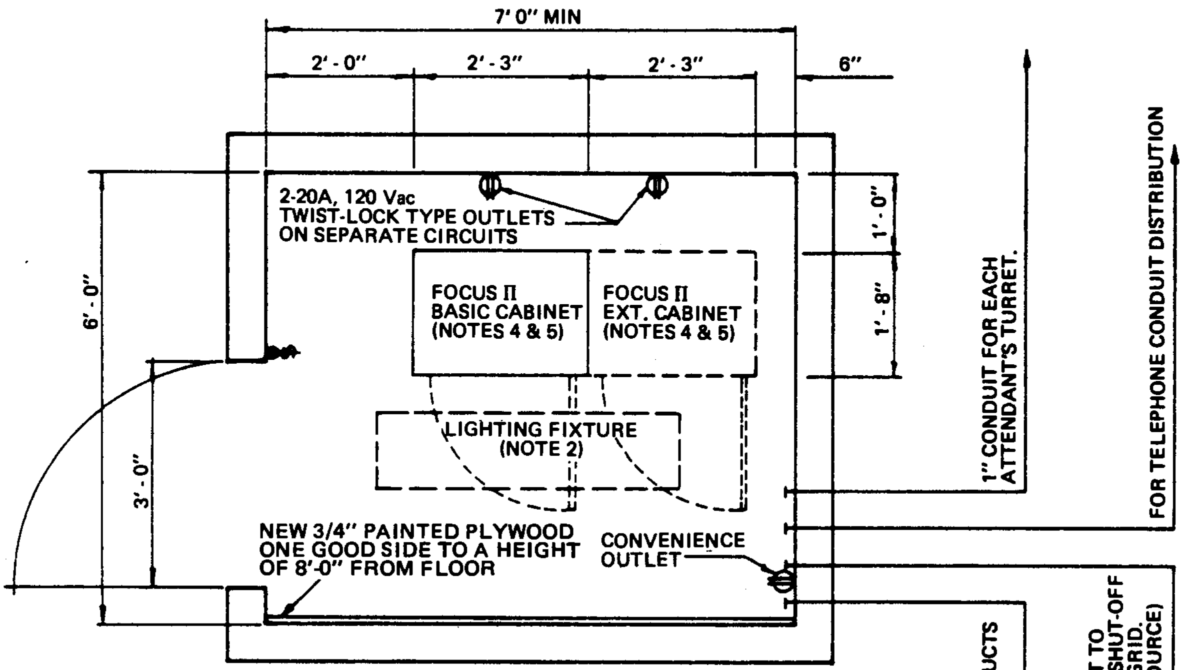
Figure 5-8. Typical Floor Plan of an AKD-741 PABX.



NOTES:

1. MINIMUM CEILING REQUIRED IS 8'-0" CLEAR.
2. LIGHTING FIXTURES TO BE 2 LAMP, 40 WATT, 4'-0" SHIELDED FLUORESCENT. FIXTURES TO BE PERMANENTLY PLACED AFTER EQUIPMENT INSTALLATION.
3. MAXIMUM EQUIPMENT WEIGHT IS 850 LBS. PER CABINET.
4. MAXIMUM FLOOR LOADING IS TO BE 120 LBS/SQ. FT.
5. FLOOR TOLERANCE: 1/8" OVER 10'.
6. ADDITIONAL FLOOR SPACE NEEDED IF STANDBY POWER OR OTHER TELEPHONE FACILITIES REQUIRED.
7. SG-1, SG-1A or SG-1L EQUIPMENT REQUIRES ADEQUATE VENTILATION AS THERE IS A MAXIMUM DISSIPATION OF 4,265 BTU'S (1,250 WATTS) PER CABINET.

Figure 5-9. Typical Floor Plan for an SG-1L Universal PABX.



NOTES:

1. MINIMUM CEILING HEIGHT REQUIRED IS 8' - 0" CLEAR.
2. LIGHTING FIXTURES TO BE 2 LAMP, 40 WATT, (4' - 0") SHIELDED FLUORESCENT. FIXTURES TO BE PERMANENTLY PLACED AFTER EQUIPMENT INSTALLATION.
3. MINIMUM 100 AMP 120/240 VAC, 3 PHASE, 4 WIRE, 8 BREAKER, SURFACE MOUNTED ELECTRICAL PANEL.
4. EQUIPMENT WEIGHT IS 375 LBS PER CABINET.
5. FLOOR LOADING TO BE 100 LBS/SQ. FT.
6. FLOOR TOLERANCE: 1/8" OVER 10'.
7. ADDITIONAL FLOOR SPACE NEEDED IF STANDBY POWER REQUIRED.
8. FOCUS II EQUIPMENT REQUIRES ADEQUATE VENTILATION AS THERE IS A CONSTANT DISSIPATION OF 3,412-4265 BTU'S (1,000-1,250 WATTS) PER CABINET.

Figure 5-10. Typical Floor Plan for a FOCUS II Two-Cabinet PABX.

6. SERVICE ENTRANCE

1. GENERAL

1.01 The service entrance is the route from where the telephone company lines or cables cross the property line to where they enter the building.

1.02 There are three types of service entrances:

(a) Underground Entrance. The underground entrance consists of a buried conduit which provides mechanical protection for the cable and minimizes the need for possible subsequent repairs to the property. The conduit is provided by the building owner from the building to the property line.
(b) Buried Entrance. A buried entrance consists of a cable that has been buried in a trench. The trench is provided by the building owner unless the cable is to be plowed-in.
(c) Aerial Entrance. The aerial entrance consists of a cable that provides service aerially from a telephone pole to the building.

2. DESIGN GUIDELINES

2.01 The advantages of an underground entrance are as follows:

(a) The conduit provides the best mechanical protection for the cable.
(b) The cable can be placed in the conduit at any time.
(c) Extra cable or replacement cable can be placed in the conduit with relative ease.
(d) The lack of visible cables provides a good appearance.

2.02 The disadvantage of an underground entrance is the cost to the building owner to provide the trench and conduit.

2.03 The advantages of a buried entrance are as follows:

(a) A buried entrance provides some mechanical protection for the cable.
(b) The lack of visible cables provides a good appearance.

2.04 The disadvantages of a buried entrance are as follows:

(a) The cost to the building owner to provide the trench if the cable is not plowed-in.
(b) It is difficult to schedule the cable placement.
(c) It is relatively difficult to replace the buried cable or to add an additional cable.
(d) Unless the cable is placed within a recorded easement, the telephone company has no protection against bearing the full cost of cable replacement and relocation should the property owner need to build upon that part of his land.

2.05 The advantage of an aerial entrance is that it is normally provided at little or no cost to the building owner.

2.06 The disadvantages of an aerial entrance are as follows:

(a) There is no mechanical protection for the cables.
(b) The exposed cables do not provide a good appearance in some areas.

2.07 Consideration for a dual or alternate entrance provision should be given to the following types of buildings:

(a) Hospitals.
(b) Airports.
(c) Police stations.
(d) Military installations.
(e) Power generation stations or control locations.
(f) Radio stations.
(g) Television stations.
(h) Transmitter sites.
(i) Data centers.

Underground Entrance

2.08 The general recommendations for underground entrances are as follows:

(a) The conduit should be of corrosion-resistant material.
(b) The conduit run should not include more than two 90-degree bends.
(c) If metallic conduit is used, it is to be reamed, bushed, and/or capped.
(d) Where applicable, metallic sleeves should be placed through the foundation wall and

extend out far enough to reach undisturbed ground. This will prevent shearing.

(e) The conduit is to be buried at a minimum depth of 18 inches or to meet local codes.

(f) Conduit that is placed on private property must not be terminated in joint-use manholes with electrical cables.

(g) Telephone conduits are to be separated from power conduits by not less than 3 inches of concrete or 12 inches of well-tamped earth.

2.09 The following types of conduit are acceptable:

(a) Galvanized iron.
(b) Plastic.
(c) Fiberglass.

2.10 The recommended size for conduit is 4-inch diameter.

2.11 The quantity of conduits depends on the size of the building. Table 6-1 provides the recommended quantity of conduits to be provided including spares. The minimum quantity is two.

2.12 At times, an underground system is laid from an aerial system. In these cases the following are recommended:

(a) The minimum entrance conduit is 2 inches. However, a 4-inch conduit should be installed to facilitate replacement or additional cable.
(b) A spare conduit of the same size should be provided.
(c) A pull wire is to be installed in the conduit.
(d) If possible, the conduit should be terminated on the field side quarter of the pole.

Buried Entrance

2.13 A buried entrance can be either direct buried service or joint direct buried service. Joint direct buried service can be standard separation or random separation.

2.14 Figure 6-1 shows a typical direct buried service entrance. Figure 6-2 shows a typical joint direct buried standard separation entrance.

2.15 Cable that passes under a paved surface that supports a vehicle load should be placed in a conduit.

Aerial Entrance

2.16 Generally, the maximum span of an aerial entrance from pole to building should be 100 feet.

2.17 The building owner is to provide the entrance into the building which should be either of the following:

(a) A sleeve through the wall.
(b) Conduit.

2.18 The exterior wall surface to which the cable is to be attached and the method of attachment are to be specified. The building owner is responsible for the attachment device which is to be according to telephone company standards.

2.19 A mast type entrance is to be used where clearance is a problem, or slack span construction must be employed. The maximum height of the mast is to be 4 feet above the roof. If a higher mast is required, it must be guyed.

2.20 Clearances between telephone cables and power cables are to be according to telephone company standards, National Electrical Code, National Electrical Safety Code, and any local code that may apply.

Cable Sizing

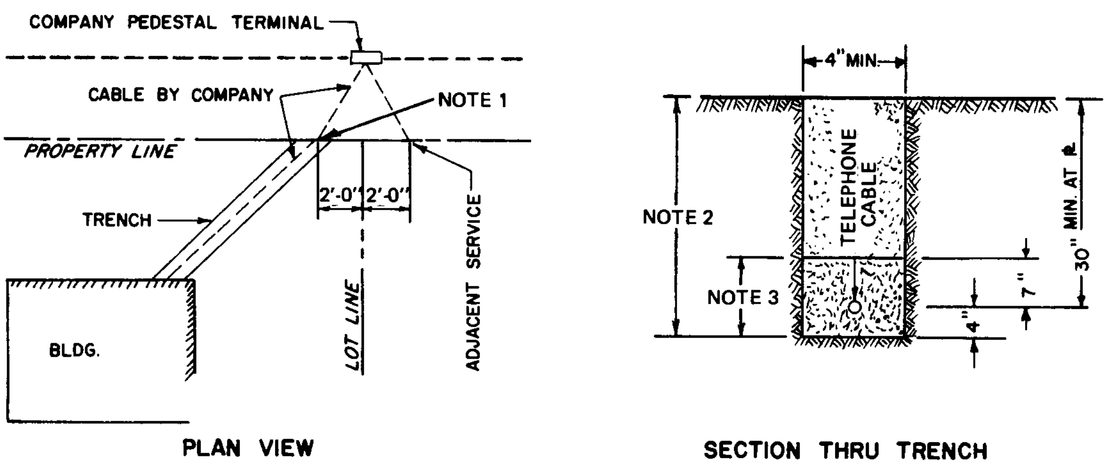
2.21 For a commercial office complex, the rule of thumb is to provide 5 to 10 pairs per 1,000 square feet of usable floor space.

2.22 Requirements to be considered are as follows:

(a) Customer requirements for a PABX or Centrex service.
(b) The type or types of business in the building.
(c) If it is an apartment building, the number of units.

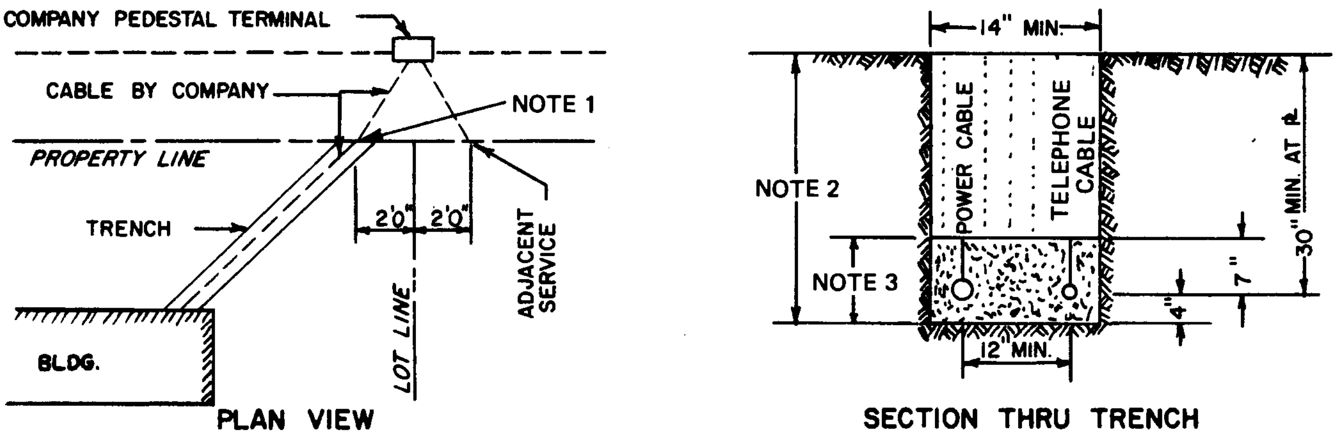
Table 6-1. Recommended Quantity of Conduits.

USABLE FLOOR AREA (THOUSAND SQ. FEET)	NO. OF CONDUITS (INCLUDING SPARES)
0 to 200	2
200 to 400	3
400 to 550	4
550 to 700	5
700 to 900	6
900 to 1050	7
1050 to 1200	8
1200 to 1400	9
1400 to 1600	10
Each additional 200,000 sq. feet	1



NOTES:
1. LOCATION AS DETERMINED BY COMPANY.
2. EXCAVATION AND BACK FILL BY OTHERS.
3. FILL TO BE CLEAR OF ROCKS AND SHARP STONES.
4. CONDUIT TO BE PLACED AS REQUIRED.

Figure 6-1. Typical Direct Buried Service Entrance.



NOTES:

1. LOCATION AS DETERMINED BY COMPANY.
2. EXCAVATION AND BACK FILL BY OTHERS.
3. FILL TO BE CLEAR OF ROCKS AND SHARP STONES.
4. CONDUIT TO BE PLACED AS REQUIRED.

Figure 6-2. Typical Joint Direct Buried Service Entrance.

7. GLOSSARY AND SYMBOLS

1. GENERAL

1.01 The definitions and symbols presented here are intended to assist the Building Industry Consultant in reading building industry drawings and in preparing the communications proposals.

2. DEFINITIONS

2.01 For purposes of this handbook, the following terms are defined:

(a) Access Unit, Handhole, or Junction Box. An opening with a removable cover to provide access to the header and/or distribution ducts or cells.

(b) Apparatus Closet. A suitable enclosure large enough to contain key telephone system apparatus, power equipment and terminating facilities for key telephone system stations and services, and central office and PABX lines. Apparatus closets may also serve as equipment closets, zone closets, or riser closets, according to the design of the underfloor raceway or riser system.

(c) Beam. A horizontal supporting structural member.

(d) Blended Floor System. A combination of cellular floor units with raceway capability and other floor units without such capability, arranged systematically in a modular pattern.

(e) Building Core. A portion of any building devoted to stairwells, elevators, electrical equipment, and rest rooms.

(f) Cellular Floor Units. A load-bearing floor unit containing one or more longitudinal cells, which may be "closed" on all sides or "open" at top or bottom. "Closed" cells may be used as raceways when the unit conforms to applicable code requirements.

(g) Cellular Floor Raceway. An assembly of cellular metal or concrete floor raceway units forming part of a continuous floor structure.

(h) Centrex. A communications service that offers a flexible "mix" of telephone services especially selected to meet the needs of the high-volume and relatively sophisticated customer. Each station may have its own telephone number so that each may be dialed directly and may dial its own calls without the intervention of an attendant. Typical Centrex services include direct outward and inward dialing; direct inside dialing for intraorganizational communications; automatic call transfer; automatic identification of outward dialing for accounting and cost-control purposes; station hunting, which automatically routes calls to another line when a called line is busy; and a variety of other services.

(i) Company Specifications. The agreed arrangements between telephone company, architect, engineer, and builder or owner.

(j) Concrete Fill. A minimal depth, lightweight grate placed atop a structural concrete pour.

(k) Curtain Wall. A non-load-bearing exterior wall.

(l) Density. The average number of individuals or units per space unit.

(m) Distribution Duct or Cell. A raceway of any of various cross sections placed within or just below the floor and from which the wires and cables serve a specific floor area.

(n) Distribution Frame. A wall- or floor-mounted vertical frame of iron work used to protect and terminate outside telephone cable pairs.

(o) Equipment Room. A room designed to accommodate PABX equipment. On occasion, it may also include automatic key telephone system apparatus and terminating facilities.

(p) Facilities. Equipment, hardware, or space provided to house communications systems to operate tenant services.

(q) False Ceiling. The area or space between ceiling tiles and the floor slab of the floor above.

(r) Floor Closets. The collecting point designed to terminate the cable wire and equipment for a specific floor.

(s) Floor Distribution. The various methods provided for the distribution of floor cable and wiring.

(t) Girders. A horizontal main structural member that supports vertical loads.

(u) Header or Feeder Duct. A raceway of rectangular cross section that is placed within or just below the floor, and ties the distribution duct or cell to the terminal or equipment space.

(v) Hollow-Core. A wall having a cavity as its center or core.

(w) Housings. Closets or built-in cabinets, equipment rooms, and other facilities provided to accommodate or furnish access to any part of a building communication system.

(x) Insert. A circular or ellipsoid cross-sectional opening into the distribution duct or cell from which the wires or cable emerge. It can be factory installed, preset, or afterset as required.

(y) Interface. A shared boundary, as the boundary between two subsystems or two devices in a communications system or telephone company and customer owned equipment. A data transmission set is a common interface between a computer and the communications network.

(z) Jack Header. A raceway similar to a header duct, but usually provided in shorter lengths to connect a quantity of distribution ducts together.

(aa) Joist. Small beams in a building arranged parallel from wall to wall or main beam to main beam to support the floor or ceiling.

(bb) Main Terminal Room. The cross-connection point of incoming cables from the telephone company offices and the in-building cable system.

(cc) Monolithic. The single, continuous pouring of the concrete floor and columns of any given floor of a building structure.

(dd) Mullion. A slender vertical pier between lights of windows, doors, or screens.

(ee) Perforated Joist. A concrete beam acting as a joist, with preformed holes provided to allow access through the ceiling by passing through the joist.

(ff) Pilaster. An upright rectangular pier that usually projects a third or less of its width from a wall.

(gg) Poke Through. An unlimited or random penetration through the fire-resistive floor structure. Used to facilitate the installation of distribution wires for power and communications.

(hh) Prewiring. A telephone company service providing for concealed telephone wiring in residential buildings, individual homes, duplexes, and triplexes only. Such wiring is installed before walls are enclosed. This service is not available in commercial or institutional buildings.

(ii) Raceway. Pipe, conduit, underfloor duct, header duct, trench header, cellular floor, overfloor molding, surface wiring systems, wiring channels in removable partitions, floor boxes and service fittings, and any other channels for holding wires and cables that are designed expressly for and used solely for this purpose.

(jj) Return Air Plenum. The utilization of the false ceiling area on each floor to move air (for heating and air conditioning).

(kk) Riser Closet. A location where riser cables terminate for further distribution throughout the floor. May also serve as an apparatus closet or satellite closet, depending upon the size of the building and the telephone facilities involved.

(ll) Riser Conduit Systems. The noncombustible tubing that interconnects floor terminal locations.

(mm) Riser Shaft Systems. A series of closets aligned vertically and interconnected by slots or short conduit sleeves between floors.

(nn) Satellite Terminal Cabinet. May include flush-mounted wall cabinets, surface-mounted terminal boxes, etc. Flush-mounted wall cabinets or boxes usually provided by the owner, and terminal boxes provided by the telephone company, differ from satellite closets while serving the same function; they are smaller and serve a smaller floor area.

(oo) Satellite Terminal Closet. A closet that has terminating facilities for key telephone system services, stations, and central office and PABX lines but does not contain key telephone system circuitry.

(pp) Service Entrance. The route from where telephone lines (or cable) cross the property line to where they enter the building.

(qq) Service Fitting. A box mounted on or in the finished floor that houses the connecting device for communication and power circuits.

(rr) Sheer Wall. A perpendicular building wall where the greatest changes or transfers of stress occur.

(ss) Slab on Grade. Concrete floor on virgin soil, no basement involved.

(tt) Sleeve or Pipe Sleeve. A circular opening through the floor structure to allow the passage of cables and wires.

(uu) Slot. An opening through the floor structure, usually rectangular to allow the passage of cables and wires.

(vv) Solid-Core. A wall having a solid center or core.

(ww) Underfloor Raceway. Any facility provided for the express purpose of holding wires or cables and located within or immediately below the floor structure. Raceways may be of metal or insulating material. The term includes rigid metal conduit, flexible non-metallic conduit, cellular metal or concrete raceways, and underfloor duct.

(xx) Utility Column (Ceiling Drop Pole). A post placed between the ceiling and floor in conjunction with ceiling distribution systems. It is used for the concealment of communications and electrical wiring from the ceiling space to the desk.

3. SYMBOLS

3.01 The architectural symbols used on drawings covering communication facilities are shown in Figures 7-1 through 7-6:

(a) Figures 7-1 and 7-2 show the basic symbols for telephone and electrical apparatus.

(b) Figure 7-3 shows the basic symbols associated with equipment used for heating and ventilating.

(c) Figure 7-4 shows the basic symbols used for the construction of the building proper.

(d) Figure 7-5 shows the architectural symbols for partitioning.

(e) Figure 7-6 shows the symbols used for piping of water and steam.

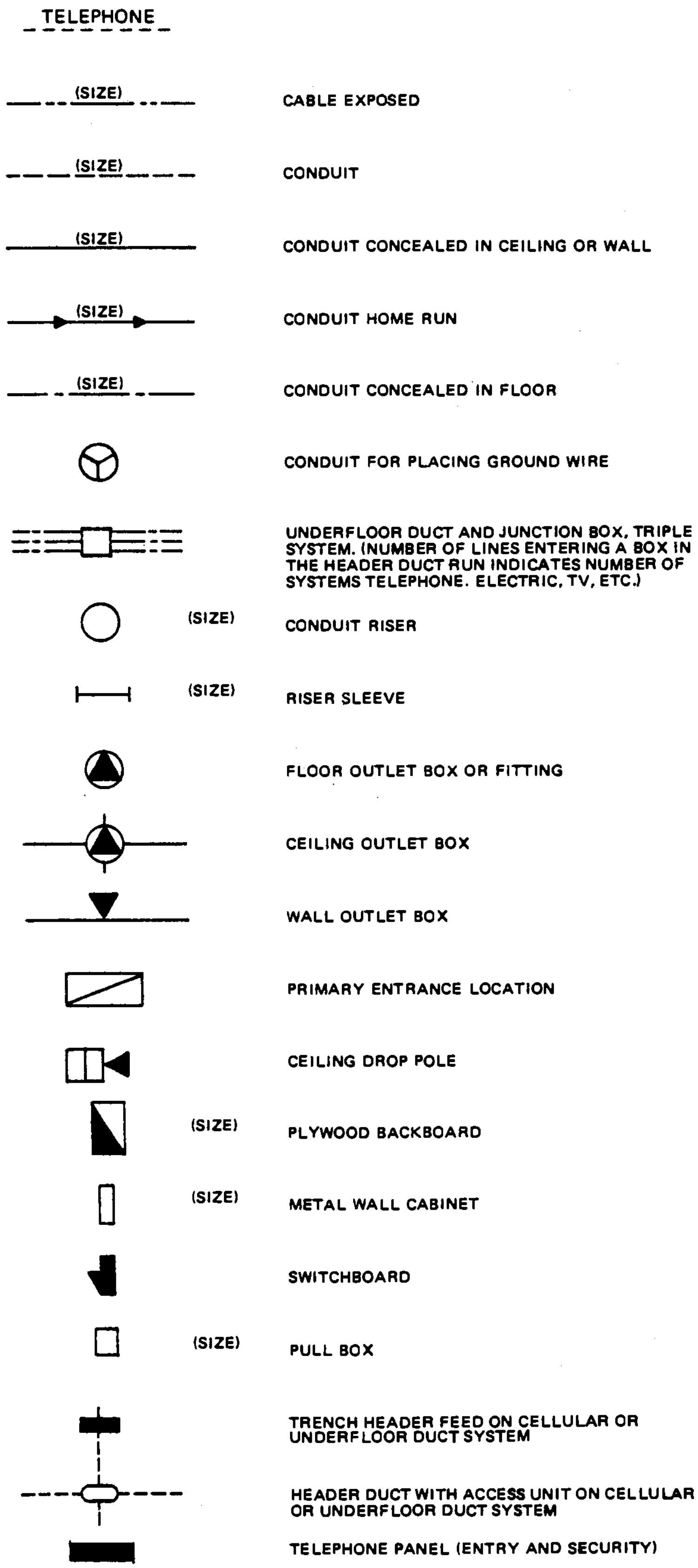


Figure 7-1. Telephone Symbols.

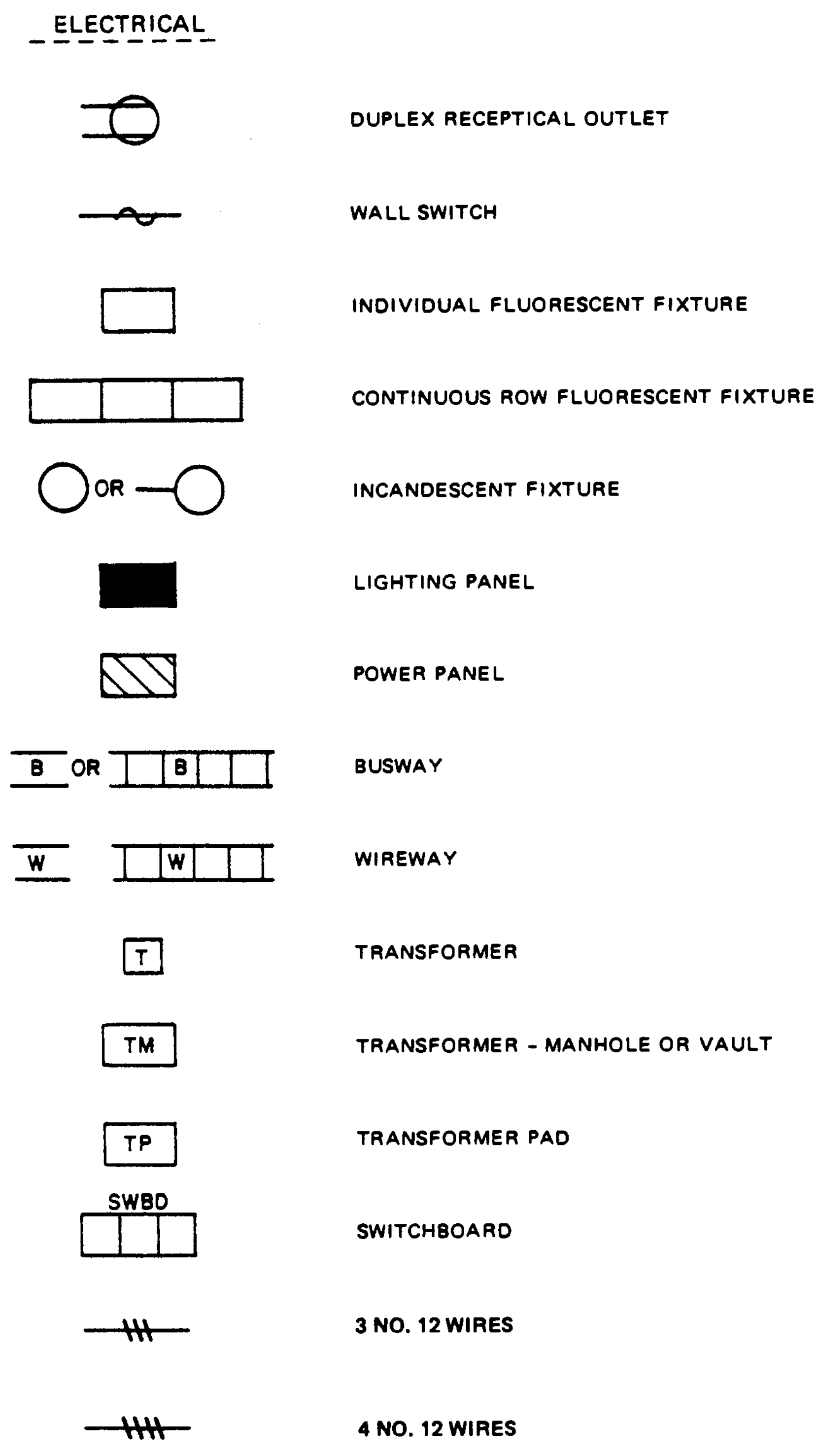


Figure 7-2. Electrical Symbols.

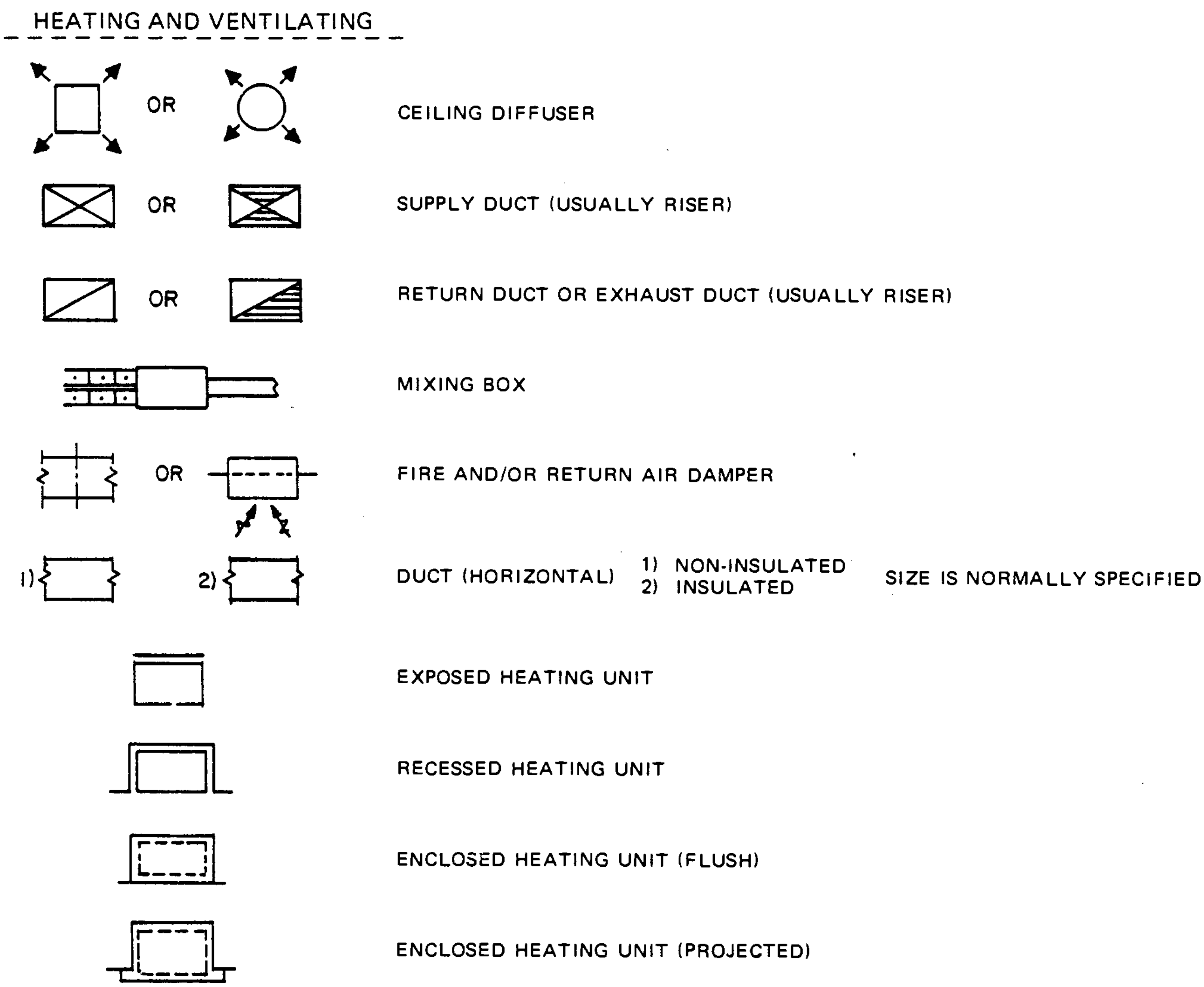
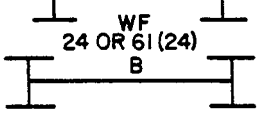


Figure 7-3. Heating and Ventilating Symbols.

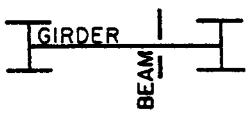
STRUCTURAL

COLUMN

COLUMN WITH CARRYING BEAM (GIRDER)



24 = DEPTH WF = WIDE FLANGE B = SERIES BEAM
61 = WT./FT. (24) = SHEAR CONNECTION

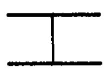


= DIRECTION OF CONCRETE EXPANSION

CONCRETE
WILL BE NOTED - STRUCTURAL = 3,000 -5,000 LBS./SQ. IN.
(USUALLY FLOORS AND SUPPORTING WALLS)
MASS = 1,500-2,500 LBS.

LIGHTWEIGHT CONCRETE (NORMALLY FILL)

STANDARD BEAM (B)



WIDE FLANGE BEAM (WF)

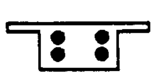
CHANNEL (C)

TEE (T)

ANGLE (L)

INSULATION

SPRAYED INSULATION



REINFORCING BARS

PRESTRESSED OR PREFORMED PLANKING (CELLULAR CONCRETE FLOOR)

Figure 7-4. Structural Symbols.

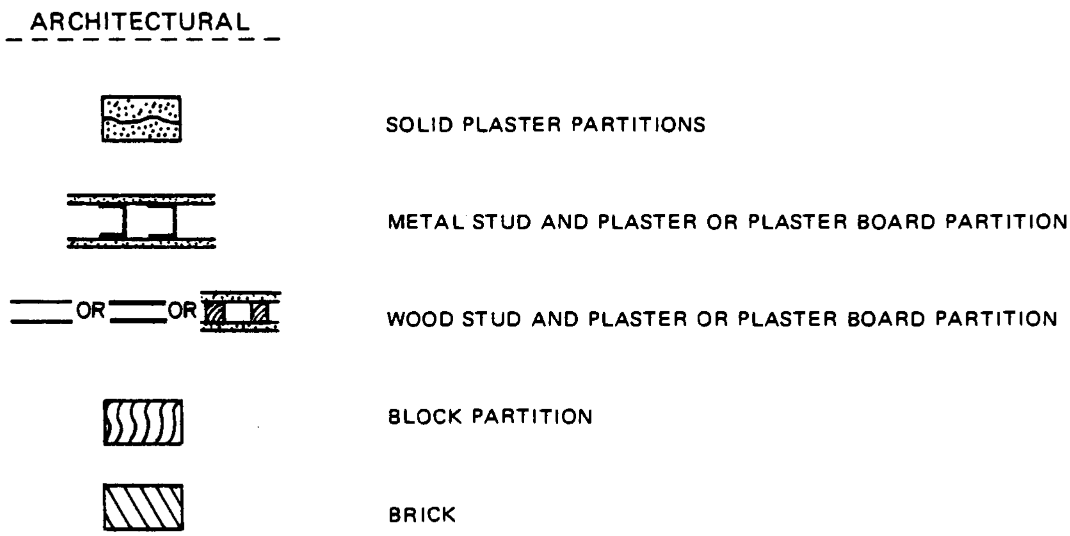


Figure 7-5. Architectural Symbols.

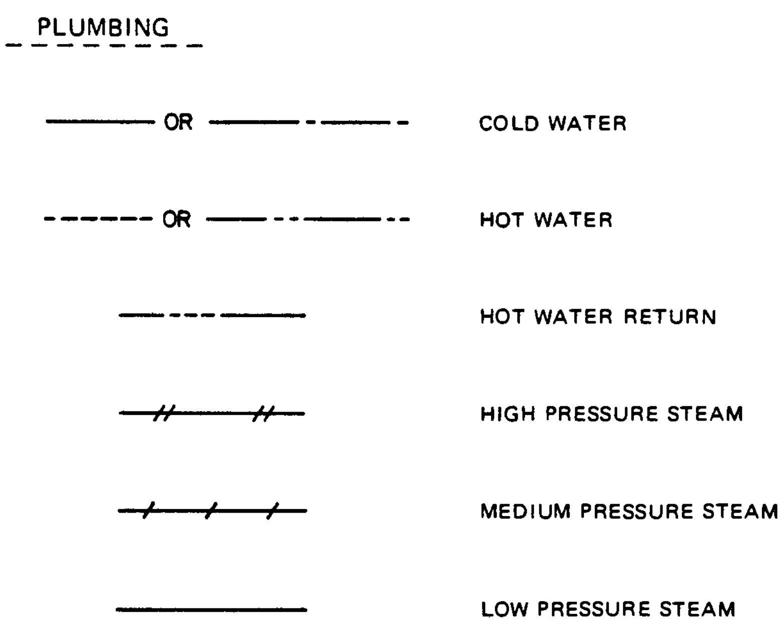


Figure 7-6. Plumbing Symbols.

HANDBOOK INDEX

REQUESTS FOR HANDBOOK PURCHASING INFORMATION SHOULD BE DIRECTED TO:

GTE AUTOMATIC ELECTRIC
GTE PRACTICES MANAGER
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