# ATT-TP-76409

# Common Systems Network Facility Cable Rack Requirements

**This practice provides the guidelines and requirements for engineering and installing cable rack arrangements in network equipment environments**

Audience: All network employees and I/R contractors

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**Table of Contents**

## INTRODUCTION

This practice shall be followed when providing cable racks for a new network equipment facility, growth to an existing facility, and when all or a portion of network equipment is to be removed from an equipment area and the cable racking above the removed equipment will remain in place. This practice should be used in conjunction with TP76305 Cable Installation, Removal and Mining and TP76408 Auxiliary Framing and Bracing requirements.

The following is a list of terms and their meanings as used in this document:

| Term | Meaning |
|---|---|
| Brace /Bracing | The diagonal member that is used to prevent swaying or whipping of a cable rack. |
| Cable Hole | An opening in a wall, partition, or floor for passage of cable and wire. |
| Cable Rack | The supporting structure for dc power and copper communications cable. |
| Power Cable Rack | Cable rack that is dedicated (restricted) to the routing and support of office and equipment dc power distribution cables only. |
| Switchboard / Misc. Cable Rack | Cable rack that is used for routing and support of network switching and transmission cables in general. Switchboard cable racks may contain certain types of equipment dc power distribution cables. |

## 1. REASON FOR REISSUE

| Issue | Date | Description of Changes | Author |
|---|---|---|---|
| 3 | 09/08/04 | Deleted reference to Fig. 5H as a free-ended arrangement in Item A. on page 11 and preceding paragraph. | Bm1924 |
| 2 | 05/03/04 | Corrected numbering of 2.2.1.1; Added note reference to ATT-TP-76409-001 following 3.1.1 and 3.1.2. | bm1924 |

## 2. GENERAL

### *2.1 Description and Sizes*

Cable racks used in network facilities shall be of the steel ladder type construction shown in Fig. 1. Cable racks shall consist of 2 x 3/8 inch rectangular side rails called “stringers” between which are welded on 9-inch centers 1 x 1/2 inch cross members called “straps”. The first and every other strap of cable racks wider than 24 inches shall be reinforced with a 1 inch by 1/4-inch steel bar.

Fig. 1 also indicates the standard widths of cable rack traditionally used in network facilities. Commercially available cable racks having widths different than those shown are acceptable for use when they are appropriate for the cabling needs of a particular equipment or office arrangement.

**NOTE:** Cable racks with side uprights welded on shall not be provided for new or growth of existing office cable rack arrangements.

## *2.2 Safe Loads*

### *2.2.1 Permissible Cable Pileups*

#### 2.2.1.1 Horizontal Cable Racks

The permissible pileups of cabling on horizontal cable racks are provided in Table A. The purpose of cable pileup restrictions are to ensure the weight of installed cable for an equipment area is evenly distributed across its ultimate support members such as ceiling anchors and/or equipment frameworks, and to facilitate the removal of cable that is no longer in service. Generally, cable pileup shall not exceed the width of the cable rack for cable racks less than 15-inches wide, or as indicated below for cable racks 15-inches and greater in width. The 5-foot and 6-foot spacing of supports refers to the overall supporting scheme of an equipment or cable racking area, not to any one support span along a run of cable rack.

| Table A | | |
|---|---|---|
| Permissible Cable Pileups On Horizontal Racks | | |
| Secured Power Cable | | |
| | Supports On | |
| Rack Width | 5’ Centers | 6’ Centers |
| 5” | Width Of Rack | Width Of Rack |
| 1’-0” to 1’-8” | 7” | 6” |
| Unsecured Switchboard Cable | | |
| | Supports On | |
| Rack Width | 5’ Centers | 6’ Centers |
| 5” to 1’-0” | Width Of Rack | Width Of Rack |
| 1’-3” to 2’-1” | 15” | 12” |
| Secured Switchboard Cable | | |
| | Supports On | |
| Rack Width | 5’ Centers | 6’ Centers |
| 5” | Width Of Rack | Width Of Rack |
| 1’-0” to 2’-1” | 12” | 10” |

#### 2.2.1.2. Vertical Racks

The cable pileup of vertical cable racks passing through building floors shall not exceed 12 inches for switchboard cable racks or 7-inches for power cable racks. To provide the space required to properly close and fire/smoke stop a cable hole, the pile-up on all vertical racks shall be additionally limited so that cable is not closer than 3-inches to the face of the cable hole.

*2.2.2. Cable Weights*

Table B can be used to estimate the weight of cable on a cable rack. The weights for switchboard cable listed in Table B are based on Table A pileup restrictions and; the assumption there is a cable density of 0.6 pounds per square inch (cross sectional area) of unsecured switchboard cable per linear foot of cable rack, and a density of 0.8 pounds per square inch (cross sectional area) of secured switchboard cable per linear foot of cable rack. These densities include an allowance for secondary power distribution cables that are usually installed on switchboard racks.

| Table B | | | | | |
|---|---|---|---|---|---|
| Approximate Weight Of Cable Racks At Full Capacity | | | | | |
| Cable Rack Width | Cable Type | Cable Rack Support Spacing | | | |
| | | 5'-0" | | 6'-0" | |
| | | lbs / Linear Ft | Total Weight | lbs / Linear Ft | Total Weight |
| 1'-0" | Secured | 105.6 | 528 | 105.6 | 633.6 |
| | Unsecured | 79.2 | 396 | 79.2 | 475 |
| | Power | 108 | 540 | 86.4 | 518.4 |
| 1'-3" | Secured | 134.4 | 672 | 112 | 672 |
| | Unsecured | 126 | 630 | 100.8 | 604.8 |
| | Power | 135 | 675 | 108 | 648 |
| 1'-8" | Secured | 182.4 | 912 | 152 | 912 |
| | Unsecured | 171 | 855 | 136.8 | 820.8 |
| | Power | 189 | 945 | 151.2 | 907.2 |
| 2'-1" | Secured | 230.4 | 1152 | 192 | 1152 |
| | Unsecured | 216 | 1080 | 172.8 | 1036.8 |

The weight of power cable varies noticeably with its diameter and no simple average exists for estimating power cable weight according to the cable pileup on a cable rack. The pileup information for power racks mentioned in 2.2.2. and in Table B are based on all cable being 750 kcm having an overall outside diameter of 1.34-inches, a per linear foot weight of 2.7 pounds, and a maximum pileup of 5 layers of cable (7") for 5'-0" cable rack support spacing schemes and 4 layers for 6'-0" support spacing schemes per the following:

A 1'-0" cable rack equates to cable layers of 5 high by 8 wide (40 cables total).
A 1'-3" cable rack equates to cable layers of 5 high by 10 wide (50 cables total).
A 1'-8" cable rack equates to cable layers of 5 high by 14 wide (70 cables total).

*2.2.3. Miscellaneous Loading Reference*

For the purpose of determining the spacing of cable rack supports for other than normal applications or office conditions, the safe loads for beam clamps, ceiling inserts, threaded rods, etc. may be considered to be as shown in Table C.

Table C
Safe Loads Of Equipment Environment Apparatus

| Apparatus | Safe Loads (lbs.) |
|---|---|
| 5/8-11 threaded inserts | 1200 |
| Ceiling insert (cast in-place) | 1200 |
| Acme type beam type clamps | 800 |
| 5/8” drop-in anchors | 480 |
| 3/8” drop-in anchors | 300 |
| 3/8” lag screws in wood 2” or more | 300 |
| Paired Framing Channel (span between supports) | |
| Up to 2’-0” | 2000 |
| 2’-0” to 3’-0” | 1500 |
| 3’-0” to 5”-0” | 1000 |
| 5’-0” to 7’-0” | 700 |
| 7’-0” to 8’-0” | 500 |
| Embedded ceiling ‘U’ channel | |
| At any one point | 2000 |
| Where two or more loads are within 2’--0” of each other | 2000 (total for group) |

### *2.3. Planning*

The objective of cable rack engineering is two-fold. First is the assurance equipment and office cable rack layouts are configured in a way that cable pileup is distributed across an equipment area so that unnecessary concentrations of cable (congestion) on individual racks are avoided. Secondly, is the assurance that a reasonable capacity for additional equipment cabling is provided initially for subsequent equipment growth jobs, thus minimizing the need to engineer and install additional racking as planned equipment is installed. This is accomplished by engineering cable rack arrangements for the foreseeable needs of the equipment area rather than just the needs of the equipment being added on a particular job, and knowing in advance when additional office cable racking is needed.

Unlike an equipment area’s auxiliary framing grid, the developed overall cable racking plan for an equipment area need not be furnished in its entirety on the initial equipment installation job. This is because equipment space usage (what is installed where) tends to change with changes in equipment technology and the business direction of the equipment office; and the actual location of office cable racks needs to be coordinated with the installed location of equipment frames and their physical cabling characteristics.

Equipment cable racking should only be furnished and installed for equipment configurations engineering knows or is reasonably certain will be installed in the near future, and to comply with the 75% cable capacity requirement discussed later in this part. This practice minimizes the possible need to reconfigure installed cable rack to suit the actual location and cabling characteristics of future equipment.

To communicate a developed overall cabling scheme of an equipment area to subsequent cable rack engineers, the overall plan for an equipment area should be depicted on the Auxiliary Framing and Cable Rack Plan office record. Using traditional office record keeping standards future cable rack paths are depicted in solid or dashed thin line work as opposed to existing cable rack paths which are depicted using heavy solid line work. The practice of continuously documenting cable racking schemes in this manner should enable harmonious equipment and cable rack growth and simplified subsequent cable rack engineering effort.

### *2.4. General Engineering Requirements*

The following guidelines apply to cable rack engineering in general:

A. Power cable racks shall not exceed 1'-8" in width.

B. Cable racks shall not be located close to building conditions or equipment that may subject installed cabling to damage or detrimental conditions.

C. Except as noted below, cables leaving a cable rack and entering equipment frames shall not be unsupported for a distance greater than 3-feet (measured along the arc of the shortest cable).

**NOTE:** Cables to conventional office distributing frames (copper cable) may be unsupported for a distance of 4-feet to accommodate the location of the frame's first transverse apparatus support member.

D. Vertical runs of power cable rack shall not exceed three floors of continuous in-line length (e.g. basement to 3rd floor). This is to avoid excessive vertical loads on cable rack fabrications and cable securing methods. When a vertical run of power cable rack must exceed three floors, a horizontal section of rack at least 20 cable feet in length shall be introduced into the power cable run at intervals not exceeding three floors (3rd, 6th, etc.). This may be accomplished by using cable holes that are vertically offset from each other by at least 20 cable feet, or by engineering a 20 cable foot horizontal loop in the cable rack run when the same vertical path of cable holes must be used. Vertical cable racks are considered continuous even though their overall length may be interrupted by cable hole sheathing material.

E. Unless otherwise directed by equipment documentation, lineup cable racks shall be placed at the front of equipment frames to complement the front mounted rear cabled characteristics of equipment units.

F. A clearance of 5-inches should be provided between the side or end of a cable rack and a building column or surface.

G. An installer's hand/forearm clearance of 4 inches should be provided between the ultimate cable pileup of a cable rack and any obstruction when possible.

H. A minimum of 1'-6" of working space should be provided on at least one side of a cable rack for installation access when possible and practicable.

I. Fig. 17 or its functional equivalent shall be provided at cable rack turns where the distance between cable supports does/may not prevent cable sag.

*2.4.1. Rack Sizing*

Cable rack layouts shall be engineered using cable rack widths that are appropriate for the cable rack's purpose and installed location. A cable rack's purpose is to accommodate equipment cabling over an extended period of time (general purpose racks), or to accommodate a specific amount of cabling to a specific equipment type or location (special purpose racks). Special purpose racks are not intended for general equipment cabling and shall be sized to the narrowest width possible to minimize the consumption of overhead cable rack space in general. The following is how the different standard cable rack widths should be applied for general purpose equipment cable rack layouts:

≤1'-0" Small or isolated equipment areas having limited long term cable capacity requirements.

1'-3" Cable racking in general where aisle space and installer access is limited.

1'-8" Main aisle, cross aisle, via, and dc power cable racks in general; vertical racks for cables passing through building floors; lineup racks for conventional office distributing frames (minimum width) and manual DSX equipment; lineup racks for equipment areas employing the use of wide equipment aisle ways (nominally 4'-0" front and 3'-0" rear).

2'-1" As necessary to suit specific equipment or office conditions. These wide racks are usually appropriate for HMDF cabling and where cable pileup space is severely restricted by HVAC ducts and other obstructions.

*2.4.2. Cable Route Diversity*

Engineering cable route diversity into an office cable distribution system (cabling scheme or cable rack layout) is a vital component of effectively managing cable lengths, cable pileup, congestion, and the usable life of an installed cable rack arrangement. Cable route diversity is a matter of providing multiple cable rack paths directly above equipment (cross aisle racks) and between equipment areas (via racks), and engineering cable lengths and routes using more than one cable rack path when appropriate (service protection or pileup avoidance).

To accomplish the above, more than enough cable capacity shall be engineered into network equipment environments initially by the use of multiple cable rack paths. The more cable paths there are, the easier it is to spread cable across an area, the less cable pileup there will be in general and at any one cable rack location, and the easier it will be to access and remove cable no longer in service.

Cable rack layouts shall be engineered so that no more than 75% of any one cable rack's cable capacity will be consumed by an individual job or project's initial cable installation activity. This is accomplished by the use of multiple via cable rack paths and by the cross aisle cable rack engineering scheme discussed later. Use Table D to determine when additional cable rack paths are needed according to the 75% requirement.

| Table D | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cable Capacity Of Standard Cable Racks (5'-0" support spacing) | | | | | | | | |
| Rack Width | Normal Capacity | | | | 75% Rule Capacity | | | |
| | Capacity (In.$^2$) | | Pileup (inches) | | Capacity (In.$^2$) | | Pileup (Inches) | |
| | Sec. | Unsec. | Sec. | Unsec. | Sec. | Unsec. | Sec. | Unsec. |
| 1'-0" | 132 | 132 | 12 | 12 | 99 | 99 | 9 | 9 |
| 1'-3" | 168 | 210 | 12 | 15 | 126 | 157 | 9 | 11 |
| 1'-8" | 228 | 285 | 12 | 15 | 171 | 213 | 9 | 11 |
| 2'-1" | 288 | 360 | 12 | 15 | 216 | 270 | 9 | 11 |

**Note:** (1) In.$^2$ capacity is based on the rack width minus 1" for stringer attachment hardware.

**Note:** (2) According to the above a new switch or other equipment entity having 500 In.$^2$ of secured interconnecting cable to other network elements requires a minimum of three 1'-8" via cable rack paths (500 ÷ 171 = 2.9 racks @ 75% capacity).

### *2.4.3. Entrance Cable Racks*

Entrance cable racks are used to route outside plant (OSP) cable from the cable entrance facility (CEF) to terminating equipment such as office distribution frames. Unless otherwise documented, OSP cable shall not be placed on cable racks with other office cabling. It is expected that OSP cable will be installed for the life of an office whereas other network cables are subject to cable removal and mining activity as equipment is relocated and replaced during the life of an office. Physically separating OSP cable from other network cabling minimizes the possibility of damage to OSP cables during the installation removal management of other equipment cabling.

Entrance cable rack for equipment frames installed along cable entrance facility building walls shall be installed at the rear of the equipment lineup. Entrance racks to equipment frames located interior to an equipment area shall be located at the highest level practical in an office to minimize any up-and-over cable rack arrangements and people activity.

### *2.4.4. Lineup Cable Racks*

Lineup cable racks are used to route cabling between equipment frames within the same equipment lineup. Lineup racks may be located above equipment frames (over-frame) or above the aisle way at the front or rear of equipment frames (over-aisle). Some equipment requires more than one type of lineup rack because different types of cable are used to interconnect the equipment to other network elements. Lineup racks used for different cable types should be arranged in one above the other multilevel fashion (likewise for any associated cross aisle racks).

Multilevel cable rack arrangements should be engineered so the greater or heaviest amount of cabling is installed at the lowest cable rack level to minimize cable installation and removal effort. For most equipment areas the lowest level of cable rack is used for copper based cables (twisted pair, coax and shielded). The upper level(s) of rack would be used for fiber optic and special purpose cable racks.

It should be noted there is an increasing use of fiber optic cable to interconnect network elements. Accordingly, for some equipment types or areas the greater or heaviest amount of cabling to be accommodated may be that of fiber optic cables with copper cables being used only for miscellaneous interconnections such as alarms, secondary power distribution, intercom equipment, etc. Under this scenario fiber optic cable racks or raceways could (probably should) be engineered as the lowest level of cable rack for the fiber equipment area, and transitional cable racks engineered for changing the copper cable to a higher level as it enters the area.

### *2.4.5. Cross Aisle Cable Racks*

Cross aisle racks are short lengths of cable rack placed directly above and at a right angle to equipment lineup racks and are used to provide as direct a cable route as possible between equipment frames in different equipment lineups. As shown in Fig. 2, cross aisle racks intersect lineup racks and are not continuous runs of cable rack except where they cross a future equipment lineup whose lineup cable rack has not been installed. Cross aisle cable racks shall be located along equipment lineups with approximately 5-feet of space between racks. This spreads cable pileup along the length of equipment lineups avoiding extreme cable pileups on lineup racks.

The above cross aisle cabling scheme shall be applied to all levels of lineup cable rack engineered into an equipment area except where it is known the inter-lineup cabling of equipment by the upper level racks (lesser overall amount of cabling) will be minimal. Under these circumstances the space between cross aisle cable racks may be increased, or narrow racks can be used to minimize cable rack congestion in the overhead environment.

### *2.4.6. Main Aisle Cable Racks*

Main Aisle cable racks are used to route inter-lineup cabling between equipment areas separated by a main cross aisle, as the primary entrance point of an equipment area for via cable racks (power being the prime example), and to supplement cross aisle cable pileup management. Main aisle cable racks shall be provided only where needed to minimize obstructing installer access to the overhead environment. Power cable racks should be provided at main cross aisles as an upper level rack because their cable pileup and rework activity is limited compared to that of other types of cable rack.

### *2.4.7. Via Cable Racks*

Via racks are used to route relatively large amounts of cabling from one equipment location to another without contributing to the cable pileup of an intermediate equipment area's cable distribution system or scheme. Via racks are usually located at a higher level than equipment lineup and cross aisle cable racking. Power cable racks are one example of a via cable rack. Via racks are also used with DMS switching equipment to route system cabling in the cross aisle direction in high seismic risk areas because the equipment's cross aisle cable troughs are not used.

Via cable racks are generally provided as needed per office or equipment area. When via cable racks are used to route cables between the office HMDF and a remotely located switch, the via racks shall be arranged in cross aisle cable rack fashion along the HMDF lineup cable rack regardless of initial cable pileup calculations (refer to Fig. 3).

### *2.5. Cable Pileup Monitoring*

Cable pileup in office cable racks needs to be continuously monitored so it is known in advance when office cable racks are reaching their ultimate cable capacity, and additional cable racks and/or cable mining is required. An alternate cable management plan (additional cable rack or cable removal effort) should be developed once installed cable racks reach 80% of their ultimate cable capacity (approximately 10 vertical inches).

### *2.6. Cable Rack Restrictive Markings*

All special purpose cable racks shall be uniquely identified to indicate the type(s) of cable they are restricted to. The restrictive information shall be in the form of labels or stampings conspicuously spaced no more than 10-feet apart on both cable rack stringers. In the case of cable racks used for the routing of fiber optic cables, it is acceptable for the cable racks to have a yellow painted finish, or to use self adhesive labels having black characters printed on a yellow background to distinguish them from other office cable racks.

### *2.7. At Customer Premises*

The engineering of equipment and cable rack for a customer's premises application will be done under one of two general scenarios. The first being where the equipment environment is managed by the customer and the AT&T affiliate is only one of several service providers having equipment in the environment. The second scenario is where the equipment environment is essentially established solely for the purpose of accommodating an AT&T affiliate's network equipment. In this scenario equipment engineering, and subsequently the equipment environment, is managed by the AT&T affiliate.

The engineering and installation of cable racks at customer premises locations shall be in accordance with the customer's guidelines and requirements for those equipment environments managed by the customer. In the absence of customer documented guidelines, the subject of cable rack engineering shall be negotiated with the customer and documented using this section as reference when possible. The negotiated customer requirements, with regard to cable rack ownership, seismic protection, cable rack construction, support methods, and other matters that directly impact the process of cable rack engineering and installation of current and future jobs, shall be documented on the AT&T affiliate office record(s) created for the equipment area.

## 3. ASSEMBLY

Cable rack fabrications should be assembled using the clamping details shown in this practice. Adjustable in-line cable rack clamping hardware is preferred for assembling vertical changes in cable runs (see Fig. 6G and 7A for example). However, it is acceptable to use non-adjustable clamps if desired. Where cable rack straps interfere with the proper placing of the clamping details, the cable rack shall be cut back to such a point that the straps will not interfere with the clamping details. Corner clamps may be assembled in positions opposite those shown where necessary to avoid interference with cable rack stringers and straps.

Except as indicated in 3.1.1 and Fig. 6F, vertical changes in cable route direction shall be provided for via gradual inclines (±45 degrees) or preformed cable rack turns to avoid sharp bends in cable. Abrupt 90 degree vertical turns in cable rack runs should be used only when absolutely necessary.

### *3.1. Junctions*

In general, the longest lengths and the fewest parts practicable shall be used in the assembly of cable rack arrangements. The joining of sections of cable rack for the usual conditions encountered in equipment environments are shown in Fig. 5A through 8B.

The method of in-line junctioning (splicing) two sections of cable rack together is shown in Fig. 5A and 5H. No more than one in-line junction shall be used between any two points of support for horizontal runs of cable rack. An in-line junction shall not be used beyond the last point of support of cantilevered racks.

Cross aisle racks shall be installed at a higher level than lineup racks as shown in Fig. 6B to provide clearance for ac power conduits, runs of secondary auxiliary framing or other apparatus. Cross aisle cable racks may be installed at the same level as lineup racks as shown in Fig. 6A when the space for associated apparatus below cross aisle cable racks is provided for by some other engineering consideration(s) or office arrangements. All cross aisle cable racks for a given equipment area shall be engineered and installed in a common manner.

Continuous runs of cross aisle racks are only permitted where ceiling heights or other overhead clearances are favorable to the additional cable pile-up this arrangement causes at cable rack intersections. The Fig. 6B "J" bolt fastenings shall be installed at all intersections of cross aisle to lineup cable rack.

Fig. 6CA or Fig. 6CB corner brackets shall be used at cable rack junctions where the radii of the cables is so large that additional cable support is required, or where cables need to be spread out to avoid excessive pile-up.

### *3.1.1. Horizontal To Vertical Transitions*

Fig. 6J or 6K shall be used when it is necessary to transfer large cables (≥3/4" dia.) from the horizontal to vertical plane above cable holes when the horizontal rack is at a right angle and in close proximity to the location of the cable hole. Fig. 6L can be used in place of Fig. 6J and 6K for small diameter cable and when dictated by existing cable rack configurations.

Use Fig. 6M whenever possible to transition cables vertically between cable racks that are more than 3 cable feet apart and are of a different construction, or are part of different ground planes. The Fig. 6M support rods may be omitted when the preformed cable rack turn is supported by direct attachment to auxiliary framing as shown in Fig. 10A or Fig. 10C. Fig. 6K can be used in place of Fig. 6M for this type of cable transfer when the upper and lower cable racks are horizontally less than 1'-4" apart provided the vertical section of cable rack is 3 feet or less in length and:

- Is independently supported similar to Fig. 6M or
- Is equipped with ±45° 5/8-11 threaded rod or flat bar bracing on both sides of the cable rack and
- The ±45° bracing is bolted to the horizontal portion of the cable rack transition.

**Note: Refer to ATT-TP-76409-001 for information pertaining to the EF&I of sweeping cable transitions (cable rack spirals).**

### *3.1.2. In-line Transitions*

In-line transitions of cable from the horizontal to vertical plane should be via Fig. 7A to 7C large cable radius fabrications whenever possible. Transitions of switchboard cable racks should be per Fig. 7A and 7B, however, the use of Fig. 7C is acceptable. Transitions of power cable racks shall be per Fig. 7B and 7C. The intermediate cross straps of the short section of rack shown in Fig. 7B shall be removed from power cable racks if the uninterrupted cable rise exceeds two floors. This is to minimize the possibility of cable insulation damage due to the weight of sagging power cables.

Clamps used to hold short sections of cable rack in place as shown in Fig. 7A, 7B and 8B to obtain a cable rack offset, or large cable turning radius shall not be subjected to any load other than the cabling at the turn or offset.

**Note: Refer to ATT-TP-76409-001 for information pertaining to the EF&I of sweeping cable transitions (cable rack spirals).**

### *3.2. Terminations*

The ends of cable rack shall be terminated as shown in Fig. 9A through 9F. Fig. 9A caps shall also be used on the ends of all cable rack attachment bars (refer to Fig. 6F as an example). Terminating vertical cable rack at cable holes with angle type sheathing may be done as shown in Fig. 9F.

Fig. 9B closing bars shall be used at non-attached offsets, junctions, and cable rack ends where cables continue to equipment or another cable rack.

The cable rack feet shown in Fig. 9C may be turned outward at the floor if space permits and the end of the cable rack is enclosed or a trip hazard is otherwise avoided.

## 4. SUPPORT

Cable racks shall be supported by direct attachment to auxiliary framing as shown in Fig. 10A unless office conditions require otherwise. Cable racks shall not be supported by their cross straps. Auxiliary framing used for the support of cable racks must be supported from ceiling inserts or other auxiliary framing. Self-drilling anchors shall not be used for the attachment of cable rack support apparatus unless their design and installation has been explicitly engineered for the cable loads and building construction they will be used with.

**NOTE:** Where auxiliary framing is associated with the support of duct type frames, and the cable rack is located 1/2” from the frame upright, the cable rack shall be fastened as shown in Fig. 10B.

5/8-inch threaded rods shall be used when it is necessary to suspend cable racks from their overhead support members. The distance from the bottom of the supporting auxiliary framing or other structure and the bottom of the suspended cable rack stringer shall not exceed 4 feet-10 inches.

Horizontal cable racks should be supported on approximately 5 foot centers and in no case shall the spacing of supports exceed 6-feet.

Cable rack assembly hardware shall not be relied upon to carry any appreciable load. Except as noted in this and the following paragraph a cable rack support shall be provided within 2’-6” of a free-end of cable rack. For the purposes of this requirement, turns, offsets, and intersections having the equivalent of free-ended cable racks are illustrated in Fig. 5B to 5G, 6D, 6E, 6G, 7A, 7B, 8A, 8B, 9A, and 9B. Fig. 6M and Fig. 7C are considered to be a free-ended cable rack arrangements if they contain a straight horizontal section of rack ≥1-foot in length.

A. A support is required for each cable rack shown in Fig. 5B to 5G, 6D, 6E and 8B.

B. The support for Fig. 6M and 7C applications shall be placed on the horizontal section of cable rack.

C. The support for Fig. 8A applications may be provided for either run of cable rack.

Where a free-ended cable rack is joined with corner clamps at a right angle to a rigidly supported cable rack as shown in Fig. 6A and 6CA, the support for the free-ended cable rack may be located up to 5-feet from the intersection provided a cable rack splice (Fig. 5A) is not used within that 5-foot distance.

Cross-aisle cable racks attached to lineup cable racks per Fig. 6B are considered adequately supported if the cross aisle rack is 6-feet or less in length. Cross aisle racks longer than 6-feet require support by additional auxiliary framing being placed below the rack, or by hanger rods attached to higher level auxiliary framing.

### *4.2.Studded-up Racks*

"Studded up" cable racks are not allowed in high seismic risk areas except as covered in the following paragraph, or where ceiling heights or overhead obstructions do not allow the installation of higher level auxiliary framing. In those cases where a cable rack must be studded up, the threaded rod supports shall be equipped with pipe sleeves and washers (Fig. 10C), threaded rod tie bars (Fig. 11B and 11C), and the rack shall be braced downward to lower level auxiliary framing in both side and endwise directions using the same practices given in part 5 for suspended cable racks.

Small vertical offsets in horizontal runs of cable rack may be used to bridge building or other apparatus as shown in Fig. 8A. The offset cable rack shall be braced in accordance with part 5 if two Fig. 8A offsets are used and the horizontal distance between the offsets is more than 4 feet. Where cable racks such as cross aisle racks are supported approximately 2-inches above auxiliary framing to clear conduit or other apparatus, they shall be supported as shown in Fig. 10C.

### *4.3. Racks On Walls and Columns*

#### *4.3.1. Vertical Racks*

Fig. 10D shall be used when vertical cable racks must be fastened to building walls or columns. Each section of vertical rack shall have a minimum of two Fig. 10D supports with a maximum spacing between supports not to exceed 5 feet. The Fig. 10D support arrangement is not intended for heavily loaded cable runs. Vertical racks fastened to building walls or columns which could ultimately support a large amount of cabling shall be terminated at the floor as shown in Fig. 9C.

Vertical cable racks attached to building walls or columns shall not be physically connected to a horizontal run of cable rack or to the office superstructure in high seismic risk areas. This is to minimize possible stress to cable rack supports should there be asynchronous movement of the building wall and office superstructure during seismic activity. A minimum distance of 6 inches shall be provided between the end of a horizontal cable rack and a continuing (cable wise) run of vertical cable rack that is attached to a building wall or column.

#### *4.3.2. Horizontal Racks*

Where it is necessary to provide for small amounts of cable run horizontally along a building wall, and facilities for an auxiliary framing grid are not available, the cable rack may be supported to the building wall as shown in Fig. 10E. Spacing of supports shall not exceed 5 feet.

Fig. 10G shall be used for cable rack support when wider than 5 inch cable racks are used, where Fig. 10E cable pileups may exceed 2 inches, and where auxiliary framing is not available. Fig. 10E support arrangements require a load bearing building surface. Fig. 10G shall be

provided and installed with three ½ inch diameter anchors appropriate for wall material per Table E. A wall support bracket shall be provided every 5-feet along the cable rack run.

The widest cable rack that may be supported by wall brackets is 12 inches. Cable pileup for wall supported cable racks shall not exceed 8-inches for cable racks carrying switchboard cable and 5 inches for cable racks carrying primary power cables.

| Table E | | | |
|---|---|---|---|
| Wall Anchor Types | | | |
| Wall Material | Anchor Type | Hilti P/N | Anchorage |
| Reinf. Concrete | Hilti HDI 1/2 | 00045754 | ½-13 x 1in. HHCS |
| Hollow Block | Toggle Bolt 1/2 | 00066366 | Included |
| Hollow Block | Adhesive HIT-HY20 | 00256479 Adhesive<br>00088979 ½ Rod<br>00020951 ½ Screen | Included |
| Reinf. Brick | Hilti HDI 1/2 | 00045754 | ½-13 x 1in.HHCS |
| Plaster | ½"x6" Wood Lagbolt | | |

### *4.4. Cable Racks On Floors*

Cable racks placed on floors require Fig. 10F fastenings to restrain their possible movement. A pair of Fig. 10F fastenings shall be provided for each cable rack in-line junction, for each section of rack ≥2 feet in length, and at the ends of cable rack runs. For safety reasons the fastening should be placed on the inside of the cable rack stringers as shown in Fig. 10F.

## 5. BRACING

### *5.1. General*

The following bracing requirements apply to high seismic areas, and can be applied in low seismic areas when hung cable rack requires lateral support to reduce movement (refer to 5.3).

Except as indicated in 5.2, cable racks not attached directly to auxiliary framing shall be hung and braced from auxiliary framing as shown in Fig. 11A through 11E to prevent swaying or whipping in both sidewise and endwise directions.

Refer to Fig. 4. Runs of cable rack runs that are supported only by hanger rods require a side brace at each support. The braces shall be staggered so they slope in opposite directions at alternate supports along the run of.

A. Intermediate hanger rod supports of cross aisle racks comprised of a single piece or section of cable rack do not require side braces because the bracing function is provided by the lineup cable rack fastenings.

B. Hanger rod supported cross aisle racks at the ends of lineups which are fastened to lineup racks on one side only require side braces on the outside stringer only.

Except as noted below, end braces per Fig. 11D and 11E are required for each run of hanger rod supported cable rack. End braces shall be provided at each end and on approximately 20-foot intervals along the length of suspended cable racks. End braces shall be slanted at opposite directions and should be installed on the same stringer. End braces may be installed on opposite stringers only to avoid obstructions.

A. End braces are not required for those hanger rod supported cable racks that are at some point attached to auxiliary framing, another cable rack, or an equipment frame that is supported and braced to prevent movement of the cable rack.

### *5.2. Fiber Optic Cable Racks*

Cable racks less than 8 inches in width used only for the routing and support of fiber optic cables require side and endwise bracing only if they are suspended more than 18 below auxiliary framing (bottom of framing to top of cable rack) in high seismic areas. 5/8-11 threaded rods shall be used in place of angle braces for bracing this type of cable rack arrangement. Part 5.1 bracing requirements apply to fiber optic cable racks wider than 8 inches because their load carrying capacity and overall weight potential is greater.

### *5.3. Low Seismic Risk Areas*

5/8" threaded rod may be used for diagonal bracing of cable racks in place of angle braces in low seismic areas. In general, braces should be provided to prevent to prevent the lateral movement of cable rack with a load equal to a medium built person pulling and pushing on an empty rack.

## 6. CDO EQUIPMENT BRACING

This part covers cable rack arrangements used in Community Dial Office (CDO) type installations that do not have ceilings suitable for the support of auxiliary framing and bracing. A seismic rated floor stanchion system should be used in new 7'-0" equipment environments having existing cable racks installed at the 9'-0" level. Such floor stanchion systems provide support for cable racks independent of equipment frames.

**Prior to 4/1/88** bracing of equipment frames in CDOs was achieved by installing cross aisle cable racks at the same level as the lineup cable racks, and bracing lineup cable racks to building walls that parallel the equipment lines. 1-1/2 x 1-1/2 x 3/16" angles were used to brace lineup cable racks to building walls, and to brace between lineup cable racks where cross aisle cable racks were not installed. **On 4/1/88** the following practices were adopted to enhance the seismic protection of equipment installations in CDO type offices.

A. In order to spread horizontal forces over a larger area, sections of 5 inch cable rack or extensions of existing cross aisle cable racks shall be used for bracing equipment to building walls, and for bracing between equipment lineups as shown in Fig. 12A and Fig. 12B. It is not necessary to replace angle braces already installed, however, cable racks shall be provided as bracing instead of relocating any existing angle braces.

B. Equipment bracing shall be continuous between walls that parallel equipment lineups including areas above power equipment. Office cross aisle cable racks serve as equipment bracing and should likewise be continuous between walls that parallel equipment lineups.

C. Locate wall braces so there is an approximate spacing of 3-feet between braces at the office distributing frame, and a 5- to 6-foot space between braces at other equipment lines. The distance from the end of the end frame in an equipment line and a brace or cross aisle cable rack fastening should not exceed 1'-0".

D. Where cable racks with 2 inch stringers are attached to lineup racks having 1-1/2-inch stringers, a section of cable rack finish cap shall be taped in place to protect cable from coming in contact with possible sharp edges of cable racks ends.

E. A vertical support such as a pipe stanchion is required for cable rack lengths exceeding 6'-0" or an equipment frame may be left in place as a support for the cable rack. Empty equipment frames shall be fitted with a 5-inch tall stiffening plate located midway up on uprights. The blank plate is required to prevent outward bowing of uprights with large vertical loads on frame. Pipe stanchions or frame supported should be located in future equipment locations whenever possible.

F. Cable rack splices in CDO buildings located in high seismic risk areas shall be of the through-bolt type shown in Fig. 13 to minimize the possible separation of cable rack sections during seismic activity.

Auxiliary framing should be used above equipment frames in new CDO buildings and in growth areas of existing buildings to provide greater flexibility in locating equipment frames and office cable racks. In such installations, standard spacing and support guidelines for cable racks and auxiliary framing are applied except that auxiliary framing is fastened to building walls.

Cable rack support arrangements illustrated in Fig. 14A through 16 should be provided in CDO offices and equipment areas where auxiliary framing is not used and cable racks are supported by direct attachment to the top cross member of equipment frames. Two cable rack supports are required for each isolated equipment frame.

## 7. MISCELLANEOUS CABLE SUPPORTS

Fig. 19 studded-up cable supports may be used to facilitate the addition of small amounts of cable where it is not practical to add cable rack. Studded up supports shall be located approximately every 12 inches along cable racks and auxiliary framing channels. The 12 inch distance shall be reduced if necessary to prevent cables from sagging more than a distance equal to the diameter of the cable or bundles of cable installed on the brackets.

The miscellaneous cable support brackets shown in Fig. 20 and 21A to 21C should be used for supporting miscellaneous runs of cable where a physical separation from other office cabling is required and the addition of cable rack is not appropriate. Unless otherwise directed by the supporting requirements for a specific cable type, support brackets shall be located on approximate 12 inch centers along their supporting structures. The 12 inch distance between supports shall be reduced if necessary to prevent cables from sagging more than a distance equal to the diameter of the cable or bundle of cable installed on the brackets.

## 8. CABLE RACK PANS AND CABLE RETAINING BRACKETS

### *8.1. Cable Rack Used For Unsecured Cable*

Fig. 1 ladder type cable racks equipped with metallic pans and straight zinc plated formed wire type bolt-on cable retaining brackets as shown in Fig. 22 shall be used for unsecured cable applications.

**NOTE**: The requirement to use straight formed wire type cable horns was implemented November 2004 with the provision the stock on hand of non-conforming horns could be used up through March 2004 as a matter of convenience to suppliers and I/R contractors. Refer to IRCN 10-03-003 and ERCN 10-03-003 for material transition details.

### *8.2. Cable Rack Horns*

Cable rack horns shall be provided in a height not exceeding the maximum allowable cable pileup of the cable racks they are used with. Generally, straight horns that extend 12 inches above cable racks shall be provided for racks 12 inches wide and wider. Horns shall be provided on opposite sides of cable racks and spaced no more than 18 inches apart. Additional cable rack horns shall be provided as necessary along lengths of cable rack and at cable rack intersections as necessary to confine cable within the width of cable racks. Cable rack horns shall not be located within the span of cable rack intersections or where they may be considered a hazard to cable.

Horns that mount on the sides of cable racks and include an integral means of providing cable support/separation may be used where necessary instead of supplemental cable racks for the support of lightweight interconnection media such as fiber optic cabling. Such horns are generally referred to as compartment horns and shall be installed on racks no more than 9 inches apart.

### *8.3. Separating Parallel Runs Of Cable*

Single-piece bolt-on brackets similar to that shown in Fig. 23 may be used when it is necessary to use a single cable rack for cable that should otherwise not be installed together for electrical reasons. In such cases cable separation brackets shall provide a minimum separation of 2 inches. Separation brackets shall be installed on cross-strap of unsecured cable racks and on every other cross-strap of secured cable racks.

### *8.4. Cable Rack Pans*

Cable rack pans may be aluminum or steel having a gray finish and shall be provided in widths appropriate for the width of cable rack they are used with. The use of multiple pans to span the width of cable racks is not permitted. Cable rack pans shall overlap along the length of cable runs in a manner that minimizes end-of-pan sag under cable racks. Cable rack pans shall not be installed through fire rated building surfaces.

Installed cable rack pans shall not present a hazard to people or cable. Edge protection shall be applied to the ends of pans that are cut by hand into shorter lengths, the ends of dead-ended pans at a horizontal to vertical change in cable level (refer to Fig. 22), and to the ends of pans considered to be a safety hazard to people or cable. Pans cut in the field shall include an approximate 1/4” radius at their corners to avoid curled edges.

## 9. REFERENCES

| Figure | Text Reference |
|---|---|
| 1 | 2.1 |
| 2 | 2.45 |
| 3 | 2.4.7 |
| 4 | 5.1 |
| 5A | 3.1, 4.1, 5.1 |
| 5B,D, G, H | 3.1, 4.1 |
| 5C, E, F | 3.1, 4.1 |
| 6A, B, CA | 3.1, 4.1 |
| 6CB | 3.1 |
| 6D, E | 4.1 |
| 6F | 3, 3.1, 3.2 |
| 6G | 3, 3.1, 4.1 |
| 6H | 3.1 |
| 6J, L | 3.1.1 |
| 6K | 3.1, 3.1.1 |
| 6M | 3.1, 3.1.1, 4.1 |
| 7A, B, C | 3.1, 3.1.2, 4.1 |
| 8A | 3.1, 4.1, 4.2 |
| 8B | 3.1, 3.1.2, 4.1 |
| 9A, B | 3.1, 4.1 |
| 9C | 3.2, 4.3.1 |
| 9D,E, F, G | 3.2 |
| 10A | 3.1.1, 4.1 |
| 10B | 4.2 |
| 10C | 3.1.1, 4.2 |
| 10D | 4.3.1 |
| 10E | 4.3.2 |
| 10F | 4.4 |
| 10G | 4.3.2 |
| 11A | 5.1 |
| 11B, C | 4.2, 5.1 |
| 11D, E | 5.1 |
| 12A, B | 6 |
| 13 | 6 |
| 14A, B | 6 |
| 15, 16 | 6 |
| 17 | 2.4 |
| 19 | 7 |
| 20, 21A-C | 7 |
| 22, 23 | 8 |

## 10. FIGURES AND SKETCHES

**Figure 1. Typical Ladder Type Cable Rack Construction**

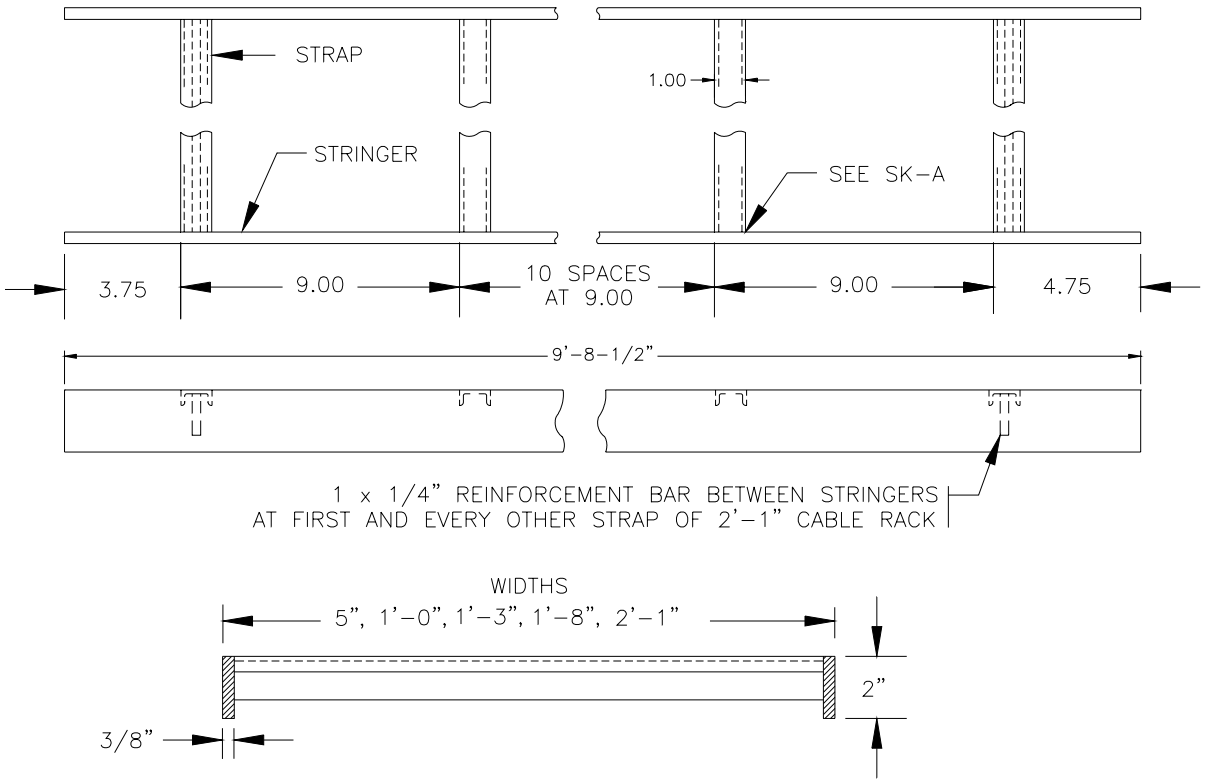


**Figure 2. Typical Cross Sectional Cable Rack Designation Scheme**

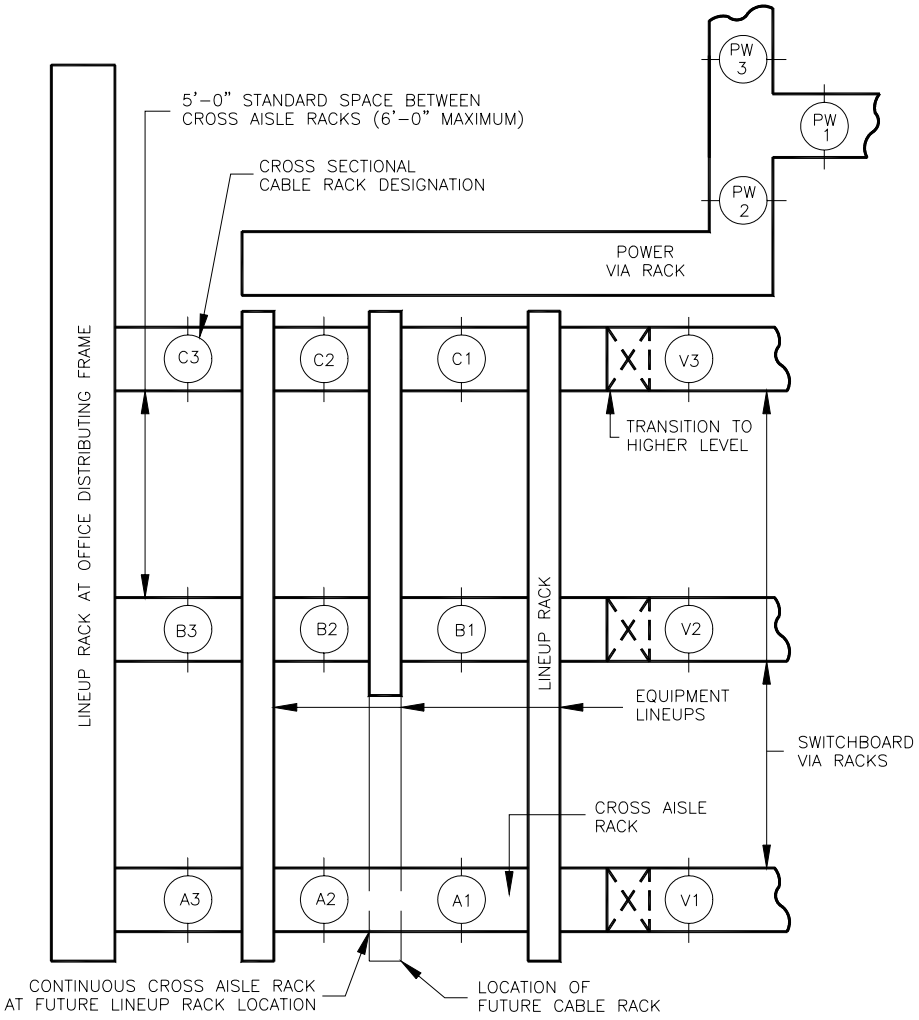


**Figure 3. Equipment Coordinate Path Cable Rack Designation Scheme**

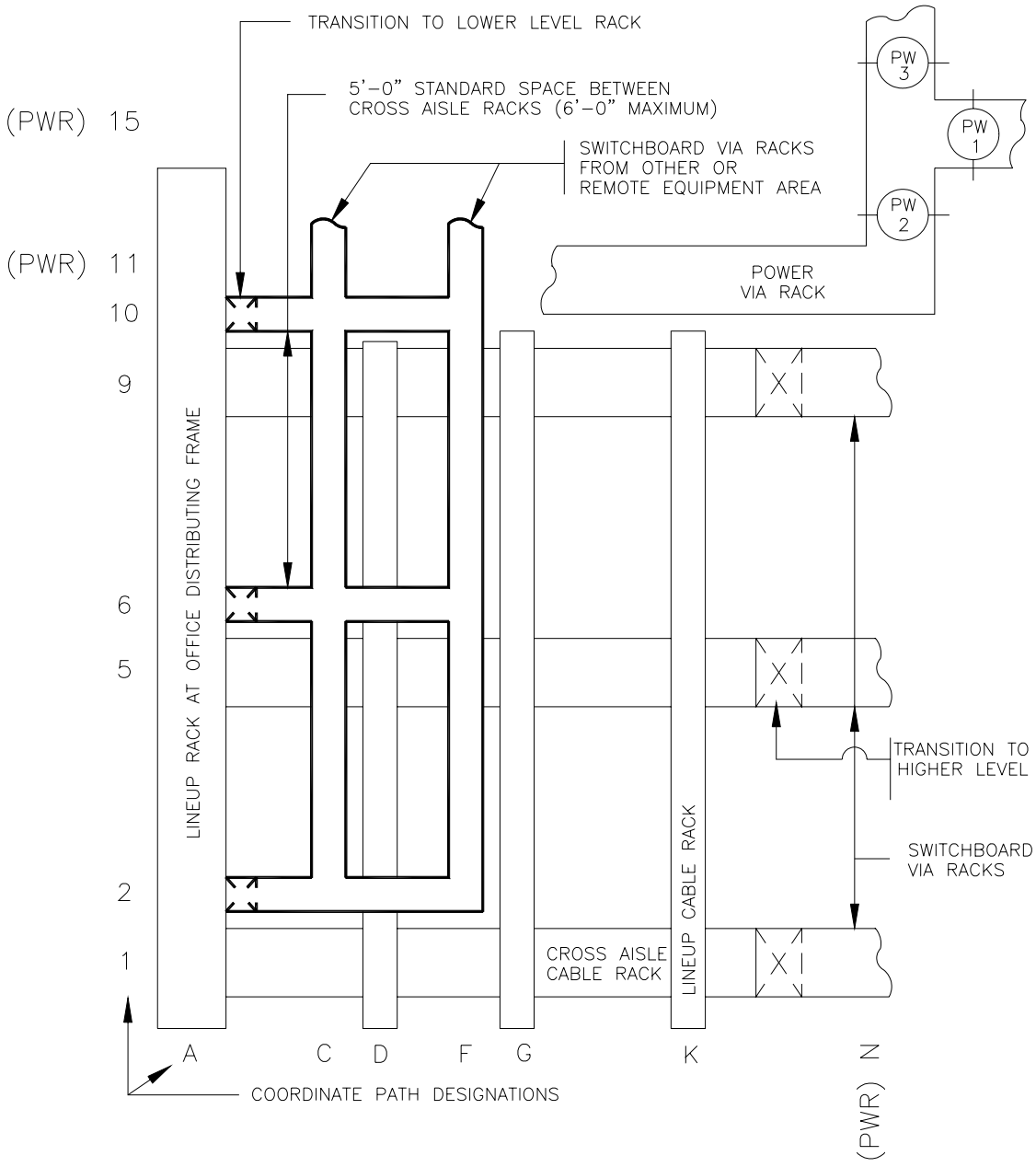


**Figure 4. Typical Application Of Cable Rack Bracing**

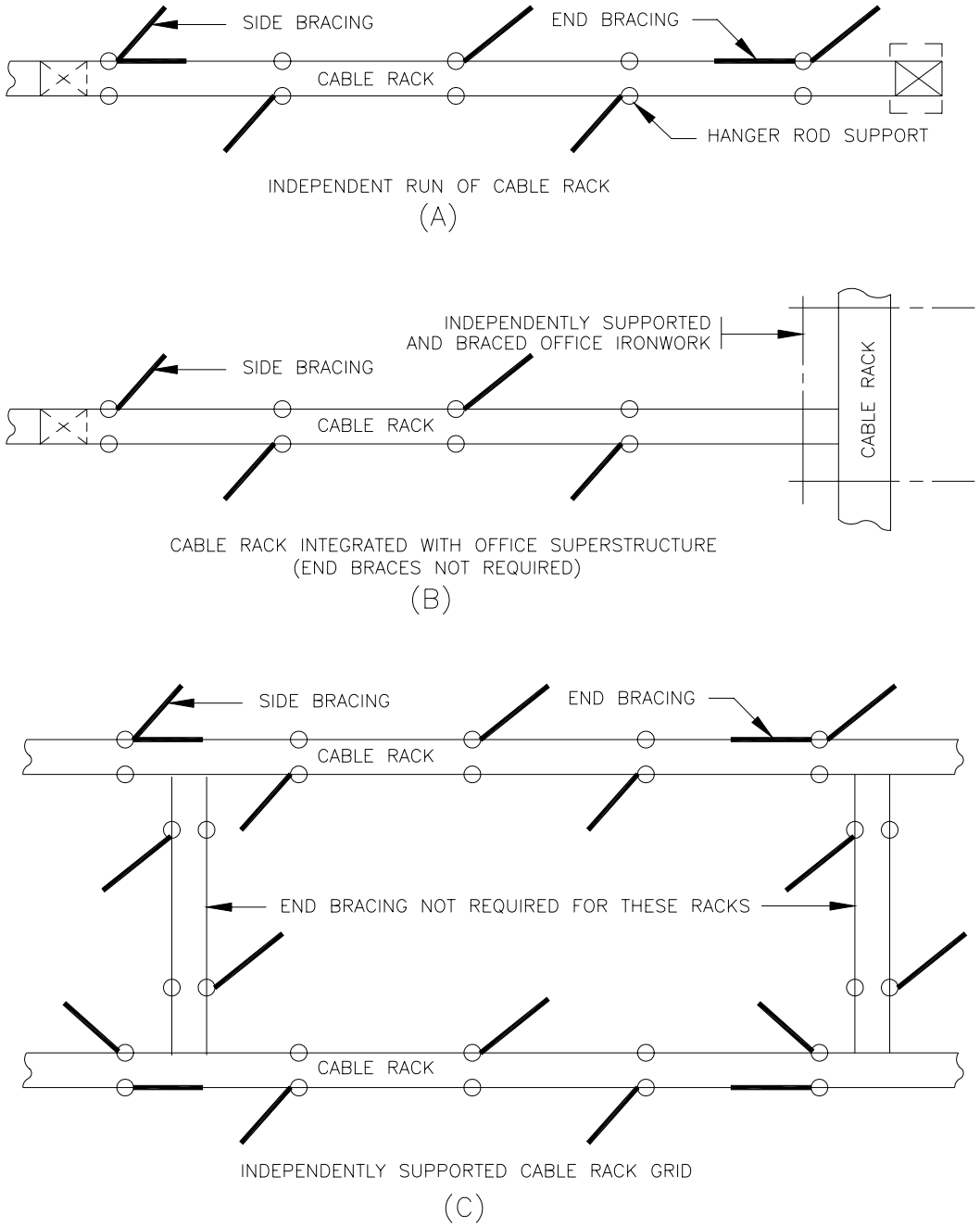
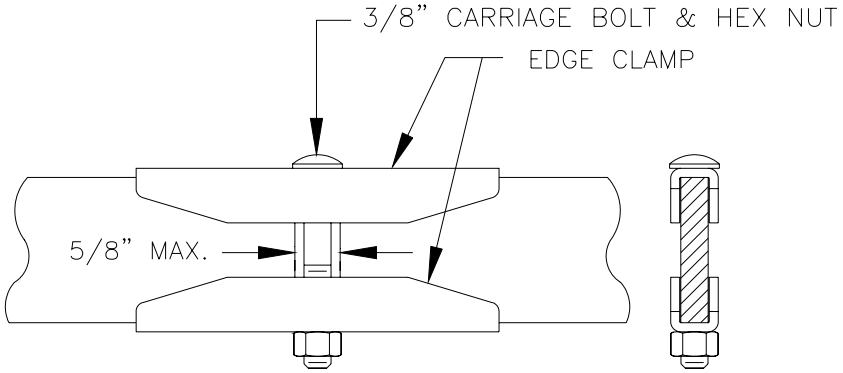
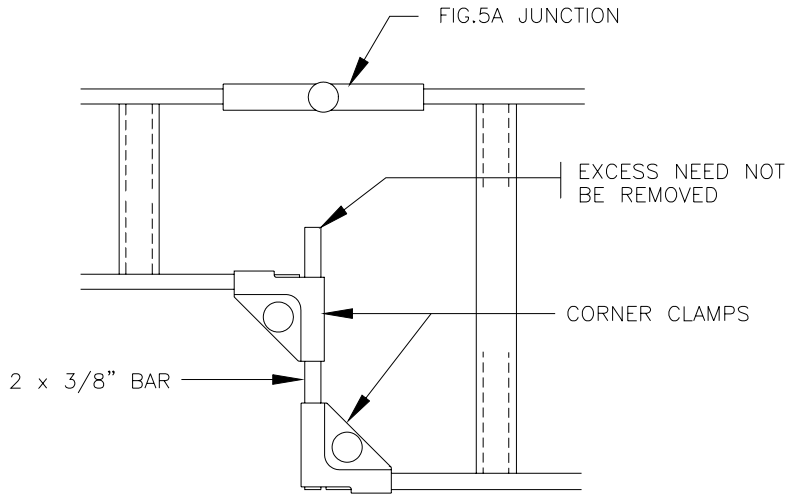


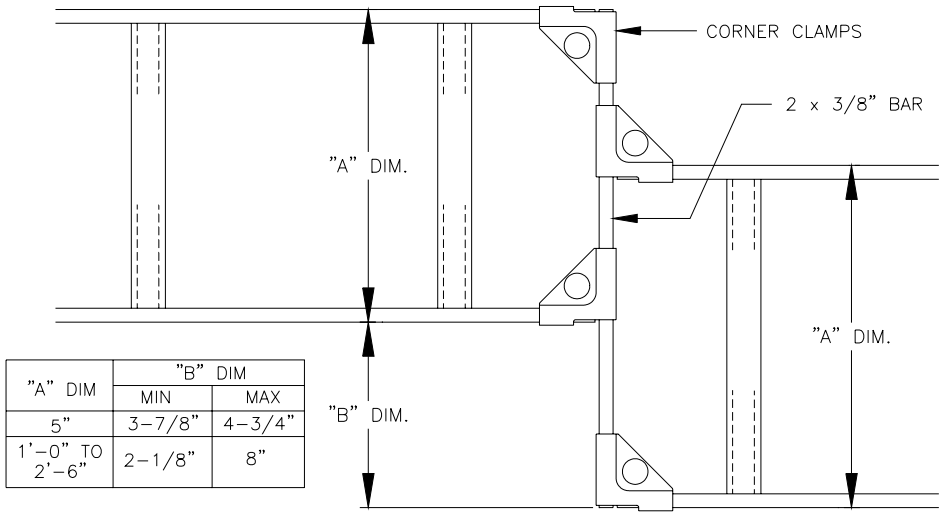
**Figure 5. Standard In-Line Cable Rack Junctions**




STRINGERS SAME SIZE
(5A)

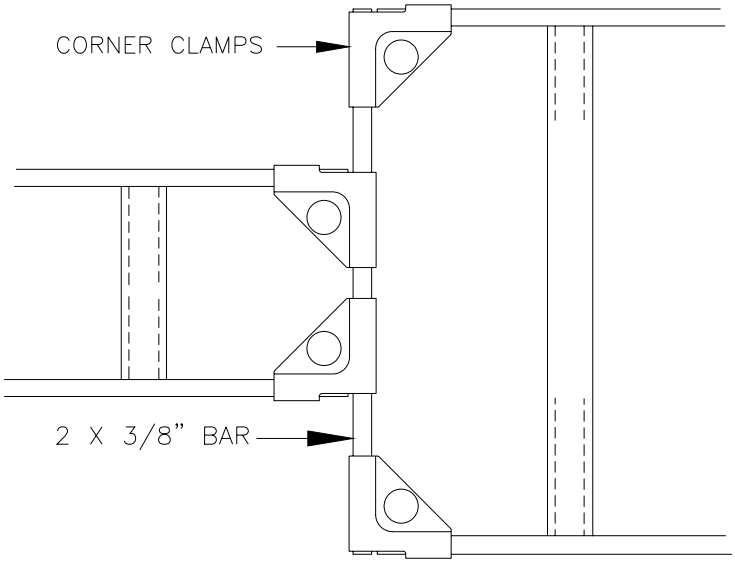



RACKS OF DIFFERENT WIDTHS – SMALLER RACK TO ONE SIDE
(5B)

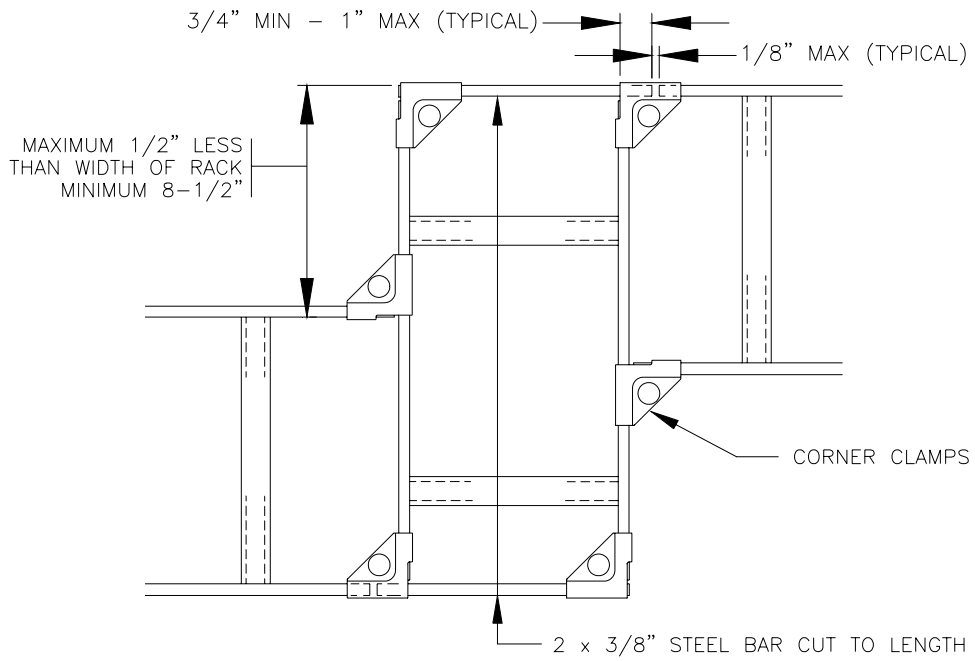



| "A" DIM | "B" DIM | |
|---|---|---|
| | MIN | MAX |
| 5" | 3-7/8" | 4-3/4" |
| 1'-0" TO 2'-6" | 2-1/8" | 8" |

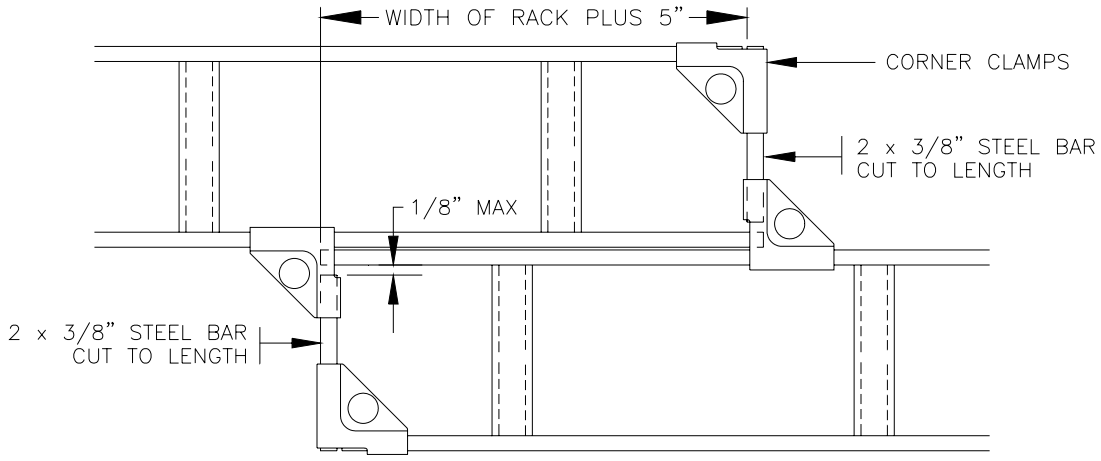
HORIZONTAL OFFSET LESS THAN WIDTH OF RACKS – RACKS IN SAME PLANE
(5C)



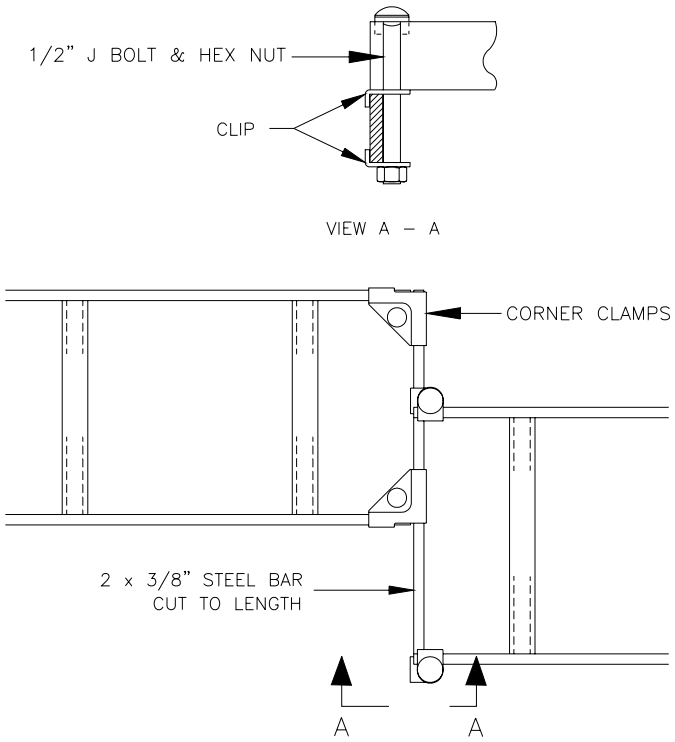

RACKS OF DIFFERENT WIDTHS
SMALLER RACK APPROXIMATELY CENTERED
(5D)



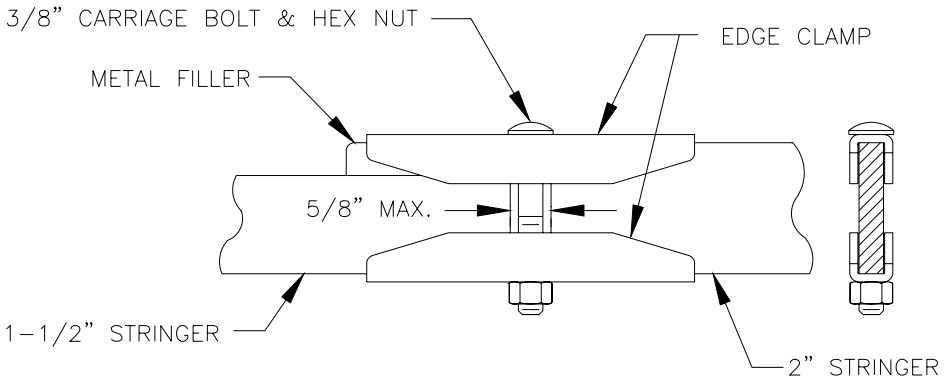

LARGE HORIZONTAL OFFEST – LESS THAN WIDTH OF RACKS
(5E)




ADJACENT CABLE RACKS
(5F)

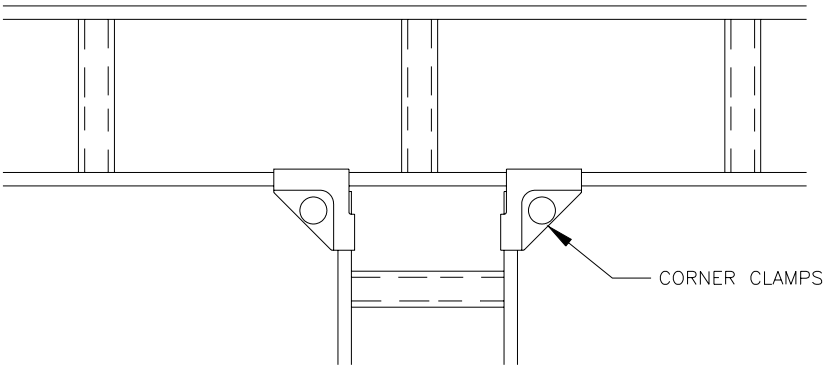



HORIZONTAL OFFEST LESS THAN WIDTH OF RACKS
2 INCH DIFFERENCE IN LEVELS OF RACK
(5G)

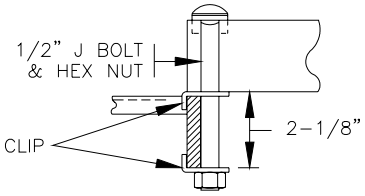



DIFFERENT STRINGER HEIGHTS
(5H)

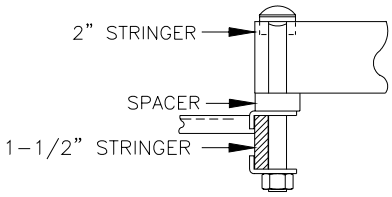
**Figure 6. Standard Cable Rack Intersections**



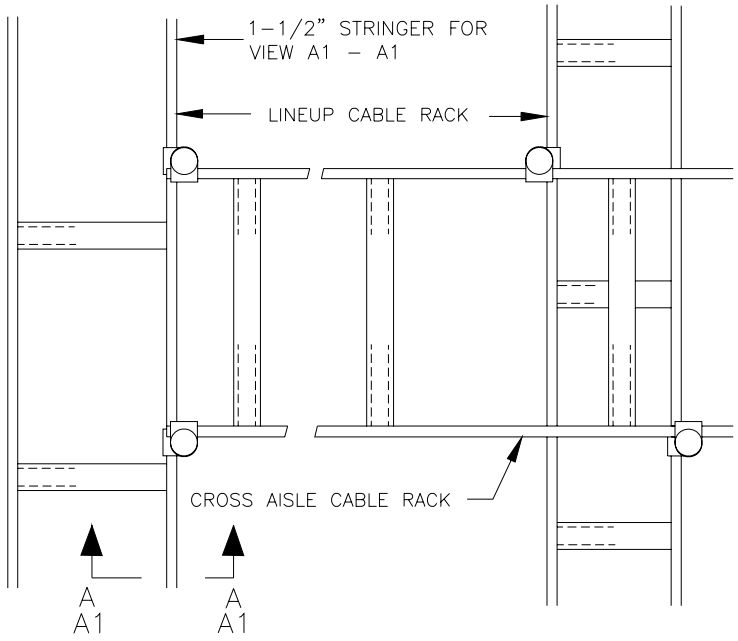

RIGHT ANGLE – CABLE RACKS IN SAME PLANE
(6A)




VIEW A – A



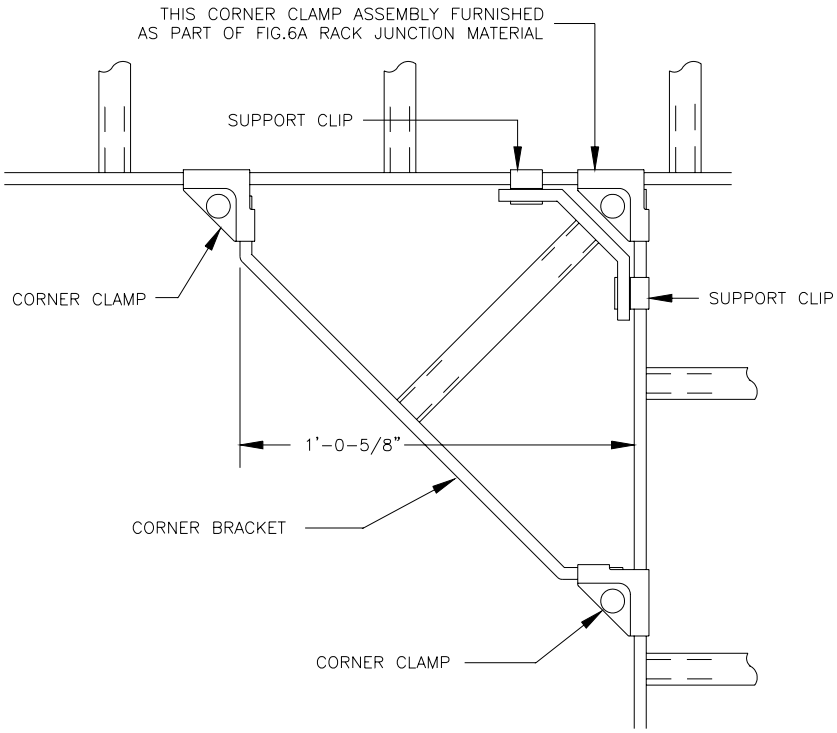

VIEW A1 – A1



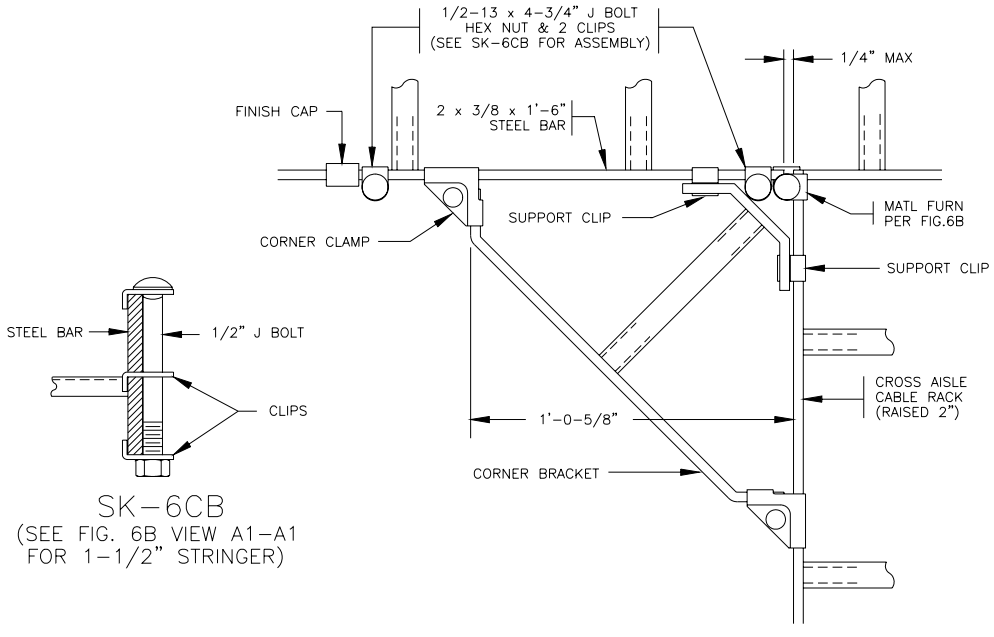

METHOD A
CROSS AISLE RACK
TERMINATES AT LINEUP RACK

METHOD B
CROSS AISLE RACK CONTINUES
BEYOND LINEUP RACK

RIGHT ANGLE – LINEUP AND CROSS AISLE RACKS
CROSS AISLE RACKS RAISED 2 INCHES TO CLEAR APPARATUS
(6B)

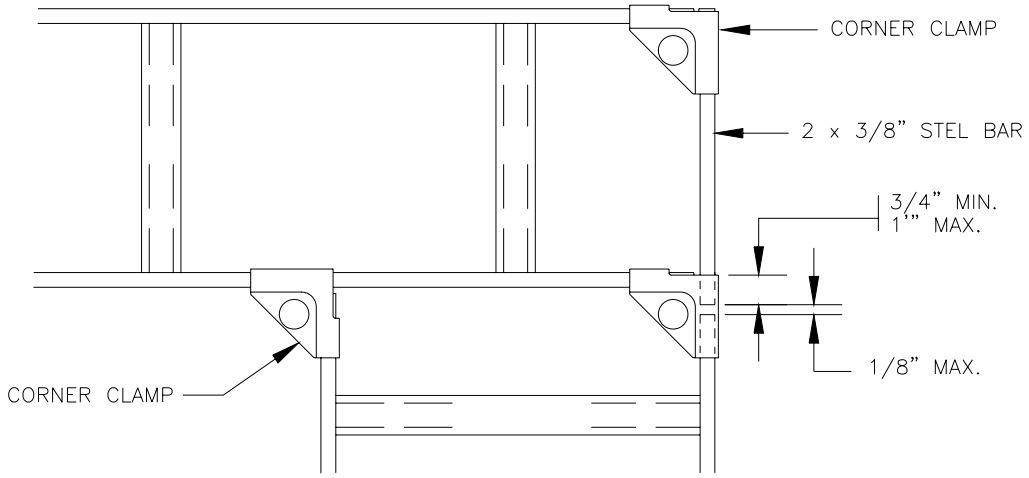



RIGHT ANGLE – ADDITIONAL CABLE SUPPORT
RACKS IN SAME PLANE
(6CA)

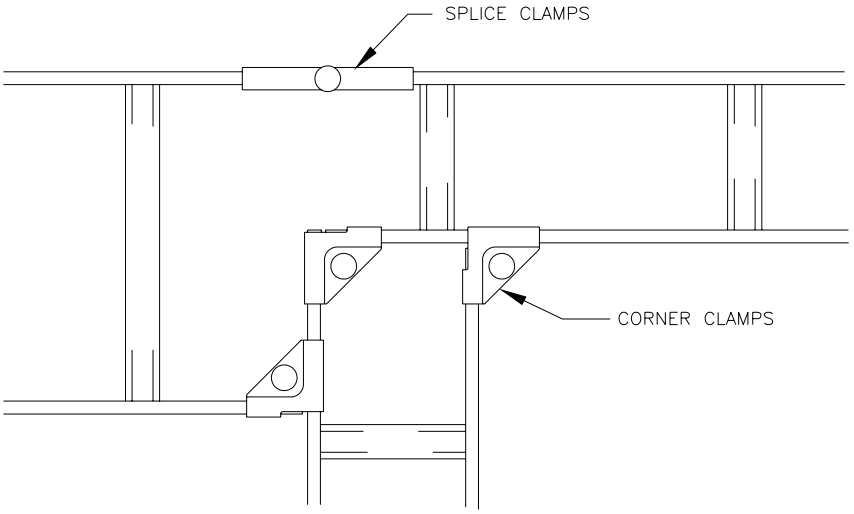



SK-6CB
(SEE FIG. 6B VIEW A1-A1
FOR 1-1/2" STRINGER)

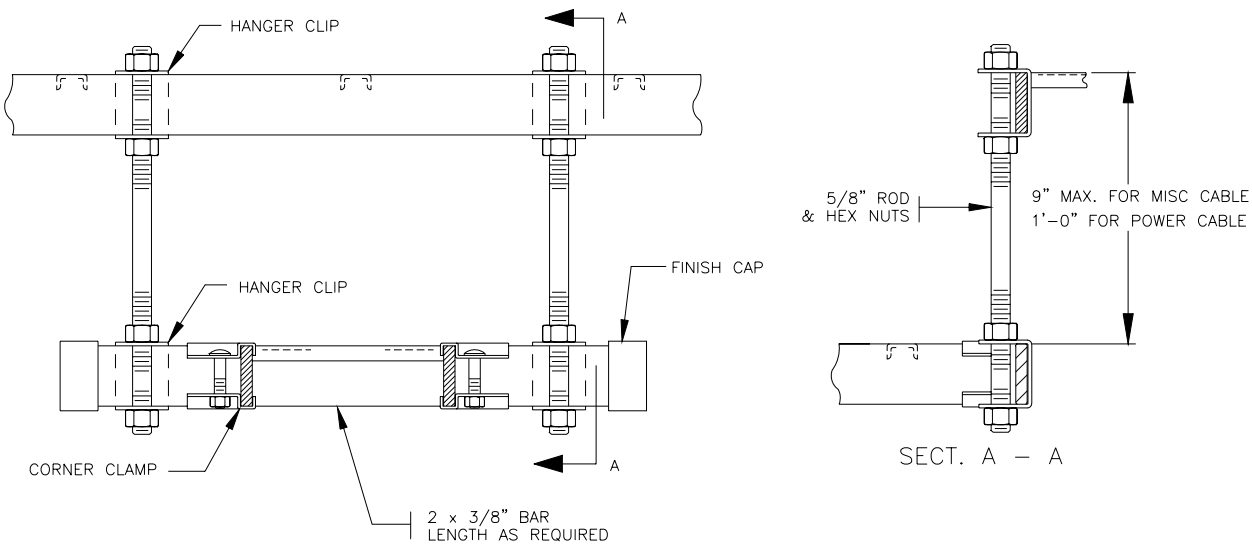
RIGHT ANGLE – ADDITIONAL CABLE SUPPORT
2 INCH DIFFERENCE IN LEVEL OF RACKS
(6CB)



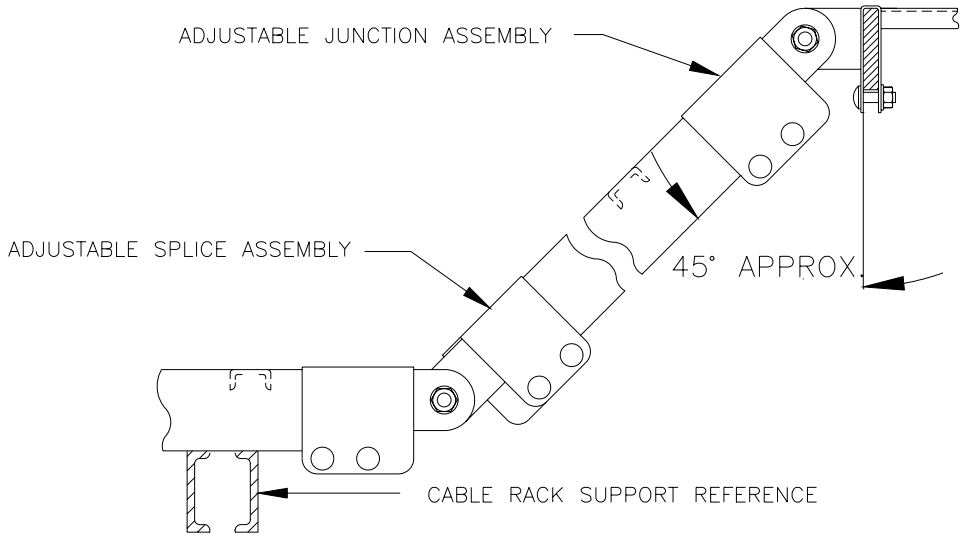

RIGHT ANGLE TURN – RACKS IN SAME PLANE
(6D)



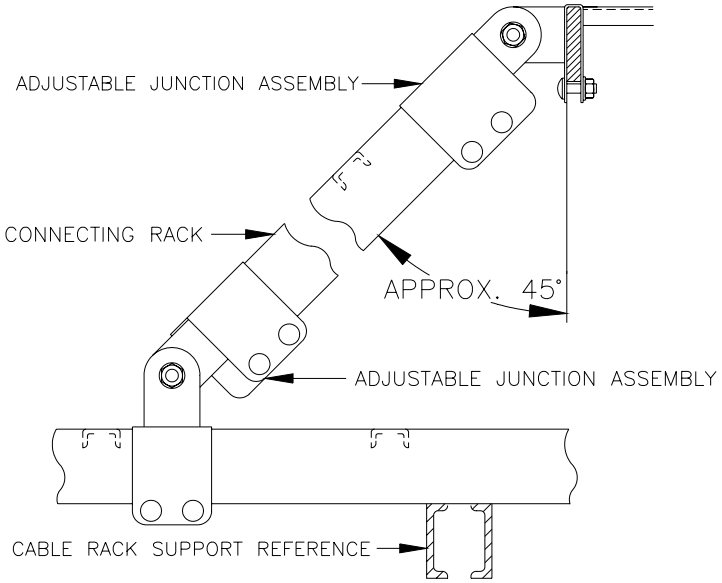

RIGHT ANGLE – THREE RACKS OF DIFFERENT WIDTHS
(6E)



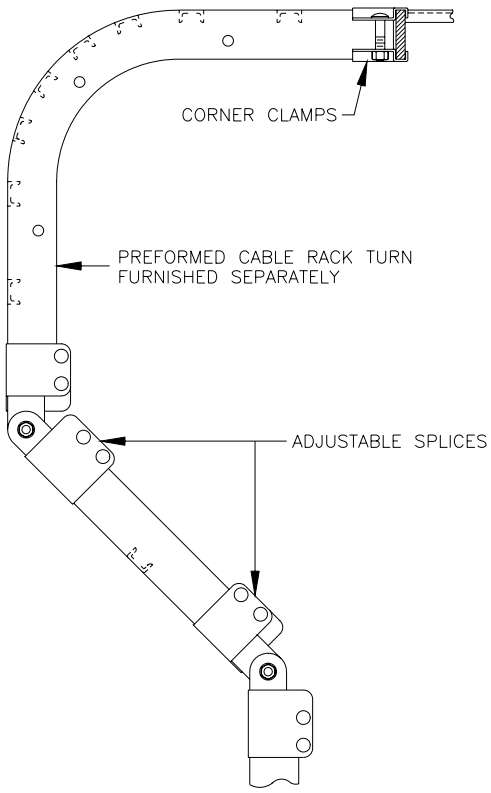

RIGHT ANGLE – SMALL VERTICAL OFFSET
(6F)



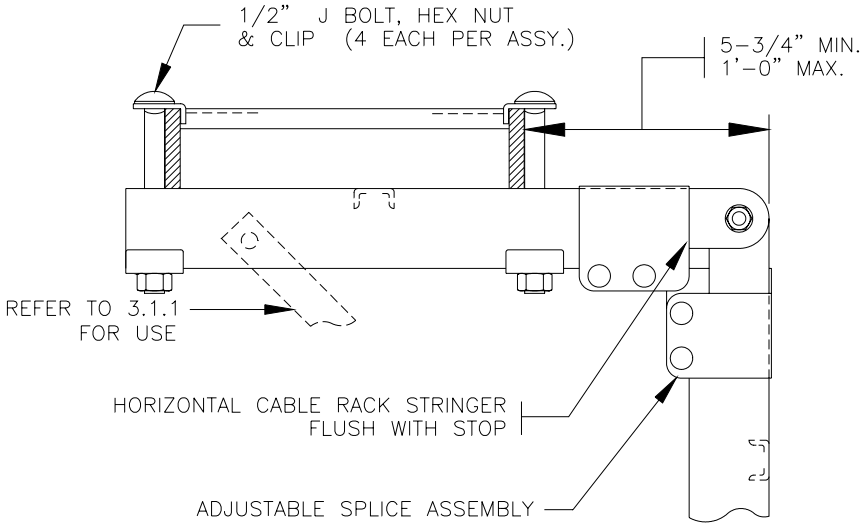

RIGHT ANGLE – LARGE VERTICAL OFFSET
CONNECTING RACK TERMINATES AT END OF JUNCTIONING RACK
(6G)



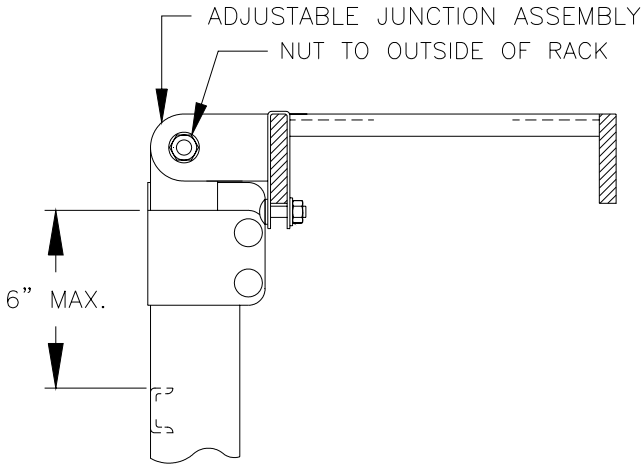

RIGHT ANGLE – LARGE VERTICAL OFFSET
INTERMEDIATE TERMINATION OF CONNECTING RACK
(6H)



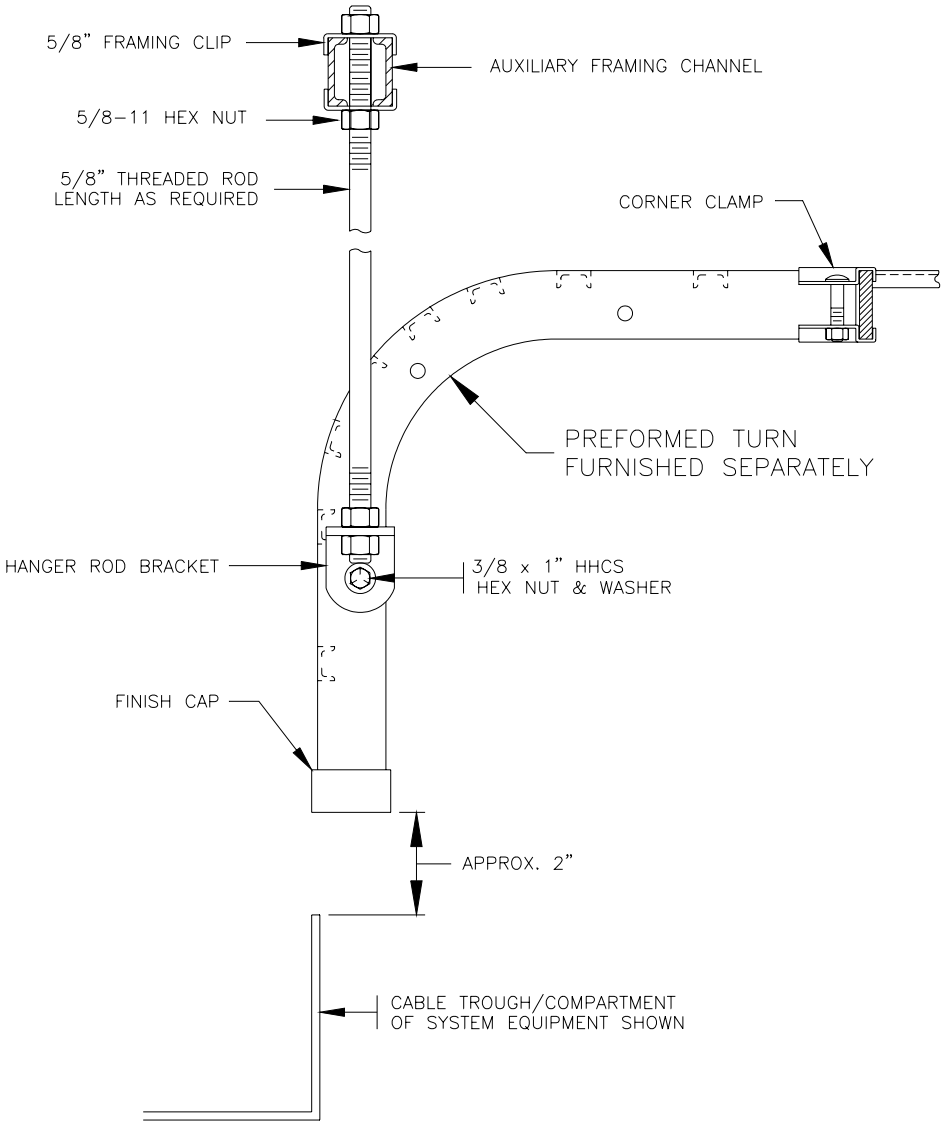

RIGHT ANGLE – VERTICAL TO HORIZONTAL RACK
LARGE CABLE RADIUS
(6J)




RIGHT ANGLE – VERTICAL TO HORIZONTAL RACKS
SMALL CABLE RADIUS
(6K)

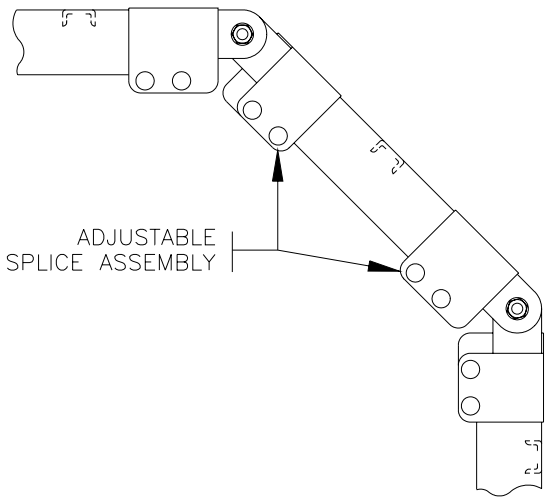



RIGHT ANGLE – VERTICAL TO HORIZONTAL RACKS
ABRUPT CABLE RADIUS
(6L)

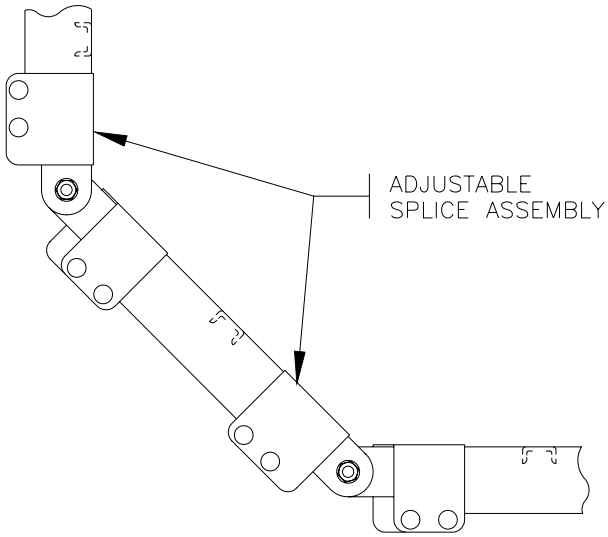



RIGHT ANGLE – TRANSITION BETWEEN VERTICALLY OFFSET RACKS
(6M)

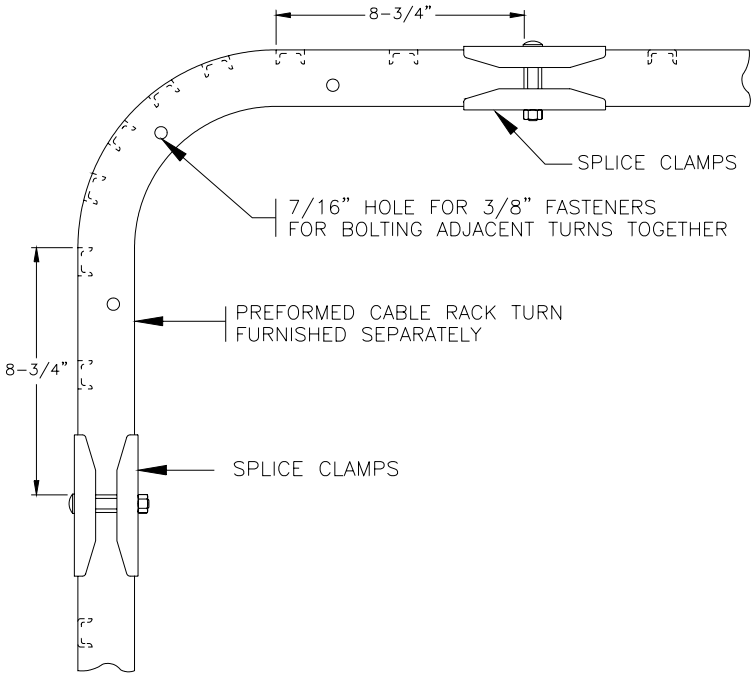
**Figure 7. Standard In-line Cable Rack Turns**




90° OUTSIDE TURN – RADIUS MORE THAN 6 INCHES
(7A)

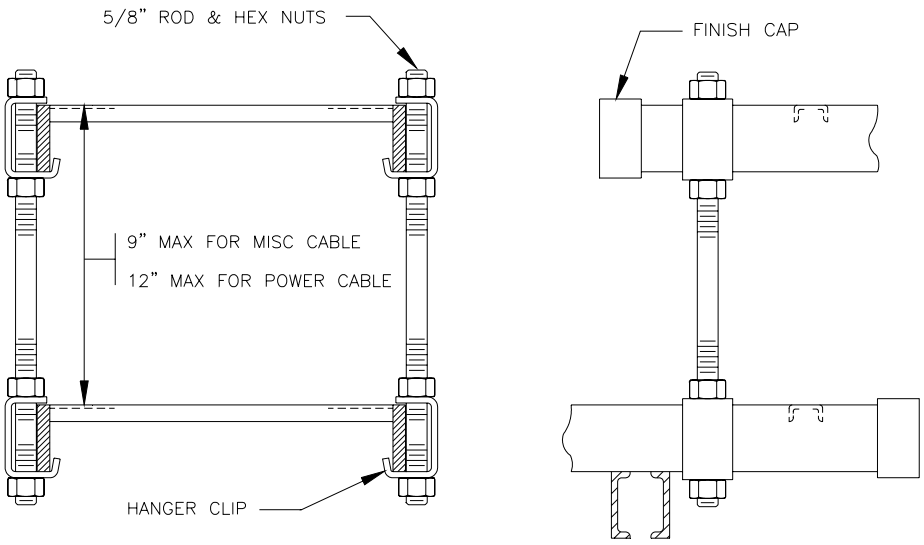



90° INSIDE TURN – RADIUS LARGER THAN 6 INCHES
(7B)

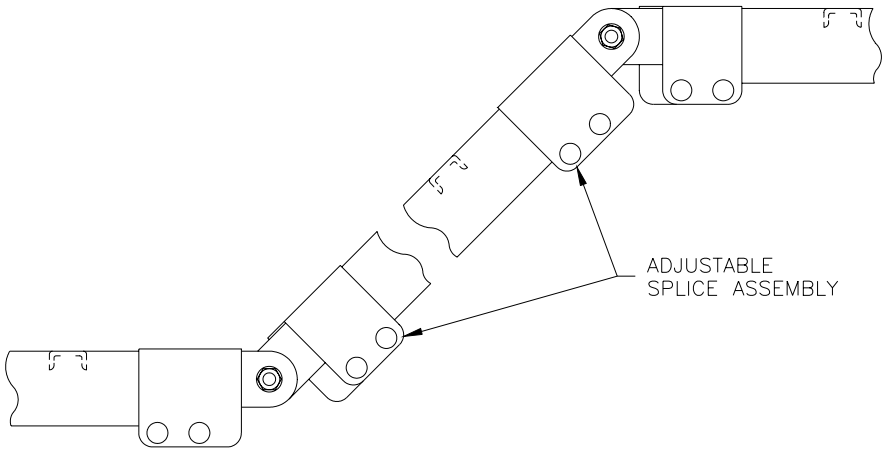



90° OUTSIDE TURN – POWER CABLE RACKS
(7C)

**Figure 8. Standard Cable Rack Offsets**

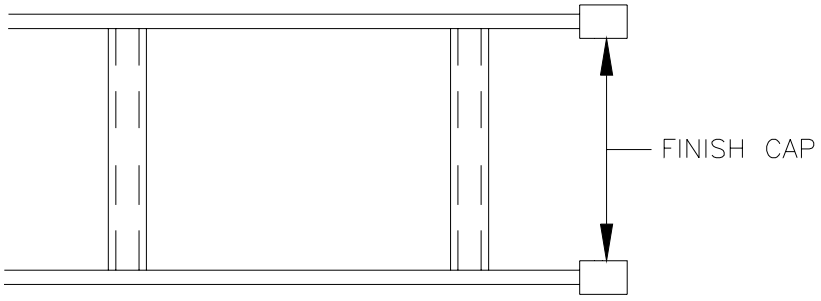



SMALL VERTICAL OFFSET
(8A)

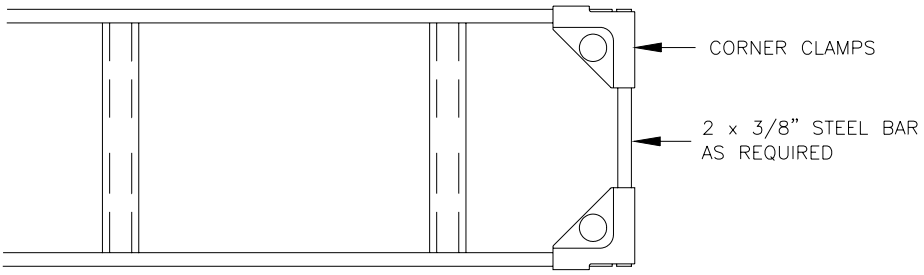



LARGE VERTICAL OFFSET
(8B)

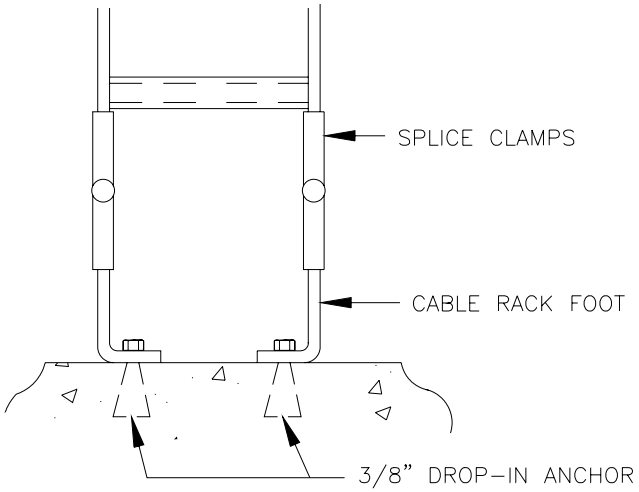
**Figure 9. Standard Cable Rack Terminations**



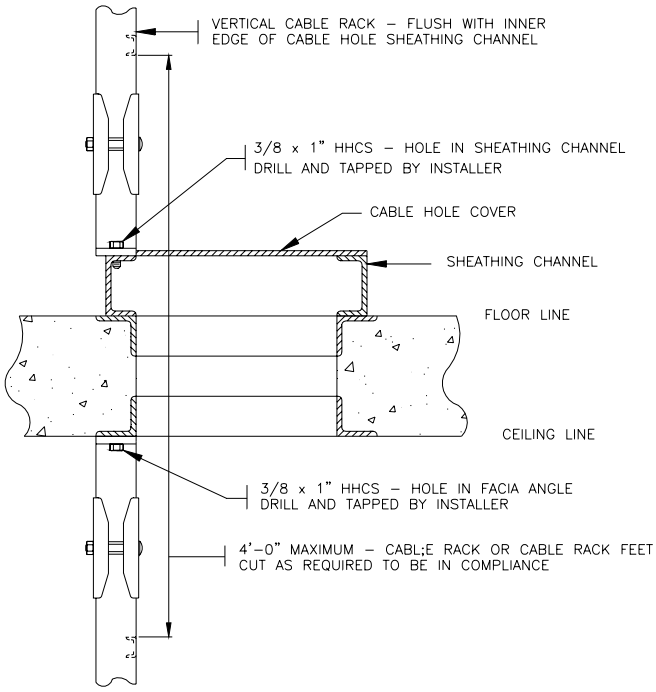

TERMINATING EXPOSED ENDS OF RACKS
(9A)



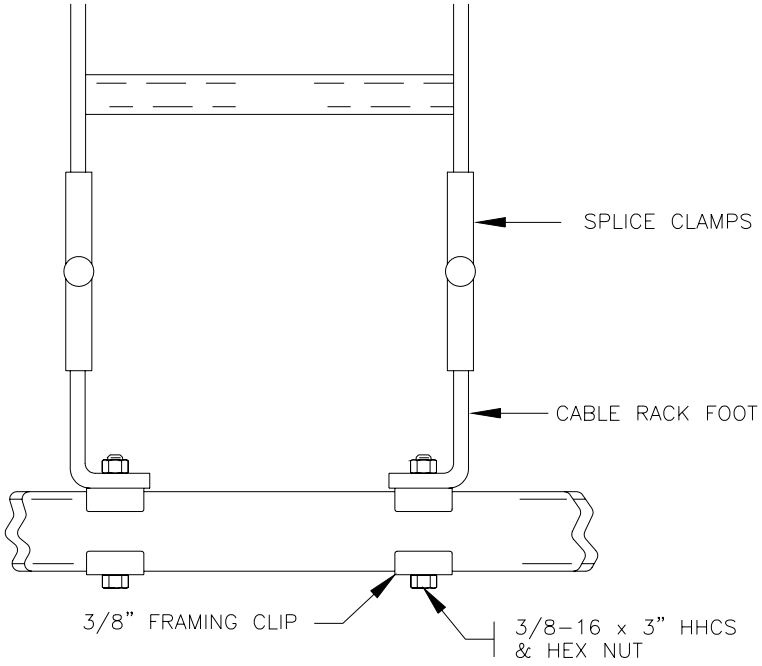

TERMINATING ENDS OF RACKS WHERE CABLE CONTINUES
(9B)



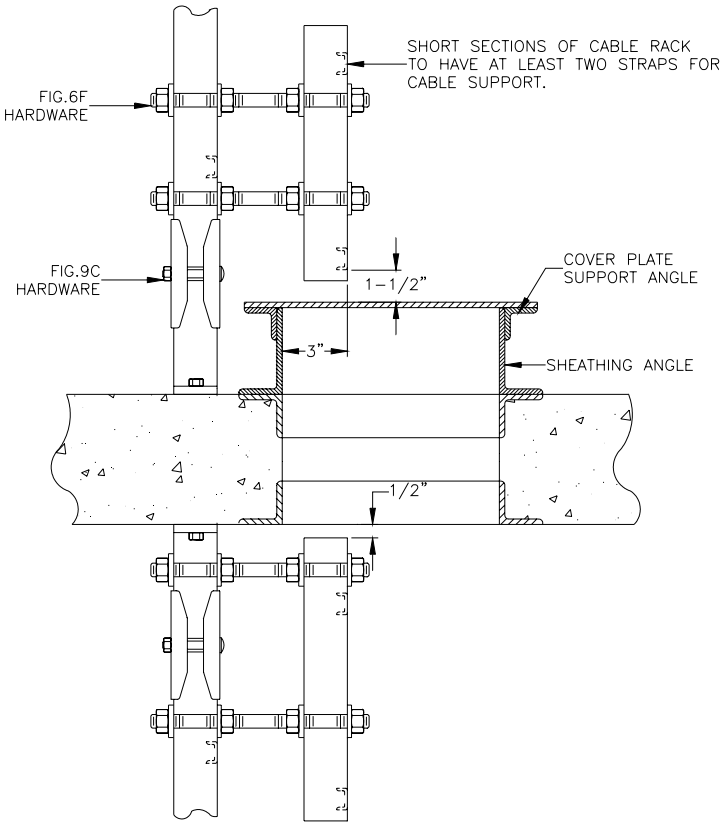

TERMINATING RACK AT CONCRETE FLOOR
(9C)



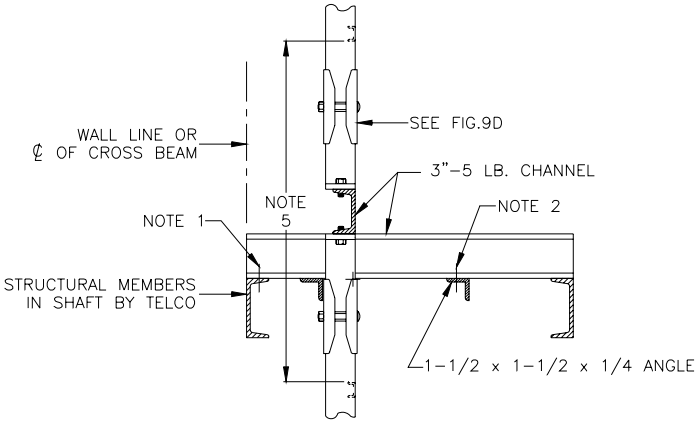

TERMINATING VERTICAL RACKS AT CABLE HOLES
(9D)




TERMINATING CABLE RACKS AT AUXILIARY FRAMING
(9E)

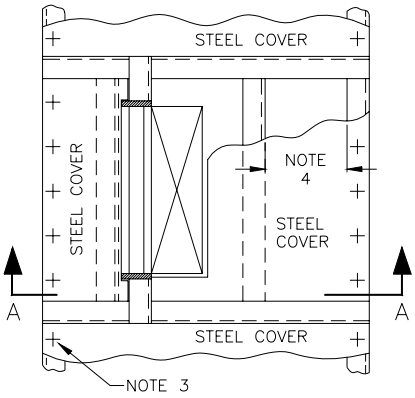



TERMINATING RACKS AT CABLE HOLES
ANGLE TYPE SHEATHING
(9F)



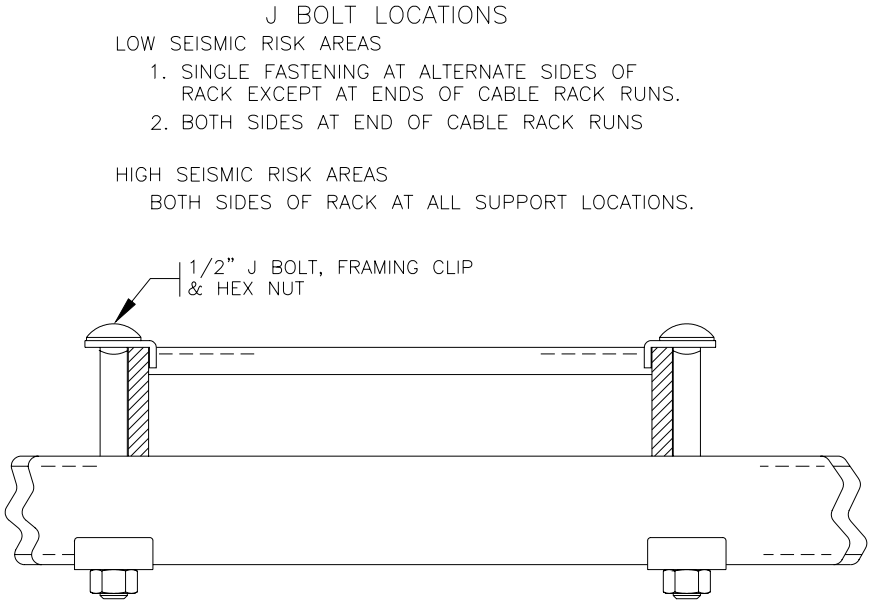

SECT. A–A

1. 3'–5 LB. CHANNEL FASTENED TO SUPPORT STRUCTURE WITH 5/8" FASTENERS
2. ANGLES AND 3'–5 LB. CHANNELS FASTENED TOGETHER WITH 1/2" FASTENERS
3. STEEL COVER PLATES FASTENED WITH 1/4" FASTENERS ON 3 INCH CENTERS
4. 1'–0" MAXIMUM SPACING FOR STEEL COVER PLATE SUPPORTS
5. 4'–0" MAXIMUM DISTANCE BETWEEN CABLE SUPPORTS

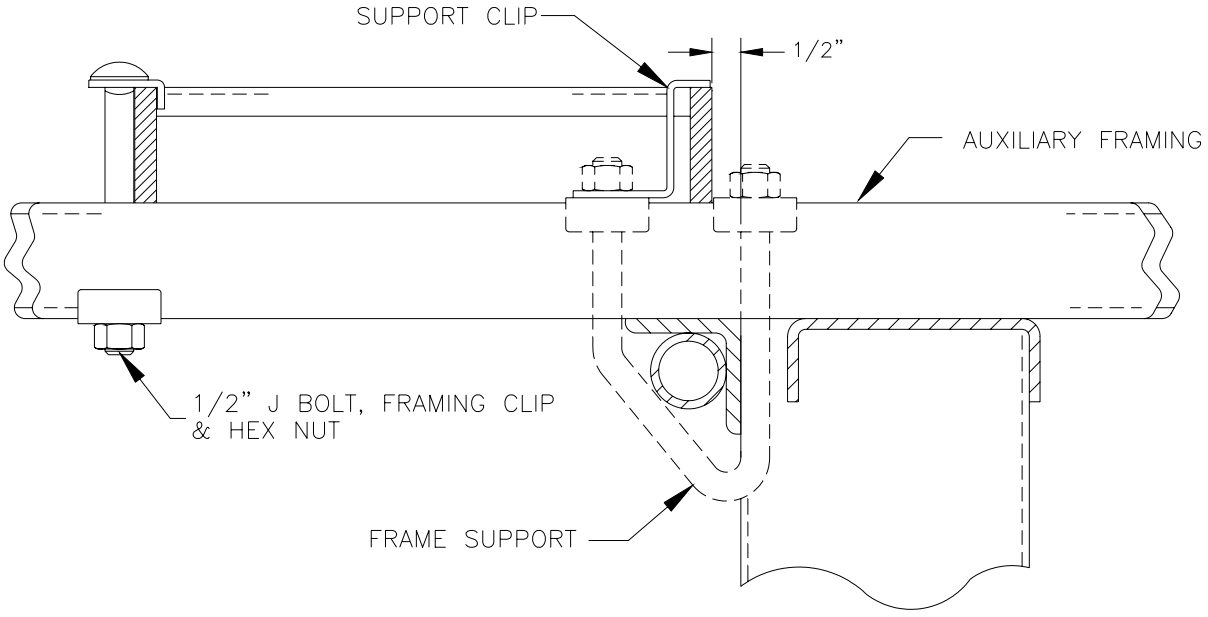



TERMINATING RACKS AT CABLE SHAFTS
(9G)

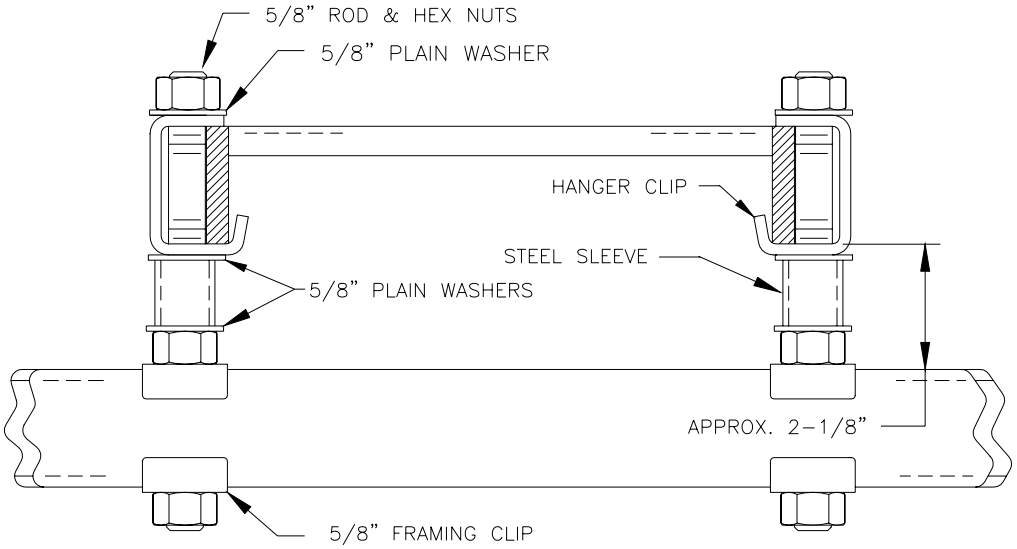
**Figure 10. Standard Cable Rack Supports**



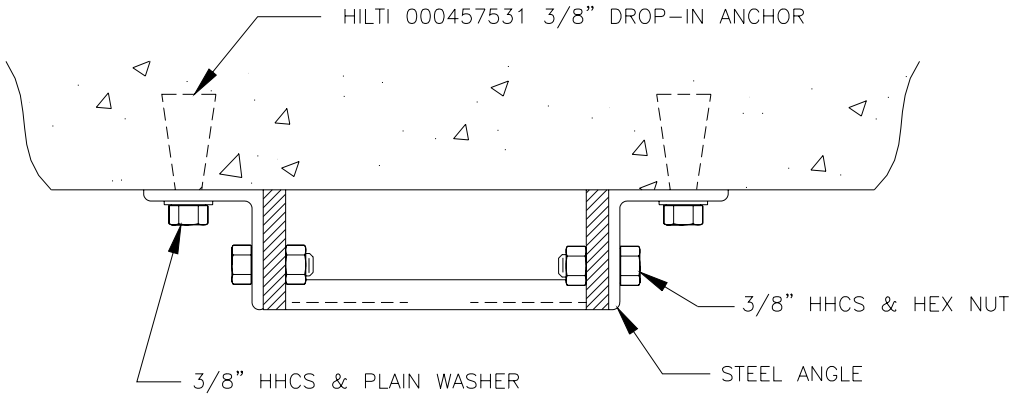

SUPPORTING RACKS DIRECTLY TO AUXILIARY FRAMING
(10A)



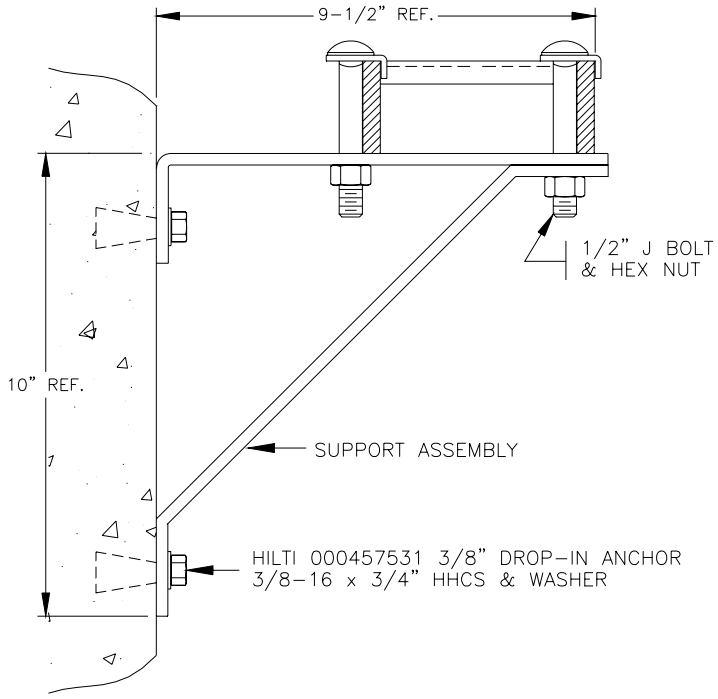

DIRECTLY TO AUXILIARY FRAMING
1/2 INCH FROM DUCT TYPE FRAMEWORK UPRIGHTS
(10B)



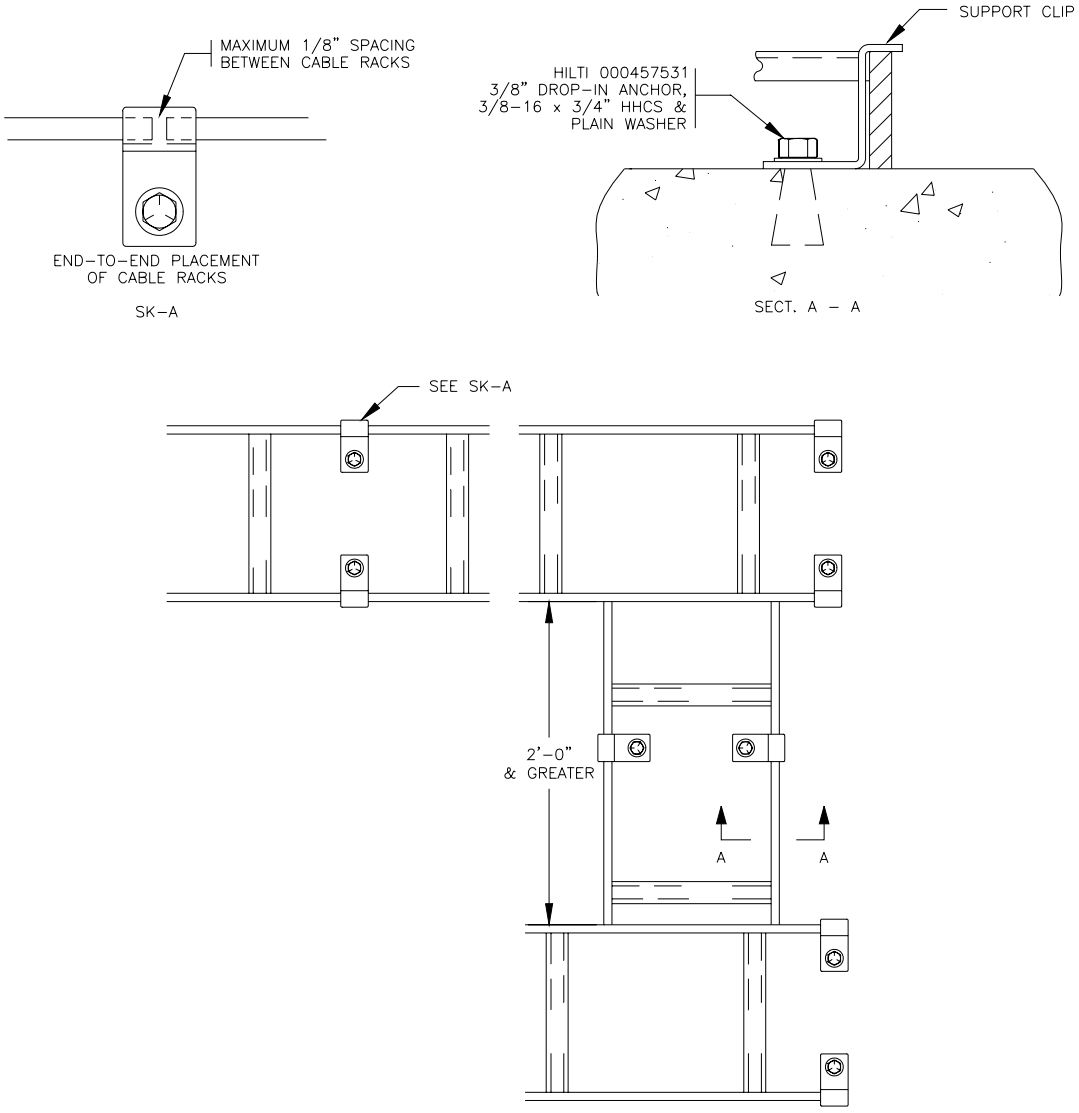

SUPPORTING CABLE RACK 2 INCHES ABOVE AUXILIARY FRAMING
(10C)



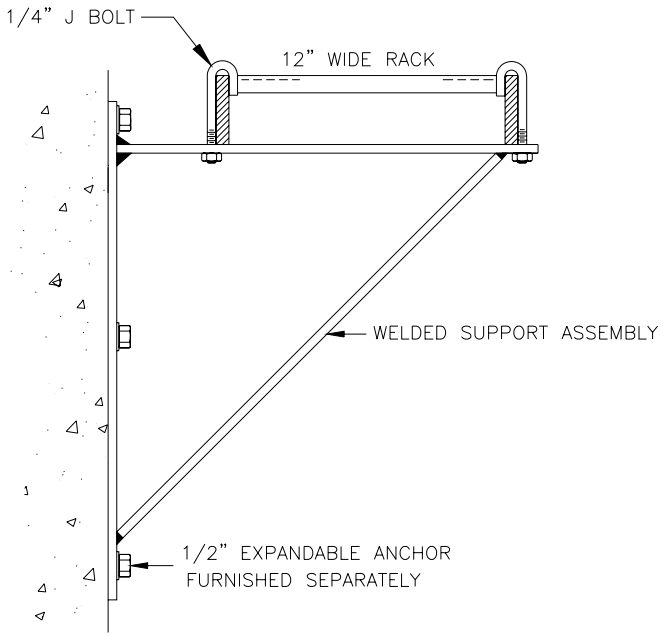

SUPPORTING VERTICAL RACKS ON WALLS AND COLUMNS
(10D)




SUPPORTING 5 INCH HORIZONTAL RACK TO WALLS OR COLUMNS
(10E)

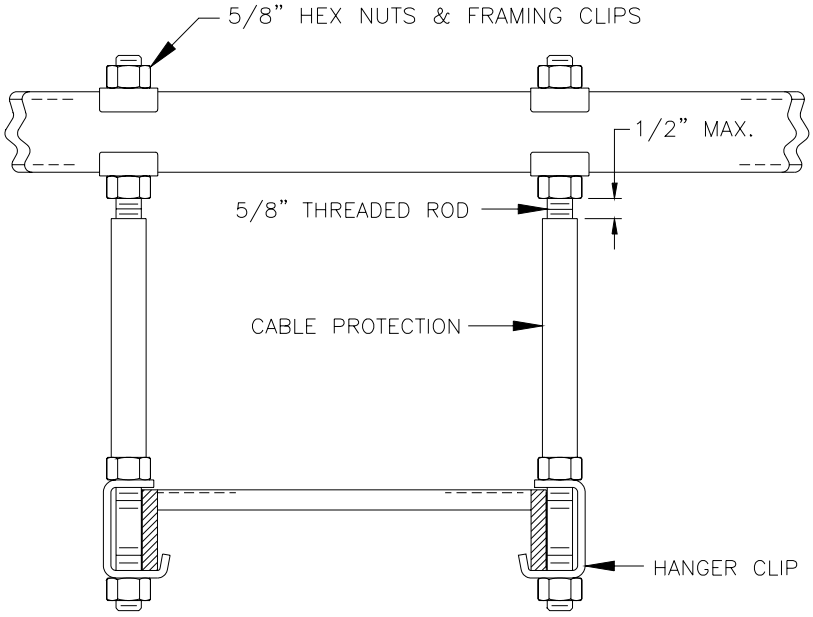



SECURING HORIZONTAL RACKS ON CONCRETE FLOORS (10F)

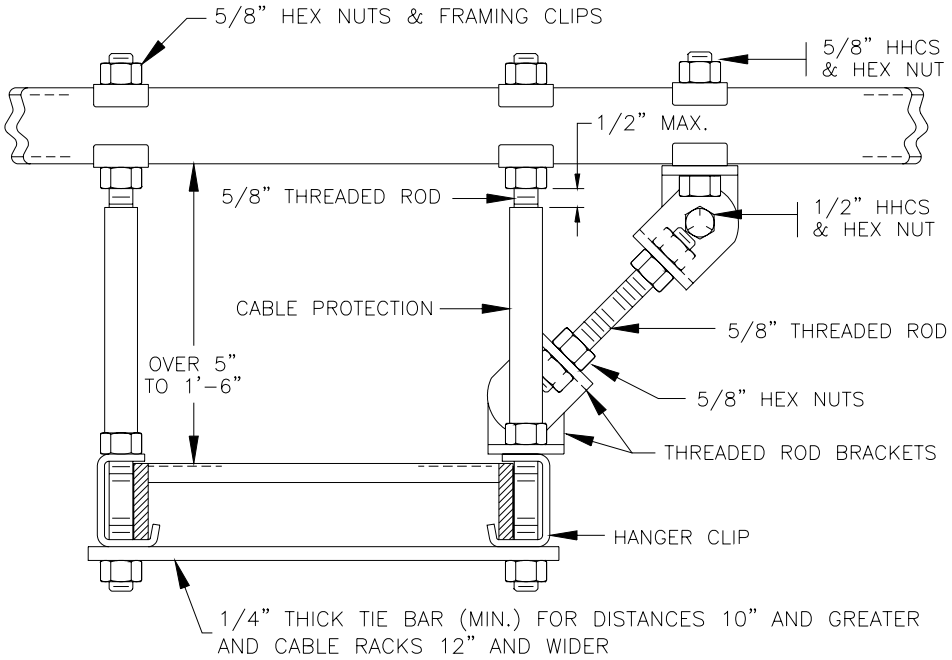



HORIZONTAL RACKS ON WALLS – HEAVY CABLE LOADS (10G)

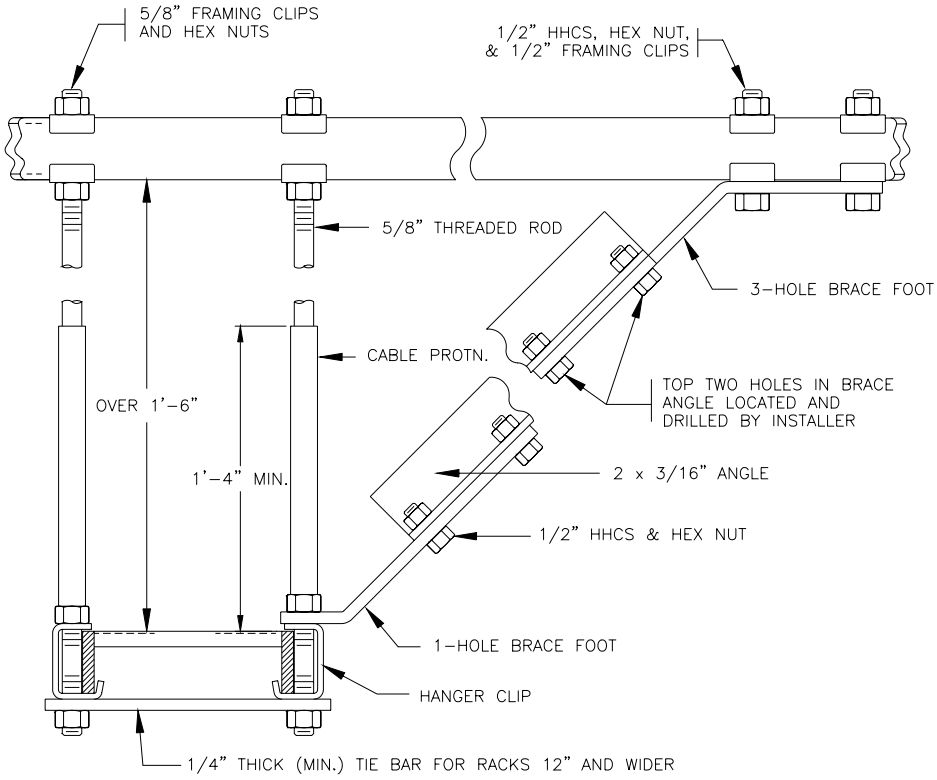
**Figure 11. Standard Cable Rack Support And Bracing – Racks Not Attached Directly To Auxiliary Framing**



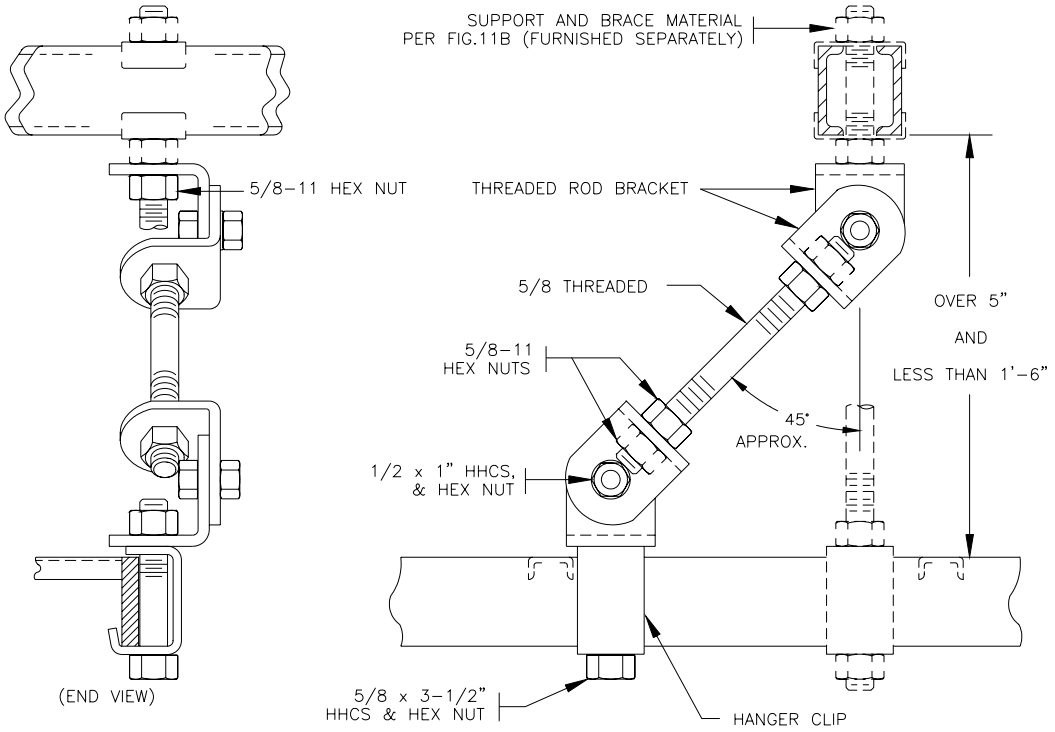

SUPPORTING CABLE RACK BELOW AUXILIARY FRAMING
(11A)



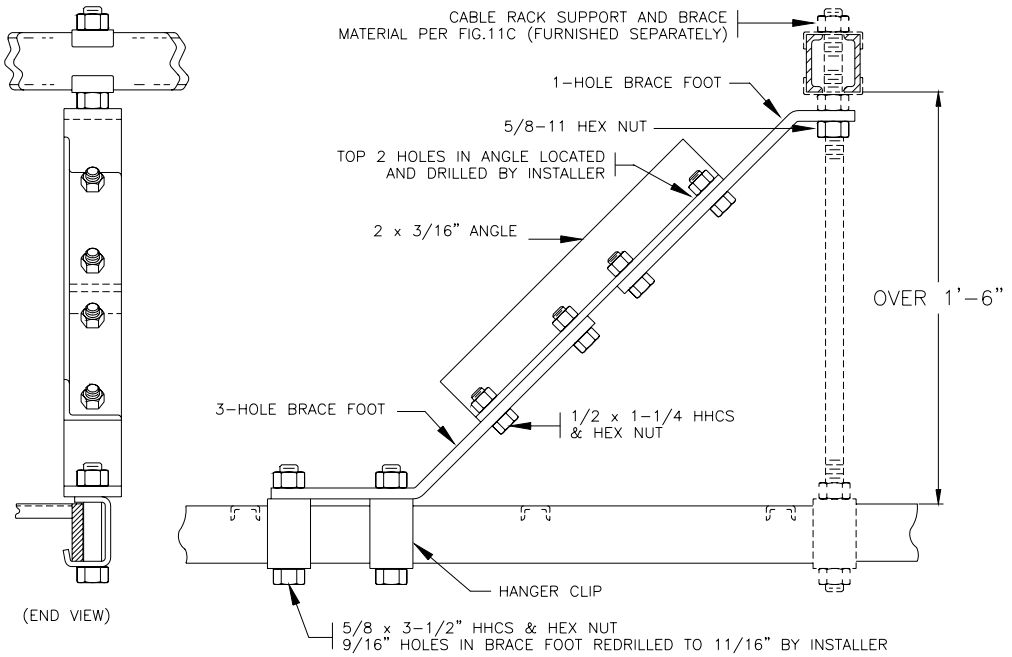

SUPPORT AND THREADED ROD BRACING OF RACKS
BELOW AUXILIARY FRAMING
(11B)




SUPPORT AND ANGLE BRACING OF RACKS
BELOW AUXILIARY FRAMING
(11C)

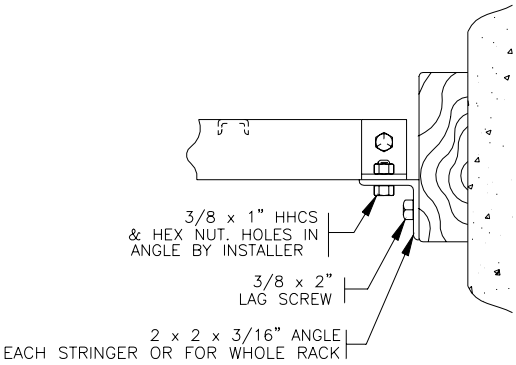



THREADED ROD END BRACING OF RACKS BELOW AUXILIARY FRAMING
(11D)

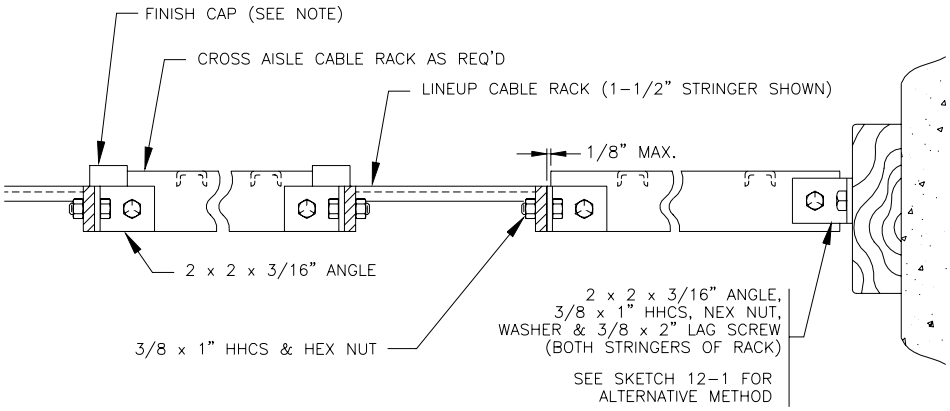



ANGLE END BRACING OF RACKS BELOW AUXILIARY FRAMING
(11E)

**Figure 12. Standard Lateral Bracing – CDO Type Offices Without Auxiliary Framing**

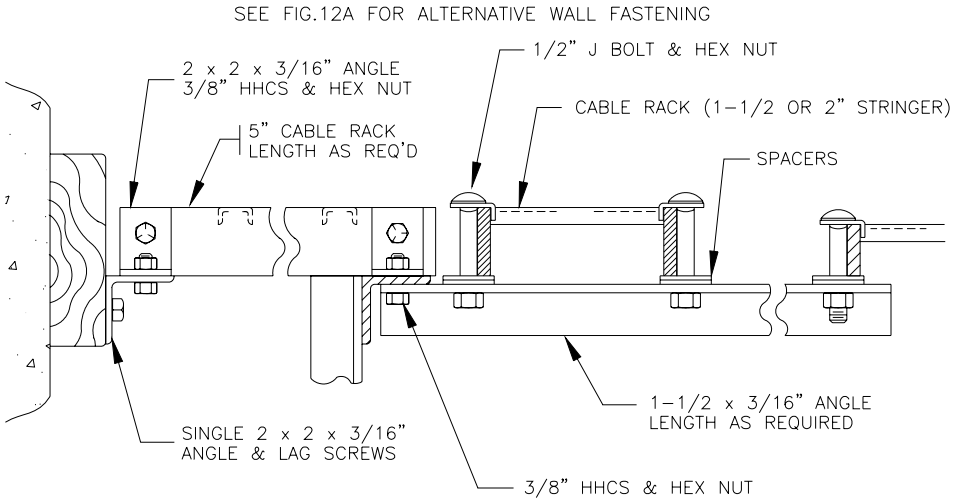



ALTERNATIVE FOR ATTACHING CABLE RACKS TO BUILDING WALLS
SKETCH 12–1




NOTE: FINISH CAPS ARE CUT TO FIT EXPOSED ENDS OF RACKS WHEN IN CLOSE PROXIMITY OF CABLE AND ARE TAPED IN PLACE.

LATERAL BRACING BETWEEN EQUIPMENT LINEUPS AND TO WALLS
(12A)




LATERAL BRACING AT DISTRIBTUING FRAMES
(12B)

**Figure 13. Standard Cable Rack Splice – CDO Type Offices Without Auxiliary Framing**

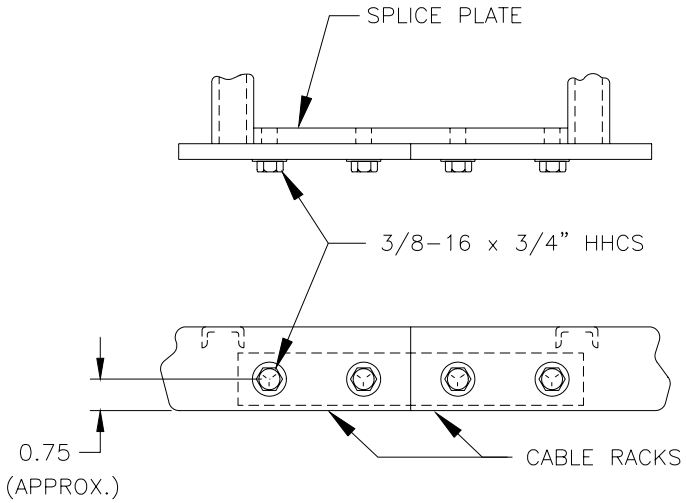
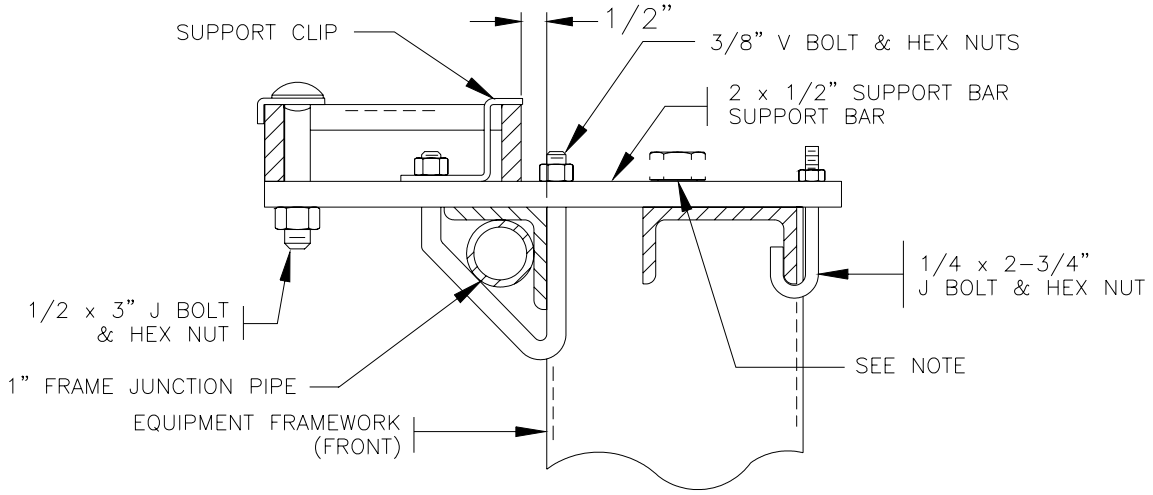
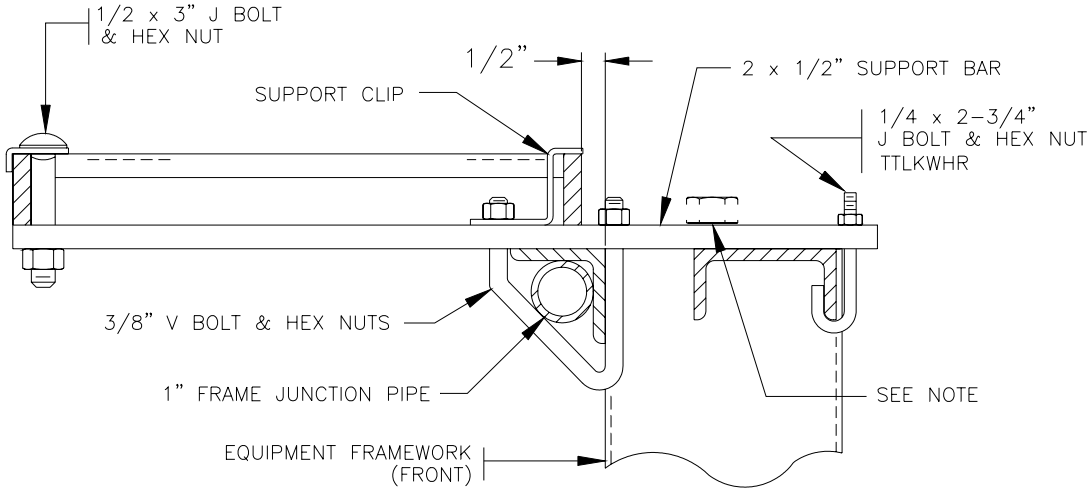


**Figure 14. Standard Cable Rack Supports – CDO Type Offices Without Auxiliary Framing – Racks 1/2 Inch From Duct Type Frame Uprights**




NOTE: 5/8 x 2" HHCS & PLAIN WASHER USED IN PLACE OF 1/4" J BOLT FOR FRAMES WITH CENTRALLY LOCATED TOP CROSS MEMBERS

SUPPORTING 5 INCH RACK IN CDO TYPE OFFICE
RACK LOCATED 1/2 INCH FROM DUCT TYPE FRAME UPRIGHT
(14A)




NOTE: 5/8 x 2" HHCS & PLAIN WASHER USED IN PLACE OF 1/4" J BOLT FOR FRAMES HAVING CENTRALLY LOCATED TOP CROSS MEMBERS

SUPPORTING 1'-0" RACK IN CDO OFFICES
RACK LOCATED 1/2 INCH FROM DUCT TYPE FRAME UPRIGHTS
(14B)

**Figure 15. Standard 5 Inch Cable Rack Support – CDO Type Offices Without Auxiliary Framing – Rack Directly Above Duct Type Frame**

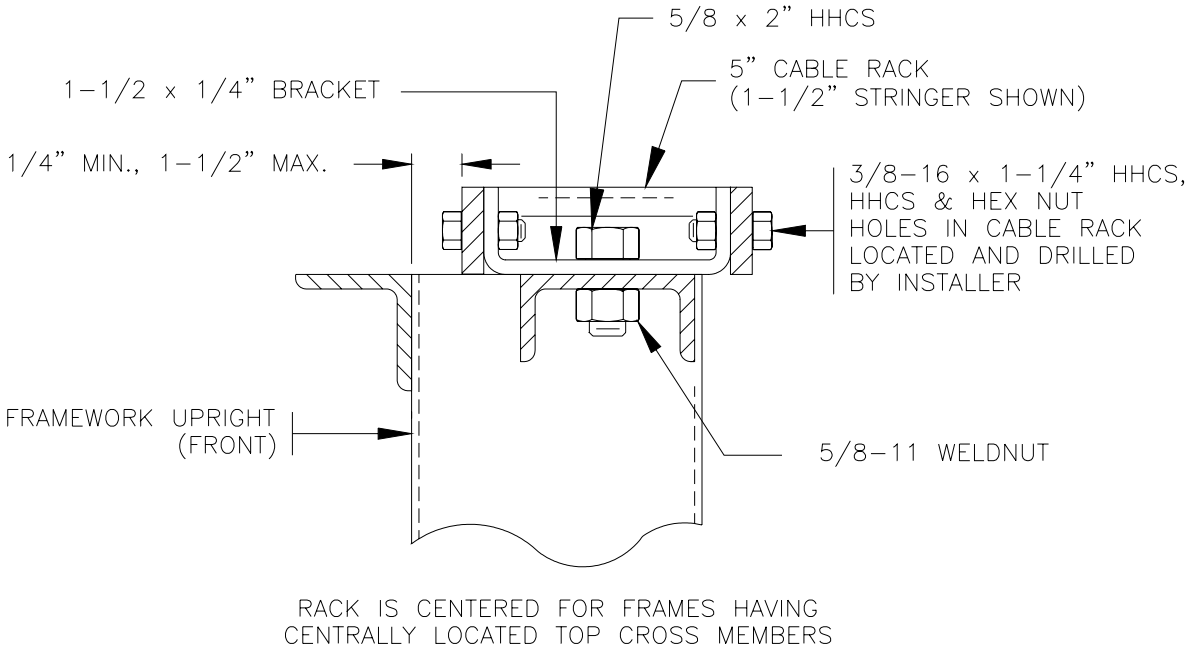



**Figure 16. Standard 12 Inch Cable Rack Support - CDO Type Offices Without Auxiliary Framing - Rack Located Directly Above Duct Type Frame**

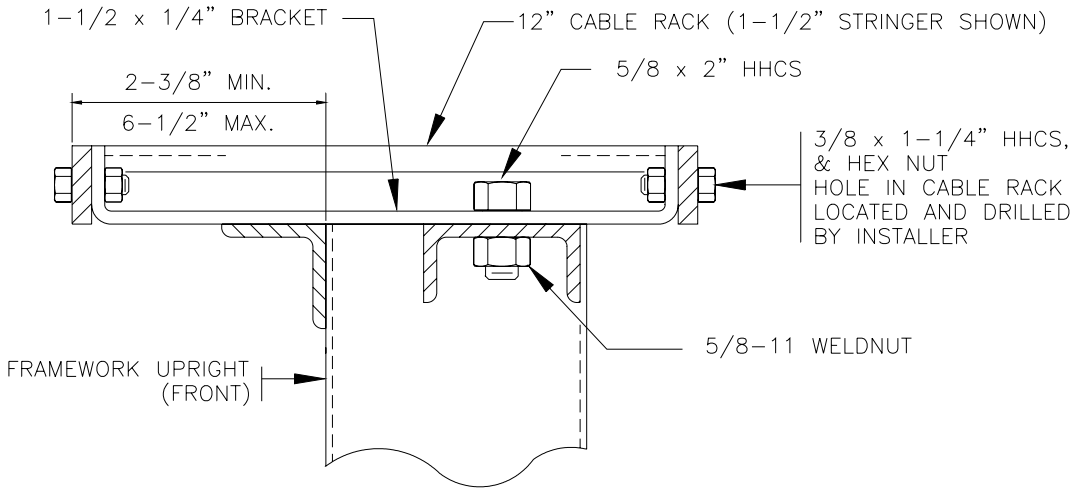


**Figure 17. Additional Cable Support To Prevent Cable Sag**

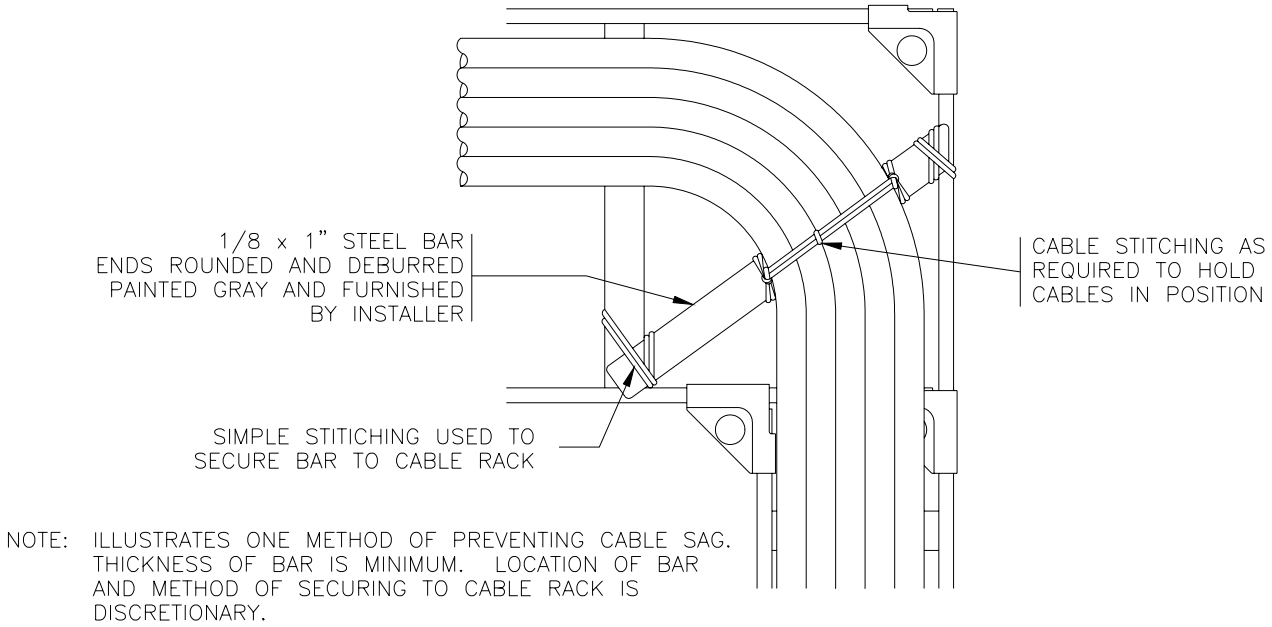



**Figure 18. Typical Support Of 5-Inch Cable Rack Not Attached Directly To Auxiliary Framing**

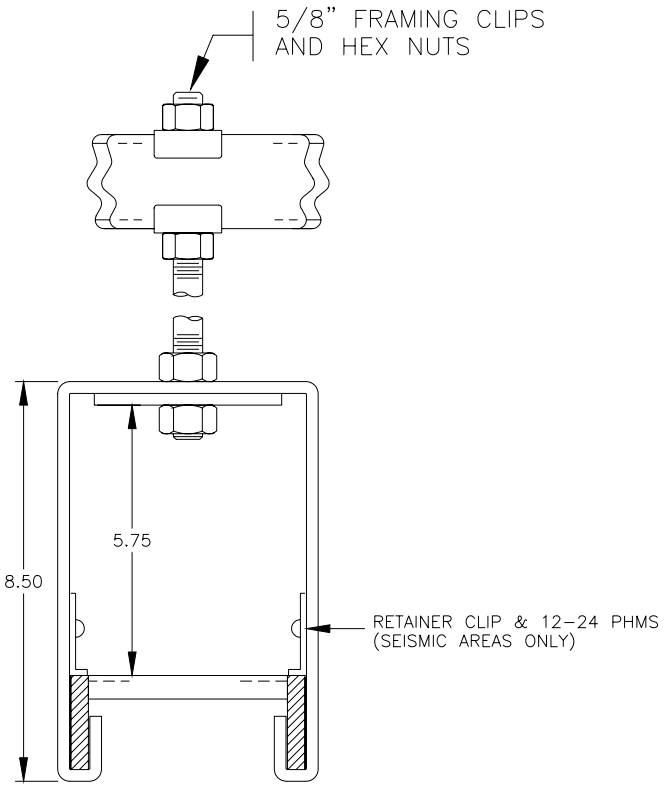


**Figure 19. Auxiliary Cable Support For Cable Racks**

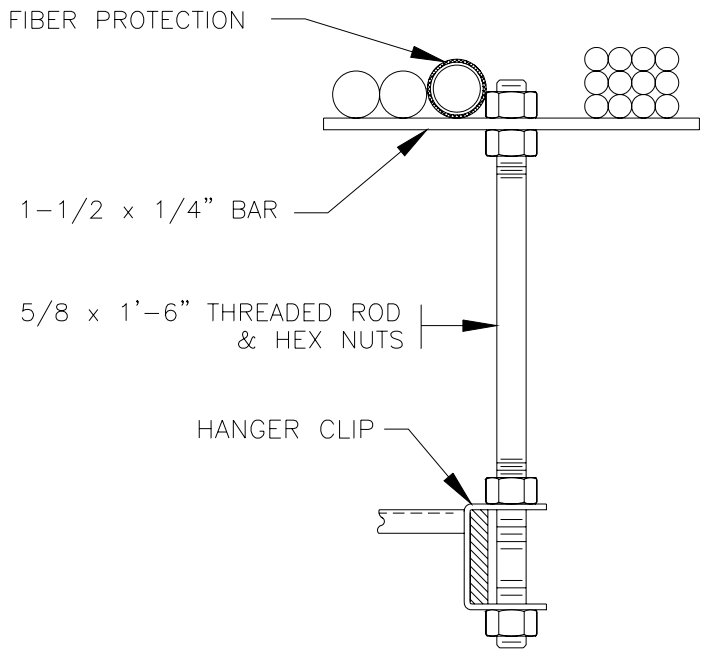


**Figure 20. Typical Arrangement Of Miscellaneous Cable Supports**

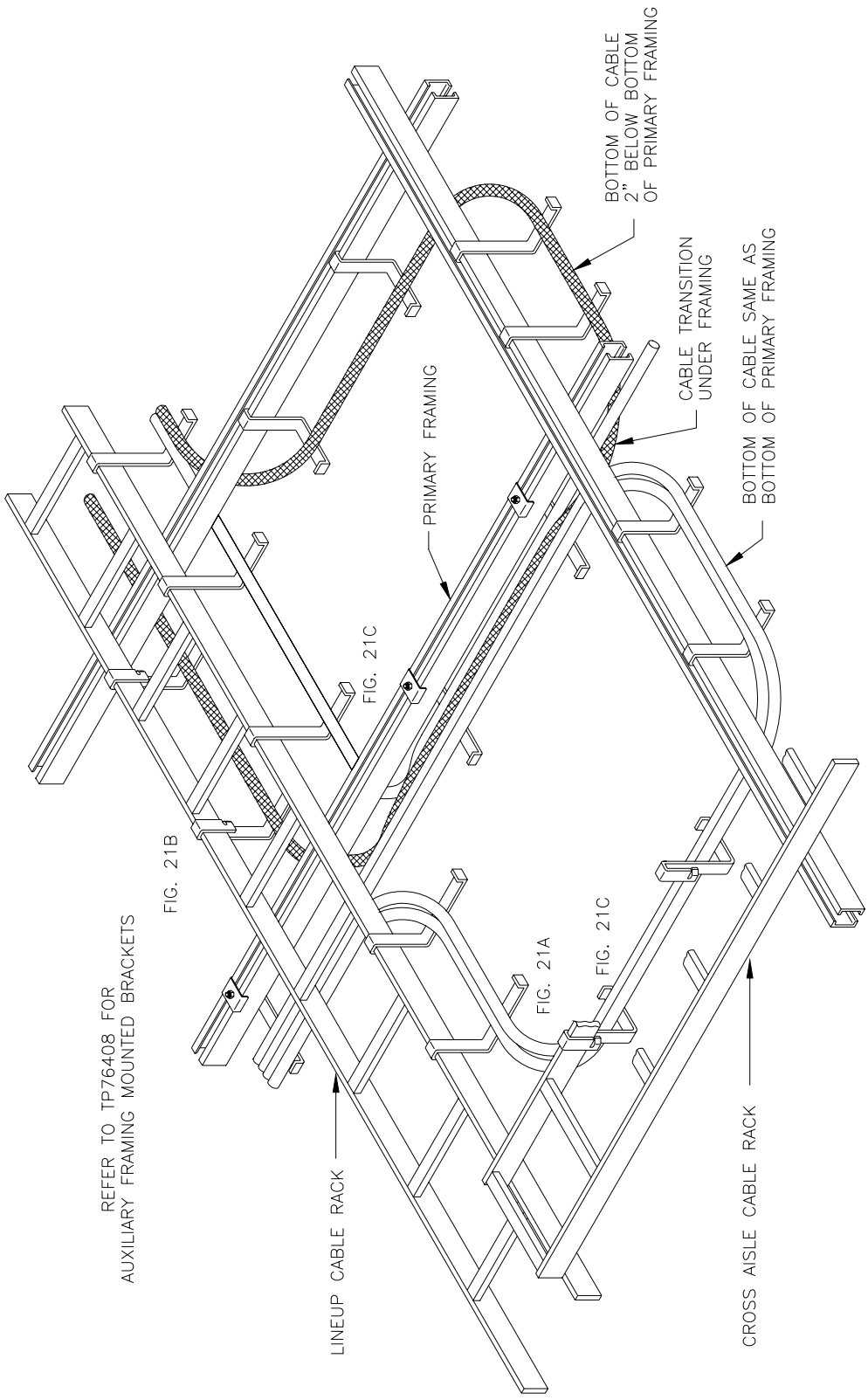
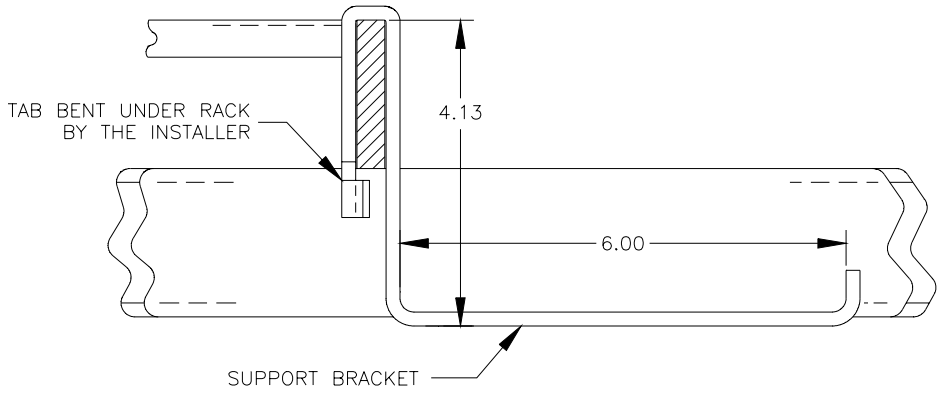
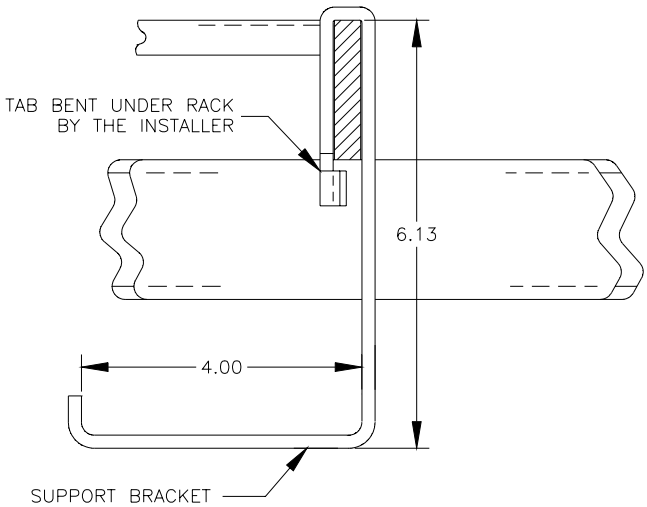


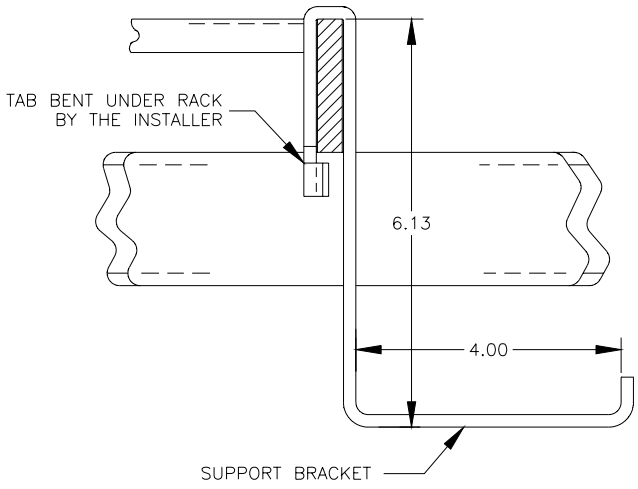
**Figure 21. Miscellaneous Cable Support Arrangements**




(21A)




(21B)




(21C)

**Figure 22. Panned And Horned Cable Rack Used For Unsecured Cable Applications**

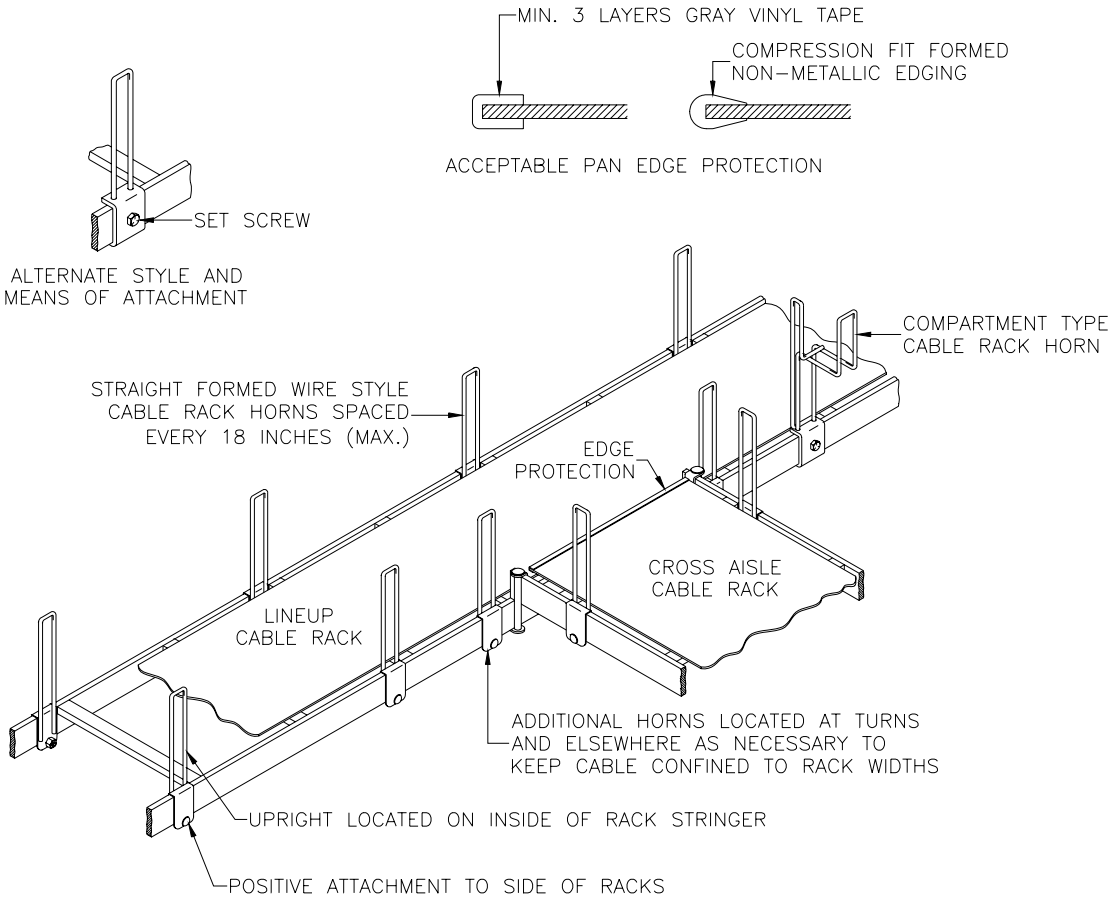
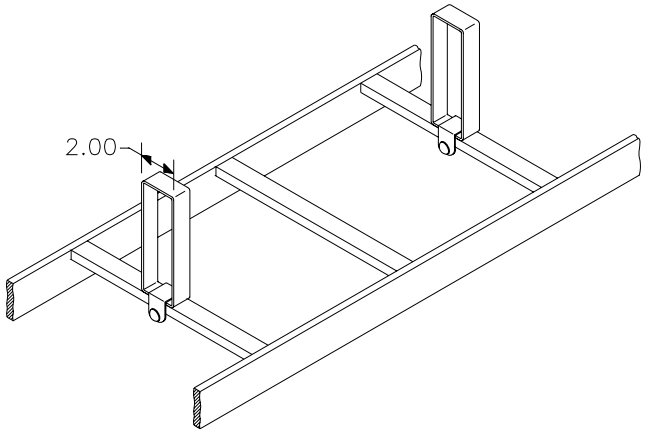
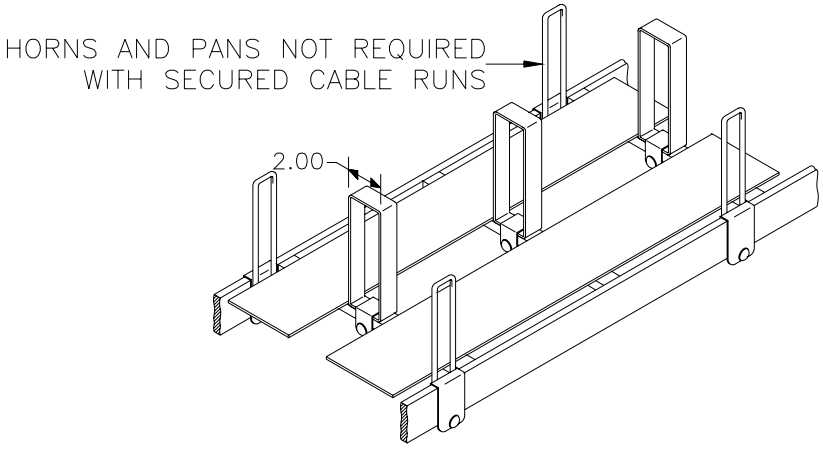


**Figure 23. Application Of Cable Separation Brackets**




SECURED CABLE APPLICATIONS




UNSECURED CABLE APPLICATIONS