

**QWEST Communications  
International Inc.  
Technical Publication**

**QWEST Engineering Standards  
General Equipment Requirements**

**Module 1**

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## **1. Introduction**

### **1.1 General**

These standards have been prepared to provide Telecommunications Equipment Engineering Services Suppliers and Qwest Detail Engineers with general engineering standards. They are necessary to insure that newly installed equipment operates in accordance with the design parameters in the owned or leased telecommunications equipment buildings of Qwest, and to make certain equipment is installed safely and efficiently.

### **1.2 Reason for Reissue**

To add clarifying information to some engineering chapters. This information is intended to make the intent of the chapters clearer. Some exhibits have been completely redrawn and placed in electronic form for ease of use corrected. To Update technical material. Whenever this publication is reissued, the reasons for reissuing will be provided in this paragraph.

### **1.3 Background**

These engineering and documentation requirements are the standard for Qwest Engineering Services Suppliers, to which engineering and performance will be compared for job acceptance purposes. Qwest may, at its discretion, specify additional requirements for specific installations or types of orders through the Standard Configuration documents. **THE ENGINEERING SUPPLIER IS RESPONSIBLE FOR READING, UNDERSTANDING AND APPLYING STANDARDS CONTAINED IN ALL PERTINENT DOCUMENTATION.**

### **1.4 Technical Publication Distribution**

These engineering standards are applicable to all types of telecommunications equipment being engineered; e.g., switching, transmission and common systems, which includes frame, fusing, power, etc. This document is not intended to be all-inclusive. Additional engineering guidance may be required to engineer a specific piece of equipment, or to meet additional requirements established by contract or by Qwest.

These standards were prepared for engineering services suppliers working on Engineering, Furnish and Install (EF&I) orders, Engineering and Install (E&I) orders and Engineering Only (EO) orders for Qwest. The preparation of the engineering for these types of orders varies, depending on the Suppliers role in the total project. An attempt has been made in the preparation of these engineering standards to accommodate the various types of orders.

These engineering standards are applicable to all types of telecommunications equipment being engineered; e.g., switching, transmission and common systems, which includes frame, fusing, power, etc. This document is not intended to be all-inclusive. Additional engineering guidance may be required to engineer a specific piece of equipment, or to meet additional requirements established by contract or by Qwest.

## **1.5 E\*Media**

The completed (i.e., finalized) Microsoft® Word documents are loaded into a system called E\*Media. This system replaced the Electronic Documentation Information Management System (EDIMS). E\*Media is available at a web site:

<http://emedia.uswc.uswest.com/>

## **1.6 Priority of Standards**

- Fire, Life Safety Standards, local, state, and federal
- Qwest Technical Publications or Standard Configuration documents
- Manufacturer's published requirements providing they meet or exceed all Qwest requirements

## **1.7 Scope of Document**

To establish general engineering standards for Central Office Equipment (COE) installation for use by engineering suppliers and Qwest personnel engaged in detail engineering. The output of this engineering effort is to provide instruction and documentation, to permit the safe, efficient and workable installation of equipment in Qwest Central Offices.

To provide guidance to engineering services suppliers and Qwest personnel on the required methodology and symbology to be used in constructing or correcting records, to insure standardization of Central Office (CO) records within Qwest.

To ensure engineering compatibility with Qwest Technical Publication 77350 "Central Office Telecommunications Equipment Installation and Removal Guidelines", compliance with this document by engineering personnel performing work for Qwest is mandatory, to meet the established installation requirements.

Acceptance of the engineering performed by an engineering services supplier shall be in accordance with the General Procurement Agreement, General Services Agreement and any agreement negotiated with that supplier.

Engineering service deliverables shall be subject to an engineering audit to be conducted by Qwest.

Audit results are expected to indicate continuous improvement.

Unsatisfactory audit results, and unsatisfactory management commitment to improve those results, will lead to decertification and elimination from consideration for future contract awards.

### **1.8 Letters of Deviation**

There are occasional cases where following the standards contained in this document are not possible because of specific, identified conditions within the structure. In these cases, it is possible for a letter detailing the condition, and the method used to provide a safe, reliable and well-engineered alternative where the standards cannot be met. The Qwest Central Office engineer authorizing the alternative, who is ultimately responsible, shall write this letter for its success.

Letters of Deviation are to be used for one-time, site-specific conditions and documented as such. A Letter of Deviation is not valid for more than one Central Office. Some situations where a Letter of Deviation will not be accepted or considered valid will be documented in a Qwest Technical Publications or Standard Configuration documents. Letters of Deviation are not valid solely for wholesale or economic concerns. Each instance of deviation shall be documented with an individual letter. These letters are not to be used in continuing non-standard practices that may have been applied in the past, or where new standards have superseded the old, (i.e. earthquake bracing upgrades caused by seismic zone changes).

All letters of deviation shall be discussed with the Qwest Common Systems Planner responsible for the structure prior to issue. Only the Qwest engineer responsible for the long-term management of the central office shall be authorized to issue a Letter of Deviation. A copy of the Letter of Deviation must be provided as part of the Document Work Package (DWP) to the installation forces. The original shall be filed in the engineering job folder and stored as part of the permanent record.

### **1.9 Engineering Responsibilities**

The engineering service supplier is responsible for:

Ensuring the equipment supplier's installation and interconnection requirements are met. This understanding is especially important when the engineering service supplier is not the equipment supplier.

Adherence to all applicable Qwest Technical Publications and Standard Configuration documents.

Ensuring engineering accomplished for Qwest is done in accordance with Federal, State and local requirements, laws and regulations.

Obtaining required documentation to engineer the order. Providing an engineering specification and Central Office marked prints detailing the scope of work.

Ensuring licenses, copyrights or permits are available if an equipment supplier requires them in the course of engineering.

Ensuring that engineering provides information to, or directs the work of an installation supplier in accordance with the requirements established by the current issue of Qwest Technical Publication 77350 (see Reference Chapter).

### 1.10 Document Organization

This document is organized as described in Table 1-1.

**Table 1-1** Document Organization

Chapter	Title	Contents
1	Introduction	General information
2	Equipment Layout	Requirements and related issues about equipment layout
3	Cross Connect Systems	Description of Cross Connect Systems
4	Power Facilities-Battery/Rectifiers (AC/DC)	Explanation and Usage
5	Central Office (Co) Grounding	Grounding Issues in a Central Office
6A	Cable Rack and Auxiliary Framing	Cable Rack
6B	Cable Rack and Auxiliary Framing	Low Type Auxiliary Framing
6C	Cable Rack and Auxiliary Framing	High Type Auxiliary Framing
6D	Cable Rack and Auxiliary Framing	Rolling Ladders
6E	Cable Rack and Auxiliary Framing	Earthquake and Disaster Bracing
6F	Cable Rack and Auxiliary Framing	Cable Distribution Systems
6G	Cable Rack and Auxiliary Framing	Cable Distribution Systems For Fiber Optic Cable
7A	Frame and Aisle Lighting	Fluorescent Type Lighting
7B	Frame and Aisle Lighting	Appliance Outlets and Miscellaneous Conduit
7C	Frame and Aisle Lighting	Emergency Lighting
8	Operations Systems	Important Issues
9	Alarms and Operational Support Systems	Equipment and Performance Monitoring
10	Wire and Cable Requirements	Requirements Relating to Cable and Wire Sheath and Gauge Use.
11	Central Office Equipment	Building Environment Requirements
12	General Interaction Requirements	Communication Channels within Engineering
13	Acronyms/Glossary	Acronyms/Glossary
14	References	References

### **1.11 Terminology**

Shall - Means the work item or material is required to meet minimum requirements.

Should - Means the work item or material is the desired or most common method of meeting minimum requirements.

A & M - Additions and Maintenance only. The figure or item is considered obsolete and may only be added within existing environments containing the figure or item. It is not to be used in new areas.

Standard Configuration - A document containing specific standard methods for engineering, ordering, and installing Central Office super-structure or Vendor specific equipment. It is to be considered the most current authority in these matters.

### **1.12 Acknowledgments and Resources**

The Engineering Standards will be maintained and updated by:

Manager - Common Systems Planning  
Network Reliability Center  
700 W. Mineral  
Littleton, CO 80120

Comments or questions on this technical publication should be addressed to this office.

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## 2. Equipment Layout

### 2.1 General

Chapter 1 of Module 1 covers the general requirements for telecommunications equipment Common Systems engineering for a Central Office environment. This information includes QWEST standard equipment framework and cabinet specifications and general requirements.

Framework, bay, and cabinet standards not specifically identified in this document shall adhere to the intent of the requirements written herein.

Refer to QWEST Technical documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or directions for applying engineering requirements.

### 2.2 Equipment Layout Requirements

Standard space criterion applies to telecommunications equipment located within QWEST Central Offices and buildings. This includes equipment frames, distribution or interconnecting frames, and DC power plant equipment.

All new areas and lineups (minimum of 2) within a Central Office environment shall be engineered and installed with the standard 7' floor supported arrangement as defined in the QWEST Standard Configuration document.

To ensure that different types of equipment frames form orderly, straight equipment framework lineups, all frames shall comply with the following criteria:

- No part of any frame, apparatus or equipment shelf attached to the frame shall extend horizontally beyond the front or rear edges of the base guardrail of the frame. This includes front and rear projections, such as knobs, cables, connectors, disks, writing shelves in the raised or writing position, etc.
- The fronts of the base of all frames should be aligned. The base includes the outer most edge of any attached guard rail extensions. For the purpose of aligning frame flanges, a protrusion of 1 inch into the front aisle if allowable.
- Equipment frames, end guards, and spacer filler panels shall be engineered to the height of the frame top support environment.
- On cabinet enclosures, the total enclosure serves the same purpose as the base footprint or guardrail on open type frames. Floor Plan dimensions are given to the outer most edge of the cabinet, not the base, to insure front aisle alignment and sizing. The installation suppliers need to be aware that for a cabinet, the base alone does not constitute the front of the lineup.
- Frameworks of the same depth shall be used in QWEST Central Office (CO) frame line-ups.

- A maximum difference of 3 inches in depth is allowable for framework or cabinets within a single Central Office lineup.

### 2.2.1 Aisle Spacing

The QWEST Standard aisle spacing should be adhered to at all times to allow for air-flow, heat dissipation, installation, and maintenance of telecommunications equipment in Central Office environments.

Equipment Type	Standard Front (Maintenance) Aisle	Minimum Front (Maintenance) Aisle	Standard Rear (Wiring) Aisle	Minimum Rear (Wiring) Aisle
Toll (up to 1200 Watts)	3'	2'-6"	2'-6"	2'
Data (over 1200 Watts)	Custom Engineering	4'	Custom Engineering	3'
FDF	4'	3'	3'	3'
Switch	3'	2'-6"	2'-6"	2'-6"
Battery Stand (2 Tier /2 Sided)	3'-6"	3'	3'-6"	3'
Battery Stand (Single Sided)	3'	3'	6" from the wall (back side only)	6" from the wall (back side only)
Cosmic Frame	4'	4'	4'	4'
CDF, MDF	4'	4'	4'	4'
DSX	4'	3'	4'	3'
Main Aisle, Egress	4'	4'	4'	4'

Toll Equipment is defined as traditional telecommunications equipment with a total heat release of less than 1200 Watts per bay or cabinet.

Data Equipment is defined as technologically advanced and concentrated telecommunications equipment with a total heat release greater than 1200 Watts.

Main Aisle in a Central Office environment provides space for placement of feeder cable racks, conduit, equipment lineup designation numbering or identification, and breaks at the ends of the 50 foot equipment lineups. The main aisle may also be considered the main egress, see below.

Egress is defined by OSHA as "Means of egress." A means of egress is a continuous and unobstructed way of exit travel from any point in a building or structure to a public way. For our purposes a public way is defined as an exit that leads out of the building.

#### AISLE MEASUREMENTS

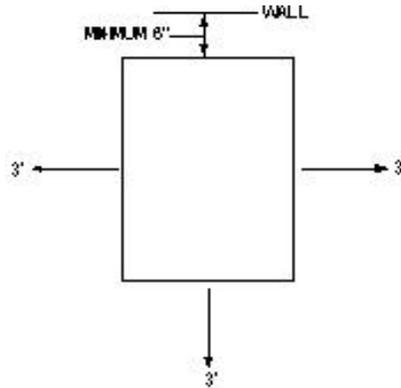
- Equipment frame aisles will be measured from the outer most edge of the frame guard rail or guard rail extension to the outer most edge of the opposite frame guard rail or guard rail extension.
- Measurements from columns are determined by finding the dimension from the farthest most point on the column face to the outer most edge of the frame guard rail or guardrail extension directly opposite the column. Lineups will be planned so columns will not protrude into the aisles.
- Main aisles are measured from the outer most point of the end guard attached to the first frame in one lineup to the outer most point of the end guard attached to the first frame in the lineup directly across the new main aisle.

#### Main Aisles

- Each grouping of 50-foot lineups will be separated by a 4-foot main aisle.
- Main aisles will run perpendicular to a Central Offices' lineup wiring and maintenance aisle.
- Main aisles are designed to allow for, but are not limited to, the placement of access cable racks, conduit, lighting, and AC feeder circuits.

#### Additional Power Requirements:

- Battery stands and power equipment frames shall never be installed directly against a wall.
- A minimum dimension of 3 feet is required on all sides of battery stands. The only exception allowed for 2 tier, 2 sided, battery stands is where one of the narrow sides of the stand is located 6 inches from a wall. At the opposite narrow end of the battery stand, a 4-foot main egress must be maintained.
- For a single sided, two-tier battery stand, the minimum a 3-foot clearance is required on all sides except the back. A minimum of 6 inches is required from the back of the single sided, two-tier battery stand to the wall.
- The 3-foot minimum clearance applies to all obstructions including columns.



Single Sided, Two Tier Battery Stand

- The recommended standard clearance for battery stand maintenance aisles is 4 feet to allow for the use of battery hoists.

In the event, the standard aisle spacing cannot be adhered to, the minimum distance may be used if all other environmental conditions are satisfied (i.e. HVAC access, air circulation, cable rack pileup, etc.). Letters of deviation violating the minimum aisle spacing to add new equipment in a QWEST Central Office will not be accepted and are not considered valid.

### 2.2.2 Walls and Columns

The standard dimension from walls and columns listed below is applicable for both seismic zones 1, 2 (light) and 3, 4 (heavy) environments.

Component Perpendicular to the Wall or Column	Standard Distance from Wall (Aisle)	Minimum Distance from Wall (Aisle)	Standard Distance from Column	Minimum Distance from Column
Equipment Frames or Cabinets	4'	3'	1'	6"
Auxiliary Framing	1'	6"	1'	6"
Cable Racking	1'	6"	1'	6"

NOTE: When the office conditions prevent adherence to the standard spacing requirements the minimum dimension may be used. Letters of deviation violating the minimum spacing requirement for new equipment add to a QWEST Central Office will not be accepted and are not considered valid.

### 2.2.3 Heat Dissipation

Frame Heat Dissipation describes the heat dissipated from the frame to its surroundings. It includes the total heat liberated by all equipment mounted in the frame. Required heat release data include:

- Heat Release Maximum: Denotes the heat given off by a frame fully equipped with options that result in the maximum heat when operational.
- Heat Release Minimum: Denotes the heat given off by a frame fully equipped with options that result in the minimum heat when operational.
- Heat Release Planning Value: Denotes the "worst case" heat release per frame that will be emitted in an operating office. The "worst case" heat release is calculated by adding the maximum heat dissipation of each shelf as documented by the equipment manufacturer.

#### Engineering Considerations

- Heat dissipation of each piece of equipment mounted in a bay or cabinet must be taken into consideration when establishing aisle spacing.
- Equipment frames with a total heat dissipation higher than 1200 Watts per bay will require wider aisles and possible office HVAC upgrades to allow sufficient airflow to ensure equipment operability.
- The support environment of telecommunications equipment frames, bays or cabinets exceeding the 1200 Watt heat dissipation limit must be custom engineered to ensure optimum functionality and reliability of the service.
- The QWEST Representative responsible for HVAC and environmental conditions must be notified prior to the installation of telecommunications equipment exceeding the 1200 Watt heat dissipation level in order to evaluate Central Office impacts.

#### **2.2.4 Lineup Length**

All equipment lineups in an area must follow the same contiguous layout design, height, and ultimate lineup length.

#### Dimensions

- Equipment frame line-ups shall not exceed 50 feet in length.
- The end of lineups will be positioned 4 feet from an outside wall to allow for a continuous main egress. Violating the main fire exit or egress of any room in a Central Office environment is strictly prohibited and letters of deviation will not be considered valid for non-adherence.
- A "dead end" lineup that is placed less than 28 inches from a wall must have a 4 feet egress or main aisle no more than 20 feet from and perpendicular to the wall. The equipment frames in these lineups shall be a minimum of 6 inches to the wall.
- An average side clearance or space of 1/8 of an inch will normally be provided in Central Office line-ups, between adjacent frames. This dimension as well as any spacers or vertical cable management panels must be considered when planning the number of frames to configure a 50 foot lineup.

#### **2.2.5 Floor Loading**

Floor load is determined by totaling the weight of all equipment over a particular floor area and dividing by that area. The area includes aisles and open areas associated with the frames.

### STANDARD FLOOR PLAN ARRANGEMENTS:

- Equipment frames, which conform to a specific standard floor plan configuration, should not exceed an optimal limit of 115 pounds per square foot (115 lb./ft<sup>2</sup>) for standard floor plans.
- Where frames are designed without prior knowledge of what other frames will be adjacent, floor load will be calculated on an individual basis. The frame weight is divided by the area of a rectangle bounded by the extended frame sides and the center line of standard front and rear aisles. Individual frames will be limited to a floor load of 115 pounds per square foot (115 lb./ft<sup>2</sup>).
- The floor loading for standard floor plan arrangements is averaged across the associated floor area and excludes the cable distribution system.

### SYSTEM FLOOR PLAN ARRANGEMENTS:

- When designed as part of a major system involving multiple frames and conform to a specific floor plan configuration, the average load will be calculated over an area equal to one building bay. An average building bay is a 20 foot by 20 foot area.
- The cable support and distribution systems, including lighting, shall have a maximum weight of 25 pounds per square foot. (25 lb./ft<sup>2</sup>).
- Any such building bay area will meet the floor loading limit requirements of 115 pounds per square foot (115 lb./ft<sup>2</sup>), regardless of the location relative to the columns.

### NONSTANDARD FLOOR PLAN ARRANGEMENTS

- Nonstandard floor plan arrangements will be compatible with standard floor plans to insure all equipment will function effectively.
- An absolute limit of 140 pounds per square foot (140 lb./ft<sup>2</sup>) floor load allocation for all equipment (including cable and lights) will be observed.
- The QWEST Representative responsible for Common Systems standards prior to implementation must approve all nonstandard floor plan arrangements.

Frame Weight - Generally, the weight for each frame is the combined weight of the following:

- Framework assembly.
- Equipment, including those options that will result in the greatest weight.
- Intra-frame cable, which when connected, does not occupy space in the cable rack.

#### **2.2.6 System Requirements**

System design considerations may justify the use of frame dimensions other than those shown in this document. All systems should conform to the following:

- All frames in a system or line-up should be of the same height and depth.
- A maximum difference of 3 inches in depth is allowable for frames or cabinets within a system lineup.

- Floor plans for large systems occupying several building bays must provide space to allow for vertical cabling, power, and miscellaneous equipment.
- New system arrangements must be evaluated by the QWEST Representative responsible for Common Systems standards prior to implementation.

### **2.3 Floor Plan Data (FPD)**

Floor plans should provide a high degree of standardization while maintaining enough flexibility to permit natural growth from the initial to the ultimate equipment configuration. Floor plan spacing should be designed to ensure that all equipment functions together effectively.

All equipment engineered in the past were in conformance with standard Floor Plan Data (FPD) requirements. Floor Plan Data (FPD) documents were established and published by Bellcore (now Telcordia).

QWEST Technical Publications and Standard Configuration documents shall be referenced for guidelines, approved applications and technical requirements.

### **2.4 Network Equipment - Building Systems (NEBS)**

All equipment engineered for installation in QWEST facilities must be in conformance with standard Network Equipment - Building System (NEBS) requirements identified by QWEST. Network Equipment - Telcordia (formerly Bellcore) publishes Building Systems (NEBS) documents.

Network Equipment - Building System (NEBS) documents communicate the proposed minimum generic spatial and environmental criteria for all new telecommunications equipment systems used, including collocated equipment, in Central Offices (CO) and other telephone buildings. Additional design requirements including functional, electrical, mechanical, and reliability requirements, may be found in the reference documents for the specific system, equipment, or component.

NEBS spacial requirements provide specifications for equipment and cabling systems to be compatible with Central Office (CO) vertical and horizontal space allocations and floor loading limits.

NEBS environmental criteria provides requirements for equipment to help ensure their compatibility with the physical environment furnished for network facilities. This environment includes physical stresses from temperature, humidity, fire, earthquake, and airborne contaminants, as well as the acoustic noise and illumination characteristics of these facilities.

Environmental test methods should be used to test equipment for conformance to the environmental requirements. QWEST requires vendors to test equipment to the Extreme Environment Level 3. The requirements should apply to all new CO equipment systems. There are three levels of NEBS testing plus the Other Criteria:

- Level 1 - Personal Health and Safety
- Level 2 - Functionality Concerns
- Level 3 - Reliability Concerns
- Other Criteria - Environmental Impacts

All QWEST Central Office drawings shall be marked to reflect the equipment symbol designation indicated by NEBS. The NEBS defined labels are to be used on the Floor Plan drawings to identify all equipment added within QWEST Central Office facilities. The Floor Plan shall be corrected immediately in the event a discrepancy or a nondescript miscellaneous label appears on the Floor Plan drawing. These corrections will allow for the accurate inventory and identification of CO equipment.

## **2.5 Equipment Framework Requirements**

This section covers the types of frames that may be installed in line-ups in the equipment areas of QWEST Telecommunications Facilities. Equipment frames, as defined here, include relay racks, bays, and cabinets that are comprised of a structural framework and all equipment mounted thereon. All frames will comply with the following requirements to ensure a diversity of frame types will fit together in straight, orderly equipment frame line-ups.

### **2.5.1 Frame Construction**

Framework and cabinet assemblies must have several common attributes:

- All frames and cabinets shall be comprised of a ferrous material (i.e., steel). Aluminum as a component metal is prohibited.
- All components shall be of welded construction.
- To prevent corrosion, all equipment framework assemblies shall have a non-corrosive plated type of finish, (i.e. dichromate), or paint, preferably gray. Other colors may be used for limited dedicated applications with approval of the QWEST representative responsible for Common Systems engineering standards.
- Any frame, when packaged for transit and accompanied or supported by the usual handling facilities, will fit through standard equipment entrances that are 4 feet wide and 8 feet high.

### **2.5.2 Ratings**

Framework assemblies are rated for use within QWEST Central Offices (CO) and other telephone buildings. These two ratings describe the applications and restrictions.

Prior to the installation of a frame, QWEST must evaluate and authorize any framework or cabinet assembly not meeting the standards and requirements reference herein. Only "grandfathered", site-specific configurations qualify for deviation from this standard.

QWEST frame ratings are defined as follows:

STANDARD - Describes equipment or material to be used in all new areas or line-ups.

CONDITIONAL - Describes equipment restricted for use within existing environments or line-ups. This rating applies where extending the current arrangement is more cost effective than utilizing the Standard framework assembly. Approved products only.

### 2.5.3 Approved Framework Assemblies

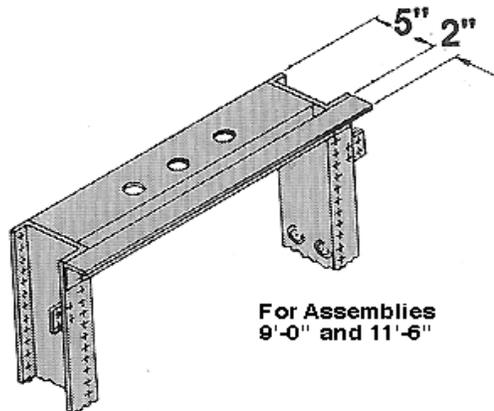
The overall dimensions of equipment frames approved for use within QWEST Central Office Environments are detailed in the exhibit below.

The Standard Framework as shown on the following page should be used for all new installations unless the QWEST Standard Configuration documents specify otherwise.

QWEST must approve all other framework assemblies prior to placement within the equipment areas of any QWEST Telecommunications Facilities.

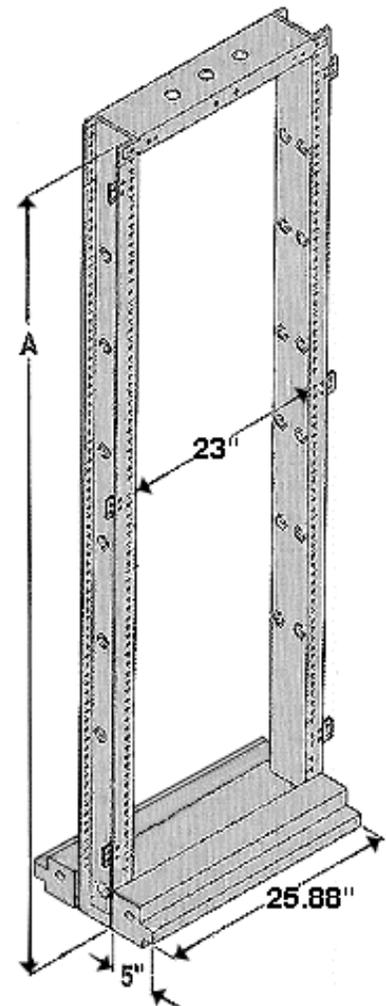
#### 2.5.3.1 STANDARD FRAMEWORK ATTRIBUTES:

- Type: Network
- Height: 7 feet; (9 feet; 11 feet 6 inches where the existing environment dictates)
- Width: 25.88 inches overall; 23 inch inside mounting
- Mounting Plate Spacing: 1-3/4 inch
- Depth: 15 inches
- Base Footprint: 5 inches - 5 inches - 5 inches



#### Framework Top Support Angle

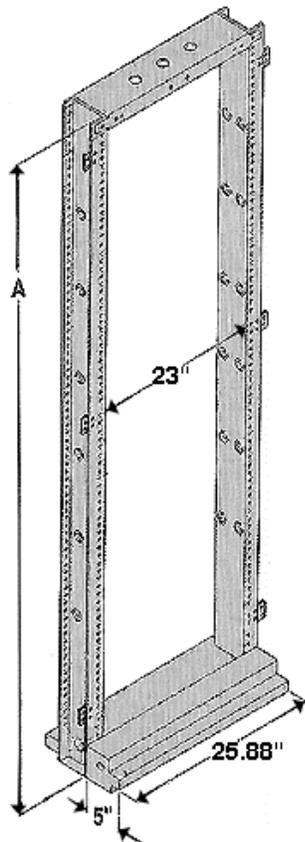
(Height to match the existing environment)



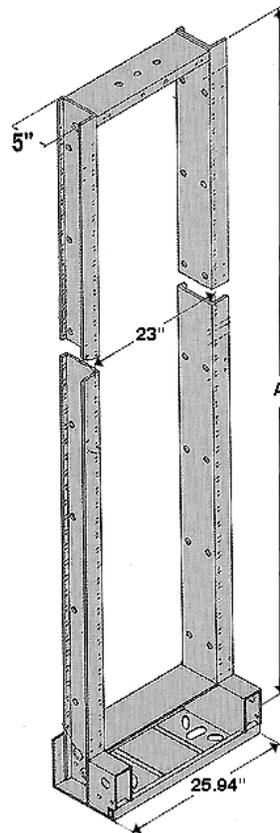
The standard equipment mounting plate spacing of 1-3/4 inches is required on all standard equipment frame uprights.

**2.5.3.2 CONDITIONAL FRAMEWORK ATRIBUTES:**

- Type: Network; Unequal Flange (Duct)
- Height: 7 feet; 9 feet; 11 feet 6 inches
- Width: 25.88 (NTWK), 25.94 (Duct) inches overall;  
23 inch inside mounting
- Mounting Plate Spacing: 1-3/4 or 2 inch
- Depth: 12 inches (Unequal Flange Framework has several guard rail options or a variable base depth)
- Base Footprint: 5 inches - 5 inches - 2 inches;  
2 inches - 5 inches - 5 inches;  
6 inches - 5 inches - 1 inch;  
1 inch - 5 inches - 6 inches



**Network Framework  
12" base footprint**



**Unequal Flange (Duct) Framework**

#### **2.5.4 Standard Cabinet Assembly**

The Standard Central Office Cabinet will be used for:

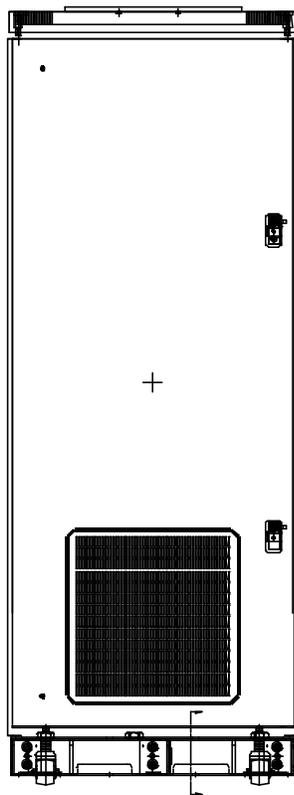
- Equipment configurations with a total heat dissipation of 1700 to 3000 Watts when equipped with an approved optional top fan assembly and applicable aisle spacing.
- Central Office equipment with an overall shelf depth (including connectors) larger than 26 and smaller than 33 inches.
- Passive equipment shelves smaller than 26 inches in depth (such as fuse panels, fiber distribution panels, DSX, etc.) may be installed in the cabinet in addition to the active network elements providing the overall total cabinet heat dissipation does not exceed the 3000 Watt limit.

#### Engineering Considerations

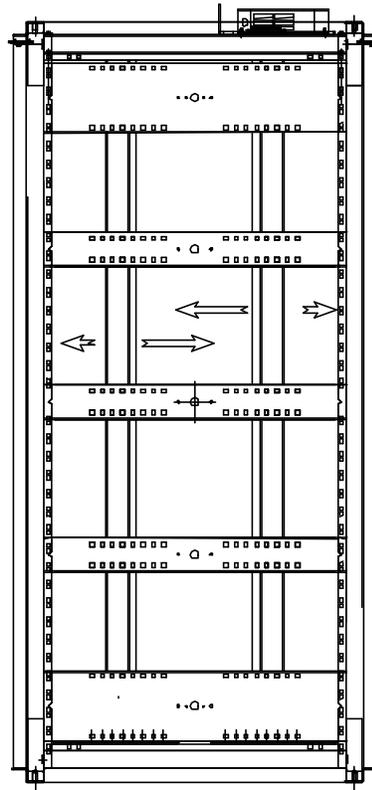
- Sufficient space should be allowed both front and rear of any equipment shelf for airflow thus taking into account any fan intake and exhaust directions.
- Due to the large depth of the cabinet, it must be placed in a 7 foot floor supported environment with cabinets of similar depth.
- A maximum of 3 inch difference is allowed between the outside depth for cabinets in a Central Office lineup.

#### **2.5.4.1 STANDARD CABINET ATTRIBUTES:**

- Height: 7 feet ONLY
- Width: 29.5 inches (outside); 23 inch inside equipment mounting
- Mounting Plate Spacing: 1-3/4 inch and 2 inch
- Depth: 35.5 inches (outside)
- Construction: Welded Steel
- Optional Components: Top Mounted 6 Fan Unit, Front & Rear AC outlet



Cabinet Front



Cabinet Side

### 2.5.5 Bay Extenders

Three heights of equipment frames are commonly installed in Qwest Central Office environments; 7 foot, 9 foot, and 11feet 6 inches. It is always recommended to match the height of the framework to the height of the top support system. However, frame (bay) extenders may be used to adapt frames to uniform line-up heights.

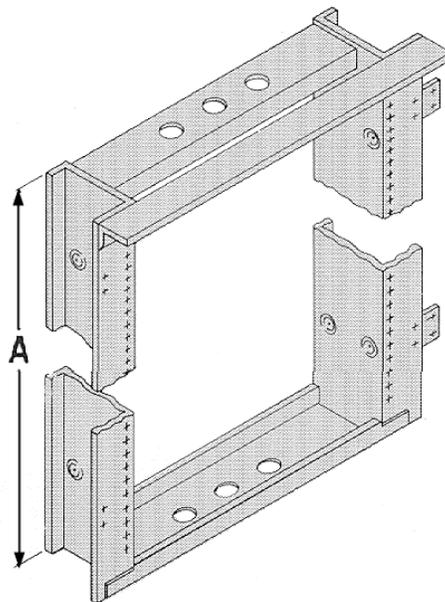
Only frames, with extenders attached, having passed earthquake zone 3,4 NEBS test criteria are approved for use within Earthquake Zone 3,4 (heavy) areas in QWEST. The QWEST Technology Selection Representative must evaluate and verify NEBS compliance prior to any installation. Unapproved frame extenders are prohibited in all QWEST Central Offices and facilities.

Approved bay extenders meet several main requirements:

- Frame extenders shall never be used to mount equipment. Letters of deviation violating this requirement will not be accepted and are not considered valid.
- Frame extenders shall conform to the width, flange configuration, and design of the frame to which they are applied.
- Extenders must provide top hole pattern configurations that are compatible with framing hardware applications as shown in the cable racking and framing units of this document.

- A ground conductor shall provide a positive bond between frame and extender to meet QWEST grounding requirements.
- The bay extender's uprights will be positioned and shaped to provide maximum space for routing cables to match the frame.
- Must be installed in the exact configuration in which it passed the NEBS Earthquake Zone 3,4 test criteria.

The figure below depicts a frame extender approved for use within the seismic zone light areas of QWEST. The “A” dimension indicates either 24 inches (7’-0” extended to 9’-0”) or 54 inches (7’-0” extended to 11’-6”) height.



**Framework (Bay) Extender**

### **2.5.6 Anchoring**

All telecommunications equipment frames, relay racks, bays and floor mounted cabinets will have a hole pattern on the base of the frame for anchoring to concrete floors. Both the equipment frames and anchoring material will comply with level 3,4 NEBS requirements.

## SEISMIC REQUIREMENTS

All equipment frames shall be anchored to meet the Seismic zone requirements for the area in which they are installed. Seismic Zones 0,1, 2 are defined as light and Seismic Zones 3, 4 are defined as heavy.

Light Seismic Zones – All Floors: Require two ½ inch QWEST standard torque indicating anchor bolts to secure QWEST standard equipment bays and cabinets at diagonally opposite corners. Floor supported cabinets shall be anchored at all four corners.

**Note:** Equipment groupings, whose average equipment and cable weight exceeds 650 pounds, require four anchors; one on each corner of the equipment bays. The average equipment and cable weight is defined as the weight of all equipment, cable equipment frameworks, and cable racks divided by the number of framework bay modules. If the cable weight center of gravity is above the 8 foot level, reduce the 650 pound decision point to 600 pounds.

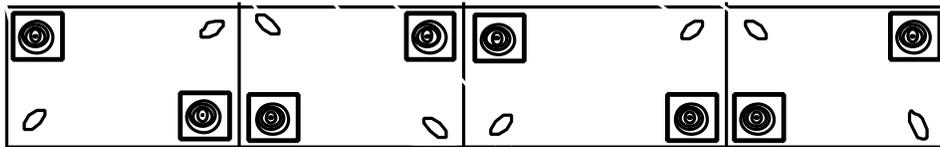
Heavy Seismic Zones – All Floors: Require four-½ inch QWEST standard torque indicating anchor bolts to secure equipment bays and cabinets. In addition, two hold down plates are recommended with each frame. Hold down plates are not required on approved frames equipped with an internally reinforced base which prevents the installation of the plates.

**Note:** Equipment groupings whose average equipment and cable weight exceeds 850 pounds, require overhead bracing for any floor and four anchors; one on each corner of the equipment bays. The average equipment and cable weight is defined as the weight of all equipment, cable equipment frameworks, and cable divided by the total number of framework bay modules. If the cable weight center of gravity is above the 8 foot level, reduce the 850 pound decision point to 800 pounds. To serve as structural tie struts, cross-aisle cable racks should have a maximum spacing of 5 feet.

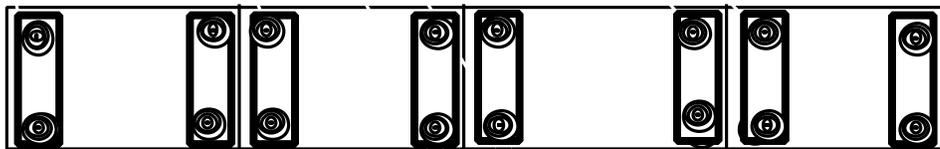
## ANCHORING TELECOMMUNICATIONS EQUIPMENT:

- There is one anchor bolt assembly approved for all telecommunications equipment placed within QWEST Central Offices and facilities. Unapproved anchor bolts are prohibited.
- The approved 12 millimeter metric anchor with a 60 millimeter embedment depth is designed for shallow floor application within Seismic zone 0,1,2 and 3, 4 areas. It is equipped with a M12 torque nut and requires an 18 millimeter drill bit to install.
- The approved torque indicating anchor bolt assembly shall be provided for both light and heavy Seismic areas.
- For the part number of the approved anchor bolt, contact the QWEST Representative responsible for Common Systems standards.
- All battery stands and other equipment placed in QWEST telecommunications power room will use the approved power equipment anchor. Two anchor bolts are required on each battery stand support foot in earthquake zone 3,4 (heavy) and one per foot in earthquake zone 1,2 (light). Four anchors are required for each power room bay in earthquake zone heavy and two anchors installed diagonally in earthquake zone light.

- A means to level and plumb the frames, to compensate for variations in floor uniformity, will be either a part of the frame or usable with the frame. These may include washers, shims, wedges or leveling screws. All kits must be evaluated and approved before use in any QWEST telecommunications facility.
- The approved base molding must be installed when anchoring each frame, cabinet or bay.
- When mounting frames, bays, and cabinets on raised floor environments, the raised floor manufacturer's instructions for mounting to the concrete floor below shall be followed. Anchoring to the raised floor plates alone is strictly prohibited.



Earthquake Light Anchoring, (showing square washers.  
This Specific pattern is not required )



Earthquake Heavy Anchoring  
(showing placement of  
earthquake plates on framework  
base plate)

### **2.5.7 Top Support**

All equipment frames, relay racks, bays and cabinets will have a means of top support. Common support requirements are identified in the cable racking and framing units (Module 1, Chapter 6, Units A and B) of this document and in QWEST Standard Configurations. New 7 foot frames, bays, and cabinets, including isolated frames, will be floor supported.

Framework assemblies, bays and cabinets in 7' floor supported arrangements will uphold the overhead structure using 5/8 inch, threaded rods.

Frames require a minimum of two top supports per bay, while cabinets require four (one on each of the cabinet's four corners).

### **2.5.8 Shelf Numbering**

The procedures for numbering shelves within a bay, relay rack or equipment frame shall be consistent for all network elements utilized within QWEST with the exception of power. For the numbering configuration of power bays refer to the QWEST, Technical Publication 77385 Power Equipment and Engineering Standards.

The Shelf Number (SFNO) identifies the numbering convention for each network element. Each network element requires a shelf, panel, plate or module designation plus a two digit numeric identifier.

The two digit numeric identifier:

- Must always be the last two characters of each unique shelf number designation.
- Shall distinguish each network element starting from the bottom and increasing upwards within the framework assembly.
- The numbering scheme of the two digit numeric identifier is not restricted to a sequential pattern. Due to required spacing between network elements and available space for future equipment, the two digit numeric identifier may skip some sequential digits.
- As long as the numeric identifier is unique within each equipment frame, any bottom to top graduating numbering sequence is acceptable.
- A heat baffle, writing shelf, etc. are not considered network elements.

### **2.5.9 Equipment Mounting**

General Guidelines for mounting telecommunications equipment include:

- Telecommunications equipment shelves shall not be mounted above the 7' level for framework assemblies installed within QWEST Telecommunications Facilities. System or equipment specific exceptions, if any, will be documented in QWEST Standard Configurations.
- Letters of deviation violating the restriction for mounting above the 7' level will not be accepted and are not considered valid.
- Mounting equipment shelves starting from the bottom upwards to distribute the weight proportionally and avoid "top heavy", potentially dangerous situations. When the

equipment is dissimilar in size and weight, the heaviest, deepest equipment should be placed in the bottom of the cabinet.

- Vertical space below shelves may be necessary for the bottom cabled equipment shelves. Verify the manufacturer's design for cabling a shelf. As a rule, for bottom fed equipment leave an additional space 4" to 6" below the shelf to allow for cable forming and bend radius.
- Deeper equipment should be supported both front and rear whenever possible to equally distribute the shelf weights within the frame or cabinet.
- Allow as much space as possible around active network elements to maximize airflow. Additional space may be required between shelves of equipment by the manufacturer for fan intake and exhaust or heat release.

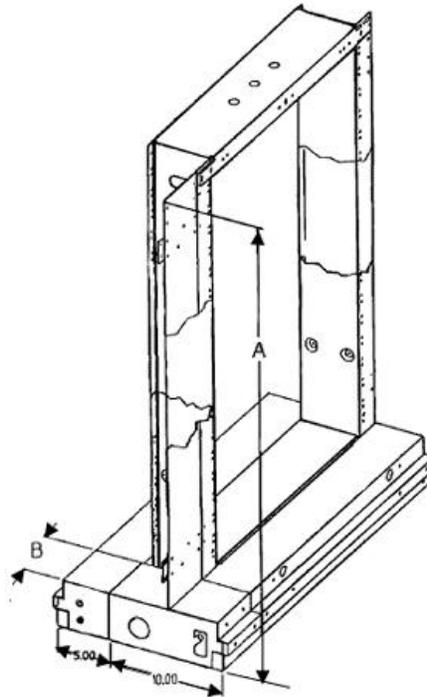
### **2.5.10 Spacers**

The sides or uprights of any framework shall not interfere with the addition of subsequent frames. If any cabling or components extend beyond the framework flange, a spacer shall be provided.

The spacer will:

- Duplicate the frame height (with extender, if any) and base configuration.
- Vertical spacer material shall consist of junction plates fastened to the frame(s) and the duct cover (to match the height of the frame) fastened to the junction plates.
- Vertical spacer duct covers for any size spacer shall be one continuous unit. Two piece duct covers for 9' or 11'6" frames are prohibited.
- QWEST has standardized on two widths for spacers placed between bays, 2-1/2 (2.5) inches or 5 inches. No other spacer width shall be accepted for use within QWEST Central Offices or facilities unless specifically stated in QWEST Standard Configuration documents or evaluated by the QWEST Representative responsible for Common Systems standards.

Illustrated in the figure on the following page is the "standard" network framework assembly with a spacer attached. The "A" dimension represents the height of the spacer and framework. The "B" dimension denotes the width of the spacer assembly.



**Standard Framework Assembly with Spacer**

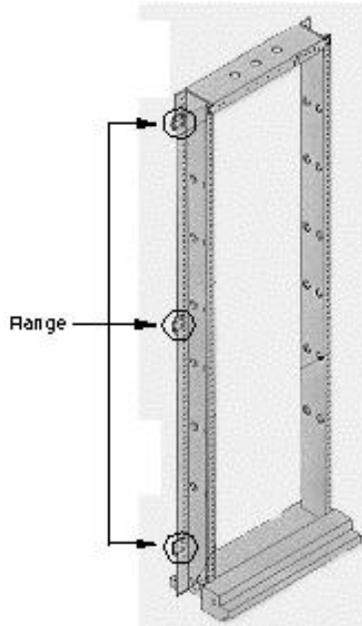
### **2.5.11 Frame Junctioning**

The uprights of all frames, when the flanges align, will be junctioned together. The uprights of all cabinets will be junctioned whenever possible.

Junctioning Guidelines:

- Equipment frames 7 feet high require a minimum of three junction plates.
- Equipment frames 9 feet or 11 feet 6 inches high require a minimum of four junction plates.
- Inter-bay bolts will be used, when available, in addition to the standard junction plates.
- Standard junction plates will be installed on the inside of the framework flange. Only on the heavy earthquake frames can the junction plates be mounted on the outside.
- When the flanges do not align, end shields (as stated in Section 2.X.X) will be used on each frame to enclose and segregate the cabling.

The illustration on the following page depicts the junction plate locations for a 7' network framework assembly.

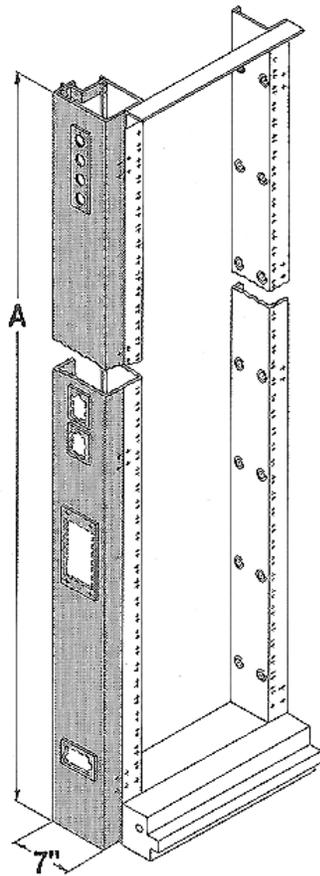


### 2.5.12 End Guards / End Shields

End guards in a Central Office telecommunications lineup perform several important functions. End guards not only close off a lineup, but also provides space for wiring switches and base AC outlet assemblies.

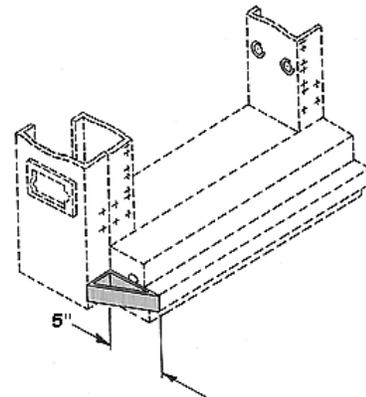
#### 2.5.12.1 End guards:

- Shall be supplied for the first and last framework assembly within a QWEST Central Office line-up.
- When adding new frames to an existing line-up, the end guard shall be relocated to the last new frame on the growth end of the line-up.
- End guards may be used when there is a break in the lineup.
- The QWEST standard end guard is 7 inches deep and 2 9/16 inches wide.
- The height of the end guard will duplicate that of the frame and extender, if any.
- Base bumper guards shall be provided to protect the equipment and personnel at the end of a network base frame.
- All end guards shall be constructed as one solid unit. Multi-piece end guard assemblies are prohibited. This does not include brackets, cover plates, etc.
- Fluorescent light switches for the front or rear of a lineup will be located in the end guard assembly.



**Framework End Guards are required on the first and last bays in a Central Office lineup.**

**The figure below depicts the base of the end guard and the guard rail adapter necessary to complete the end guard assembly.**



#### **2.5.12.2 End Shields:**

- Where the uprights of the framework assemblies will not line up, end shields will be used on each frame to enclose the cabling.
- Will match the height of the frame (including extenders, if any) or cabinet. Multi-piece end shields are prohibited.
- Commonly not relocated when the frame flanges do not align.
- End shields shall be used when there is a break in the lineup unless spacers have been provided then an end guard is installed with the spacer.
- Can be used to segregate the cabling in one bay from another.

#### **2.5.13 Support Capability**

Equipment frames and cabinets 7 feet high will be capable of supporting overhead cable distribution systems and lights located up to 10 feet above the floor that have a maximum weight of 25 pounds per square foot (25 lb./ft<sup>2</sup>). In partially equipped line-ups, cable distribution and lights may be partially supported by approved floor mounted stanchions or framework only stanchions. Over unequipped areas, via-cable distribution may be supported either by ceiling or stanchions.

**Note:** In Seismic zones 3, 4 (heavy) only approved stanchions shall be used. Framework only stanchions are empty relay racks, which serve the same function and are used for bracing in heavy Seismic zones.

#### 2.5.14 Base AC Outlets

Base mounted AC appliance outlets are required in every Central Office lineup. The following information describes the parameters, purpose, and use of these outlets.

- Base mounted AC outlets are required, both front and rear, in every third equipment frame (approximately 6 feet) located in QWEST Central Office (CO) frame line-up.
- All remaining network frames **and spacers** in the lineup shall be equipped with a blank raceway assembly, all other bays or cabinets will have a cover over the base opening for the outlet when an AC outlet is not required.
- Base AC outlets placed in telecommunications frames, bays or cabinets shall be used for the testing and monitoring of equipment only. Plugging in any equipment shelf mounted within the framework assembly is strictly prohibited.
- Base AC outlets are not wired to an essential circuit.
- The sides of the frame base must have holes or be sufficiently open to facilitate distribution wire running through the frames.
- The frame base/guardrail will provide a means and location for convenience outlets.
- Orange isolated outlets or raceway assemblies are prohibited within QWEST Central Offices and buildings.

## 2.6 Cross-Connect Systems

All cross-connecting frames can be grouped into two categories:

**DISTRIBUTION FRAMES:** Frames that are not usually installed in line-ups with equipment frames, such as, the Main Distributing Frame (MDF), the Protector Frame (PF), and Intermediate Distributing Frame (IDF); considered primary choices.

**INTERCONNECTING FRAMES:** Frames that may be installed in line-ups with equipment, or in separate line-ups parallel or perpendicular to equipment frame line-ups, such as the following:

- Intermediate Distributing Frame (IDF)
- Circuit Concentration Bay (CCB)
- Electronic Digital Cross-connect frames (EDSX)
- Group Distributing Frames (GDF)
- Digital Cross-connect (DSX)
- Quick Connect Cross-connect (QCX)
- Trunk Distributing Frame (TDF)
- Fiber Distributing Frame (FDF)

Although no single standard floor plan is applicable for all Distributing Frame (DF) configurations, floor plans should be prepared specifically for each type of distributing frame. These plans should reflect efficient use of building space and allow adequate aisle space for maintenance functions. Generally, DF and interconnecting frames have 4-foot aisles between frames, walls, and other building structures.

## **2.7 DC Power Equipment**

Specific power standards and requirements are identified in the QWEST Technical Publication 77385.

All DC power equipment is grouped into two categories:

GENERAL POWER EQUIPMENT: Equipment will usually be located in a separate power room or area.

STANDARD FRAME POWER EQUIPMENT: Equipment that is mounted on standard equipment frames and may be installed within equipment frame line-up.

### Height

General power equipment with associated overhead cabling, cable racks and clearance will have a maximum height of 10 feet. This includes all super-structure and overhead facilities, such as cable and bus bars and the necessary clearance and headroom for installation, operation, and maintenance.

### Floor Loading

General power equipment will have a weight allowance of 140 pounds per square foot (140 lb./ft<sup>2</sup>). This uniform load is the total actual weight of all power equipment divided by the total associated floor area. If the total area is over 400 feet squared (400 ft<sup>2</sup>), such averaging must then be on individual areas not exceeding a 20 foot by 20 foot square. Any such 20 foot by 20 foot square area will not exceed the floor load requirements, regardless of location. The floor load allocation must include the weight of all equipment in the area, such as battery stands, bus bar, cables, cable racks, lights, etc.

### Support

General power equipment must support all overhead cable distribution systems, bus bars, and lights. In partially equipped areas, these elements must be supported by seismically rated and approved floor mounted stanchions. General power equipment will be designed for base mounted attachment to the floor, and it must be capable of standing in a normal Central Office (CO) environment. Power equipment shall comply with both light and heavy Seismic zone requirements per the QWEST Earthquake Standards Map shown in Exhibit J-1 of this module.

### Standard Configurations

A QWEST Standard Configuration document is available for approved power systems. Floor plans will conform to the standard building requirements; 10 feet clearance height and 140 pounds per square foot (140 lb./ ft<sup>2</sup>) floor load. Power systems are often loaded on the base slab of buildings that may in fact support loads greater than 140 pounds per square foot (140 lbs./ ft<sup>2</sup>). Power system placement shall reflect standard Central Office aisle dimensions, while allowing adequate space for the routine operation and maintenance functions.

### Capacity

The determination of input voltages for an equipment frame should include an evaluation of the power supply requirements for other equipment installed at a site. Exhausted or near depleted power capacity shall be communicated to the QWEST Equipment Space Planner immediately upon identification.

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### **3. Cross-Connect Systems**

#### **3.1 General**

The cross-connect network is comprised of conventional Distributing Frames (DF), modular DF, manual Digital Signal Cross-connect (DSX) frames, and Fiber Distributing Frames (FDF).

#### **3.2 Conventional Distributing Frames (DF)**

A conventional DF is an ironwork framework consisting of contiguous vertical units and channel sections that form a vertical and horizontal mounting apparatus for connecting blocks and connector blocks.

The advantages of a conventional DF are low cost hardware, flexibility, and growth capability when zoned efficiently.

##### VERTICAL SIDE OF THE DF

- Used for Outside Plant (OSP) cables, trunk cables derived Digital Loop Carrier (DLC) pairs, tie cables, and certain special services equipment.

##### HORIZONTAL SIDE OF THE DF

- Used for line equipment and special services.

NOTE: The tendency of the horizontal side to exhaust earlier than the vertical side should be kept in mind when placing equipment.

The “Low Profile” configuration, which limits the number of horizontal shelves to a maximum of 10 (designated A - K) and the number of outside plant connectors mounted on the vertical to no more than 10 per vertical is recommended. This recommendation applies operating efficiencies and safety concerns.

##### **3.2.1 DF Zoning and Spread**

All equipment terminated on a DF should be zoned and spread. Zoning and spreading keep jumper wires that run on the frame shorter and the frame less congested, preventing premature exhaustion of the frame hardware.

##### ZONING

- Defined as reserving a certain area for specific equipment.
- Zoning information is detailed on a frame mask prepared by the cross-connect planner. Along with graphic information shown on the mask, a written summary of the information is also prepared, often presented in the form of a comprehensive plan.

## SPREADING

- Defined as insuring the placement of equipment in several locations on the frame.

## ENGINEERING CONSIDERATIONS

- Connecting blocks ordered frequently should be placed on more convenient lower shelves (B through G) rather than higher up the frame.
- Tie cables should be placed in more than one location on the distributing frame. For example, a ten thousand count of tie cable should have five appearances on a forty-vertical frame, ideally at every eighth vertical.
- The comprehensive zoning plan should be consulted for forecasts, connecting block density needs, alternative evaluations and economic analysis. Copies may be obtained from the local Common Systems Planning and Engineering group.

### **3.3 Subscriber Digital Distributing Frames (SDDF)**

Subscriber Digital Distributing Frames (SDDF) provide a workable method for pre-provisioning high capacity, high-speed equipment in a central location within an office.

#### ENGINEERING CONSIDERATIONS

- Shielded jumper wire should be used for all jumpers running on the SDDF circuits. The shielded wire to be used for jumpers should be ordered by the engineer when placing the SDDF on the floor.
- Shielded tie pair cable is also required between equipment frames when the SDDF is not part of the main frame.
- All special service circuits should be appropriately labeled as such.

### **3.4 Connecting Blocks**

Connecting blocks provide cross-connect and testing access to the Central Office equipment.

- The standard single wire-wrap front facing type block, with floating pins, is preferred for all installations on conventional distributing frames.
- Front facing block with quick clip pins is approved for use on existing modular DFs.
- Bifurcated pins are required for connecting blocks that are used for line equipment. This facilitates half taps for cutovers, cable throws and to/from service orders.

### **3.5 Connector Blocks**

Connector blocks provide access, electrical protection, unit sockets and testing appearances for OSP cable pairs and trunk cable pairs.

- Connector blocks can be ordered in wire-wrap and bifurcated models.
- All new connectors ordered will be the 5-pin type connectors.

### **3.6 Connecting Blocks for Digital Loop Carrier (DLC) Pairs**

Connecting blocks are to be used, rather than pseudo-connectors (stubless connectors which provide a uniform appearance) for derived DLC pairs. The use of connecting blocks requires less frame space and costs significantly less than connectors and protector coils.

### **3.7 Frame Conversion**

When a new switch conversion requires more connecting blocks mounted on the distributing frame and space is not available to terminate the blocks, use one of the following methods:

**GROW THE FRAME** — This method may be used if growth does not result in long jumper lengths. Re-centering some of the OSP equipment adjacent to new switch blocks will help minimize jumper length.

**TANDEM BLOCK** — This method piggybacks a new connecting block over the old block using a special apparatus, while allowing frame operations to proceed on the old blocks. This method is considered a temporary solution and is not approved for long term arrangements.

**Y-SPLICE** — This method reuses all connecting blocks and jumpers, eliminating the labor activity normally required for a switch conversion. A modular, fire retardant splicing connector cabled from the new switch equipment is spliced onto the old switch cabling, usually behind the connecting blocks, or in the cable racks above. This method is very cost efficient, often half the cost of ordering new blocks and running new jumpers. The Y-Splice can be used on modular type or conventional frames for approved applications.

### **3.8 Manual Digital Signal Cross-Connect (DSX) Lineups**

The manual Digital Signal Cross-connect (DSX) is a device that provides a central location for testing, patching, rearranging, and cross-connecting network elements that use the 1.544 (DS1) and 44.736 (DS3) Mb/s transmission rates. This device provides a simple, non-intrusive, effective method of interconnecting digital network elements and offers a flexible alternative to “hardwiring” with semi-permanent cross-connections using copper cable.

DSX lineups are treated as DF, in that they also require zoning and spread of equipment for successful utilization. The Common Systems Space Planner should prepare a DSX mask much like the frame mask mentioned under the zoning and spread heading.

### 3.8.1 DSX Engineering and Planning

Care should be given to engineering and planning a DSX area.

#### PLANNING CONSIDERATIONS

- A large enough area should be provided so that long term DSX needs will be accommodated in an orderly and efficient manner.
- Future DSX requirements and growth should be anticipated and appropriate floor space allotted. DSX frames must be added in dedicated, contiguous lineups.
- When DSX lineups are added on an “as required” basis, severe cable management problems can occur. In most cases, it costs far more to solve these unplanned situations than to have planned appropriately initially.

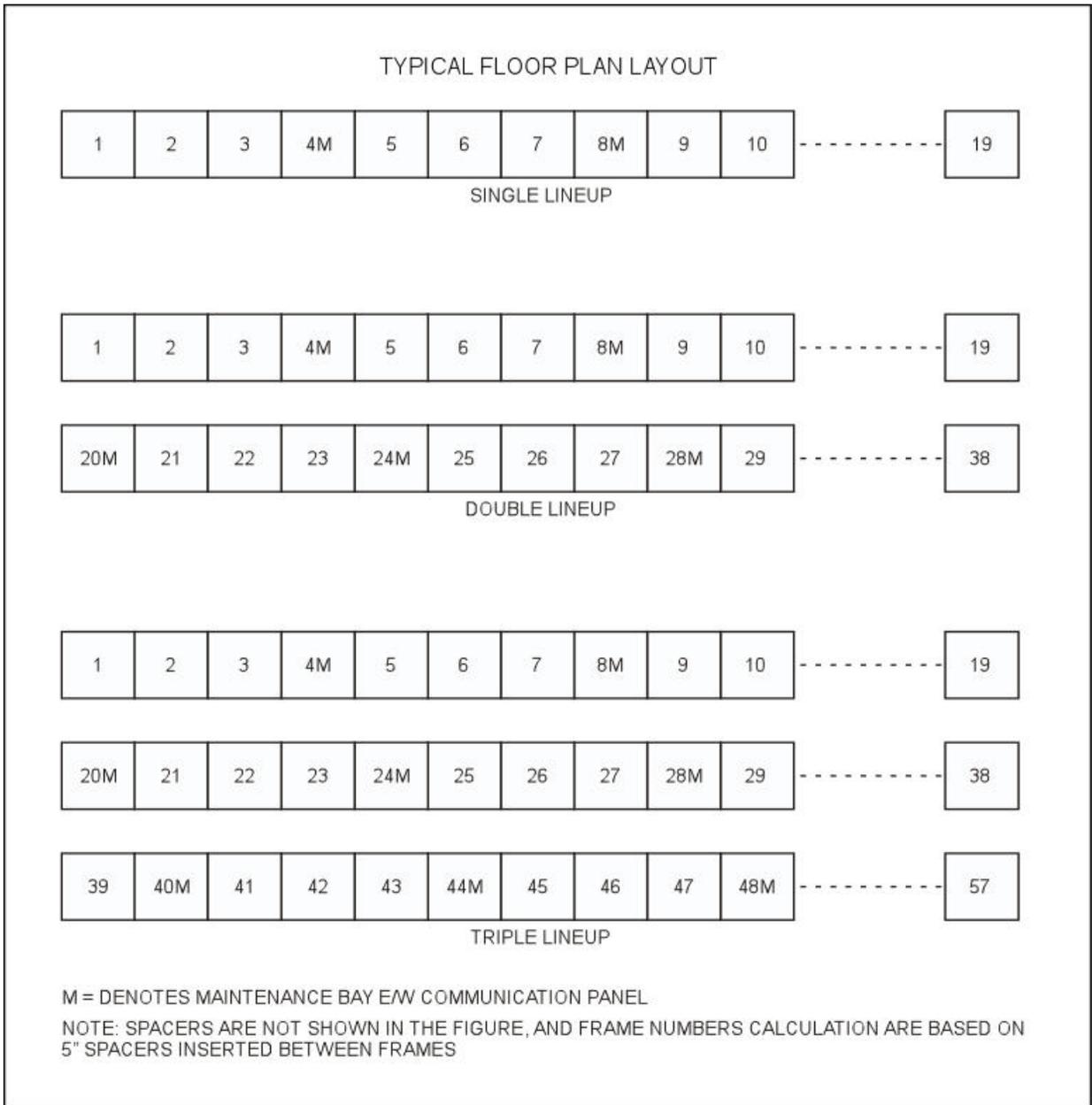
#### FRAME CONFIGURATION

- All DSX bays should have an upper and lower express trough for intra-system cable management.
- Express troughs should be carefully located and appropriately sized to avoid impeding the placing, removing, and tracing of jumpers. These troughs should be as large as possible, preferably 5” × 8”, or 8” × 8” depending on the footprint of the DSX framework.
- All DSX bays should reserve at least one cross-aisle panel space per frame. Cross-aisle panels are used when more than one DSX lineup is required within the Central Office. These cross-aisle panels will provide permanent hardwired cabling between two lineups to ease the transition and congestion.
- Since there is so much cabling associated with DSX panels, extra spacing is required between bays, as well as, between the end bay and the end guard. Depending on the type of DSX panels, different size of the bay spacers will be used and this information is documented in QWEST Standard Configurations.

#### LINEUP ARRANGEMENT

- For both DSX 1 and DSX 3 lineups, every fourth bay should be a maintenance bay. Maintenance bays contain space for communication panels, inter-bay panels, cross-aisle panels, writing shelves, and miscellaneous jack panels.
- If an existing DSX lineup is approaching full capacity, a new DSX area may be required in the near future. Rather than add a final bay of DSX panels to the existing lineup, a bay dedicated to cross-aisle panels should be added as the final growth bay. A similar bay should be added initially to the new area, and then cabled the two cross-aisle panel bays together. This will provide an efficient method of connecting the existing and new areas together. This option is dependent on the forecast of the new DSX area and also the size of the Central Offices. Although there will be slightly more cost, it will be out weighed by avoiding future jumper problems that might develop.

The figure below shows generic DSX floor plan arrangements. In some office applications, the odd bays may be in one lineup and the even bays in another.



**CABLE RACK PLACEMENT**

The position of the cable rack relative to the bay must be given careful consideration.

- In new 7' floor supported environments, the cable rack should be located over the aisle rather than over the bay. This position will allow the cable to “water-fall” into the bay and provide installation with adequate space to place the cables in the DSX bay.

**DSX ASSIGNMENTS**

DSX assignments should be maintained, and Attachment A below provides a table for this purpose.

- DSX assignments should be grouped together by similar technologies (i.e.: FLM, D4, DCS, SLC, ORB). A record of these assignments should be maintained manually or in an appropriate mechanized system.

**ATTACHMENT A:**

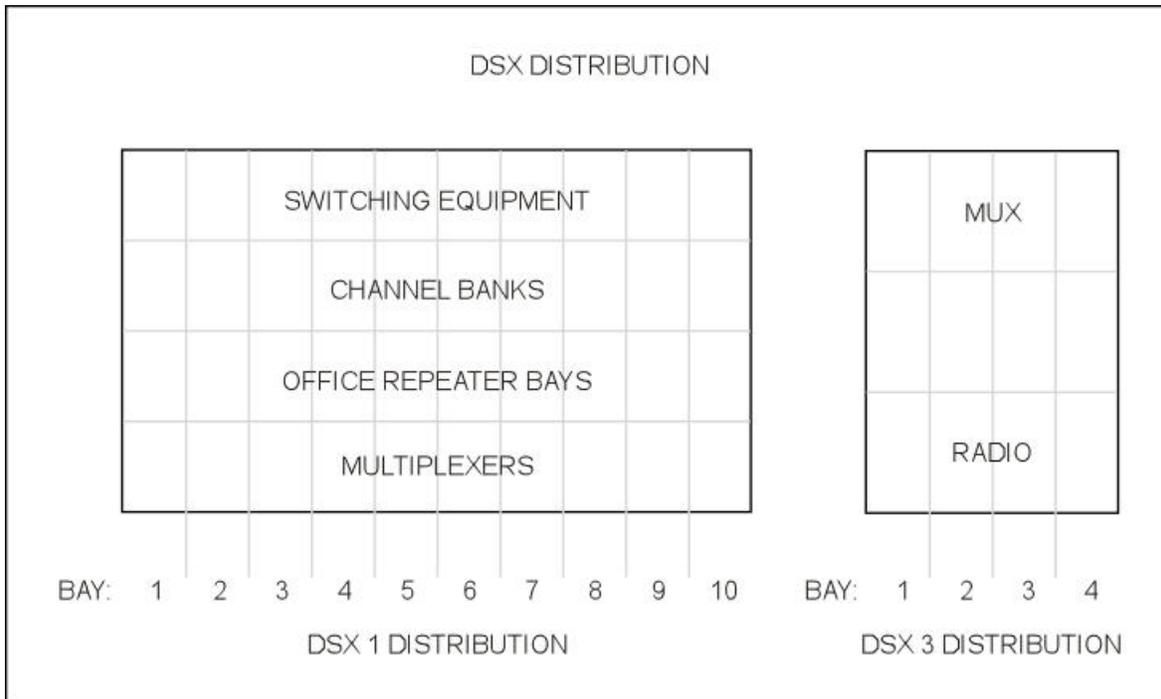
DSX JACK AND CROSS CONNECTION PANEL							
LINE NO.	POS. NO.	BAY	EQPT. BAY	DSX BAY	DSX PNL	DSX POS	NOTE

**DSX TERMINATIONS**

DSX terminations should be zoned and spread to provide successful and efficient equipment utilization. An analysis of the applications and limitations of the equipment will permit partitioning of the DSX lineup into one or more functional areas.

- When adding multiple DSX panels, spread the DSX terminations across several bays to keep the jumpers as short as possible.
- Termination appearance types should be divided and spread horizontally in alternating modules (and in alternating lineups where multiple lineups exist) to achieve a uniform distribution of equipment.
- Termination types should be placed in alternating modules because it provides 1/3 more opportunities for short jumpers (those between immediately adjacent modules) when interconnecting unlike terminations (facilities to equipment).

The following example depicts how to plan for a DSX arrangement layout:



### 3.8.2 DSX Cross-Connect Jumper Lengths

To maintain an equal level point for all signals at the DSX, lengths of cross-connect jumpers (from one DSX panel to another DSX panel) are essential. As a rule, jumpers should be kept as short as possible.

#### INTRA-SYSTEM JUMPER

##### DSX 1

- Maximum length is 85 feet using 24 AWG non-shielded jumper.
- 26 AWG shielded cable will be used when running cross-aisle tie cable.

##### DSX 3

- Maximum length is 18 feet using 26 AWG coaxial cable.
- Maximum length is 27 feet using 20 AWG coaxial cable.

### 3.8.3 DSX Cable Lengths

All inter-office cabling between network elements and the DSX have length limitations.

#### INTER-OFFICE CABLE

##### DSX 1

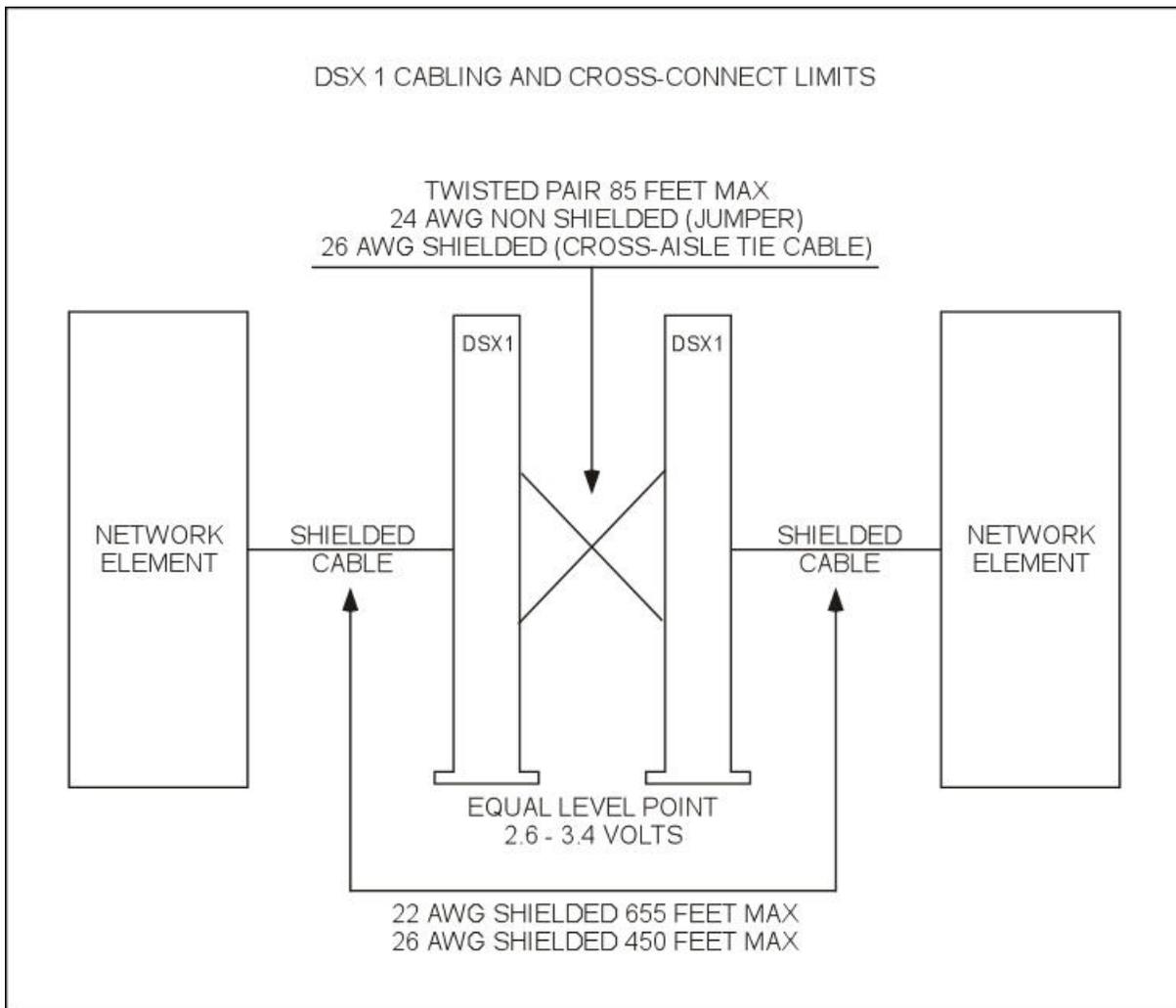
- Maximum length is up to 450 feet using 26 AWG shielded cable.

- Maximum length is up to 655 feet using 22 AWG shielded cable.

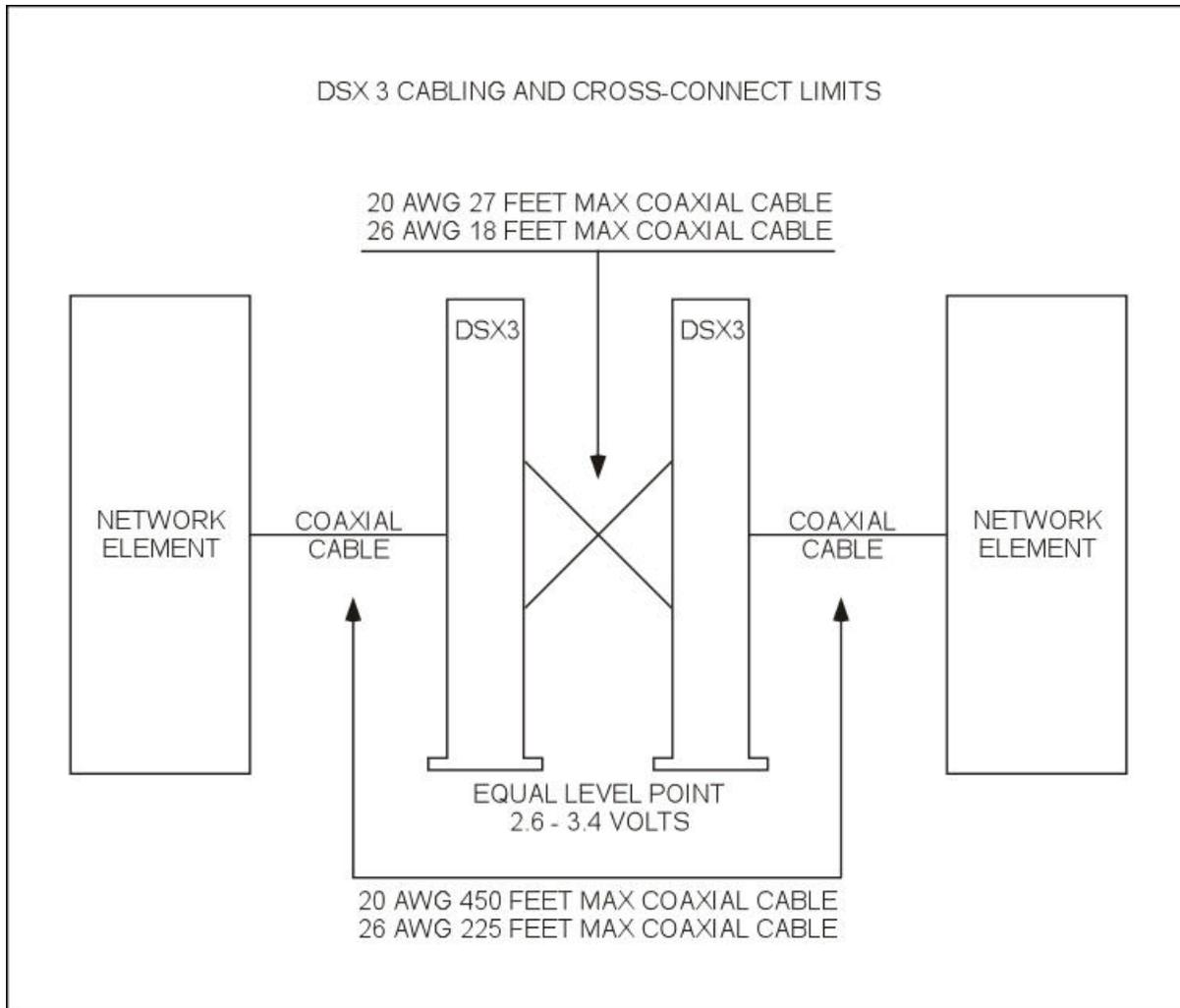
DSX 3

- Maximum length is up to 225 feet using 26 AWG coaxial cable.
- Maximum length is up to 450 feet using 20 AWG coaxial cable.

The following is a figure summarizing the lengths for DSX 1 cabling and cross-connect lengths:



The following is a figure summarizing the lengths for DSX 3 cabling and cross-connect lengths:



### 3.8.4 DSX Cabling Rules

- The cable shield should be grounded at one end only, usually at the equipment end.
- Input and output digital signal (T & R) leads should be cabled in separate cables.
- The transmit leads (T) should terminate on the OUT jacks and the receive leads (R) should terminate on the IN jacks.
- Shielded cables should not be run in the same cable rack as power and grounding cables. Cabling for digital equipment is very sensitive to electrical interference. If these requirements are not met, a high level of impulse noise may develop and signal errors will result.

- Switchboard cables should not be run in cable rack above equipment that produces a great deal of electrical interference such as electromechanical switching equipment.

### **3.9 Fiber Distributing Frames (FDF), Fiber Splice Frames (FSF), and Fiber Protection Systems (FPS)**

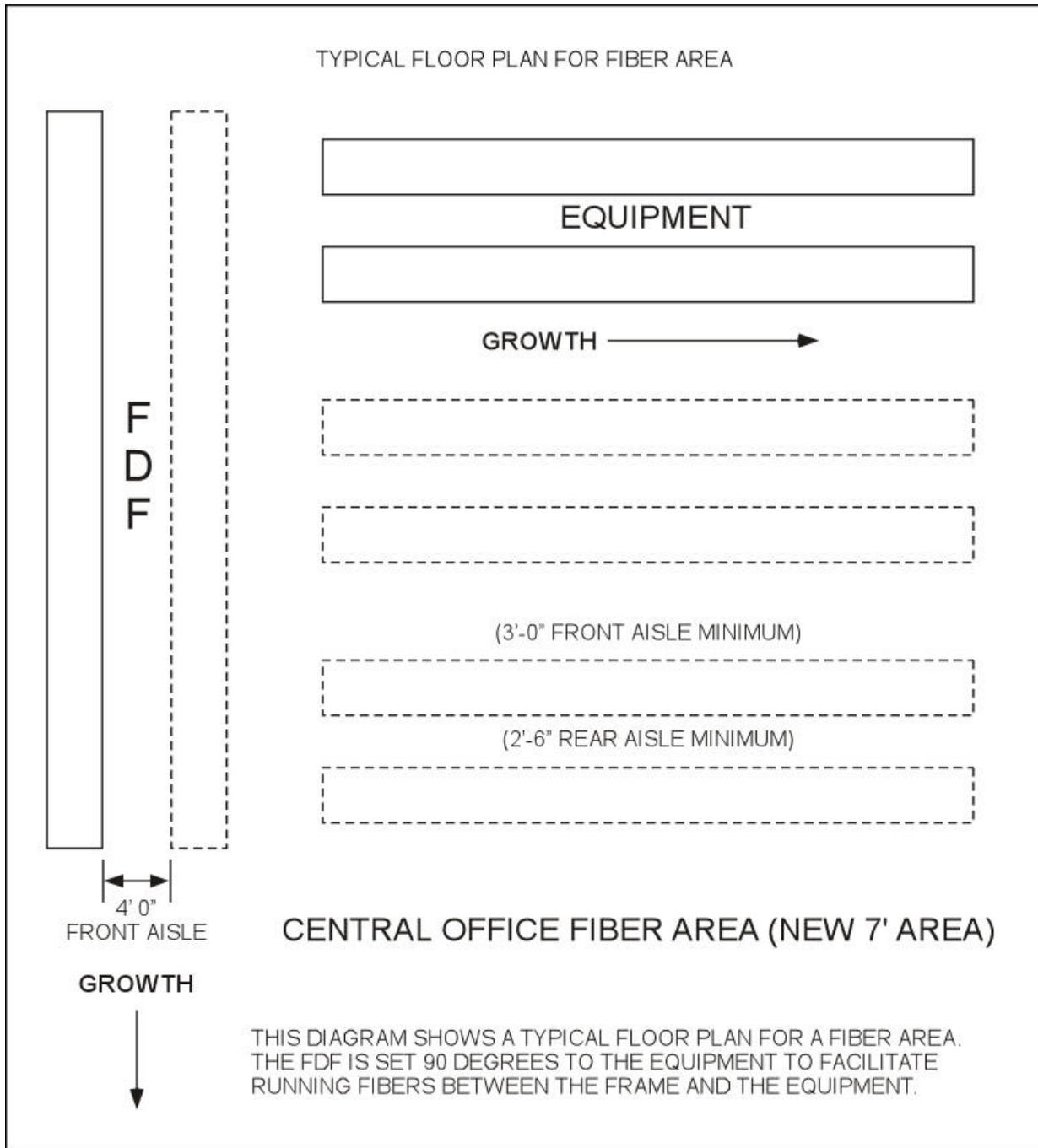
The Fiber Distribution Frames (FDF), Fiber Splice Frames (FSF), and Fiber Protection Systems (FPS) (that includes special purpose fiber cable rack) constitute a cross connection SYSTEM, or distributing frame assembly, and must be planned and engineered as a unit, with future growth and equipment demands always considered. These systems will be long lived, and flexibility is the key to successful planning. Additional engineering requirements may be found in Chapter 6, Section G of this document.

#### **3.9.1 FDF Engineering and Planning**

Fiber Distributing Frame lineups must be planned and installed to prevent blocks growth.

- While multiple lineups are an option, fiber tie cables between lineups adds connectors to the fiber optic circuit, and should be considered a last resort alternative to a single FDF lineup. If necessary, reserve floor space for a cross aisle lineup of the same size, if possible.
- Frame Masking shall be done by the QWEST representative responsible for frame planning, in conjunction with the QWEST representative responsible for Outside Plant Facility planning. Close coordination between outside plant and Central Office will assure the FDF plan accommodating growth and change.
- FDF growth patterns must be closely watched to insure deployments will have a clear growth route.
- Fiber Distributing Frames should be perpendicular to equipment lineups whenever possible to allow fiber cable access from the lineups at several different points.
- Planning functions shall be done with the ultimate FDF lineup length in mind.
- Floor plans should be clearly marked, and all planners dealing with the office should be advised of the location.
- Cables shall be ordered in increments of 12 fibers, whenever possible.
- Equipment/FOT (fibers coming from the network elements) Bays and Cable/OSP (fibers coming from the FSF/OSP) bays shall be spread throughout the FDF lineup, to allow for growth of the fiber network.

The following is a typical plan for a fiber area in a Central Office:



### **3.9.2 FSF Engineering and Planning**

- Fiber Splice Frames lineup is required in offices having more than 288 fibers.
- FSF shall be no more than 50 sheath feet away from the OSP (vault) entrance into the Central Office environment. At the FSF the Outside Plant Fiber Cable will be spliced to the type of fiber cable required for intra-office applications.
- FSF will be located away from power or battery areas.

Metal Conduit shall not be used to protect fiber in lieu of a fiber protection system. See Chapter 6G of this document.

### **3.9.3 FPS Engineering and Planning**

Fiber Protection Systems shall allow for future bay positions to modification of Fiber Protection Systems with live fibers. See Chapter 6G of this document.

#### **ENGINEERING CONSIDERATIONS**

- Fiber slack storage within the FPS is strictly prohibited and shall not be permitted. Letters of deviation will not be accepted and are not considered valid.
- Fiber cables shall be sized as accurately as possible to minimize slack, and any slack shall be stored at the distribution frame slack storage unit ~~and~~ whenever possible. Slack storage may also be utilized if it is available at the equipment frame.
- Fiber slack storage units, an integral component of Fiber Distribution Frames, are designed to accommodate minimal amounts of fiber cable slack. Because fiber cables are connectorized on both ends, fiber cables with excessive slack are prohibited.

### **3.9.4 Fiber Cabling Rules**

- Fiber jumpers/patchcords whether single or multiple (Dual, Quad, 12-, 24-, 36-, 48-, and 72-fiber) shall be factory connectorized, with FCPC connectors.
- Buffered Riser (OFNR) type cable is sufficient and preferred for Central Office and most remote (QWEST structure) sites.
- Use of plenum (OFNP) type cable should be restricted to those instances (usually CPE) where cable routing is in air supply or return systems.
- Fiber jumpers or patch cords shall be run in an approved Fiber Protection System designed for that purpose.
- Inter-Office fiber optic cable shall not share space with switchboard or other copper cables within an office. The approved segregated orange, panned and bracketed fiber only cable rack will be provided for all new installations.
- Systems requiring both fiber and copper cables shall be approved in advance by the QWEST Representative responsible for fiber standards and documented in QWEST Standard Configuration documents.

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## **4. Power Facilities-Battery/Rectifiers (AC/DC)**

### **4.1 General**

This unit covers requirements for battery/rectifier systems utilized within telecommunications facilities.

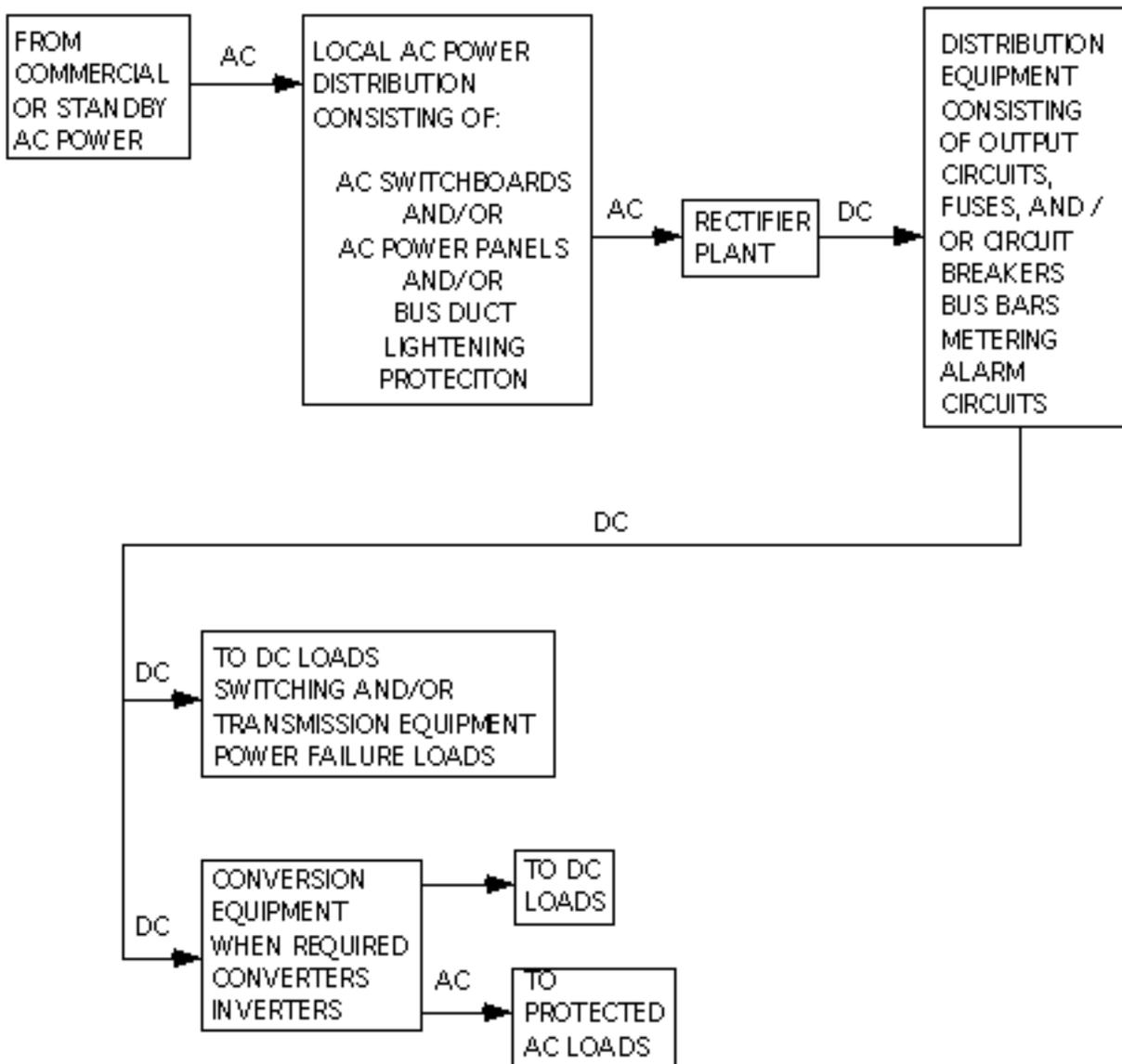
All power equipment must conform to the National Electrical Code (NEC), American National Standards Institute (ANSI) and Underwriters Laboratory (UL) standards

All DC power wire and cable is listed in Technical Publication 77385 sec. 8.4. RHH wire shall not be used on cable racks. See Technical Publication 77385 sec 8.4.

AC wiring is contained in Technical Publication 77385 sec 1.3.

### **4.2 Rectifier Plants**

A typical power distribution plant is shown in Figure 2-C1-1. See Technical Publication 77385 for specifics.



**Figure 2-C1-1** Power System

The principle components of the power distribution plant are:

- LOCAL AC POWER DISTRIBUTION which includes conduit, cabling, fasteners and protective equipment.
- CHARGING EQUIPMENT consists of rectifiers and associated equipment to convert AC power to DC power at voltages suitable for QWEST applications.
- STORAGE BATTERIES provide a source of DC power to the equipment when AC is not present, until the AC can be restored. They also provide filtering of the rectifier output.

- DISCHARGE BAYS contain the control and output circuits; including fuses and/or circuit breakers, shunts, meters, bus bars, alarm circuits and other equipment necessary for plant operation.
- BATTERY DISTRIBUTION BOARD (BDB) is the primary power distribution within the rectifier plant. It is powered directly from the batteries and rectifiers and contains the primary cable protection equipment and shunts. The BDB may also contain meters and alarms.
- DISTRIBUTION EQUIPMENT is the primary protected power distribution to the equipment. Distribution equipment is powered from the BDB and includes Power Distribution Fuse Boards (PDFB), Battery Distribution Fuse Boards (BDFB), Area Bus Centers (ABC) and protective equipment. (The BDB and distribution equipment may be combined in small power plants.)
- CONTROL VOLTAGE is the voltage used to operate alarm relays and control circuits in the power plant. The voltage of the primary plant (48 volts, if available) will be the control voltage.

AC connections shall be of the crimp, exothermic weld, or amphanol type that have completed the QWEST product selection procedure. Bare wire setscrew type connectors are not acceptable.

All power connections for both supply and return will utilize crimp type copper connections. Connectors for direct battery connections are defined in Section 3.4 of this unit. Aluminum connectors will not be acceptable. Power connectors will be configured as follows:

- Within the supplier's equipment, power connections will be configured to meet the supplier's requirements.
- Between the supplier's equipment in the bay and the top of the bay, connections will be one hole or two-hole crimp, depending on equipment design.
- All connections to a bus bar will be a two-hole crimp only.

All bus bars shall be 95 percent hard drawn copper. Aluminum or soft drawn copper is not acceptable.

Power wire shall be copper only. (See Bellcore Technical Reference GR-347-CORE, "Generic Requirements for Central Office Power Wire".)

Armored power cable is not approved for use in QWEST.

All AC feeders in telecommunications equipment areas (including power rooms) will be enclosed in conduit. Insulation coated armored power cable will only be used in special applications where conduit is not practical.

Conduit [rigid or Electrical Metallic Tubing (EMT)] shall be acceptable if it is not installed on cable racks. If EMT is used, compression couplings and junction boxes shall be used; setscrew type couplings are not acceptable. See grounding section Module 1, Chapter 5 for additional precautions relating to metallic conduit.

Primary DC power distribution cable shall be run on a separate exclusive cable rack, on a going forward basis. Primary DC power distribution is defined as leads from the power plant to the BDFB. Secondary DC power distribution is defined as power from the BDFB to the equipment.

Cable temperature shall not exceed 115 degrees Fahrenheit (115° F) in any horizontal cable rack. In addition, there shall be no instance where an equipment surface temperature exceeds 115° F without a highly visible warning label. Cable temperature in the vertical riser within the bay to the overhead rack may exceed 115° F. However, if the cable temperature in any vertical riser within a bay exceeds 125° F, there will be a highly visible warning label.

See Technical Publication 77385 section 8.2 for specific requirements for independent feeds to Telecommunication Equipment Loads.

The minimum bending radius of ground conductors shall be 12 inches. (Details for ground conductors can be found in Module 1, Chapter 5 and in QWEST Communications International, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".)

#### **4.3 Charging Equipment - See Technical Publication 77385.**

Designations: When all the charging units in a plant operate in the same mode, (either sequential or parallel), each charging unit is designated G1, G2, G3, G4, . . . Gn. When the charging units in a plant operate in a mixed mode, (some units charge sequentially and others use parallel charging), each unit in the sequential group is designated G1, G2, G3,... Gn, and each unit in the parallel group is designated G01, G02, G03, . . . G0n.

#### **4.4 Batteries**

For requirements on Batteries see Technical Publication 77385.

#### **4.5 Engineering Guidelines**

For engineering guidelines see Technical Publication 77385.

#### **4.6 Alarms**

For requirements on Alarms see Technical Publication 77385.

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## **5. Central Office (CO) Grounding**

### **5.1 General**

#### **5.1.1 Objectives**

The objectives of providing a dependable low impedance grounding and bonding system are:

- Personnel Safety - All metallic parts within a ground plane shall be grounded so that shock voltages are not transmitted to personnel. The grounding and bonding of metallic frames and raceways should minimize potential differences between these structures when lightning or fault currents flow.
- Equipment and Distribution Circuit Protection - The grounding system should provide fault current paths of sufficiently low impedance that overcurrent devices can disconnect faulted circuits to prevent electrical fires and limit damage to equipment or circuit conductors.
- Electrostatic Discharges (ESD) - The effects of ESD are minimized by maintaining low impedance paths between grounded points throughout the ground plane. No metallic parts of the ground plane should be capable of storing electrostatic charges.
- Reliability - The grounding system should resist deterioration and require minimal maintenance.
- Equipment Operation - The grounding system should minimize the effect of disturbances originating outside the ground plane on the equipment operating therein.
- Noise Reduction - The grounding system should minimize electrical interference by maintaining low impedance paths between ground points throughout the communication system and prevent or minimize the injection of noise currents into the telecommunications equipment.

#### **5.1.2 General Information**

This part consists of general information on the effective protective grounding of telecommunications equipment. The information presented deals with Central Office Equipment (COE) protection and does not provide engineering standards for engineering a Central Office Ground (CO GRD) system. This information, both engineering and installation standards, can be found in QWEST Communications International Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment". Equipment suppliers normally specify the grounding requirements for their equipment. These requirements should be utilized unless other or additional requirements are specified by the equipment order or by QWEST Communications International, Inc. Technical Publication 77355 (see Reference Chapter).

### 5.1.3 Codes

While the National Electrical Code (NEC) does not cover installations of communications equipment under the exclusive control of communication utilities (see Article 90-2 (b) (4)), the grounding standards contained in this part conform to or exceed the requirements of the Code. Grounding requirements must conform to the NEC, local code requirements, equipment specifications, QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter), and this engineering standard. If conflicts occur, the QWEST Communications International Inc. Equipment Engineer should be consulted.

## 5.2 Integrated Ground Systems

### 5.2.1 Integrated Ground Plane

The Integrated Ground Plane includes the CO GRD system, which consists of the principal earthing electrode, various supplementary electrodes, the Office Principal Ground Point Bus (OPGPB), the office vertical equalizer (riser), and CO GRD bus bars connected to the riser. Also part of the Integrated Ground Plane are the Alternating Current (AC) Equipment Ground (AC EG), building structural steel, interior metallic piping, the interior building superstructure, equipment frames, cable support racking and a multiplicity of other metallic objects. These conductive structures are bonded together to allow currents imposed on the Integrated Ground Plane to flow through an large number of parallel paths in seeking a path to earth or to their point of origin within the building.

- The CO GRD system is extended throughout the building or facility and connects to various points on the DC power plant discharge ground conductors. Since the CO GRD provides a path in parallel with the discharge ground conductors, it carries a portion of that current. The voltage differential between the extremities of the CO GRD system will fluctuate in relation to the office DC power load. In an office with a 48-volt power supply furnishing the bulk of the DC power, the differential should be less than one volt between the ground electrode and any point on the CO GRD system. The power discharge ground conductors must be sized in accordance with Technical Publication 77385 Chapter 2.
- It is not essential that every portion of the ground plane be at precisely the same potential. Communication system equipment is effectively grounded when the voltage differential at different points on the ground plane cannot exceed a value that will interfere with proper operation of the circuit.
- Personnel and equipment protection is afforded when the ground system provides a path for sufficient current to operate overcurrent devices quickly during an electrical fault or provides a low impedance path to earth ground during a lightning stroke.

### 5.2.2 Central Office Ground (CO GRD)

The CO GRD system is connected to the office principal earth electrode. This electrode establishes the zero reference point (ground) for the CO.

- The CO GRD system consists of an OPGPB bus bar to which the principal earth electrode is connected, along with bonds to supplementary earthing electrodes, the office AC entrance switchgear, the interior cold water piping, and other bonds as required by the NEC and/or local codes. A 750 MCM copper ground conductor extends the ground potential from the OPGPB to convenient bus bar connection points throughout the office. This conductor is called the Office Vertical Equalizer (Riser) in a multifloor building and a Horizontal Equalizer on every equipment floor requiring earth reference. Bonding and grounding conductors shall be made of copper; QWEST Corporation prohibits Aluminum. Conductors may be wire, bus bar or braided strap. Wire shall be stranded or insulated and shall not be smaller than No. 6 AWG or equivalent. Bare stranded wire may only be used as an alternative to ground frame members when run in cable distribution systems.
- On each floor, conductors extend the CO GRD to power plants, equipment frameworks, Power Distribution Frames (PDF), and equipment. These conductors are referred to as horizontal equalizers, relay rack, framework, or equipment grounds and by other names derived from the equipment served.
- Grounding equipment mounted on relay racks or frameworks is usually accomplished with the mounting plate screws or bay ground leads which provide the unit with CO GRD. The continuity through these ground bonds shall not be utilized for return of DC ground current to the power plant. (Exhibit 2-D-1 is an illustration of CO GRD system in an Integrated Ground Plane.)

**Note:** Details of the office principle earth electrode and the CO GRD system are beyond the scope of this standard. Consult QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter) or the QWEST Equipment Engineer should questions arise.

### 5.2.3 Alternating Current Equipment Ground (AC EG)

This is used to ensure that personnel and equipment are protected from shock hazard or damage resulting from faults in the AC distribution system. The AC EG is commonly referred to as the "green wire ground". The AC EG may be bare or insulated, but when insulated wire is used it must employ green colored insulation or the conductor must be marked with green paint or tape for identification purposes, as required by the NEC.

**Notes:**

1. In all situations, the AC EG must satisfy the NEC and local codes. Local codes are frequently more stringent than the NEC.
2. Specific requirements for the AC EG are shown in the Grounding Engineering Requirements in this chapter and in detail in QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter).

**5.2.4 Incidental Grounds**

Incidental ground paths between metallic objects occur spontaneously without conscious design effort to construct an electrical path. Dependence on incidental ground paths is not reliable throughout an office. Painted surfaces, loose connections, discontinuities in building materials and other conditions contribute to the isolation of individual equipment units from an otherwise low impedance path to ground. This therefore, does not provide an effective ground plane. Incidental ground paths should not be considered as a contributing factor in the design of an Integrated Ground Plane. Since the impedance of such paths is not known, their effect on the discharge ground and CO GRD cannot be calculated. Although an incidental ground path may contribute to the equalization of potential, there is a possibility that an incidental ground path may introduce noise into a communication system. The purpose of the CO GRD and AC EG is to minimize the impact of these incidental ground paths in the Integrated Ground Plane.

**5.3 Isolated Ground Planes**

**5.3.1 Ground Window**

Certain types of communications systems, such as Stored Program Control Switching Systems (SPCSS), that utilize solid state devices that are easily damaged by transient voltage surges, require an Isolated Ground Plane. The Isolated Ground Plane insulates the system requiring protection from contact with the Integrated Ground Plane except at a single point. This single point provides earth reference to the Isolated Ground Plane and is known as the "ground window".

- The ground window is a dimensional transition zone, which is the interface between the building's Integrated Ground Plane and a given Isolated Ground Plane. The ground window is spherical with a maximum radius of three feet.
- The Main Ground Bus (MGB) in the ground window is a bus bar (or bars) located within the ground window that provides the electrical interface for connections between the Integrated Ground Plane and the Isolated Ground Plane. (Exhibit 2-D-2 is an illustration of a ground window and its relationship to the Integrated and Isolated Ground Planes.)

### 5.3.2 Power Plants

All power sources serving an Isolated Ground Plane shall be single-point solidly grounded. This is accomplished by running a ground reference conductor from the power plant return bus to the MGB within the ground window. The principal power source return bus must be insulated from the plant's framework. If the return bus is not isolated from the plant's framework then this return bus must be designated as the ground window. The location of the power plant with respect to the Isolated Ground Plane is not restricted provided that the -48v return bus in the plant is not used as the ground window.

### 5.3.3 Equipment Isolation

Isolation of equipment requiring an Isolated Ground Plane is accomplished by placing insulating material between points of contact where the protected equipment must be connected to metalwork and concrete in the Integrated Ground Plane. Fastening points include:

- Floor anchor bolts
- Bottom of frames
- Superstructure supports

Conductive material such as lighting fixtures, metal conduits, cable racks and so on which are in proximity to but not a part of the Isolated Ground Plane must be insulated from contact with the Isolated Ground Plane. However, to maintain an equal potential for protection purposes, these "foreign" objects must be connected to the MGB in the ground window. Incidental ground paths between these "foreign" objects cannot be counted on to provide the necessary continuity. Therefore, if deliberate electrical continuity cannot be verified the various parts must be bonded together and connected to the MGB within the ground window.

Details of the Isolated Ground Plane are beyond the scope of this standard. Consult QWEST Communications International Inc. Technical Publication 77355, Bellcore Technical Reference TR-EOP-000295 or the equipment engineer should questions arise.

## 5.4 Ring Ground System

### 5.4.1 Exterior Ring Ground

This grounding system is primarily intended for use in buildings housing microwave radio equipment or where satisfactory grounding cannot be otherwise provided.

The exterior ring ground establishes a station ground electrode that tends to equalize potentials in the earth surrounding the building and tower by ensuring that a low impedance current path exists throughout the area, regardless of earth resistivity. The exterior ring is composed of a minimum bare No. 2 American Wire Gauge (No. 2 AWG) solid tinned copper wire buried at least 18 inches below grade and spaced at least two feet from the building foundation. The ends of the wire are exothermally welded together to form a ring. Driven ground rods are exothermally welded to the ring at 10 to 15 foot intervals to ensure contact with moist earth. The exterior ring is connected to the interior ring or OPGPB with a minimum of two #2 AWG solid bare tinned copper conductors.

Any separate antenna tower structure will have a separate ring similar to the building ring and spaced at least two feet from the tower footings. The tower ring is connected to the building

exterior ring at their closest proximity. The ring is also exothermally connected to each metallic tower leg.

Under adverse soil conditions, or where bedrock prevents driving of ground rods, a horizontal counterpoise system is employed. A counterpoise system consists of bare No. 2 AWG solid tinned copper wire exothermally connected to the exterior ring at the four building corners and buried at least 18 inches below grade out from the ring to the property boundaries or to 125 feet, whichever is lesser; but in no case less than 25 feet.

#### **5.4.2 Interior Ring Ground**

The interior ring ground system consists of a No. 2 AWG stranded insulated copper conductor extended around the periphery of the radio equipment area. The interior ring ground is exothermally bonded to the exterior ring ground. It is also connected to supplementary interior ring buses. This system is then connected to all metallic objects in the radio equipment area to provide a low impedance path between metallic objects within the building and ground. (Exhibit 2-D-4 is an illustration of a typical ring ground installation.)

#### **5.4.3 Transmission Lines**

Waveguides, coaxial transmission lines, metallic supportive framework, and AC conduits for tower lights and heaters extend a path for lightning currents into the building from the tower. Waveguides, transmission lines and conduits which enter through the waveguide hatch plate are bonded to the hatch plate. The hatch plate is bonded to both interior and exterior ring grounds. Metallic support frameworks and other conduits are bonded directly to the exterior ring at the point where they enter the building.

**Note:** Details of ring ground systems are beyond the scope of this standard. Consult QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter) or the QWEST Equipment Engineer should questions arise.

## **5.5 Computer Room Ground Environment**

### **5.5.1 Operations Support Systems (OSS)**

Generally, systems identified as OSS use computer systems to provide various analytical and data processing services. Peripheral cabinets that contain interfacing circuitry are included in the OSS. Normally, OSS are separated from the switching system equipment when they are located in a COE area. Operations Support Systems (OSS) are also located in commercial office space, often in buildings not associated with telephone switching equipment.

Computer systems are similar to Stored Program Control Switching system (SPCSS) in respect to voltage disturbance sensitivity. The SPCSS are protected from voltage transients by placing them in an isolated ground plane/single point ground environment. Although the single point ground system is recommended for a SPCSS environment, in a general-purpose computer room environment it is difficult to prevent foreign ground contacts. For this reason the single point ground system is not recommended for a computer room environment.

In the case of a computer room, the Signal Reference Grid (SGR) system is recommended. In the SGR system all components are effectively bonded together to create a common signal reference ground plane. The SGR system forms a complete equipotential ground reference point for the raised floor computer equipment. This equipotential ground will provide a low impedance path to high frequency disturbances and a capacitive coupling with the data cable shield to reduce high frequency noise.

**Note:** Details of the computer room Signal Reference Grid (SRG) environment are beyond the scope of this standard. Consult QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter) or the QWEST Equipment Engineer should questions arise.

## **5.6 Grounding Engineering Requirements**

### **5.6.1 Intent**

The intent of this chapter is to provide some of the engineering considerations involved in the grounding systems described above. Detailed information on these grounding systems can be found in QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter). This publication should be consulted before any engineering work is begun.

### 5.6.2 Office Ground Electrode

Some office electrodes include:

#### A. Driven ground electrode.

- Electrodes of stainless steel rods shall be used. They shall be of American National Standards Institute (ANSI) grade 302 or 304 alloy, which is resistant to corrosion. The stainless rods shall be at least 5/8 of an inch in diameter and at least 8 feet in length.
- The electrode shall be placed such that at least 8 feet in length is in contact with the soil. Where conditions prevent the electrode from being driven vertically, they may be driven at an oblique angle not to exceed 45 degrees.
- Where possible, the driven electrodes shall be connected so as to make an exterior ring ground, described in 5.4 of this part. If a ring is not practical, the electrodes shall be joined into a grid of at least 6 rods in small offices and at least 12 rods in large offices.
- The No. 2 AWG tinned solid copper conductor can be connected to the stainless steel rods by exothermic weld or approved crimp (compression) type connections. A minimum of two No. 2 AWG tinned solid copper conductors, shall extend from the ground electrode system to the office principal ground point via diverse routes.
- The diameter of the well casing shall be at least two inches.
- The depth of the well shall be at least 40 feet and no greater than 250 feet.
- All connections shall be exothermic weld.

#### B. Water pipes

- Due to the proliferation of nonmetallic water pipes and insulating joints for corrosion control in commercial water systems, water systems shall not be used as primary grounding electrodes.
- If a metallic water system is available, it should be bonded to the Office Principal Ground Point Bus (OPGPB) as a supplementary electrode.

### 5.6.3 Central Office Ground (CO GRD)

The Vertical Equalizer (Riser) shall be an uninterrupted length of 750 MCM insulated stranded copper conductor. The only splices permissible in this Riser shall be exothermic welds or compression connections.

Grounds shall not be extended from the Riser past a perimeter which consists of a square superimposed on a circle of 100 feet radius, and the conductor to that furthest equipment shall not exceed 200 feet in length. Should site conditions dictate that these limits will be exceeded, additional Risers shall be extended from the OPGPB. These Risers shall be interconnected at every third floor for purposes of equalization.

All metal structures in the structure shall be bonded to the CO GRD, either directly or through a ground window, as applicable.

Only copper conductors will be used in the CO GRD system. This includes wire conductors, bus bars, straps, clamps and connectors. Aluminum conductors and aluminum connectors are not acceptable.

Two-hole crimped copper connectors are required.

Risers shall not be enclosed or encircled by any metallic support or metallic conduit without proper bonding at both ends. Parallel tapping of grounding cables shall be directional, toward the ground source, to eliminate 180 degree turns in the conductors.

#### **5.6.4 Alternating Current Equipment Ground (AC EG)**

The design of the AC EG shall satisfy the NEC and any local code that applies. In all cases, an AC EG conductor, appropriately sized, shall be placed in conduits and raceways containing AC power circuits. The continuity of the conduit or raceway shall not be used to constitute an AC EG even if the applicable code should allow the practice.

Only copper conductors will be used in the AC EG system. This includes wire conductors, bus bars, straps, clamps and connectors. Aluminum conductors are not acceptable.

An appropriately colored (green) AC EG shall always be provided in AC conduits and raceways. (Do not use bare AC EG conductors)

Two-hole crimped copper connectors are recommended.

#### **5.6.5 Isolated Ground Plane**

Equipment requiring an Isolated Ground Plane for protection from voltage transients shall be insulated from the Integrated Ground Plane at contact points where the metalwork of the isolated equipment is connected to the metalwork and concrete in the Integrated Ground Plane. Points of contact are:

- Anchor bolts
- Bottom of frames
- Superstructure
- Cable support racking and conduits

A ground window shall be established as a point of interface between the Isolated and Integrated Ground Planes. The Main Ground Bus (MGB) within the ground window shall be connected to the CO GRD bus on the same floor as the ground window with a 750 MCM stranded insulated conductor.

The primary power plant for the Isolated Ground Plane shall derive its ground reference from the ground window.

Equipment in the Integrated Ground Plane which is powered by the primary power plant in the Isolated Ground Plane shall have its power leads run through and the grounded lead bonded to the MGB in the ground window.

If no CO GRD system exists on which to connect the MGB, one shall be established.

In no case shall the equipment in the Isolated Ground Plane be more than one floor away from the ground window.

Only copper conductors will be used in the central office portion of the Isolated Ground Plane. This includes wire conductors, bus bars, straps, clamps and connectors. Aluminum conductors and aluminum connectors are not acceptable.

Two-hole crimp copper connectors shall be used.

#### **5.6.6 Ring Ground System**

The exterior ring ground shall consist of a minimum of four stainless steel driven ground rods connected by exothermic weld or approved compression to a bare No. 2 AWG solid tinned copper wire with the ends connected together to form a ring. The ring shall be buried at least 18 inches below grade and extended at least 2 feet from the building foundation. A minimum of two No. 2 AWG tinned solid copper conductors, shall extend from the exterior ring ground to the office principal ground point via diverse routes.

An antenna tower shall have a separate ring ground of construction similar to item (A). If the tower is roof mounted, the ring shall encircle the roof. The tower ring shall be connected to the building exterior ring at two separate points.

The interior ring ground shall consist of No. 2 AWG stranded insulated wire extended around the periphery of the radio equipment area.

The interior ring shall be exothermally bonded to the exterior ring.

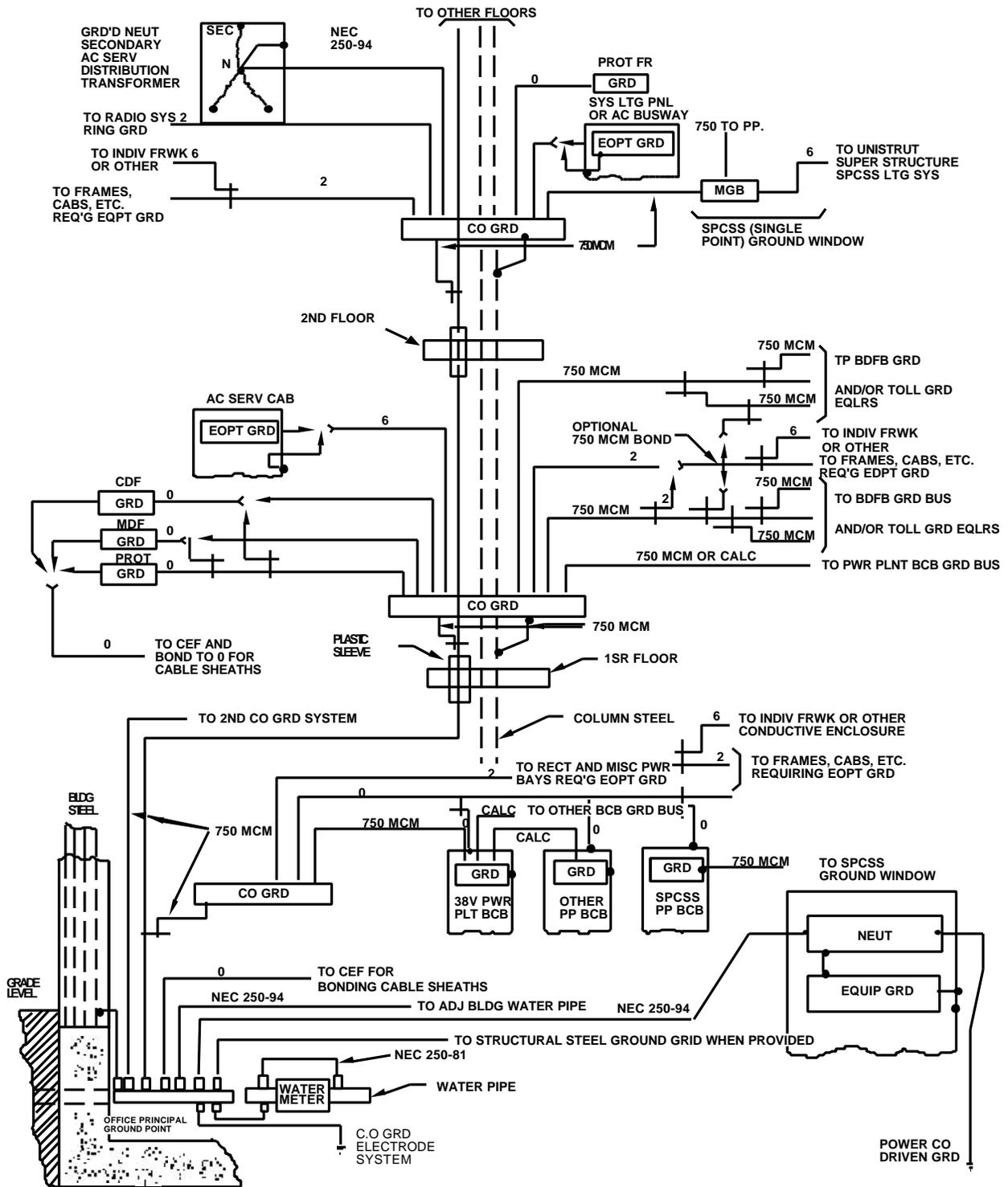
All metallic objects in the radio equipment area shall be bonded to the interior ring ground with as short a connection as possible.

Only copper conductors will be used. This includes wire conductors, bus bars, straps, clamps and connectors. Aluminum conductors and aluminum connectors are not acceptable.

All connection on cable to cable shall be made with C-tap or H- tap connectors, all connections to frames or bus bars shall be made with two hole crimp connectors.

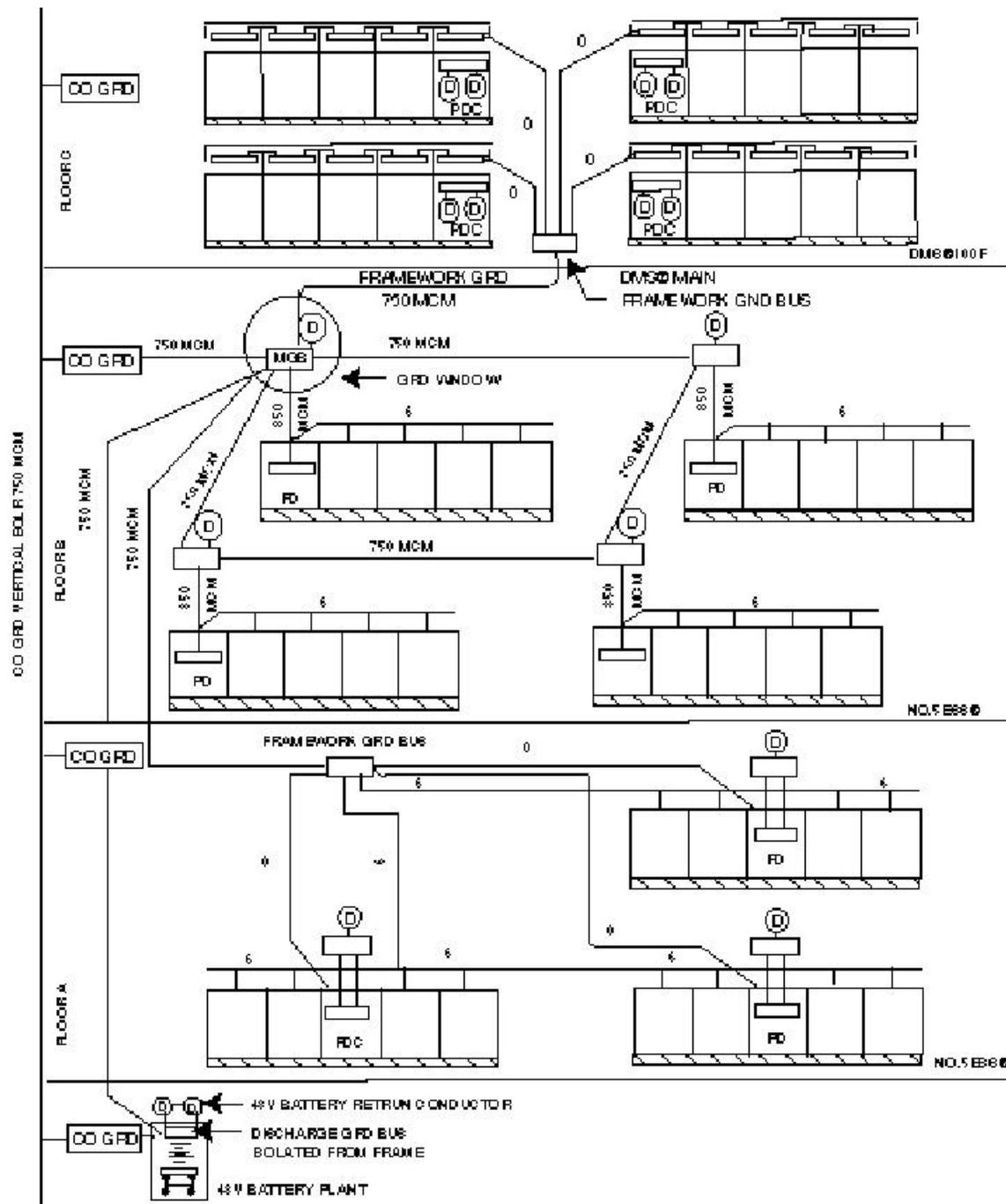
### **5.6.7 Further Information**

Detailed information on these grounding systems can be found in QWEST Communications International Inc. Technical Publication 77355 (see Reference Chapter). This Publication should be consulted before any engineering work is begun.



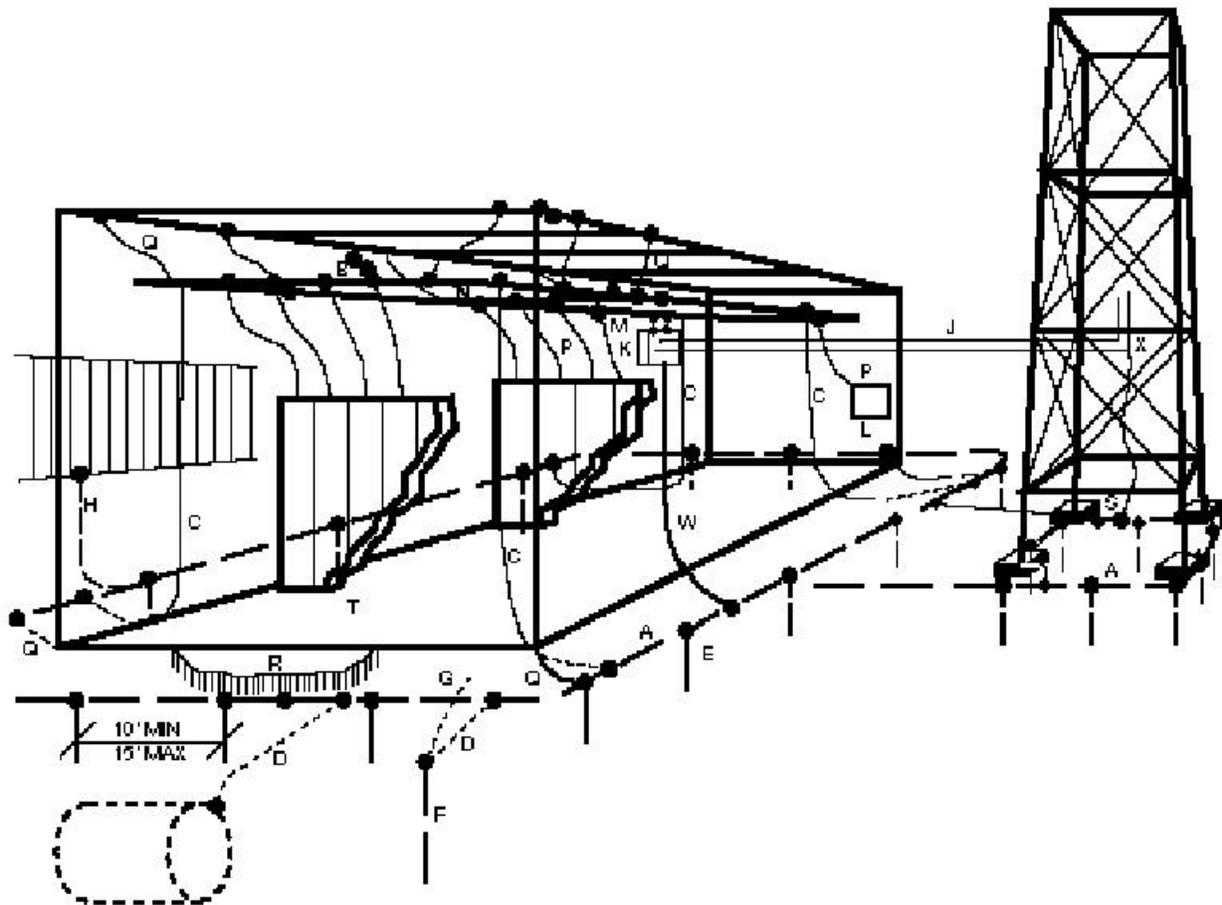
**EXHIBIT 2-D-1**  
**CENTRAL OFFICE GROUND SYSTEM**  
**INTEGRATED GROUND PLANE**





**EXHIBIT 2-D-3**

MAXIMUM MULTIFLOOR STORED PROGRAM CONTROL SYSTEM (SPCS) GROUND PLANE SPREAD WHEN A SINGLE SPCS DEDICATED POWER PLANT SUPPLIES POWER TO ONE OR MORE SPCS OFFICES



**LEGEND**

- |  |   |
|--|---|
| (A) BURIED EXTERIOR RING BUS   | (L) WALL MOUNTED CAB NET                            |
| (B) PERIPHERAL BUS   | (M) HATCH BOND                                      |
| (C) INTER-BUS BOND   | (N) SUPPLEMENTARY BOND                              |
| (D) BOND TO BURIED OBJECTS   | (P) EQUIPMENT BOND                                  |
| (E) GROUND ROD   | (Q) BUILDING STEEL BOND                             |
| (F) POWER CO GROUND ELECTRODE  | (R) GRADE LEVEL                                     |
| (G) POWER CO NEUTRAL BOND  | (S) TOWER BASE SHOE BOND                            |
| (H) BOND TO FENCE WITHIN 6'  | (T) BOND TO METALLIC OBJECT<br>OR BUILDING EXTERIOR |
| (J) WAVEGUIDE (RECTANGULAR, CIRCULAR,<br>ELLIPTICAL, HELIAX, COAX, ETC.) | (W) WAVEGUIDE HATCH PRIMARY BOND                    |
| (K) WAVEGUIDE HATCH  | (X) WAVEGUIDE VERT. TO HORIZ. TRANSITION            |

**EXHIBIT 2-D-4**  
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## **6. Cable Rack and Auxiliary Framing**

### **6.A. Cable Rack**

#### **6A.1 General**

This unit covers engineering requirements for cable rack in transmission and power equipment areas and above switching systems.

- The requirements for Cable Distribution Systems (also referred to as "Cableway" or "Compartment" type systems) above 7 foot high frames and fiber management systems are covered in Chapter 6, Unit F of this module.
- All measurements shown in exhibits indicate maximum or minimum allowable gap tolerances where cable rack and framing parts are joined.
- Self-drilling anchors shall not be used to secure frames or ironwork to ceilings, walls or floors. For attaching frames or ironwork to wooden ceilings, walls or floors, substitute appropriate lag bolts. Where embedded inserts or expansion anchors are shown substitute torque indicating anchors.
- Refer to the "Earthquake and Disaster Bracing" section for additional cable racking requirements in earthquake heavy zones.

Abandoned cable should be removed (mined) from cable runs, where practical, to maintain cable pileup limits and safe loads.

- Cabling and cable rack arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.
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#### **6A.2 Description and Sizes**

To prevent corrosion and facilitate grounding, cable rack sections should be of a non-corrosive plated type, or painted, preferably gray.

- All switchboard and power cable rack shall be painted gray. Fiber cable rack shall be painted orange. Cable rack specifically for a switch system, and within the "footprint" of the switch, can be per the manufacturer requirements and guidelines. This would not include via type cable rack to a distributing frame, BDFB, etc.
- The QWEST representative responsible for Common System Standards may approve the use of other colors of paint.

Cable rack assembly hardware shall be of a non-corrosive plated type.

- Where hardware is intended for bonding purposes, refer to QWEST Communications, Inc. Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines" and QWEST Communications, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

Exhibits in this unit apply to all ladder-type cable rack configurations.

### **6A.2.1 Ladder Cable Rack**

Ladder-type cable rack is preferred for all new construction.

Ladder-type cable racks are manufactured in full length (9 feet 8-1/2 inches long) or in half-lengths (4 feet 5-1/2 inches long) and in various widths as shown in Exhibit 2-E1-1.

- The straps are 1 inch by and 1/2 of an inch channel spaced on 9-inch centers and welded to the stringers. The first, last, and each alternate strap of the cable racks that are 2 feet 1 inch and 2 feet 6 inches in width are reinforced with a 1 inch by 1/4 of an inch bar.
- The actual construction of the stringers can be channel or solid. Tubular or hollow stringer type cable rack is prohibited.

The fabrication exhibits in this unit show solid stringers.

### **6A.2.2 Bar Cable Rack**

Bar-type cable racks, as shown in Exhibit 2-E1-1D, 1E, 1G and 1H, are examples of existing embedded base equipment and may be encountered during additions to those systems.

Bar-type cable racks are made of 1 inch by 3/16 of an inch bent steel cross-straps on 9-1/2 inch centers welded to stringers that have an outside dimension of 1-1/2 inches by 3/8 of an inch.

- The construction of the stringers may be channel, or solid.
- Solid stringers are illustrated in fabrication figures in this unit.
- Thin metal or plastic plates are to be provided for covering the bottom of the racks. Plastic type plates are preferred.

### 6A.3 Safe Loads

Safe loads for steel ceiling inserts, threaded rods, and lag screws, for the purpose of determining the spacing of supports other than normal, may be considered as follows:

<u>MATERIAL</u>	<u>POUNDS</u>
5/8-11 threaded rods	1200
Embedded Ceiling inserts (poured in place)	1200
5/8 inch expansion anchors	480
Framing bars (one pair 2 inches by 3/8 of an inch steel) or channels (one pair 2 inches by 9/16 of an inch by 3/16 of an inch steel) span between supports:	
Up to 2 feet 0 inches	2000
2 feet 0 inches to 3 feet 0 inches	1500
3 feet 0 inches to 5 feet 0 inches	1000
5 feet 0 inches to 7 feet 0 inches	700
7 feet 0 inches to 8 feet 0 inches	500
Embedded ceiling channel (U-type):	
At one point	2000
Where 2 or more loads are within 24 inches of each other, total load cannot be in excess of	2000

### 6A.4 Cabling

Proper cabling practices and procedures are required to preserve safety and maintain service within the cabling environment. The following guidelines and requirements shall implemented where practicable

### 6A.4.1 Cable Pileup

The permissible pile-up of cabling on ladder-type cable racks for the normal and maximum spacing of supports is as follows:

CABLE PILE-UP IN TERMS OF SWITCHBOARD CABLE

WIDTH OF CABLE RACK	SUPPORTS ON 5 FEET 1 INCH CENTERS	SUPPORTS ON 6 FEET 0 INCH CENTERS
5 inches to 12 inches	See note	See note
15 inches to 25inches	12 inches	10 inches
30 inches	10 inches	7 inches

Note: The maximum cable pileup for a cable run is also limited to a height not to exceed the width of the cable rack for cable racks 12 inches or less and to the values given in the above table for wider racks.

\* Cable pileup on racks supported by wall mounted brackets shall be limited to no more than 2 inches for switchboard cable or fiber cable and 1 inch for power cable.

Cable pile-up on bar-type cable racks is limited by the height of the vertical bars, not to exceed the limits for ladder-type rack.

The permissible pile-up of vertical switchboard cable runs shall not exceed an ultimate pile-up of 12 inches.

Runs of power cable smaller than No. 6 AWG are to be considered as roughly ten percent heavier than switchboard cable. Larger sizes of power cable are considered 5 times heavier than switchboard cable. The permissible pile-up on combined vertical and horizontal power cable racks is 7 inches. The maximum width of horizontal and vertical dedicated power cable racks shall be limited to 20 inches unless reinforced rack is used to accommodate extra weight.

### 6A.4.2 Support of Cable

Cable spanning horizontal planes shall not exceed 9 inches without additional support.

Sections of ladder-type cable rack shall be assembled so that support for the cabling is provided every 9 inches.

- At turns or junctions, in vertical or inverted horizontal cable runs, where proper support is not provided for the cables, 1/2 inch by 1 inch channel shall be placed diagonally across the rack in a manner to provide proper support for the cables. The channel straps shall be secured with bolts at the corner clamps.
- At cable rack junctions and turns, where the radii on which the cables turn are so large that an additional support is required; or where cables are spread out to avoid excessive piling, a corner bracket shall be provided, as shown in Exhibit 2-E1-34.

Cable leaving cable racks to equipment frames shall not be unsupported for a distance greater than 3 sheath feet.

- Where the distance exceeds 3 feet, additional cable support shall be provided.

### **6A.4.3 Secured and Unsecured Cable**

Cables secured to cable rack shall be sewn and, where practical, shall utilize the full width of the cable rack for each layer prior to securing additional layers. Additional layers shall be secured to the previous layers in a similar fashion.

Cables, run on cable rack with a vertical offset greater than 9 inches, shall be secured at the offsets per the standards for securing vertical cable in Technical Publication 77350.

Horizontal bar and ladder type cable racks not equipped with screen or pan require the securing of cable. Cable shall be secured per standards in Technical Publication 77350.

- Switchboard cable shall be run secured on cable rack not equipped with screen and brackets.
- Power cable shall be run secured on dedicated power cable rack.
- Power cables run on panned or screened cable rack shall be secured per standards in Technical Publication 77350.
- Fiber cable shall be run secured on standard gray type cable racks and unsecured on orange fiber cable racks equipped with pan and brackets. Refer to Chapter 6 Unit F for additional requirements.
- For cable securing intervals and requirements, see QWEST Communications, Inc. Technical Publication 77350, (see Reference Chapter).

### **6A.4.4 Cable Slack Storage**

Cable slack storage in any type of cable rack is strictly prohibited.

- Customary cable slack for wide turns, cable rack offsets, and at break-off points to the equipment is acceptable.
- Letters of deviation will not be considered valid.

#### **6A.4.5 Cable Protection**

All cabling shall be protected from contact with sharp edges, such as those occurring at cable rack stringers and non-rounded straps, edges of duct type frames and all threaded rods within 3 inches of a cabling surface.

- Soft rubber power cable and all coaxial type cables shall be protected where they are secured to metal straps and brackets.
- Where separation of metallic continuity is required, effective insulation may be provided per Exhibit 2-E1-94.
- To protect cabling at T-intersections of bar-type cable racks and cross-aisle racks, finishing caps shall be installed on the ends of all cross-straps that project within the T-intersection area as shown in Exhibits 2-E1-17C, 17H, 17J and 2-E1-18A. The finishing caps shall be secured to the cable rack horns by coating the inside of the caps with an adhesive prior to placing the caps on the horns..

#### **6A.4.6 Cable Routing and Transitions**

Incorrect cable routing and transitioning can block existing or future cable paths and inhibit the ultimate cable capacities of the racking system. Cable routing and transitioning not specifically identified in this document shall adhere to the intent of the following requirements.

Cables shall be routed and secured so that they do not block future cable additions or adversely affect the ultimate cable pileup.

Where cables transition off a cable rack they shall be routed over the side stringers or off the end of a cable rack that will not be extended at some future date.

- Cables shall not be routed "through" cable rack stringers.

Cables shall follow cable rack routing and shall not transition between cable racks except as noted.

The following are examples of cable rack arrangements of different elevations where cable transition from one cable rack to another is considered acceptable.

- Cable rack arrangements as provided for in Exhibits 2-E1-39, 54, 54F
- When transitioning between via cable rack and Cable Distribution Systems, refer to Chapter 6, Unit F.
- When it is necessary to transfer cables from one run to another, provide sufficient clearance at the transfer so that future cables may be installed on either cable rack without blockage.

The following are examples of cable rack arrangements for different elevations where cable transition from one cable rack to another is prohibited.

- EXHIBIT 2-E1-83, Transitions to or from one rack above another. This includes racks not positioned directly above but parallel to each other.
- EXHIBIT 2-E1-84, Transitions to or from racks at right angles and above.

### **6A.5 Engineering Requirements**

Space required for access to, or removal of, equipment shall be taken into consideration when determining the location of cable rack and supports.

Cable rack shall not be located below the tops of windows, doors, or transoms so as to obstruct their proper operation.

Cable rack or troughs shall not be located in the maintenance area of an equipment environment. A maintenance area is defined as that area below the top of the framework (including extenders) and in a front or rear aisle (guard rail to guard rail).

- Where environments of differing heights intersect, such as 7 foot and 11 foot 6 inch, the cable racking of a 7 foot floor supported environment may encroach into the other environment as long as it does not interfere with rolling ladders and normal C.O. activities.

Wherever possible, allow a horizontal clearance of 18 inches on the "working side" of a cable rack to allow proper access for installing the cables.

Cable racks shall be located and securely supported to accommodate the maximum cable pile-up allowed.

- A minimum 12 inches clearance is required above the top of a cable rack to the bottom of any obstruction to accommodate cable pileup.
- Components such as conduit, cable brackets, bracing, other cable rack, etc shall be arranged so as not to interfere with the ultimate cable pileup.

Cable racks shall not be located close to pipe, radiators, windows, doors, or any other equipment that may subject the cabling to detrimental conditions.

Ladder-type cable rack, engineered for horizontal applications, shall be installed with the cross-straps upward per cable racking exhibits.

- Cable rack with channel-type straps, smaller than 25 inches in width, may be inverted to gain necessary cabling heights due to fixed obstructions. Inverted cable racks must be equipped with panning and cable retaining brackets.
- Cable racks 25 inches or wider, with reinforced straps, may not be inverted.

- Cable racks shall be installed so that no excessive load or binding will be imposed on frames, racks, or other equipment attached or adjacent to the cable racks, unless such equipment is engineered to support the cable racks.
- Splicing of threaded rods per Exhibit 2-E1-75 is not approved unless the rod being spliced is over six feet in length. No more than one splice is allowed in any threaded hanger rod.

When cable rack and associated equipment are located within the isolated ground plane, separation from all integrated ground plane members must be maintained as specified in QWEST Communications, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

### 6A.5.1 Cable Rack Capacities

The cable capacity required to serve an equipment area or lineup can vary widely. Cable rack capacities should be evaluated when determining the size and/or number of cable racks required to supply a lineup of equipment or equipment area.

The following information shall be used to determine appropriate cable rack sizing.

NUMBERS OF MISCELLANEOUS CABLES SECURED ON  
 LADDER TYPE CABLE RACK AND APPROXIMATE WEIGHT OF CABLE

Width of Rack		Capacity for Height of Cables											
Actual	Cable Space	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"
5"	3-1/2"	11 2	21 4	32 6	42 8								
12"	10-1/2"	32 6	63 12	94 19	126 25	158 31	189 37	221 44	252 40	283 46	315 62		
15"	13-1/2"	41 8	81 14	122 24	162 32	203 41	243 48	284 61	324 70	365 78	405 86	446 94	486 102
20"	18-1/2"	56 12	111 23	167 34	222 45	278 56	333 67	389 79	444 90	500 102	555 114	611 126	666 138
25"	23-1/2"	71 15	141 29	212 43	282 56	353 71	423 86	494 100	564 115	635 130	705 145	776 160	846 175
30"	28-1/2"	86 18	171 35	257 52	342 70	428 87	513 105	599 122	684 140	770 158	855 176		

The upper number on the table represents the approximate number of cables and the lower number the approximate weight.

The capacities of the above table are based on approximately 3 cables or 150 pairs per square inch.

When combining power and switchboard cable runs determine the ultimate pileup and width of cable racks by using the table above and converting power cables to terms of switchboard cables using the table below.

#### CONVERTING POWER WIRE INTO TERMS OF SWITCHBOARD CABLE

Width of Cable Rack	Equivalent To:	Equivalent To:
#4 - #14	1/2 cable	75 pair
#2	1 cable	100 pair
#0 - #0000	2 cables	225 pair
#350,000	3 cables	350 pair
#500,000	4 cables	450 pair
#750,000	6 cables	700 pair

Where cables will cross at intersections of the cable racks the capacities shall be determined at approximately 75 percent of the capacity of cables of the widest cable racks entering the intersection.

#### 6A.5.2 Cable Rack Assembly

To maximize strength and rigidity, the longest length of sections and the fewest assemblies practical shall be employed in assembling cable racks.

- Clamping details used to junction ladder-type cable racks are shown in Exhibits 2-E1-2 through 2-E1-12.
- The joining of sections of cable rack for usual conditions is shown in Exhibits 2-E1-23, 2-E1-24, 2-E1-26 through 2-E1-38, 2-E1-38H, 2-E1-39 through 2-E1-43.
- Exhibit 2-E1-39 covers arrangements for making small vertical offsets in horizontal racks.
- Ladder-type cable racks over the rear of channel-type frames supported by 11 foot 6 inch auxiliary framing shall be secured to ladder-type cable rack over the front of bulb-angle or channel-type frames supported by 11 foot 8 inch auxiliary framing as shown in Exhibit 2-E1-28A.
- Closing bars of the same width and thickness as the stringers of the cable racks, as shown in Exhibit 2-E1-25, shall be used at offsets as shown in Exhibit 2-E1-29 and to join cable racks of different widths as shown in Exhibits 2-E1-31 and 32.
- Closing bars used to junction cable racks of different widths and stringer sizes are shown in Exhibit 2-E1-21A.

**SPLICING CABLE RACK:** Splices shall be made as shown on Exhibits 2-E1-2, 2-E1-3 and 2-E1-94.

- No more than one splice shall be placed between any two adjacent points of support on horizontal runs.
- Multi-level and adjacent cable racks should stagger the splices, especially in heavy seismic zones.
- Cable rack splices shall not be construed as support.
- A splice shall not be used beyond the last point of support when the end of a rack extends in cantilever fashion.

**CORNER BRACKET:** Corner brackets, per Exhibit 2-E1-34, are required at all right angle turns where the inside cable is turned on a radius greater than 8 inches.

- Corner brackets at right angle turns will be required on dedicated power or fiber cable racks.

**HORIZONTAL AND VERTICAL OFFSETS:** Edge clamps on cable rack assembled as shown in Exhibits 2-E1-35, 36, 37, 38, 40, 40A, 40B, and 40C shall not be subjected to any load other than the cabling at the turn or offset.

Offsets for horizontal cable racks are shown in Exhibits 2-E1-28, 29 and 30. Offsets for vertical cable racks are shown in Exhibits 2-E1-35, 36, 37, 38, 39, 40, 40A, 40B, and 40C.

Vertical cable rack offsets of 9 inches or less of in parallel planes shall be made as shown in Exhibit 2-E1-39.

Vertical cable rack offsets of greater than 9 inches in parallel planes shall be made using fixed degree edge clamps as shown in Exhibits 2-E1-35, 36, 37, 38, 40 and 40C.

- Vertical offsets per Exhibits 2-E2-40, 40A, 40B, and 40C are limited to a vertical offset of no more than 3 feet measured from top to top of the cable rack stringers.
- Where it is not practical to use fixed degree edge clamps for vertical offsets due to obstructions, adjustable clamps as shown in Exhibit 2-E1-40A or 40B may be utilized. Adjustable edge clamps shall be installed as close to 45 degrees as possible. For additional requirements when using adjustable offsets in earthquake heavy zones, refer to Chapter 6 Unit E of this Module.
- Vertical offsets in parallel planes shall be arranged so that they are positioned between supports for the horizontal rack. Supports shall not exceed 6 feet separation.
- Adjustable offsets per Exhibit 2 -E1-40A or 40B shall be installed as close to either a 45 or 90 degree angle as practicable.

- Adjustable offsets per Exhibit 2 -E1-40B are prohibited on power and fiber cable racks and at right angle turns where the inside cable is turned on a radius greater than 8 inches.

FINISHING DETAILS: The open ends of sections of cable racks and the protruding ends of supporting bars, shall be protected with rubber bumpers per Exhibit 2-E1-25C.

### **6A.5.3 Cable Rack Support**

Ladder and bar-type cable rack shall be supported from high or low-type auxiliary framing, other cable rack, threaded rods, stanchions, or approved wall or ceiling mounted brackets.

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

- Each horizontal cable rack section shall have a least one point of support. Junctions and bracing fabrications shall not be considered a point of support.
- A support shall be provided within 36 inches of the free end of a cable rack.
- Note: The free end of a cable rack is the end not junctioned to another cable rack, floor, wall, etc.

At intersections, where a free-ended cable rack is joined to a rigidly supported cable rack by corner clamps, as shown in Exhibits 2-E1-27 and 2-E1-34, supports shall be provided on the free-ended rack not more than 5 feet from the intersection.

- A rigidly supported cable rack is the section of rack between supports that does not consist of junctioning hardware such as corner clamps and splices.

At turns, offsets, and intersections having the equivalent of free-ended cable rack, such as in Exhibits 2-E1-26, 28, 28A, 29, 30, 31, 32, 33, 35, 36, 37, 38, 40, and 40C, the rack shall be supported such that the clamps will not carry an appreciable load.

- Exhibits similar to 2-E1-82, 83, 84 shall not be used to support cable rack from the equivalent of free-ended cable racks.

SUPPORT FROM OTHER CABLE RACKS: Ladder and bar-type cable rack shall be supported from other cable rack per Exhibits 2-E1-17C, 2-E1-18A, 2-E1-19A, 2-E1-27, 2-E1-54 and 2-E1-54F.

- Cable rack cross-straps shall not be used for support.

AUXILIARY FRAMING SUPPORT: Ladder and bar-type cable rack shall be supported from high or low type auxiliary framing per Exhibits 2-E1-65, 65B and 65C.

- Both stringers shall be bolted at each end of the run and only one bolt is required at intermediate supports on alternate sides of the rack.

**THREADED ROD SUPPORT:** Ladder and bar-type cable rack shall be supported from threaded rods per Exhibits 2-E1-39, 66, 67, 74, 76, 77, 77B and 81 through 87.

- Cable racking supported by means of threaded rods shall be a maximum of 18 inches above auxiliary framing or other cable racks. (Examples can be found in Exhibits 2-E1-66, 2-E1-77, 2-E1-81, 2-E1-82, 2-E1-83, and 2-E1-95).
- Cable rack may be supported to an embedded ceiling insert, expansion anchor or U type channel, per Exhibits 2-E1-85, 86, 87 and Safe Loads Table.
- Cable rack or auxiliary framing support arrangements shall be such that threaded rods will not pass through cable racks.

**WALL BRACKET SUPPORT:** Ladder and bar-type cable rack, no greater than 12 inches in width, may be supported along walls using brackets.

- Brackets may only be used on a limited basis where office conditions prevent the installation of other support options.
- Brackets shall be provided per requirements for supporting horizontal cable rack.
- Multiple level cable rack arrangements shall not be supported using wall brackets.
- Brackets shall not be located below the top to frames within the maintenance area of a distributing frame, equipment frame, etc.

**STANCHION SUPPORT:** Ladder and bar-type cable rack may be supported using stanchions where auxiliary framing cannot be provided.

- Multiple level cable rack arrangements shall not be supported using stanchions. An exception is where an ironwork "grid" arrangement on 5 feet to 6 feet centers has been provided. Refer to Exhibit 2-E2-2F
- Stanchions shall be placed at 5 feet intervals, not to exceed 6 feet, and located so as not to interfere with existing or future aisles or egress routes.
- Alternate stanchions shall be braced where more than one stanchion is required along a cable rack path.
- Stanchions arranged to form a grid of support per "Auxiliary Framing - Low, Floor Supported Environments" do not require additional bracing.
- Stanchions with abase 10 inches or smaller shall be anchored using two anchors in light seismic zones and four anchors in heavy seismic zones.
- Stanchions with bases larger than 10 inches shall be anchored using four anchors in all seismic zones.

Threaded rod extended from the top of a stanchion to the bottom of auxiliary framing shall not exceed 2 inches.

Where equipment frames are omitted, stanchions shall be provided where the gap between top supports exceeds 6 feet.

Only seismically tested and approved stanchions are allowed in heavy earthquake zones.

#### **6A.5.4 Cross-Aisle Cable Rack**

Cross-aisle cable rack shall be located at a maximum of 10 feet intervals where not dictated by specific cable rack system arrangements or QWEST Standard Configuration documents.

- High density cabling areas, such as distributing frames and DSX, should have cross-aisle cable rack at approximately 5 feet intervals.

Ladder-type cross-aisle cable racks may be installed at the same level as the ladder-type over-frame racks, junctioned per Exhibit 2-E1-27, or at the high level shown in Exhibit 2-E1-54, where necessary to clear lighting, conduit or other obstructions.

- Cross-aisle cable racks must connect cable racks used for the same cable application (i.e. switchboard rack to switchboard rack) and shall be used for the same cable application as the racks connected to.

#### **6A.5.5 Vertical Cable Rack**

Refer to the "Cable Rack Assembly" and "Cable Rack Support" sections for requirements on vertical "offsets".

Vertical ladder-type cable racks arranged to attach directly to floors or to similar flat surfaces shall be terminated as shown in Exhibit 2-E1-13.

- When the foot of the rack does not present a hazard and space permits, the cable rack feet may be turned outward.

Vertical cable racks used to support cables passing through floors shall be supported at the floor and ceiling adjacent to the cable hole or slot as shown in Exhibit 2-E1-13A for cable holes equipped with channel sheathing or Exhibit 2-E1-13B for cable holes equipped with angle sheathing.

Vertical cable racks used to support cables in shafts shall be supported at each floor and ceiling as shown in Exhibit 2-E1-13D.

### **6A.5.6 Bracing Cable Rack**

Hanger rods supporting continuous horizontal cable runs more than 2 feet below auxiliary framing or a ceiling and over 20 feet long shall be braced sidewise to prevent sway. Bracing shall be installed at approximately 20 feet intervals and, where practical, in a staggered arrangement on opposite stingers of the cable rack.

- An additional brace shall be provided at the end of a cable rack run where the distance from the last brace is 10 feet or more.
- Cable rack installed horizontally shall be braced sidewise as shown in Exhibits 2-E1-88 and 2-E1-89.
- Vertical cable rack between floors will not normally require bracing, however, cable rack with unusual sway should be braced to the ceilings using methods similar to Exhibits 2-E2-88 and 89.

### **6A.5.7 Cable Support Brackets**

Cable pileup in brackets shall adhere to the limitations listed in Tech Pub 77350.

Cable brackets or horns shall be mounted at approximately 12-inch intervals with a maximum of 18 inch intervals.

Compartment type cable brackets extending above the cable rack stringer shall not be used for the purpose of running cable that is required to be "separate" or "segregated". This includes power and fiber cables.

Cable rack "cable brackets" similar to Exhibit 2-E1-57E, 57F, or 57G may be mounted to cable rack or auxiliary framing.

- The above brackets may be used for all fused power cables or framework ground feeders. They shall not be used for fiber cable.
- Power cables and ground feeders shall not be run together on the same cable brackets.
- Cable brackets shall be installed with the bracket pointing toward the center of the cable rack where possible except where they would interfere with the ultimate cable pileup of other cable racks.

Cable support brackets, per Exhibit 2-E1-95, may be used for limited applications of dedicated cable runs. These brackets shall not be used for fiber cable.

- Cable support brackets shall be installed so as not to obstruct the ultimate cable pileup.
- Where cable support brackets are used for cable runs that are to be segregated, the cable must be supported a minimum 2 inches above the ultimate cable pileup.

### **6A.5.8 Screen, Pan, and Brackets**

Panned or screened racks with cable retaining brackets are generally intended for high volume cabling routes which allow for free running of cables and limited securing.

- "Screen" generally applies to a metal plate supported to the underside of cable rack with clips.
- "Pan" generally applies to a plastic or metal plate placed on top of a cable rack.
- "Brackets", when used with screen or pan, generally applies cable retaining type brackets.
- Where brackets and screen or pan are used the following requirements shall apply.
- Pan or plates, placed on cable rack, shall be used where cables are to be run unsecured. Metal pan, except where included with bar type cable rack ordering codes, shall not be utilized on a going forward basis.
- Where a cable rack is terminated with rubber bumpers and plastic plate is utilized the plate shall be moved back so that it terminates at the last cross-strap.
- Cable rack screen, supported beneath cable rack, shall be used only in light earthquake areas where the bottom cabling layer has become unsecured as in cable mining activities.
- Screened type cable rack per Exhibit 2-1E-92 shall not be used in heavy earthquake areas. For heavy earthquake areas thin plastic plates will be provided.

Exhibit 2-E1-93 illustrates some of the types of cable retaining brackets (cable horns) that are available.

- Secured type cable retaining brackets shall be used in place of snap-on type cable horns.
- Cable retaining brackets shall be located on alternate straps of the cable racks.
- At crossing points and points where cables drop off the racks, it may be necessary to locate additional brackets to add protection for the cable.
- Snap-on type cable horns are not designed to withstand impact loading and shall not be used to form troughs in which cables are pulled or dragged.

Cable Distribution Systems provide separation of free-running cables with limited securing, and are described in Unit F of this document.

### 6A.6 Power Cables and Racking

It is the intent of these requirements that, as much as practical, power cables will be segregated from switchboard cable and separate power cable rack will be provided where space permits.

All Power cable with a 70 Ampere protection device or larger shall be run on separate, segregated cable rack or supported on brackets below existing cable rack.

- Power cables 350,000 or larger are prohibited on switchboard cable rack no matter what amperes they are fused at.
- Cables protected at less than 70 Amperes can be run on the same cable rack as switchboard cables if there is no space to provide a power cable rack.
- A Letter of Deviation shall not be accepted allowing cables protected 70 Amperes or above placed in the same cable rack as switchboard cables.

Power cable number 00 or larger, shall not be unsupported for a distance greater than 3 sheath feet.

- This requirement shall only apply to vertical transitions between cable rack and frames, battery stands, etc.

CABLE RACK: Cable rack used for segregated power runs shall be solid stringer type only.

- Power cable rack shall be supported utilizing auxiliary framing as illustrated per Exhibits 2-E1-65 and 77B.

Main power cable runs require considerable support, particularly at horizontal to vertical outside turns. The cable rack at such turns shall be of the type shown in Exhibit 2-E1-53.

- Turns in cable racks 20 inches wide may be assembled by bolting together, side by side, two 10 inch turns.
- Power cable rack turns are similar in general construction to ladder-type cable racks, except that the straps are formed to 7 and 14 inch outside radii of 90 degree turns, the straps being on the outside of the turns as shown in Exhibit 2-E1-53. Power cable rack turns are available in a variety of widths.

Extended vertical runs of power cable rack, in excess of three floors must have a minimum of 20 feet of horizontal cable rack provided on every third floor to alleviate cable weight build-up.

At the bottom of vertical cable racks that carry power cables exclusively, the intermediate cross-straps shall be removed when the uninterrupted rise exceeds two floors as shown in Exhibit 2-E1-36, to prevent damage to sagging power cables.

CABLE BRACKET: Refer to the section "Engineering Requirements - Cable Support Brackets" for requirements.

### 6A.7 Bar Type Cable Racking

Bar type cable racks shall only be provided where extending existing bar rack in older ironwork arrangements such as those for Crossbar or Step-by-Step. New lineups should be of ladder type rack where bar type cable racks were not previously provided.

- The general requirements for ladder-type cable racks also apply to bar-type cable racks.
- Bar cable rack requires a pair of framing bars or channels under the racks for support.
- Sections of bar-type cable racks shall be assembled so that cross strap support for the cabling does not exceed 11-5/8 inches.
- Bar-type over-aisle cable racks shall be junctioned to bar-type cross-aisle cable racks at the same level as shown in Exhibit 2-E1-17C.
- Bar-type over-aisle cable racks shall be junctioned to bar-type cross-aisle cable racks 2 inches higher, as shown in Exhibit 2-E1-17J.
- Bar-type over-frame cable racks shall be junctioned to bar-type cross-aisle cable racks 2 inches higher, as shown in Exhibit 2-E1-17H.
- Bar-type cable racks shall be junctioned to ladder-type cable racks at the same level as shown in Exhibits 2-E1-18A, 19A, 20A and 21A.
- A vertical ladder-type cable rack dropping off the side of a bar-type cable rack with a 90 degree outside turn is shown in Exhibit 2-E1-38J.
- Where bar-type cable rack is terminated with rubber bumpers, the sheet metal or plastic plate shall be moved back so that it terminates at the last cross strap.
- Flat tubular extension sleeves arranged to fit over the vertical ends of the cross-straps are available for increasing the capacity of bar-type, over-aisle cable racks as shown in Exhibit 2-E1-16A. Extension sleeves shall be installed at all T-intersections of bar-type over-aisle cable racks on the ends of the cross-straps on both sides of the intersection as shown in Exhibits 2-E1-17C, 17J, 18A and 19A. In these cases, the extension sleeves shall be provided with finishing caps. The caps shall be secured to the sleeves with adhesive. Use of extensions shall not exceed cable pile-up limitations.
- Bar-type cross-aisle cable racks shall be run at the same level as over-aisle cable racks where ceiling supported lighting is furnished. Where frame supported universal type fluorescent lighting fixtures are furnished, cross-aisle cable racks shall be raised 2 inches above the auxiliary framing. The metal plate covering the bottom of bar-type, cross-aisle cable racks may be cut away to permit cabling to pass through the rack to the frames beneath. When metal plate covering is cut, protective materials shall be installed on exposed metal edges.
- Bar-type, cross-aisle cable racks run at the same level as over-aisle cable racks shall be supported, as shown in Exhibit 2-E1-54E, at locations where frames have been omitted. If run at a level 2 inches high, where frames have been omitted, the cross-aisle cable racks shall be supported by additional framing covered in Chapter 6 Unit B of this module for low type framing.

## 6A.8 Cable Holes and Firestopping

### 6A.8.1 Cable Holes

- **CABLE HOLE CAPACITIES:** Firestop material manufacturer requirements often include maximum limits on cable hole fill for the firestop material warrantee to be valid. Cable hole capacities shall be limited per manufacturer requirements.
- **FASCIA ANGLES:** Cable holes shall be provided with fascia angles at floors, ceilings, or wall penetrations for the attachment of cable hole sheathing, covers, firestop materials, or cable rack.
- The addition of fascia angles is requested through Building Real Estate.
- Fascia angles shall be tapped to accept 3/8-16 type screws.

**CABLE HOLE SHEATHING:** Cable holes shall be sheathed with a steel collar and drilled to accept a cover and bolting material. Sheathing shall be capable of supporting vertical cable racking and load.

Joints between the cable hole sheathing and the floor shall be made functionally tight and waterproof by filling with a form-a-gasket compound.

**CABLE HOLE COVERS:** Floor and wall covers shall be secured to the sheathing or fascia with 3/8-16 screws. Covers shall be cut to fit as closely as practical to fit around the cable bundle.

- Where possible, cable hole covers shall be cut to allow a straight cable path through the cable hole. Cables shall not be routed to avoid appropriate modifications to the cable hole cover.

All cable holes or slots through the floor which are accessible by personnel for any reason must be provided with a top cover made of steel, regardless of the technology employed.

- Floor opening covers shall be HRPOCQ type steel with a minimum thickness of .119 inches (11 gauge).

Firestopping of occupied wall cable openings shall be provided for all types of fire rated walls and partitions by applying a steel cover to one side of the opening.

- Wall opening covers shall be HRPOCQ type steel with a minimum thickness of .060 inches (16 gauge).

### 6A.8.2 Firestopping

All cable holes or slots, whether occupied or unoccupied, in a fire rated wall or floor of an interior area to be enclosed, will be sealed with approved firestop materials.

- Enclosed cable distribution systems, including conduit, shall not continue uninterrupted through a floor or wall cable hole. The cable system shall be arranged so that only the cable passes through the floor or wall opening. The opening shall then be enclosed per the appropriate firestop methods.

Materials and components shall meet Occupational Safety and Health Administration (OSHA) requirements, QWEST requirements, and Central Office Fire Resistance Requirements (located in Chapter 11 of this module) as well as state and local statutes.

- OCCUPIED CABLE HOLES pertain to openings in floors and walls with cable passing through them.
- UNOCCUPIED CABLE HOLES pertain to openings in floors and walls without cable passing through them.

All cable holes shall be temporarily closed at the end of each working day, or whenever it is anticipated that no additional cable will be run that same day.

**CABLE HOLES:** The recommended method of smoke stopping is accomplished with approved intumescent and endothermic materials and high temperature caulking compound.

- Materials must be applied according to manufacturers and Underwriters Laboratory (UL) recommendations.
- Mixing of firestop products and technologies is prohibited unless a configuration has been specifically approved by QWEST.

Apply high temperature caulking between the cable bundle and edge of the cover plate, as well as any other openings.

The cables should then be tied together with a cable support strap, level with the top cover to compress the cable bundle and eliminate voids. The opening between the cables and cover plate, as well as any additional openings should then be sealed with high temperature caulking compound.

- This step is not required if the vertical cables are secured in a row, not bundled, where they pass through the cover.

**CABLE HOLE CAPACITY:** Cable holes shall not be filled beyond 3/4 capacity to allow for firestop to operate effectively.

- Cable holes nearing or surpassing capacity will be brought to the attention of the Qwest representative responsible for Space Planning immediately.

**CABLE SLEEVE:** Cable hole sleeves shall use a high temperature caulking between the cable bundle and edge of the sleeve as well as any other openings.

**SLOTS AND HOLES FOR DISTRIBUTING FRAMES:** Cable holes and slots shall be upgraded to the approved intumescent and endothermic materials where practical.

- Occupied distributing and protector frame slots that have not been upgraded shall have the space between the stub cables or bundles and the slot filled with three to four inch thick mineral wool batting material to the full depth of the slot or 12 inches. Voids between the cables may be filled with high temperature caulk. No bottom cover is required. The top cover should be secured in place and the batting compressed from below, adding additional wool to assure a tight fit around the cables and to obtain the depth required.
- Slots beneath protector and distributing frames do not require steel top covers or require certification labels to allow for personnel access.
- Unoccupied cable slots may be closed using either of the methods described in the previous paragraphs for occupied cable slots.

**CABLE HOLES WITH WOOL BAGS:**

Occupied cable holes utilizing wool bag type firestop materials shall be upgraded to preferred materials when opened for a cabling addition or as soon as practical.

- All cable holes and slots that utilize mineral wool bags must be provided with steel cover plates on both sides of the enclosure.
- Unoccupied wall openings may use approved mineral wool bags in place of approved intumescent and endothermic materials; however, the wool bags must be replaced when the hole is activated.
- Secure the first cover to the ceiling or wall opening. Pack mineral wool bags tightly to the thickness of the wall or floor and install the second steel cover.

### **6A.8.3 Firestop Certification Labels**

Certification labels shall be provided across the edge of all cable hole covers to verify that the opening has been properly firestopped according to QWEST Policy. Label placement shall assure that the label will be destroyed when a cover is removed.

**PERMANENTLY CLOSED HOLES:**

- Certification labels shall be approximately 3 inches high by 6 inches long, pressure sensitive, predominantly red or with a red border. Printing shall be in obvious contrast to its background.
- Certification labels shall contain the following statement in bold lettering; "FIRESTOPPED CABLE HOLE NOTICE" followed by the statement "This cable hole has been firestopped in accordance with QWEST Communications, Inc. Technical Publication 77350". Labels shall also provide fields for the following entries:
  1. Order No.
  2. Vendor/Organization
  3. Date

**TEMPORARILY CLOSED HOLES:**

- A label, approximately 3 inches high by 6 inches long, pressure sensitive, predominantly green or with a green border shall identify the closure as part of an on going cabling operation.
- Label printing shall be in obvious contrast to its background.
- Certification labels shall contain, in bold lettering, the words "CABLE HOLE OPENED" and the statement "This hole is to be temporarily closed at the end of each working day or when no additional cable is to be run that same day and shall conform to QWEST Technical Publication 77350". Labels shall also provide fields for the following entries:
  1. Order No.
  2. Vendor/Organization
  3. Date

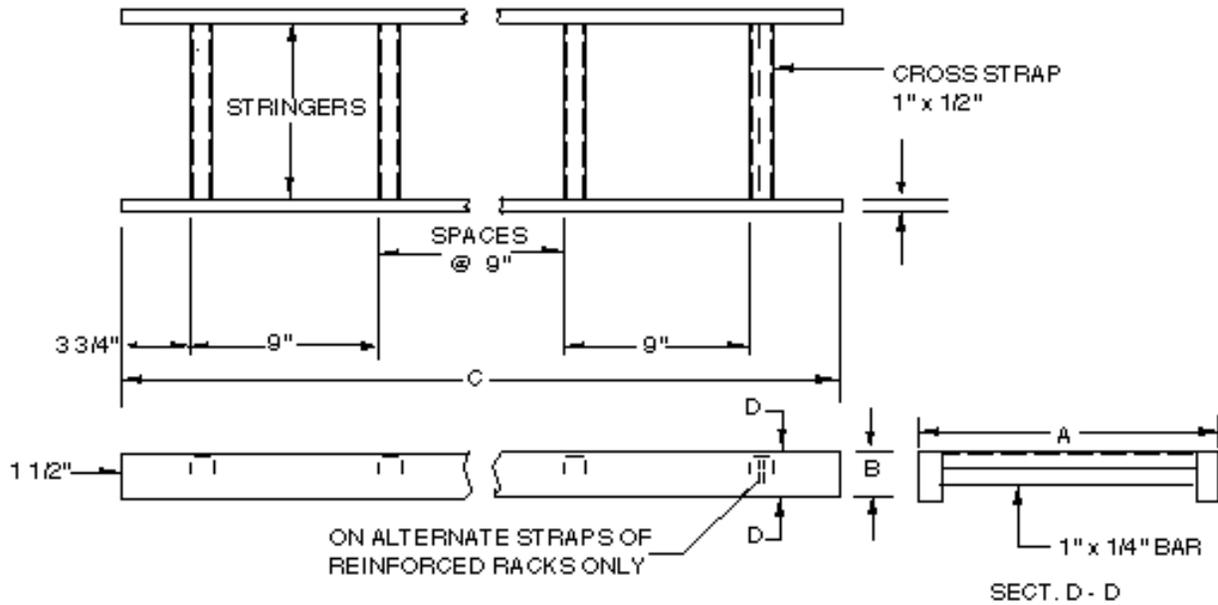


TABLE OF DIMENSIONS

STANDARD WIDTHS		SIZE OF STRINGER	
DIM. A	DIM. B	DIM. B	DIM. C
5"	1 1/2"	1 1/2"	9'- 8 1/2"
10"	1 1/2"	1 1/2"	9'- 8 1/2"
1'- 0"	1 1/2"	1 1/2"	9'- 8 1/2"
1'- 0"	1 1/2"	1 1/2"	4'- 5 1/2"
1'- 3"	2"	2"	9'- 8 1/2"
1'- 3"	2"	2"	4'- 5 1/2"
1'- 8"	2"	2"	9'- 8 1/2"
1'- 8"	2"	2"	4'- 5 1/2"
2'- 1" * REINFORCED	2"	2"	9'- 8 1/2"
2'- 6" * REINFORCED	2"	2"	9'- 8 1/2"

NOTE:

CABLE RACK IS REINFORCED WITH THE 1 x 1/4" BARS ON ALTERNATE CROSS STRAPS, SEE SECTION D-D.

EXHIBIT 2-E1-1  
 STRAIGHT SECTIONS LADDER-TYPE CABLE RACK

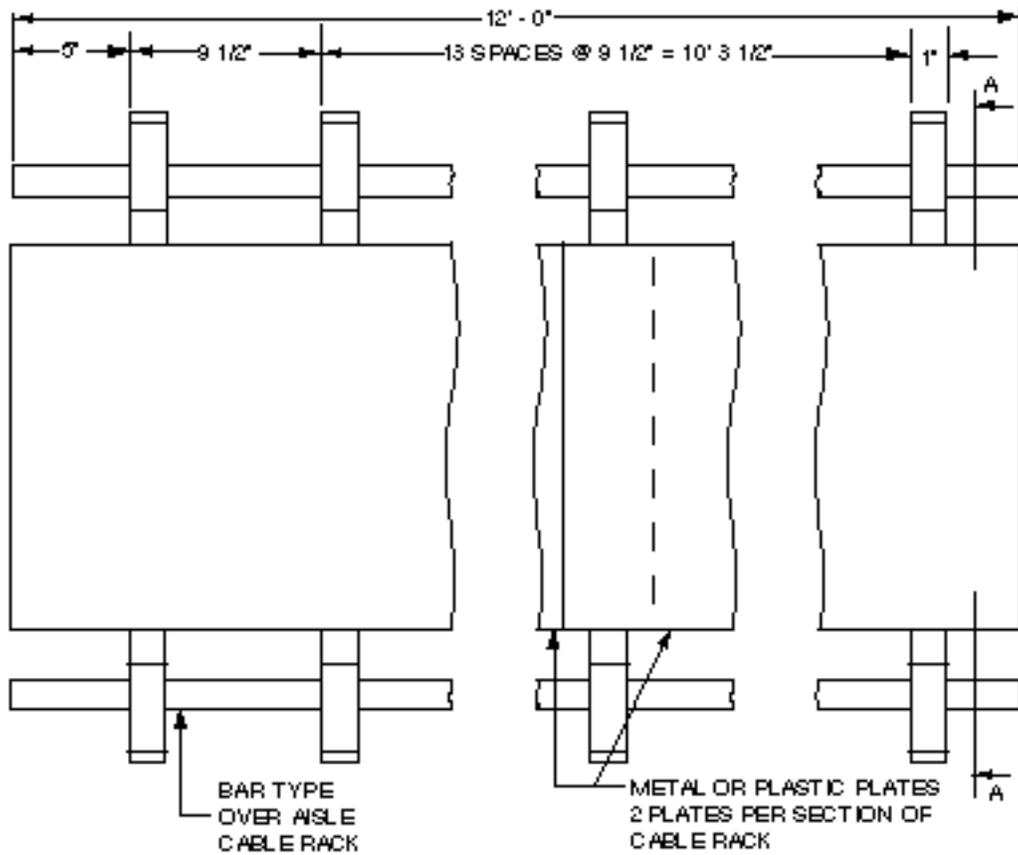
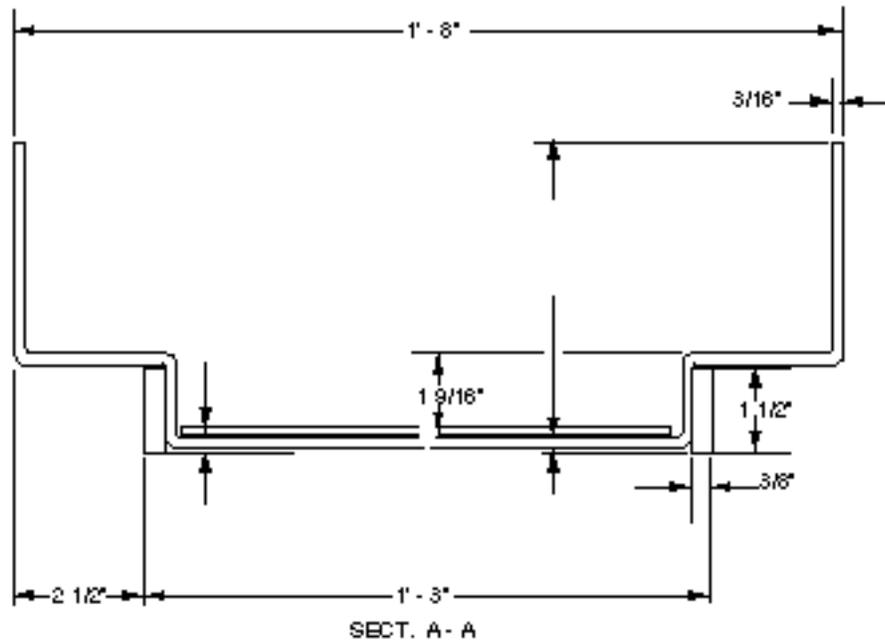
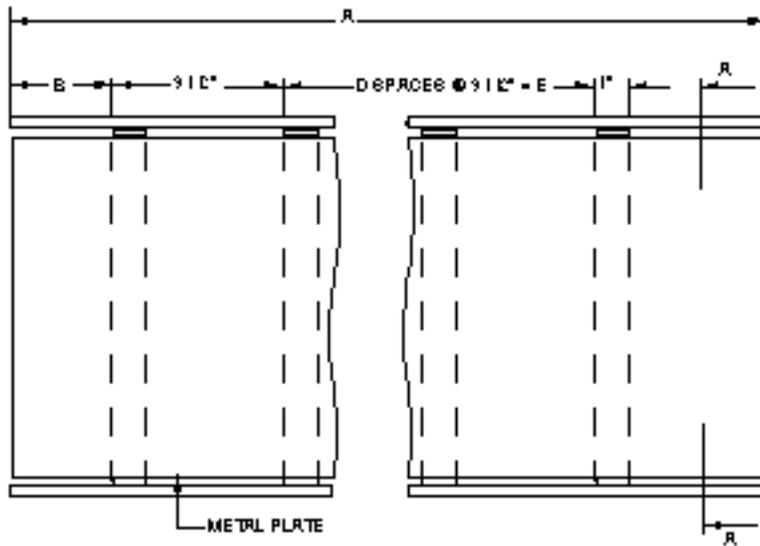
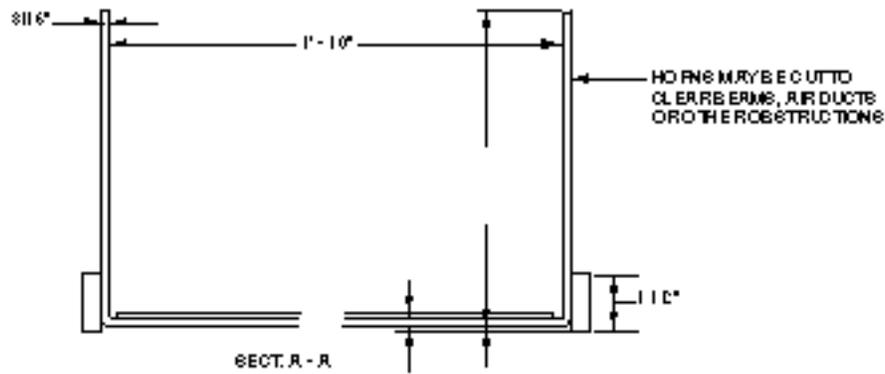


EXHIBIT 2-E1-1D (A&M)  
STRAIGHT SECTIONS BAR-TYPE OVER-AISLE CABLE RACK



DIMENSIONS				WIRING RACK C TO C	NOTE
A	B	D	E		
5'-4 7/8"	8 7/16"	5	8'-11 1/2"	8'-8"	1
4'-10 7/8"	5 8/16"	4	8'-2"	8'-2"	
4'-8 8/16"	4 1/8"			8'-0"	
4'-11 8/16"	5 5/8"			8'-8"	
4'-5 8/16"	2 5/8"			8'-2"	
4'-8 8/16"	1 5/8"		8'-0"	2	
1'-5 1/8"	8 5/16"	0	0"	8'-2"	3
2'-8 7/8"	8 15/16"	1	9 1/2"		
12'-0"	5"	18	10'-8 1/2"		4

NOTES:

- CROSS-AISLE CABLE RACK AT THE SAME LEVEL AS THE BAR-TYPE OVER-AISLE CABLE RACK.
- CROSS-AISLE CABLE RACK 2" ABOVE THE BAR-TYPE OVER-AISLE CABLE RACK.
- CROSS-AISLE CABLE RACK 2" ABOVE THE BAR-TYPE OVER-FRAME CABLE RACK-BULB ANGLE FRAMES-10 INCH GUARDRAILS.
- CUT TO FIT WHERE LINES OF FRAMES ARE OMITTED OR WHERE PRECUT LENGTHS ARE NOT FURNISHED. THE USE OF THIS RACK FOR OTHER THAN CROSS-AISLE APPLICATION IS PROHIBITED.

EXHIBIT 2-E1-1E (A&M)  
STRAIGHT SECTIONS BAR-TYPE CROSS-AISLE CABLE RACKS

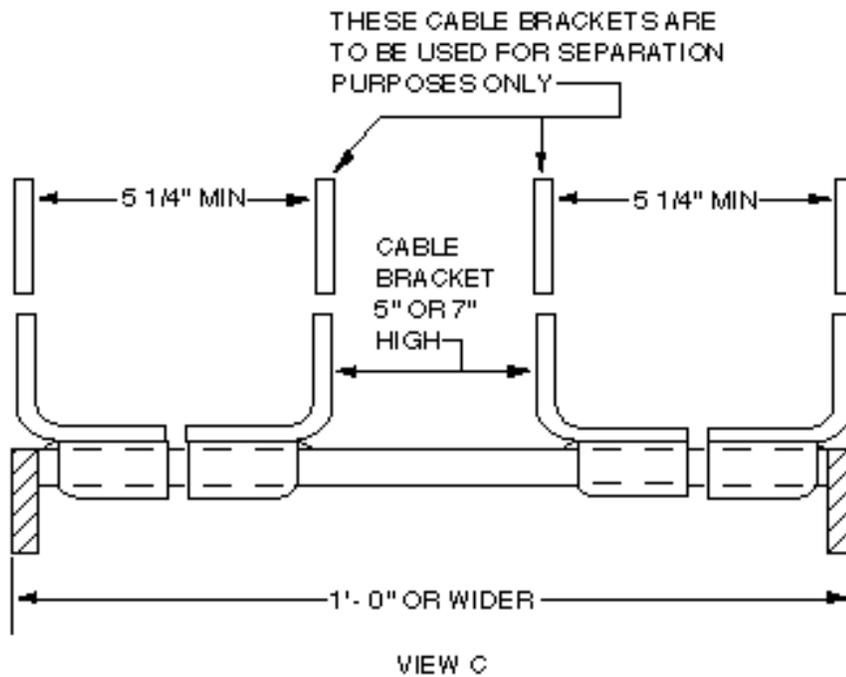
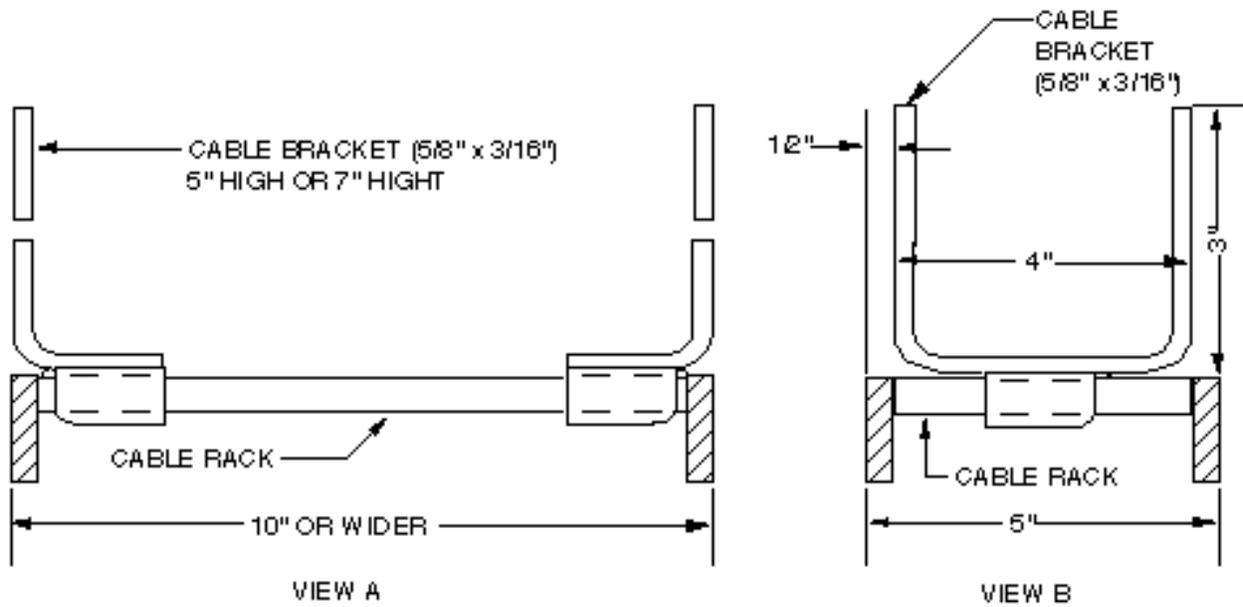


EXHIBIT 2-E1-1F (A&M)  
MOUNTING SNAP-ON CABLE BRACKETS ON LADDER-TYPE CABLE RACKS

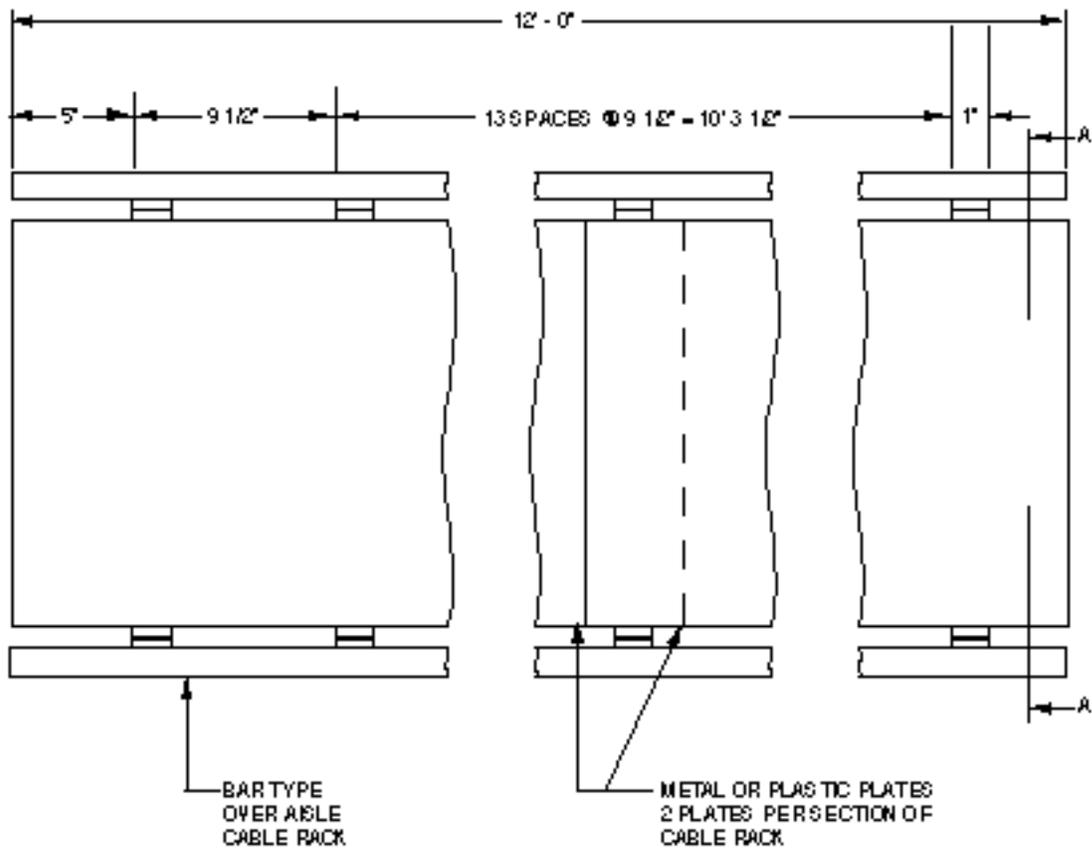
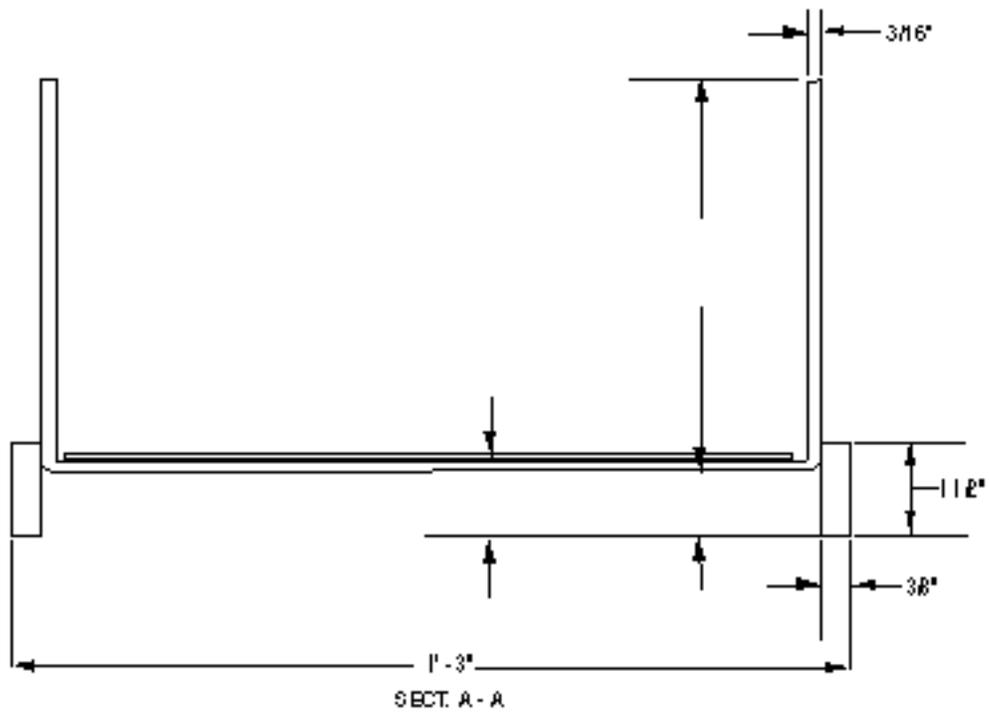
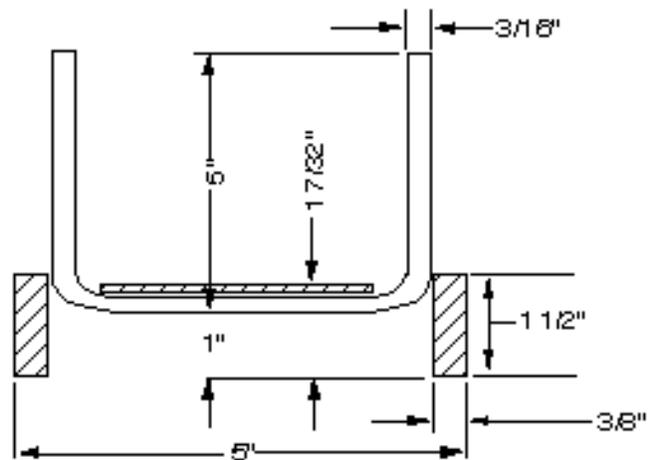


EXHIBIT 2-E1-1G (A&M)  
 STRAIGHT SECTIONS BAR-TYPE OVER-FRAME CABLE RACK



SECT A - A

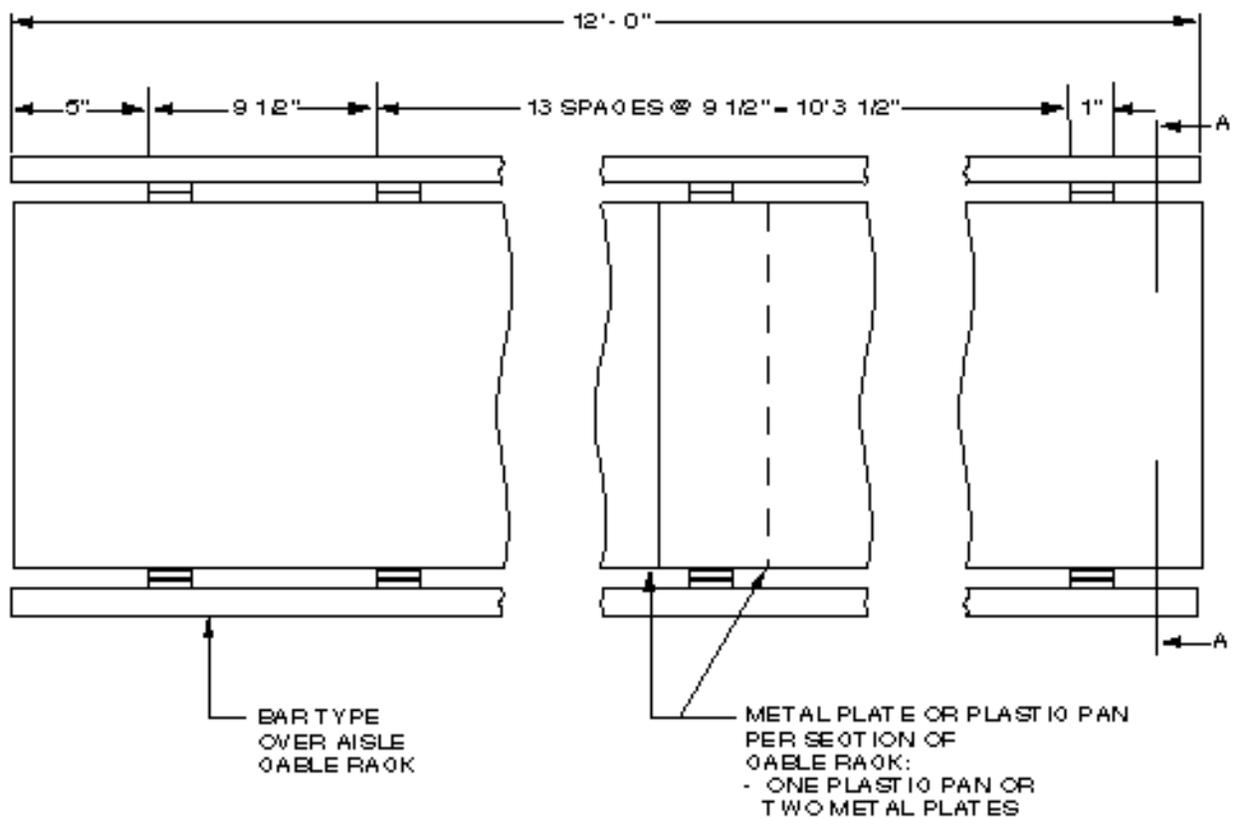


EXHIBIT 2-E1-1H (A&M)  
 STRAIGHT SECTIONS BAR-TYPE CABLE RACK

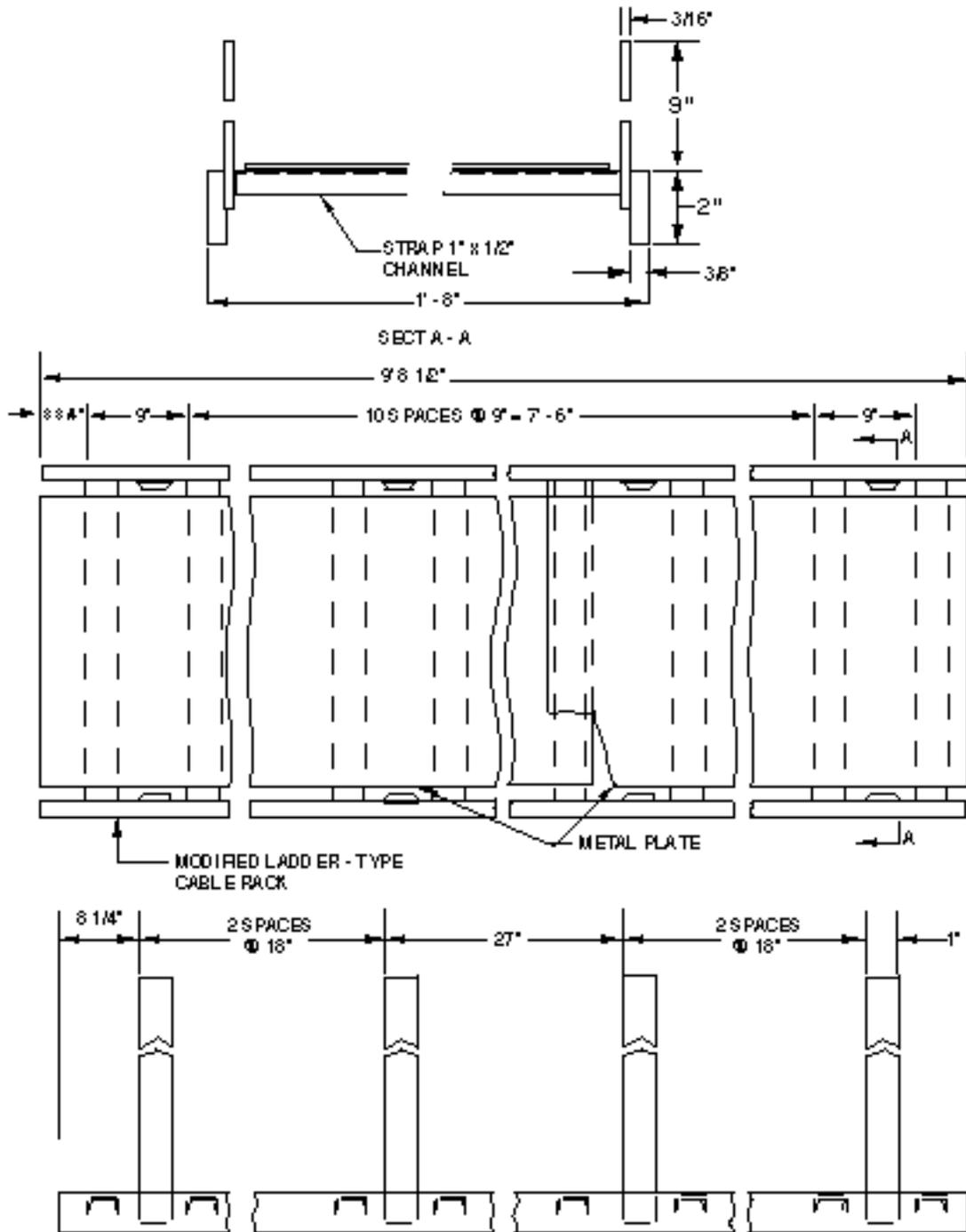


EXHIBIT 2-E1-1J  
STRAIGHT SECTIONS MODIFIED LADDER-TYPE CABLE RACK  
FOR UNSECURED CABLING

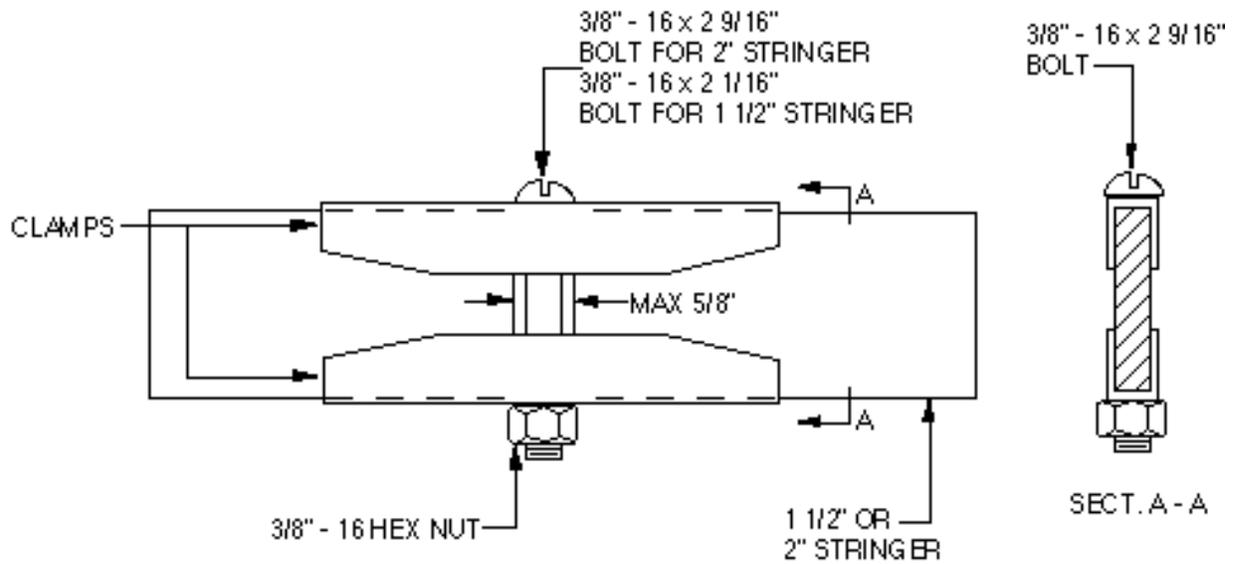


EXHIBIT 2-E1-2  
STRAIGHT CLAMP FOR STRINGER OF SAME WIDTH

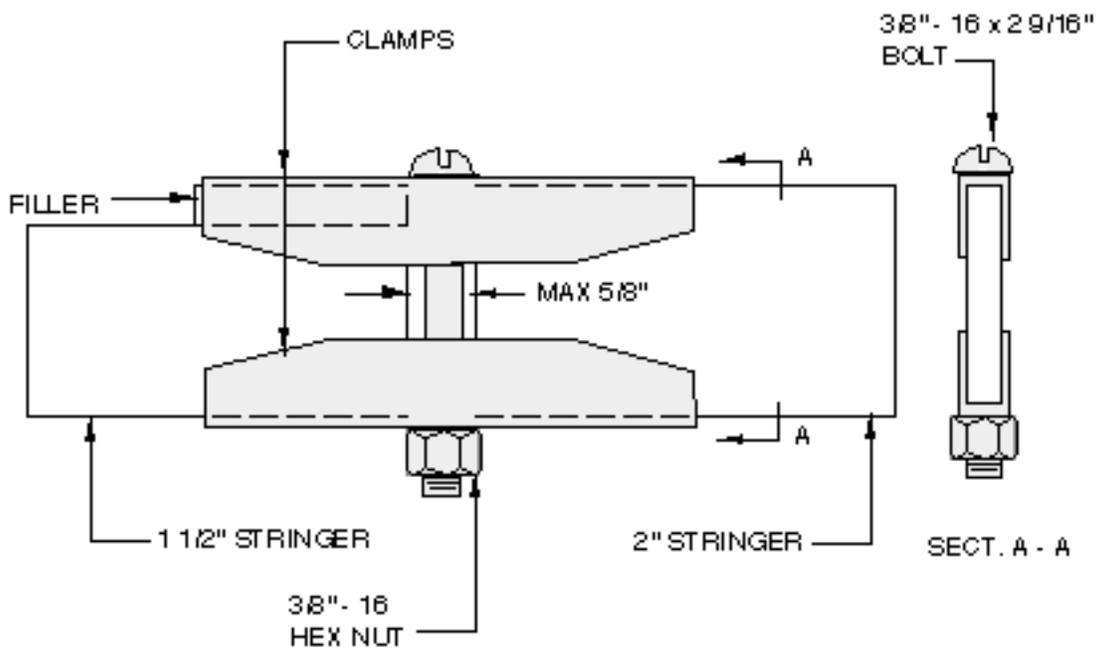


EXHIBIT 2-E1-3  
STRAIGHT CLAMP FOR STRINGERS OF DIFFERENT WIDTHS

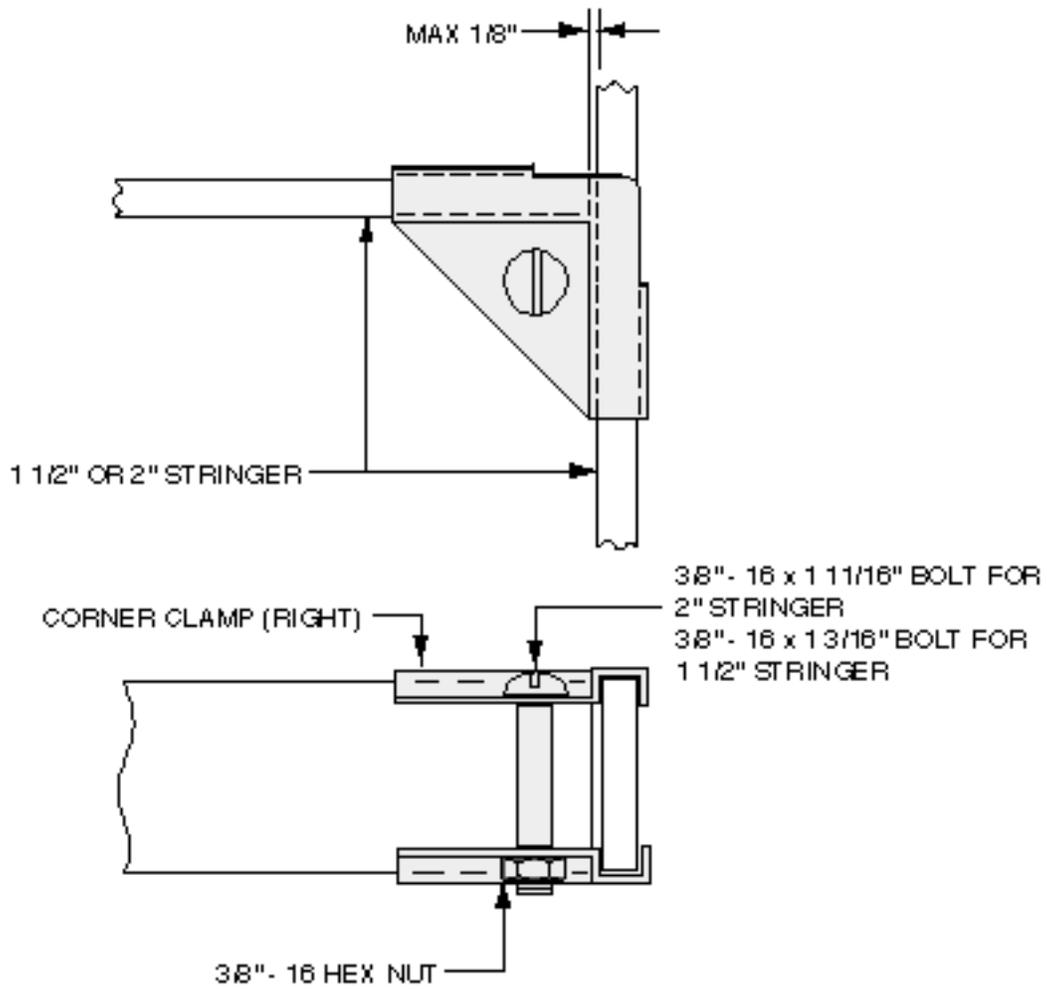


EXHIBIT 2-E1-4  
CORNER CLAMP FOR STRINGER OF SAME WIDTH

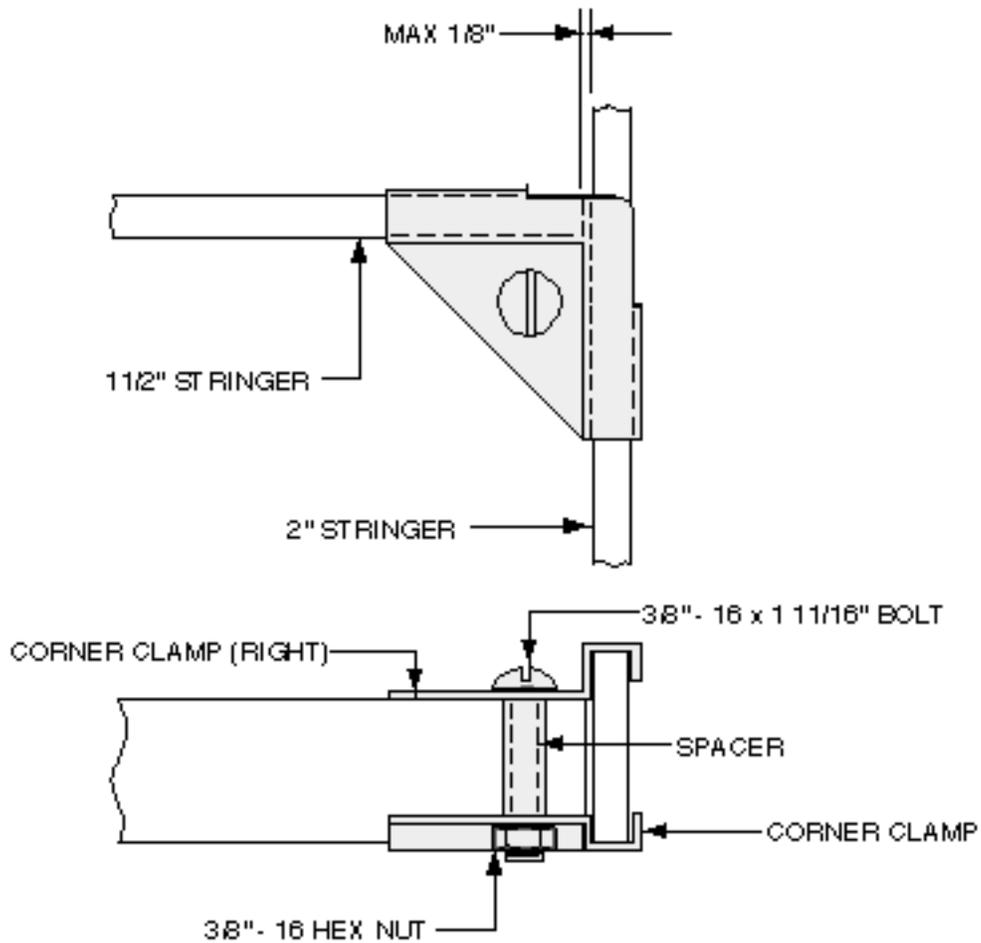


EXHIBIT 2-E1-5  
CORNER CLAMP FOR STRINGERS OF DIFFERENT WIDTHS-LEFT

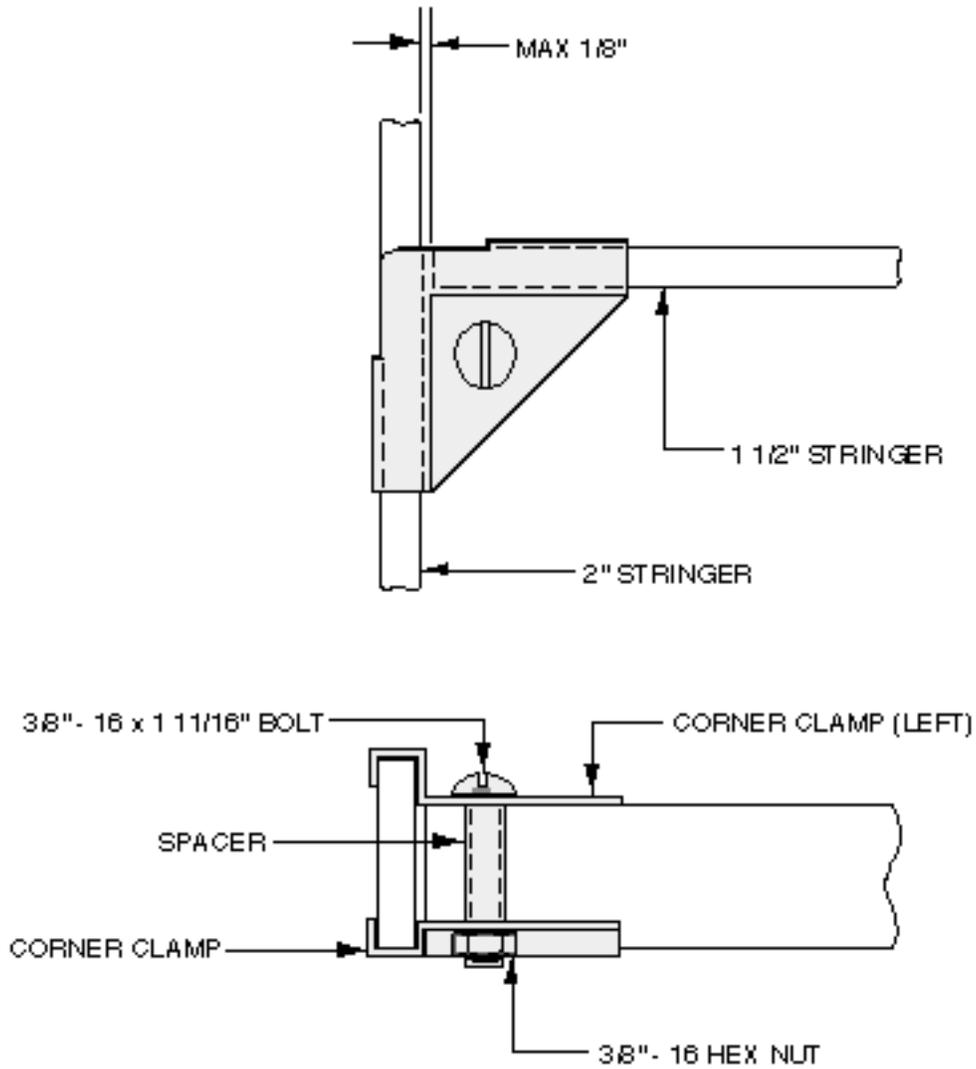


EXHIBIT 2-E1-6  
CORNER CLAMP FOR STRINGERS OF DIFFERENT WIDTHS-RIGHT

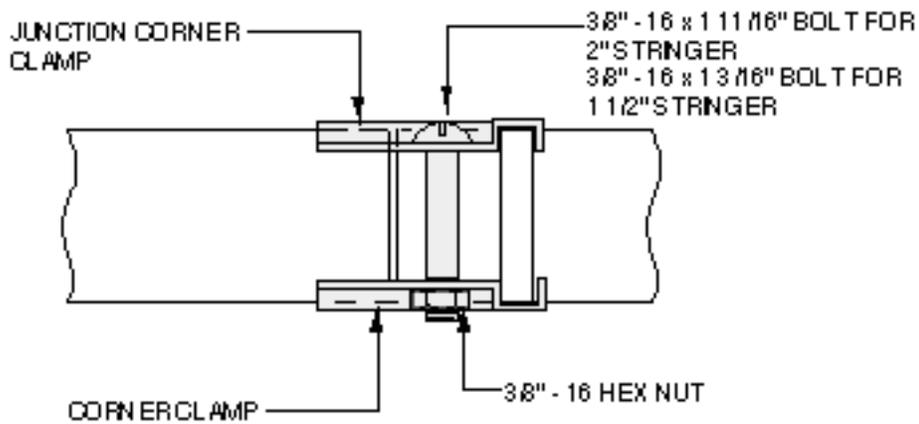
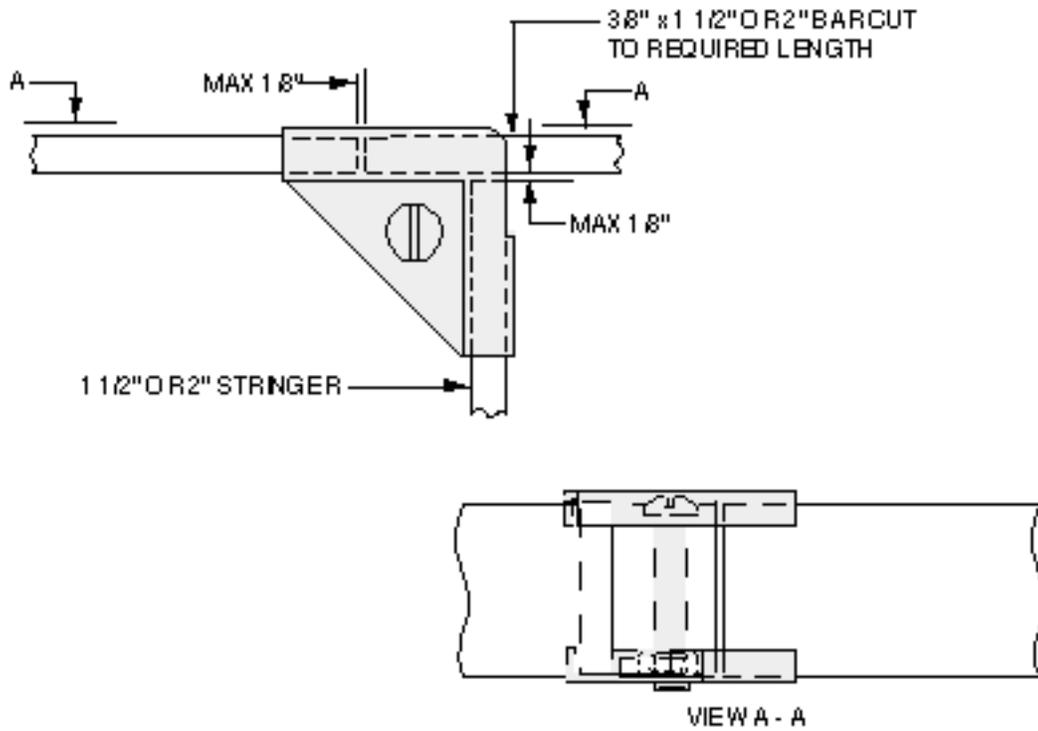


EXHIBIT2-E1-7  
JUNCTION CORNER CLAMP FOR STRINGERS OF SAME WIDTH-LEFT

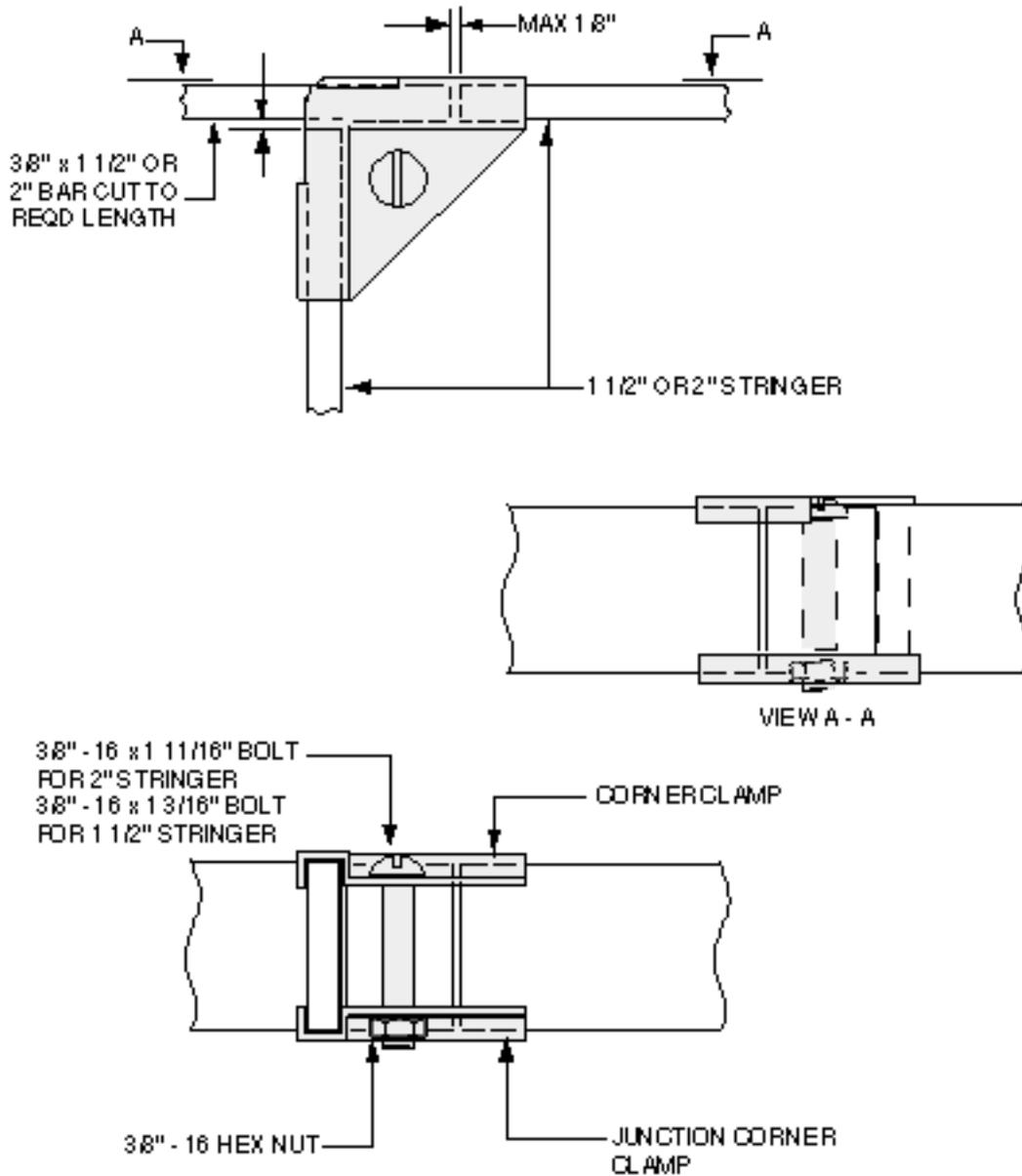


EXHIBIT 2-E1-8  
JUNCTION CORNER CLAMP FOR STRINGERS OF SAME WIDTH-RIGHT

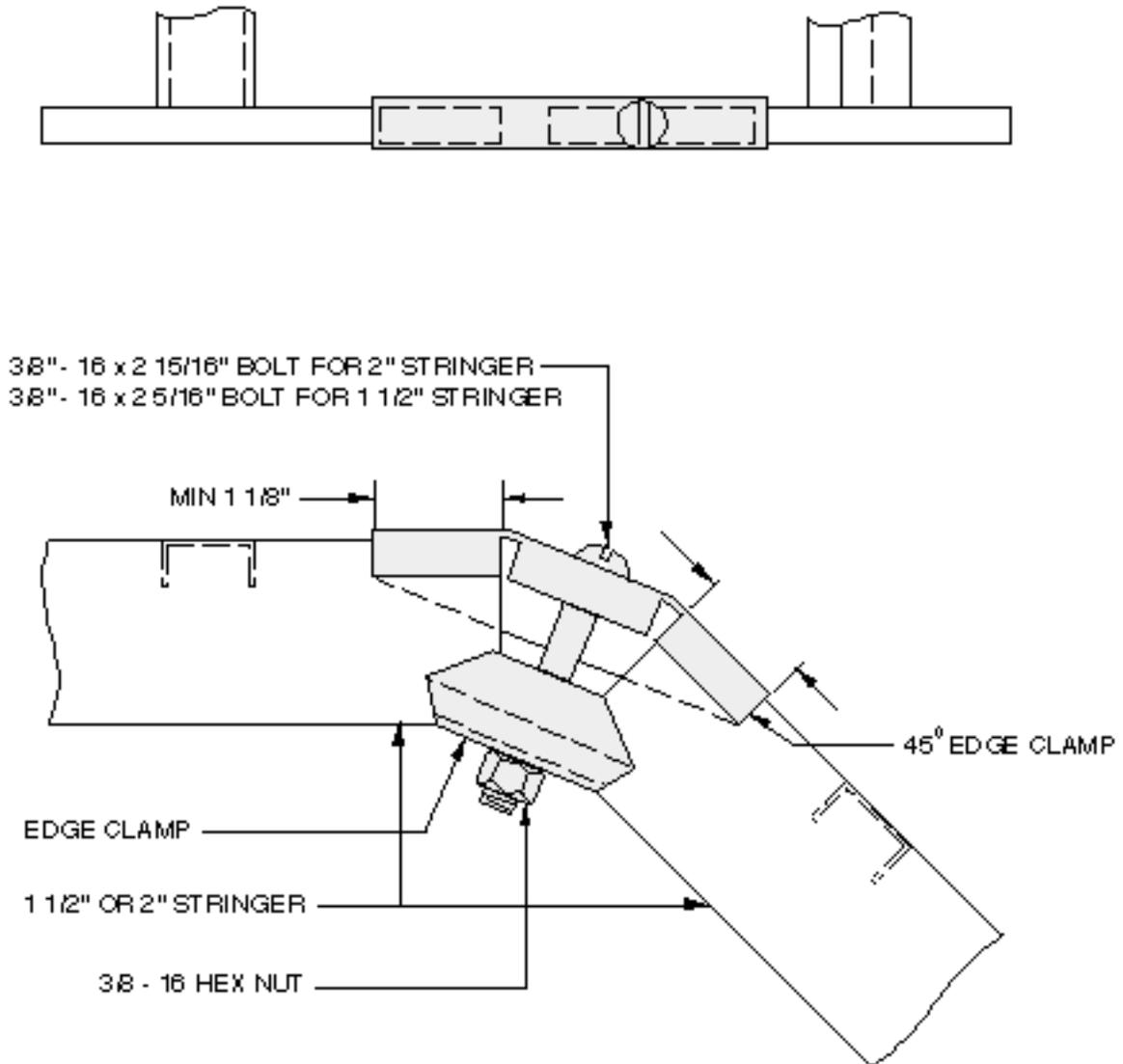


EXHIBIT 2-E1-9  
45 DEGREE EDGE CLAMP FOR OUTSIDE TURN

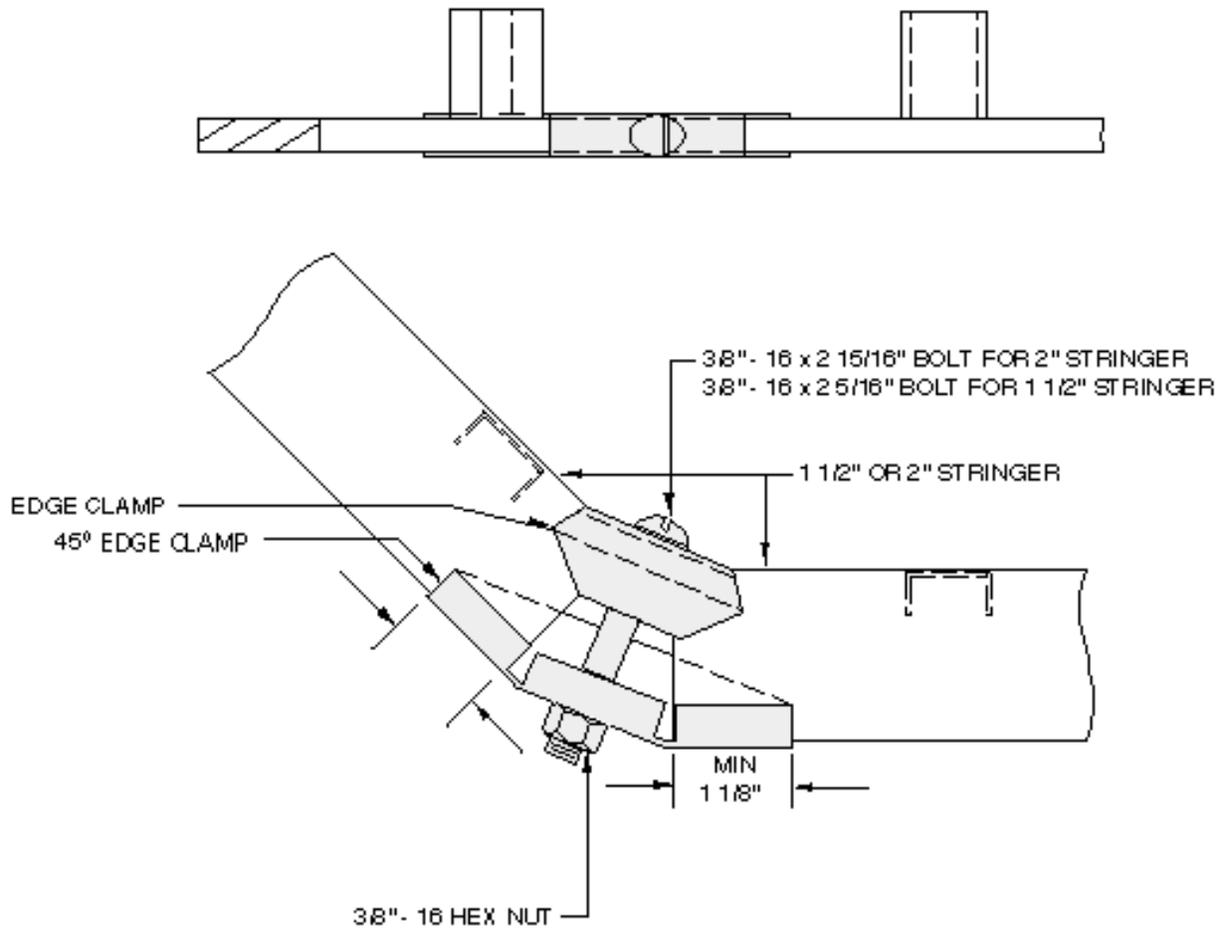


EXHIBIT 2-E1-10  
45 DEGREE EDGE CLAMP FOR INSIDE TURN

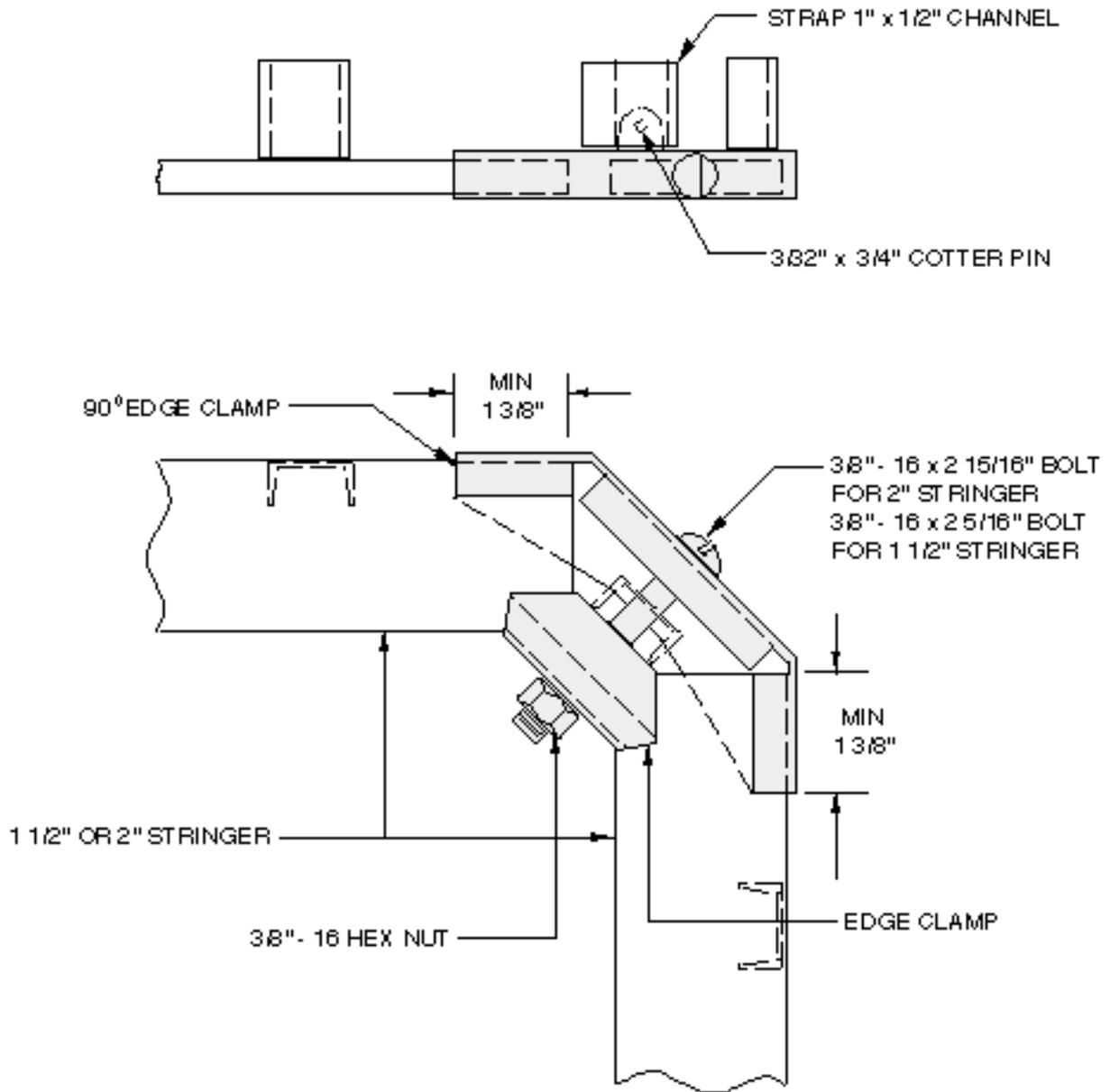


EXHIBIT 2-E1-11  
90 DEGREE EDGE CLAMP FOR OUTSIDE TURN

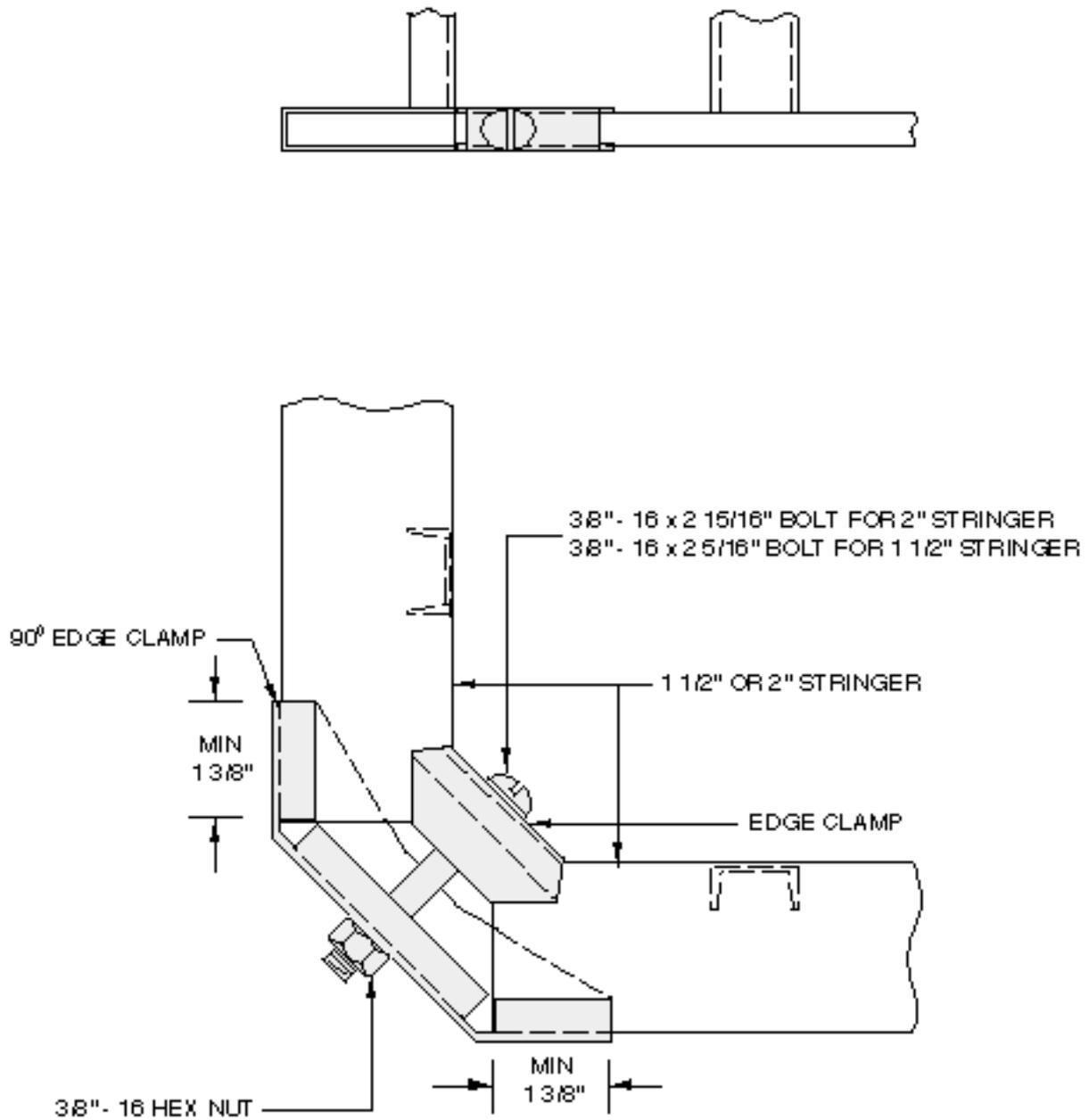
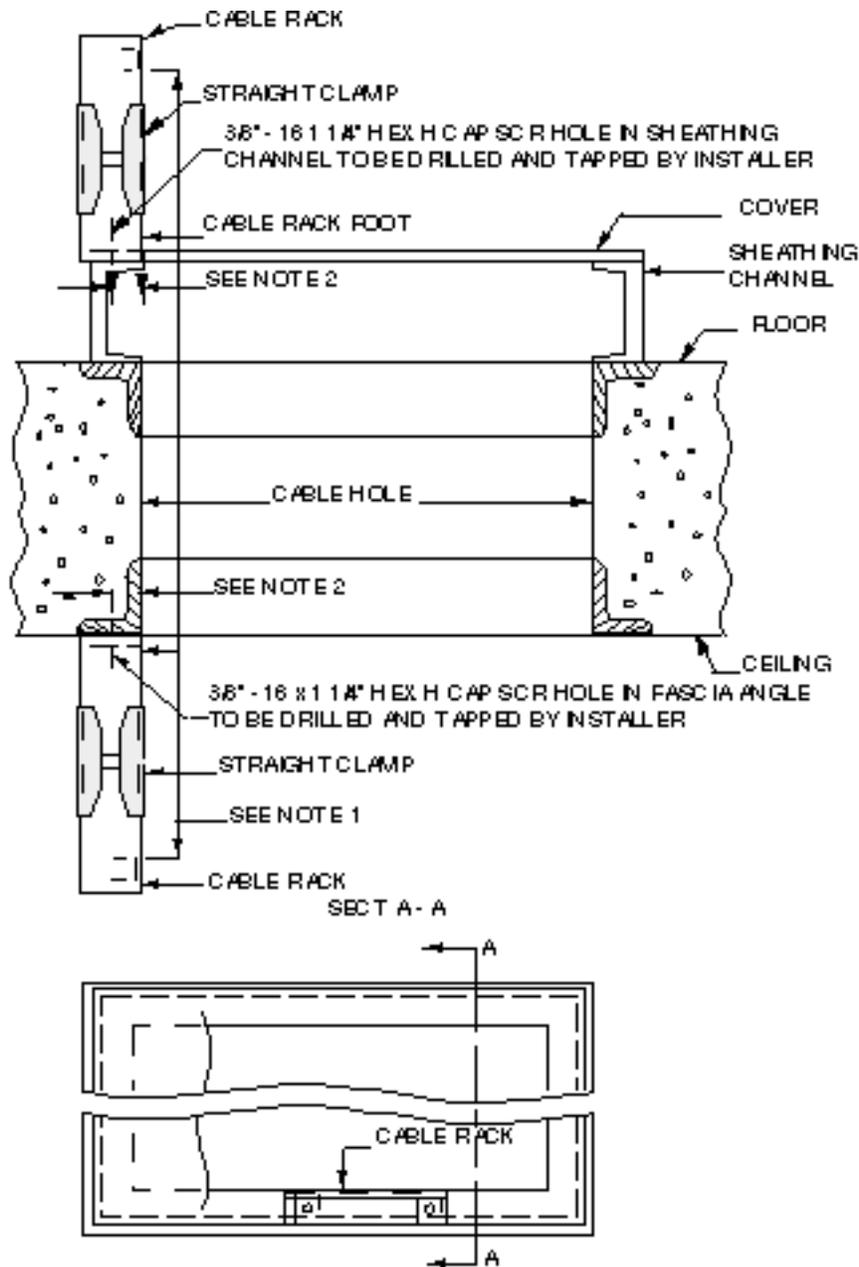


EXHIBIT 2-E1-12  
90 DEGREE EDGE CLAMP FOR INSIDE TURN

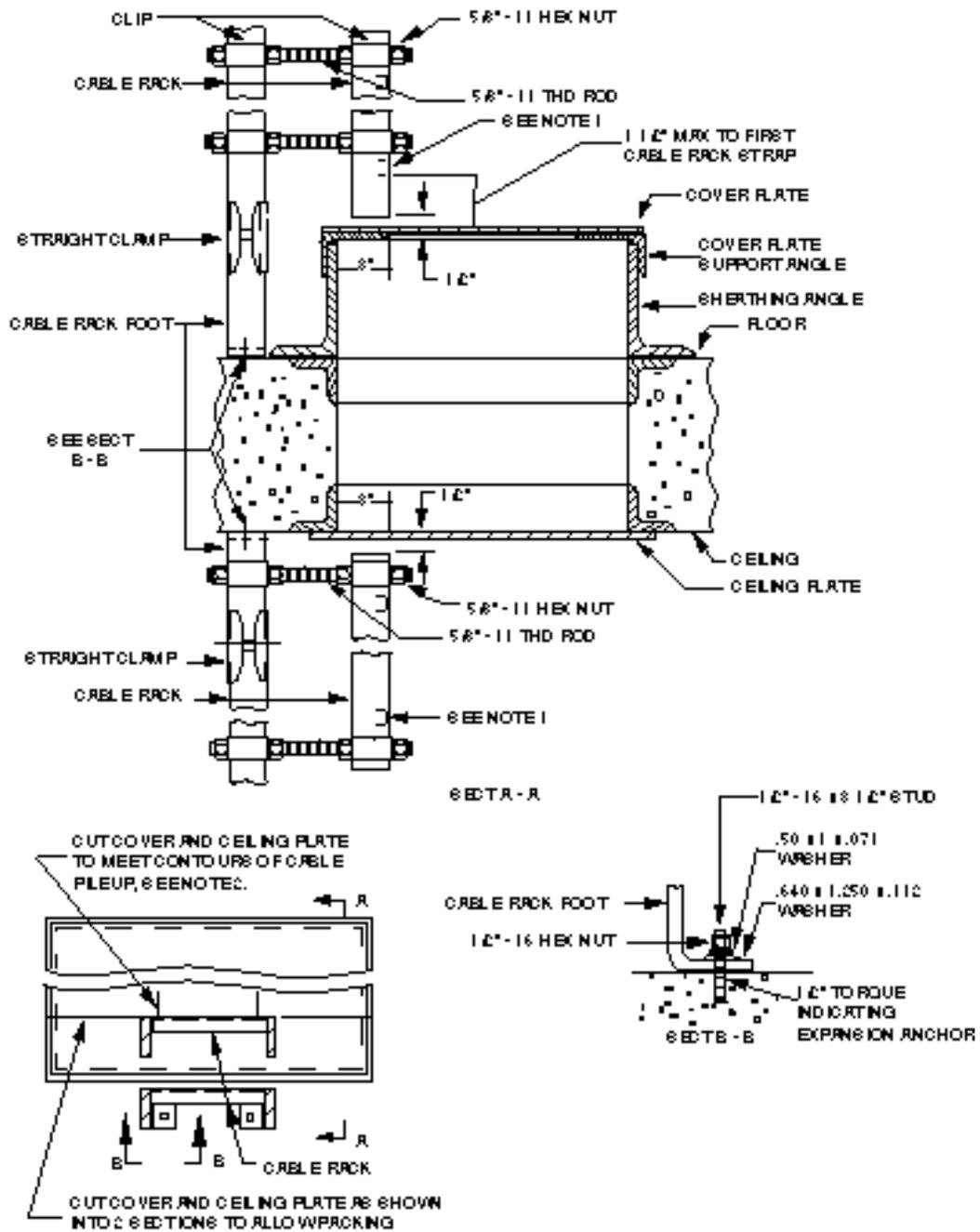




NOTES:

1. WHEN THE DISTANCE BETWEEN THE FIRST AND LAST SUPPORTS FOR THE CABLES EXCEEDS THE ALLOWABLE 4'-0" MAXIMUM, THE INSTALLER SHALL CUT OFF PART OF THE CABLE RACK FEET OR THE ENDS OF THE CABLE RACK AS REQUIRED.
2. CABLE RACK FOOT SHALL BE FLUSH WITH INNER EDGE OF SHEATHING CHANNEL AT THE FLOOR AND FASCIA ANGLE AT THE CEILING.

EXHIBIT 2-E1-13A  
 TERMINATING VERTICAL CABLE RACK AT CABLE HOLE  
 CHANNEL-TYPE SHEATHING



NOTE:

1. SHORT SECTIONS OF CABLE RACK SHALL HAVE AT LEAST TWO STRAPS FOR CABLE SUPPORT. STRAPS SHALL BE PROVIDED WITH GRAY SHEET FIBER FOR PROTECTION

EXHIBIT 2-E1-13B  
 TERMINATING VERTICAL CABLE RACK AT CABLE HOLE. ANGLE-TYPE SHEATHING - ADDITIONS ONLY.

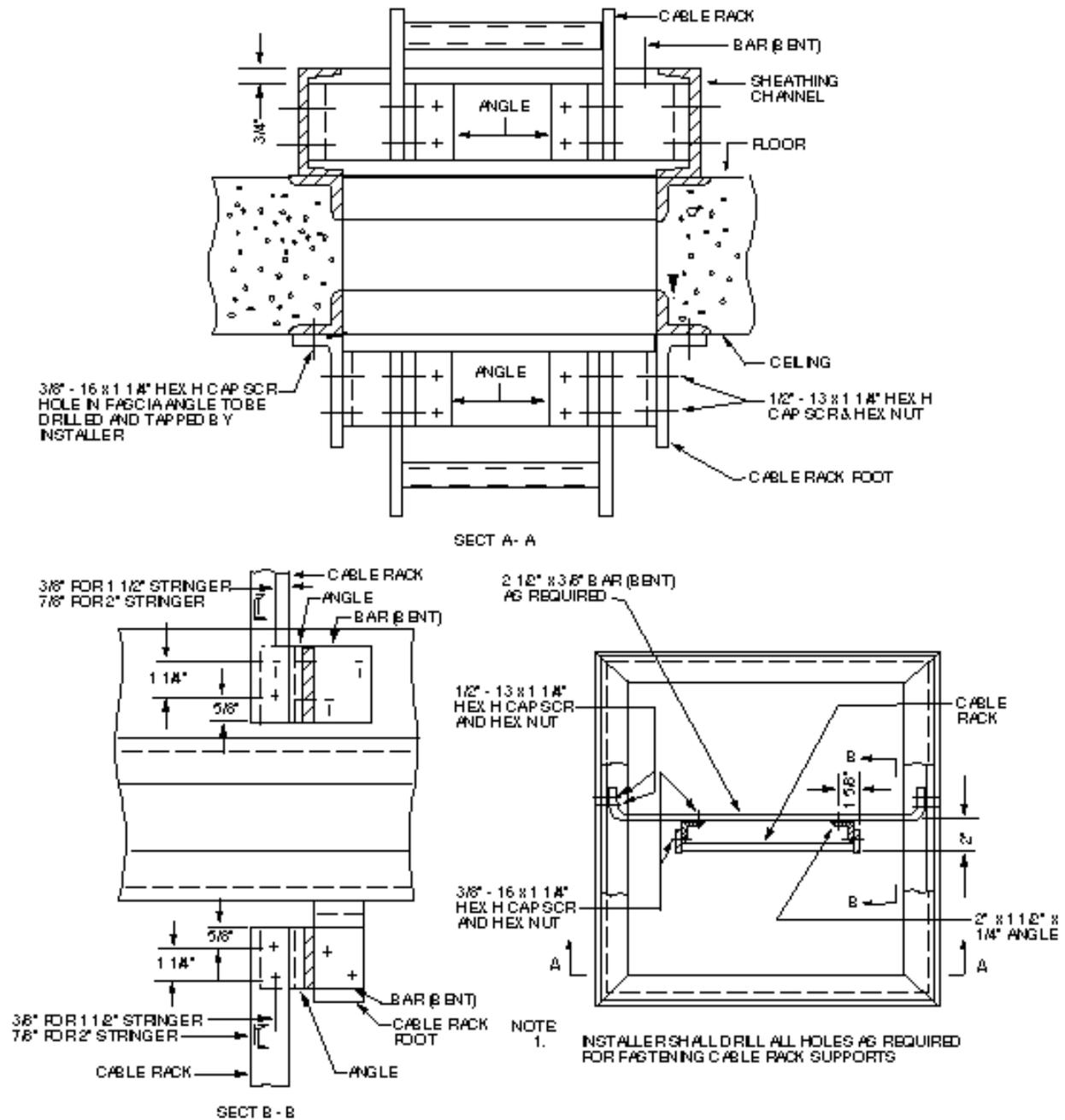
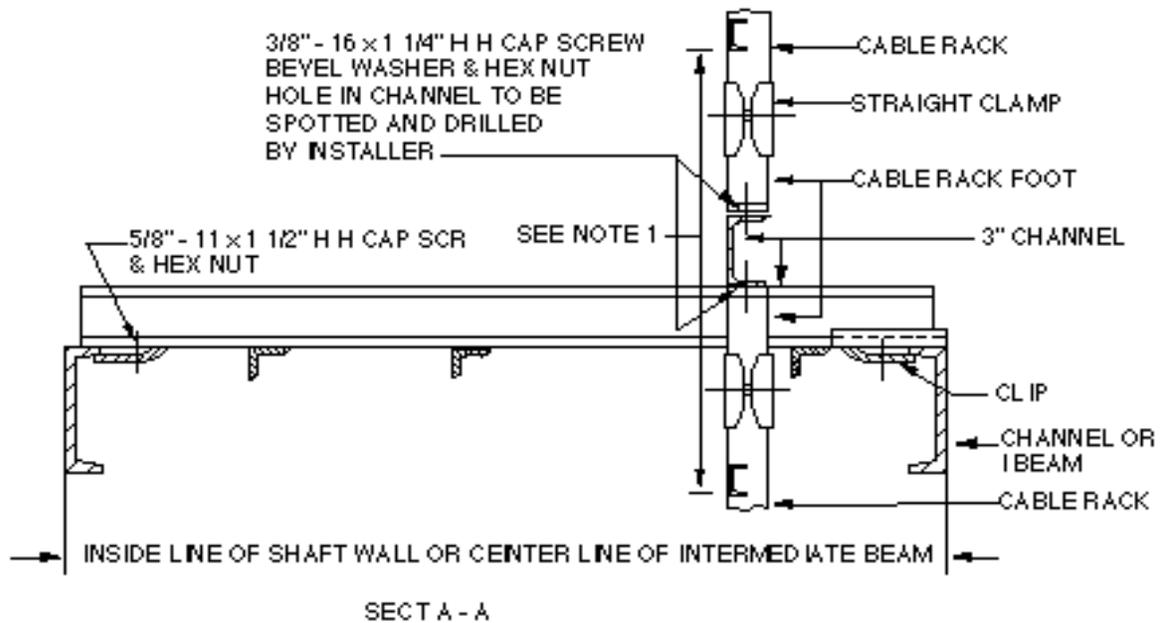
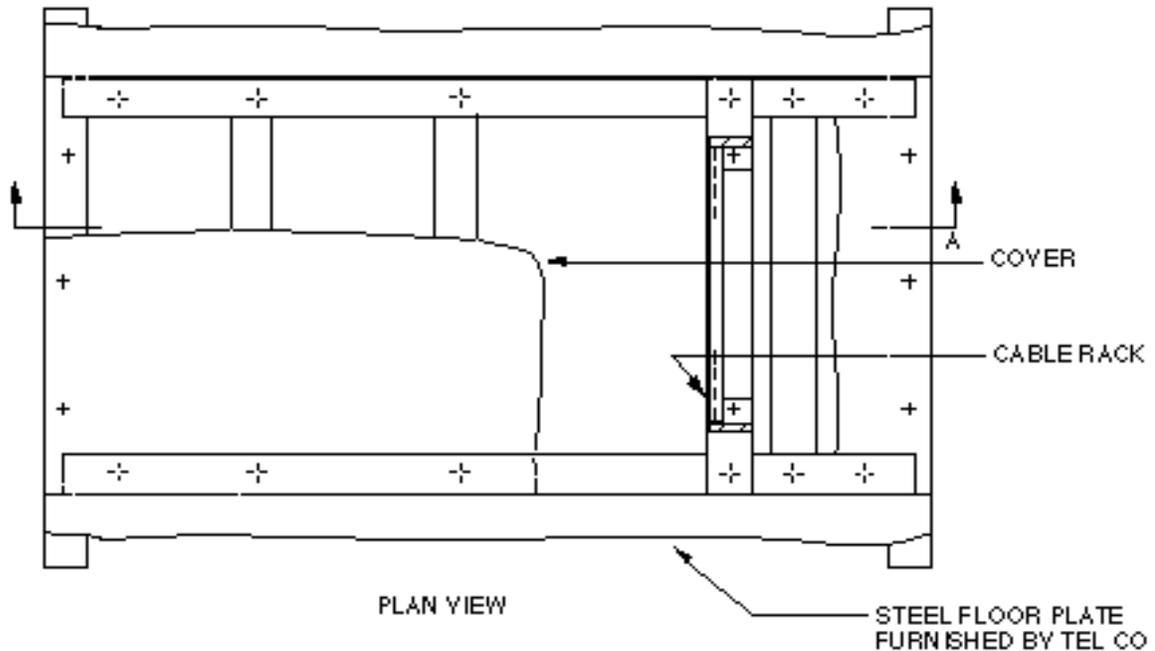


EXHIBIT 2-E1-13C  
 TYPICAL SUPPORT OF CABLE RACK UNDER SWITCHBOARD OR DESK  
 CABLE TURNING SECTION.



NOTE:

1. WHEN THE DISTANCE BETWEEN THE FIRST AND LAST SUPPORTS FOR THE CABLES EXCEEDS THE ALLOWABLE 4'-0" MAX., THE INSTALLER SHALL CUT OFF PART OF THE CABLE RACK FEET OR THE ENDS OF THE CABLE RACK AS REQUIRED.

EXHIBIT 2-E1-13D  
 TYPICAL SUPPORT OF CABLE RACK IN CABLE SHAFT

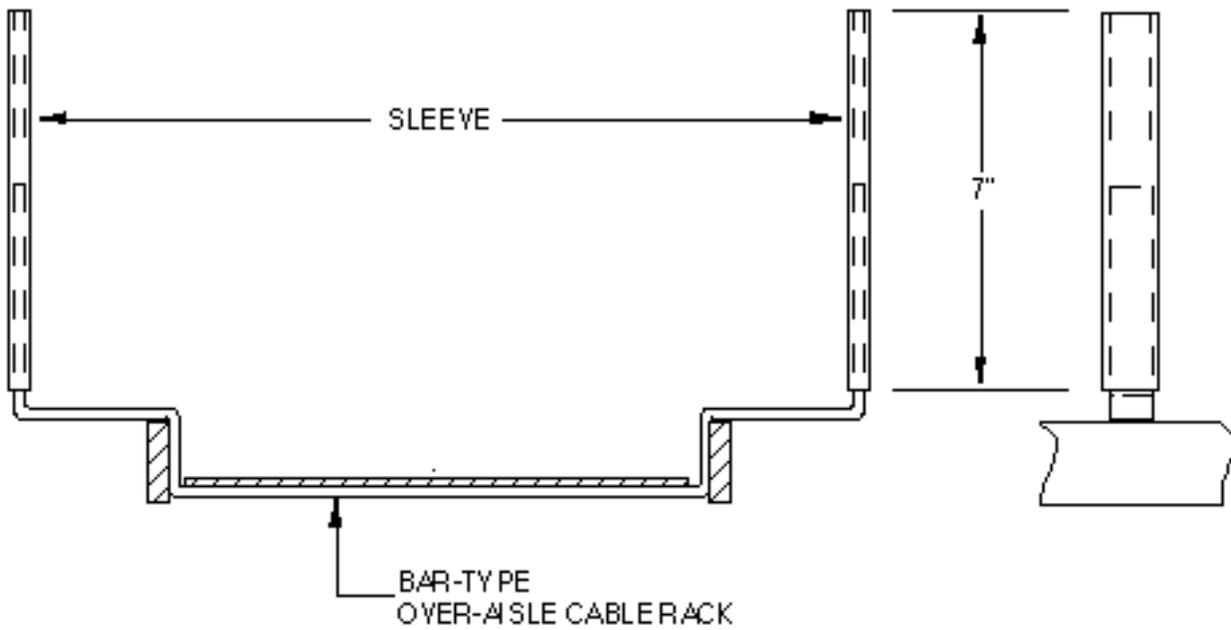
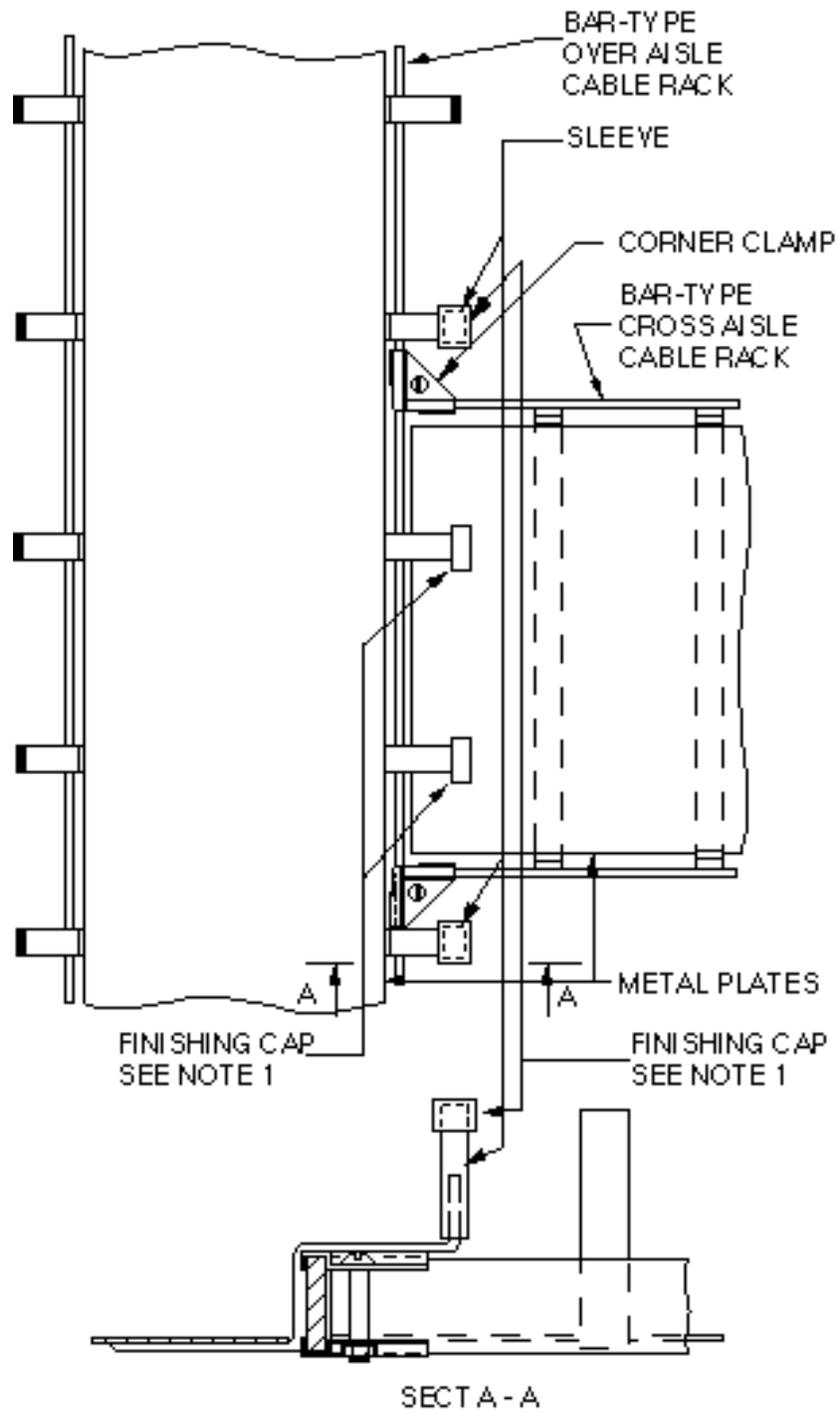


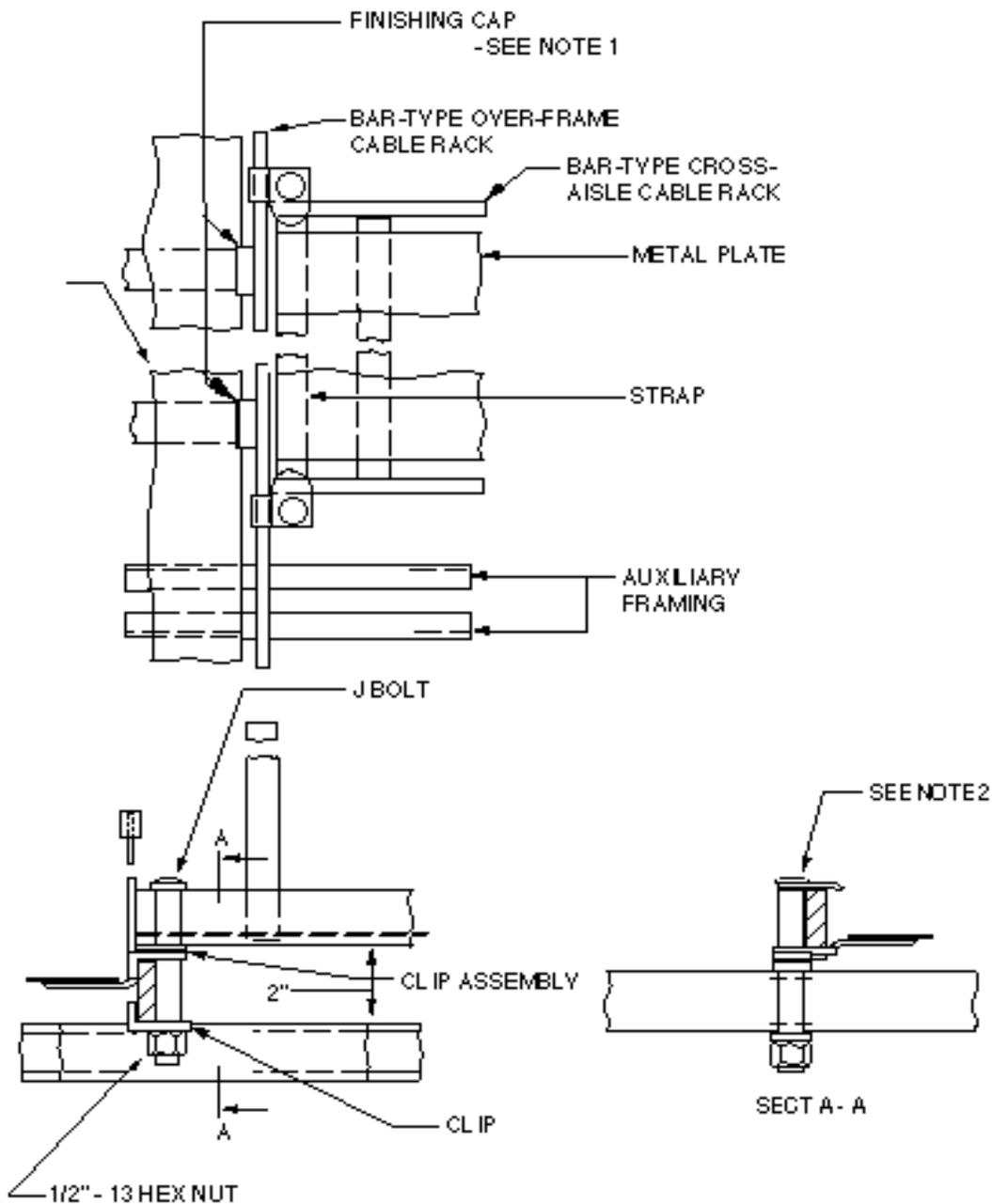
EXHIBIT 2-E1-16A (A&M)  
EXTENSIONS FOR BAR-TYPE OVER-AISLE CABLE RACK



NOTE:

1. FINISHING CAPS SHALL BE SECURED TO THE CABLE RACK HORNS BY COATING THE INSIDE OR THE CAPS WITH ADHESIVE.

EXHIBIT 2-E1-17C (A&M)  
T-INTERSECTION BAR-TYPE OVER-AISLE TO BAR-TYPE CROSS-AISLE  
CABLE RACK SAME LEVEL

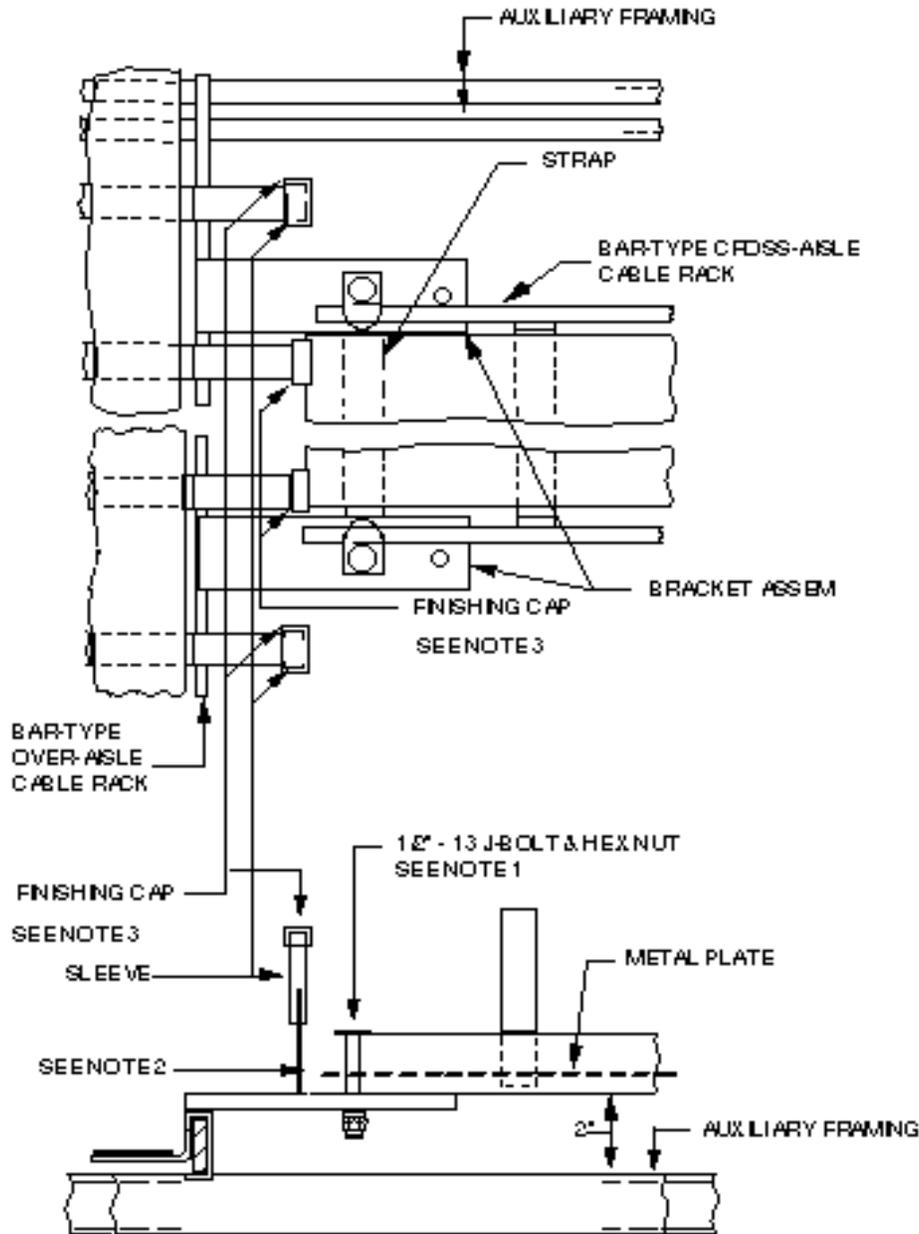


NOTES:

1. FINISHING CAP SHALL BE SECURED TO THE CABLE RACK HORNS BY COATING THE INSIDE OF THE CAP WITH ADHESIVE PRIOR TO PLACING ON THE HORN.
2. PVC PROTECTION SHALL BE PROVIDED ON THE ENDS OF CROSS-AISLE CABLE RACK STRINGERS.

EXHIBIT 2-E1-17H (A&M)

T-INTERSECTION BAR-TYPE OVER-FRAME TO BAR-TYPE CROSS-AISLE CABLE RACK CROSS-AISLE CABLE RACK RAISED 2 INCHES TO CLEAR CONDUIT AND LIGHTING FIXTURES

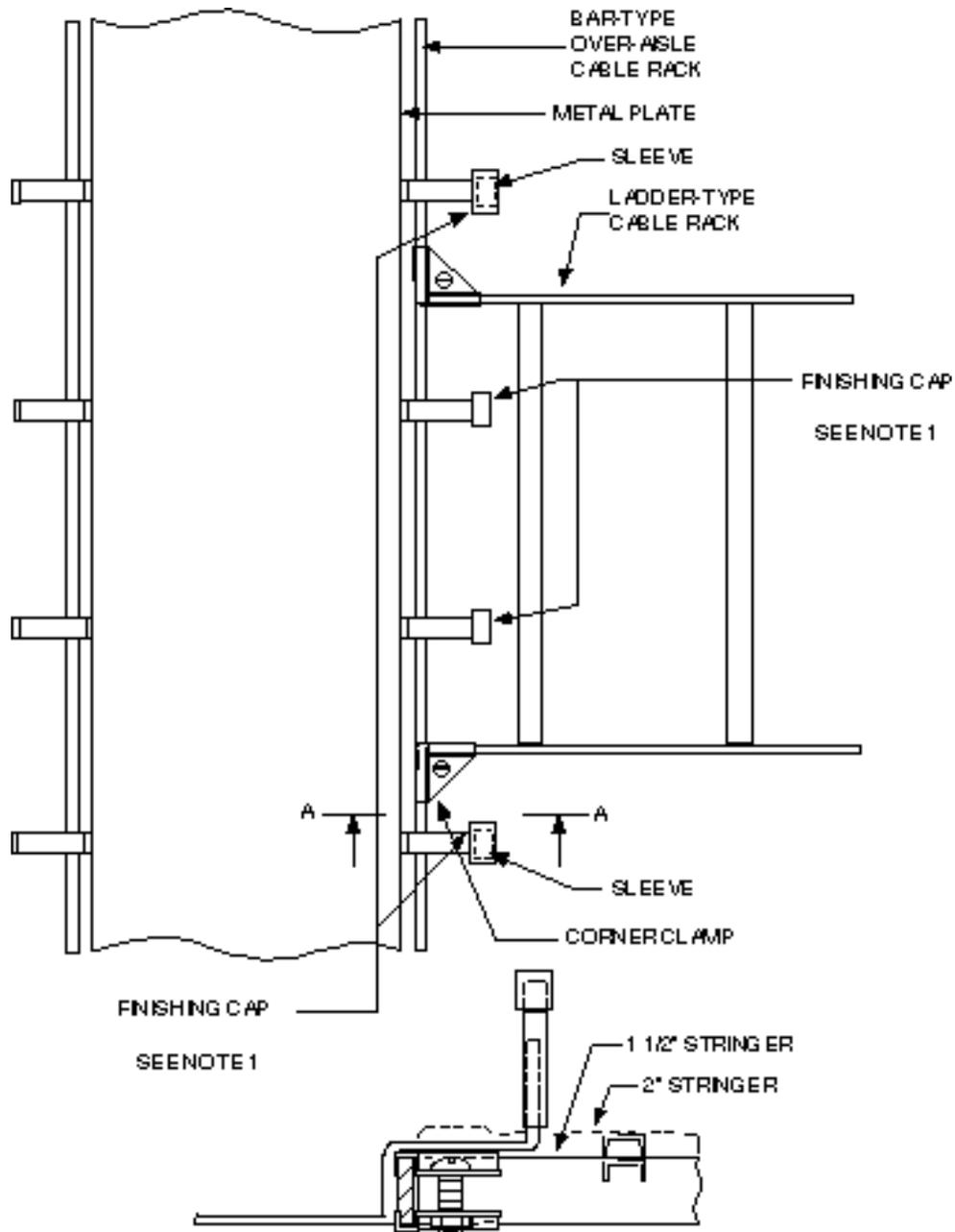


NOTES:

1. ONLY ONE J-BOLT PER ADAPTER IS REQUIRED. WHEN A CROSS STRAP PREVENTS J-BOLT FROM BEING USED IN THE HOLE SHOWN, USE THE OTHER HOLE OF THE ADAPTER.
2. PVC PROTECTION SHALL BE PROVIDED ON THE ENDS OF CROSS-AISLE CABLE RACK STRINGERS.
3. FINISHING CAPS SHALL BE SECURED TO THE CABLE RACK HORNS (WITHIN THE T-INTERSECTION) AND THE SLEEVES, RESPECTIVELY, BY COATING THE INSIDE OF THE CAPS WITH ADHESIVE.

EXHIBIT 2-E1-17J (A&M)

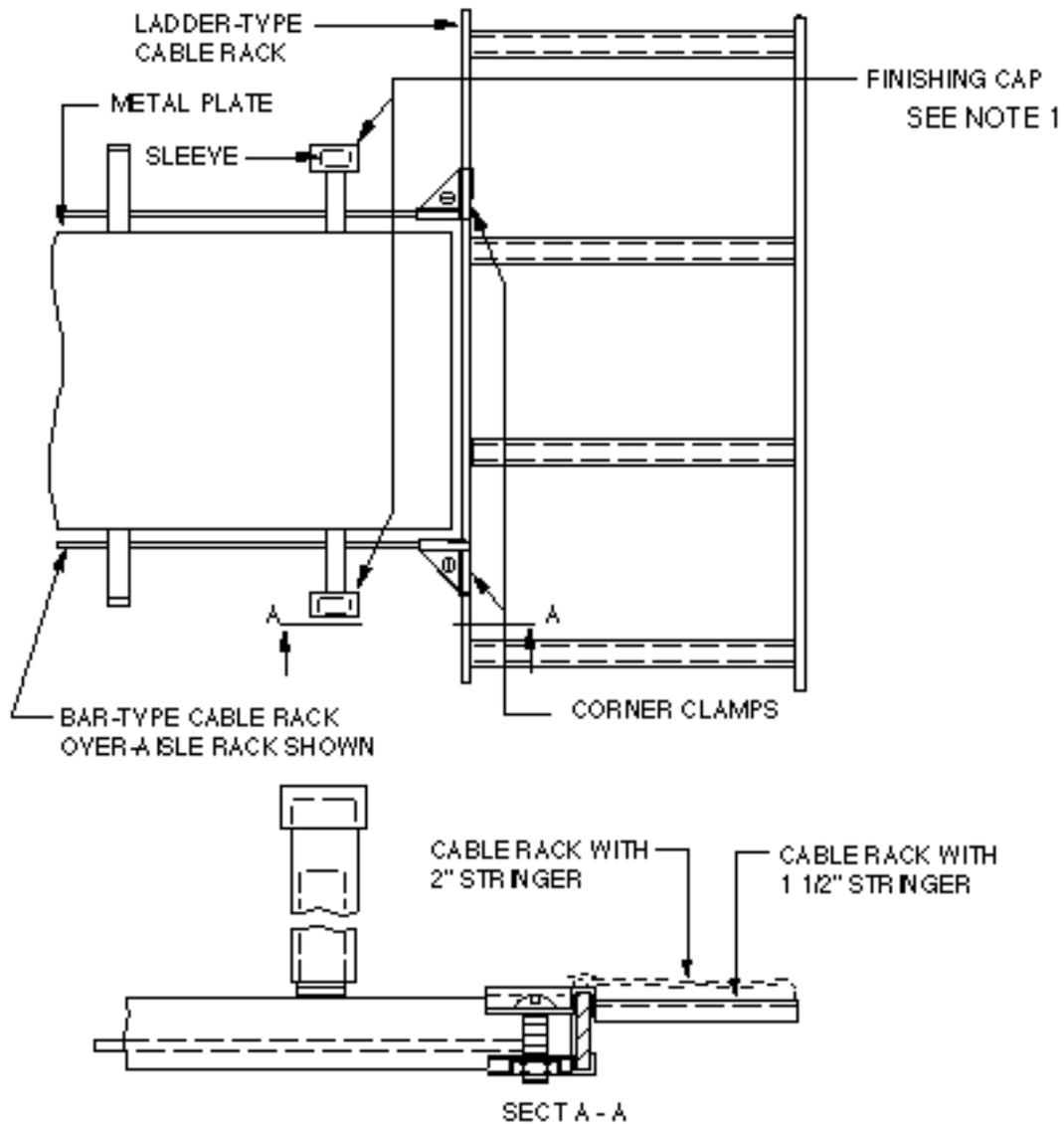
T-INTERSECTION BAR-TYPE OVER-AISLE TO BAR OR LADDER-TYPE CROSS-AISLE CABLE RACK RAISED 2 INCHES TO CLEAR CONDUIT AND LIGHTING FIXTURES. FULL LENGTH PLATES BAR-TYPE CABLE RACK SHOWN.



NOTE:

1. FINISHING CAPS SHALL BE SECURED TO THE CABLE RACK HORNS (WITHIN THE T-INTERSECTION) AND THE SLEEVES, RESPECTIVELY, BY COATING THE INSIDE OF THE CAPS WITH ADHESIVE.

EXHIBIT 2-E1-18A (A&M)  
T-INTERSECTION BAR-TYPE OVER-AISLE TO LADDER-TYPE CABLE RACK



NOTE:

1. FINISHING CAP SHALL BE SECURED TO THE SLEEVE BY COATING THE INSIDE OF THE CAP WITH ADHESIVE PRIOR TO PLACING ON THE SLEEVE.

EXHIBIT 2-E1-19A (A&M)  
T-INTERSECTION LADDER-TYPE TO BAR-TYPE CABLE RACK

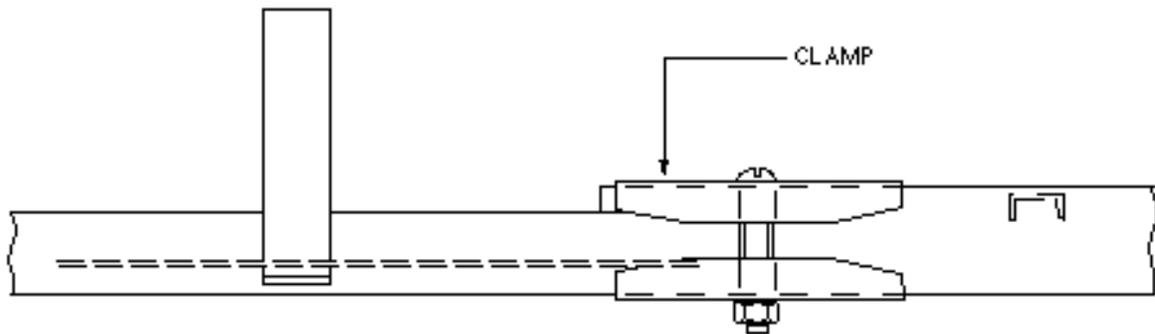
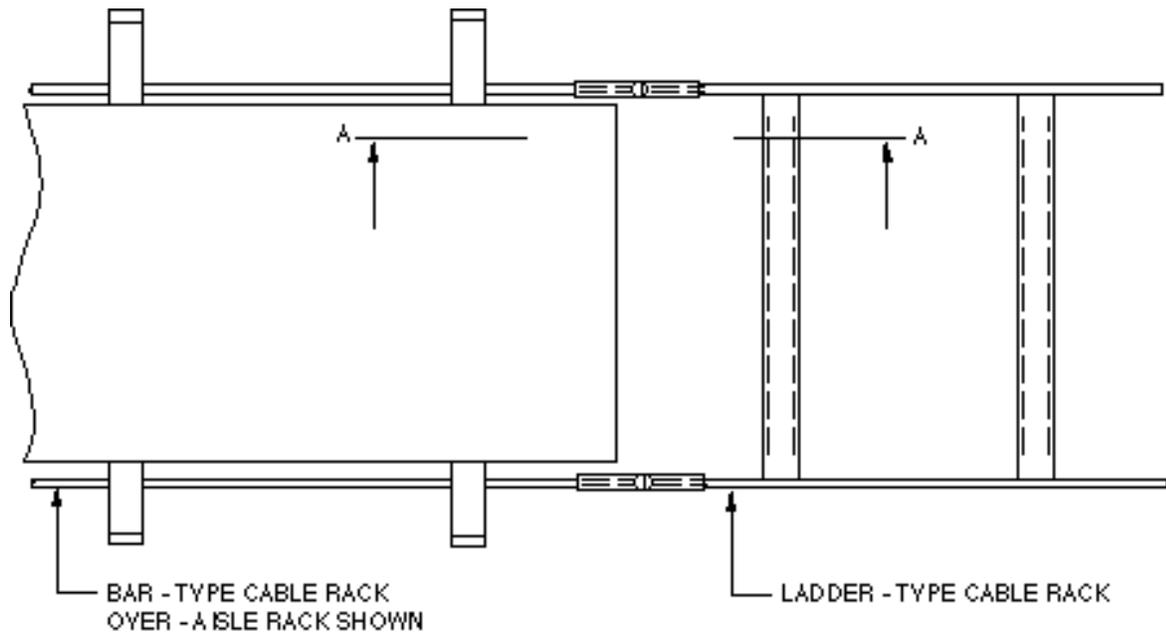


EXHIBIT 2-E1-20A (A&M)  
JOINING BAR-TYPE TO LADDER-TYPE CABLE RACK OF THE SAME WIDTH.

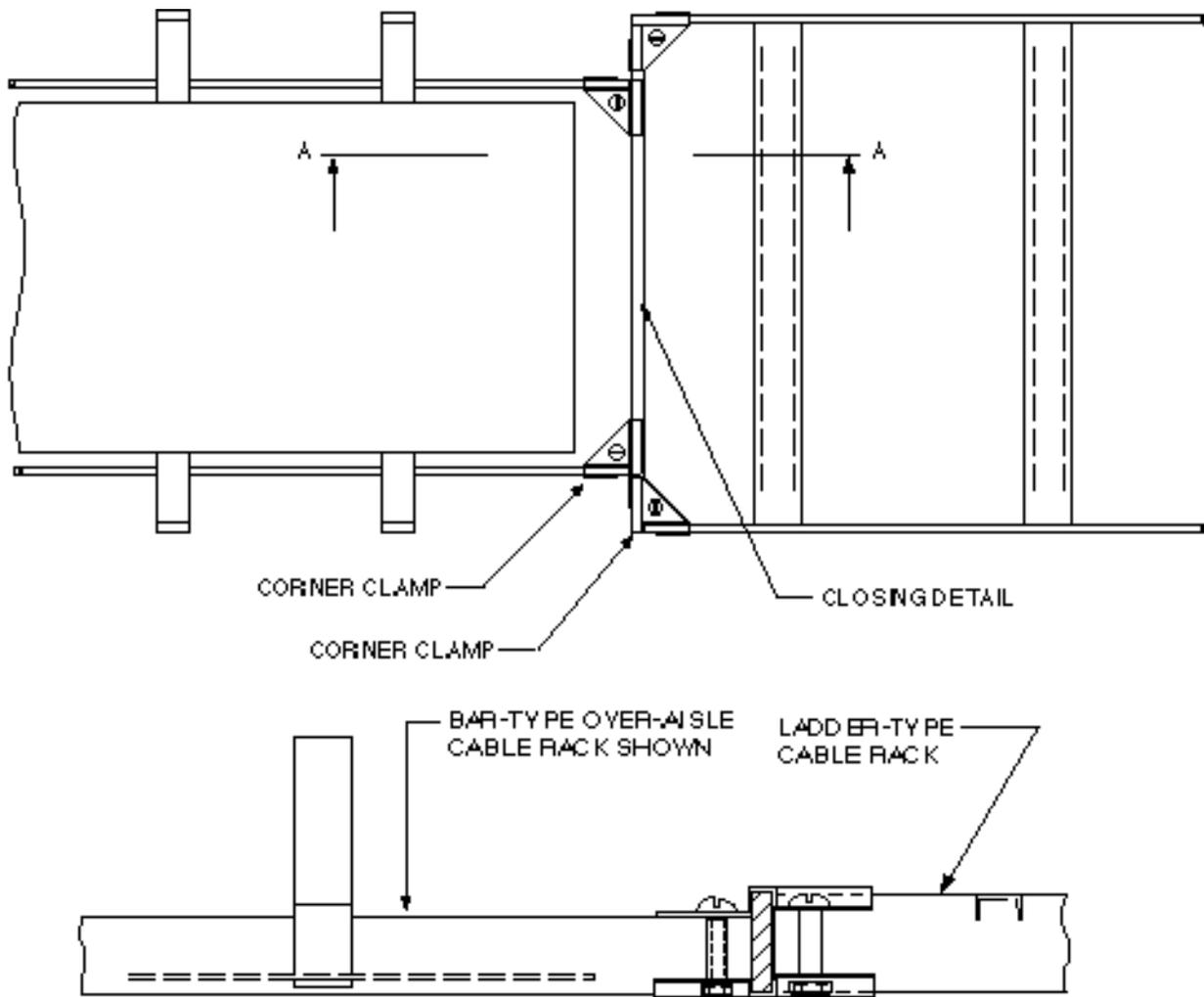


EXHIBIT 2-E1-21A (A&M)  
JOINING BAR AND LADDER-TYPE CABLE RACK OF VARYING  
WIDTH AND STRINGER SIZE.

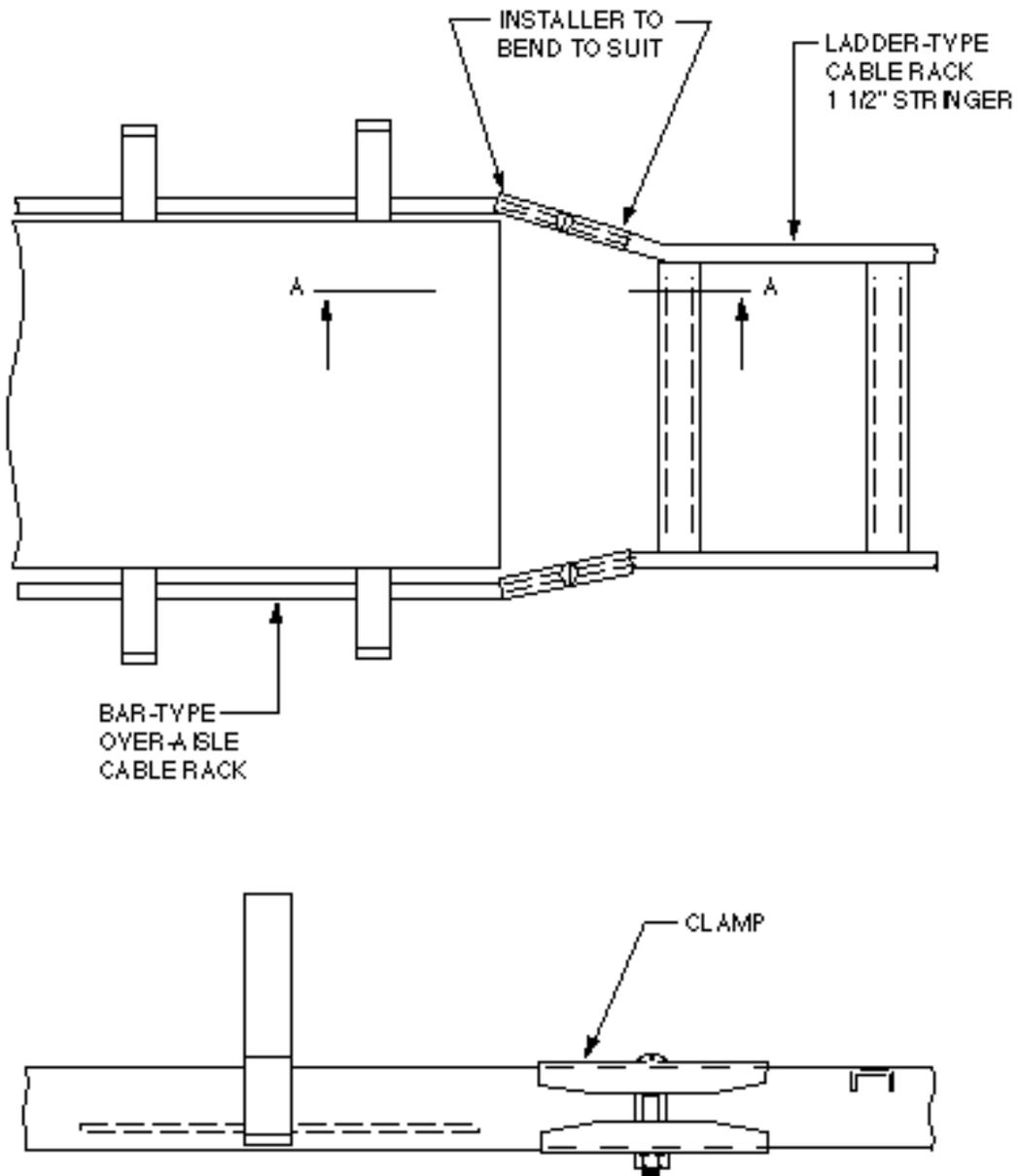


EXHIBIT 2-E1 22A (DISCONTINUED)  
JOINING BAR-TYPE TO NARROWER LADDER-TYPE CABLE RACK.

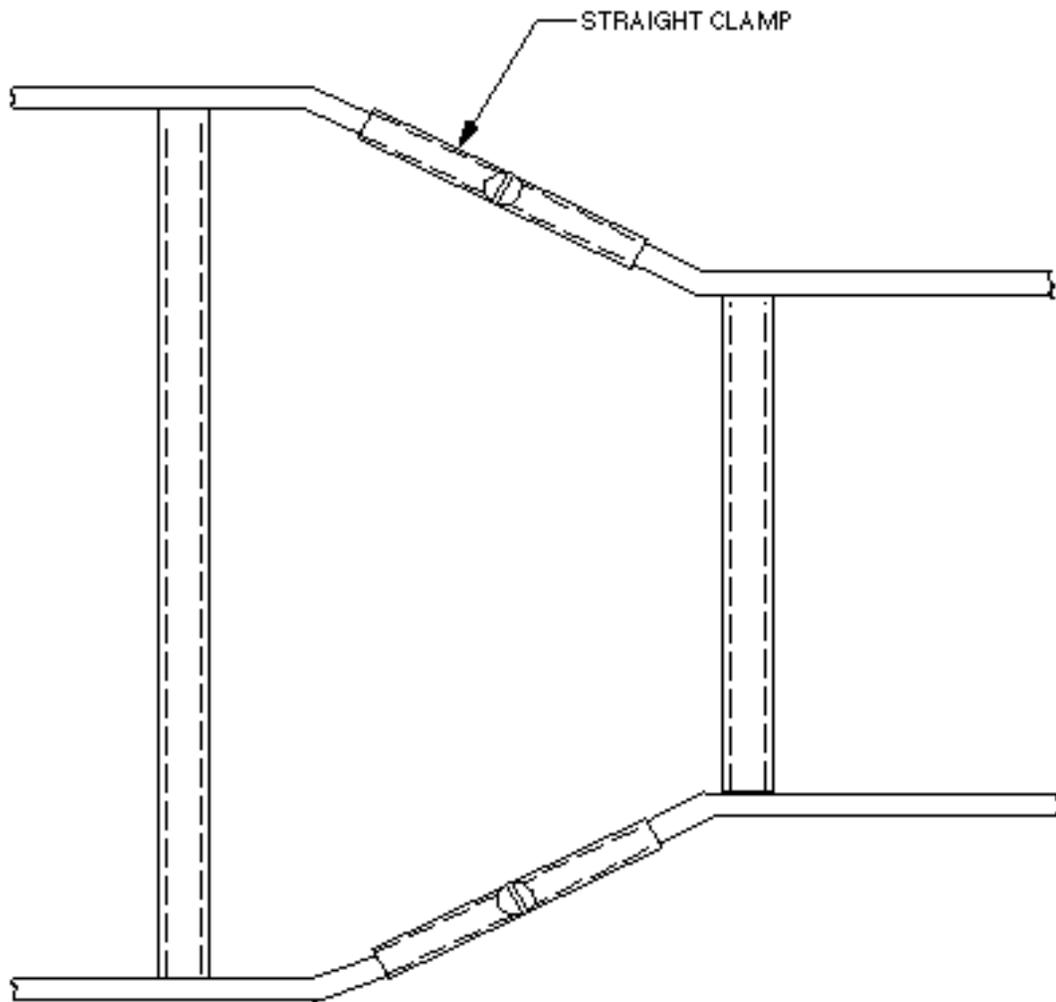


EXHIBIT 2-E1-23 (DISCONTINUED)  
JOINING 10 INCH TO 1 FOOT 0 INCH OR 1 FOOT 0 INCH TO 1 FOOT 3 INCH  
CABLE RACKS IN THE SAME PLANE USING STRAIGHT CLAMPS-SMALLER  
RACK APPROXIMATELY IN THE CENTER.

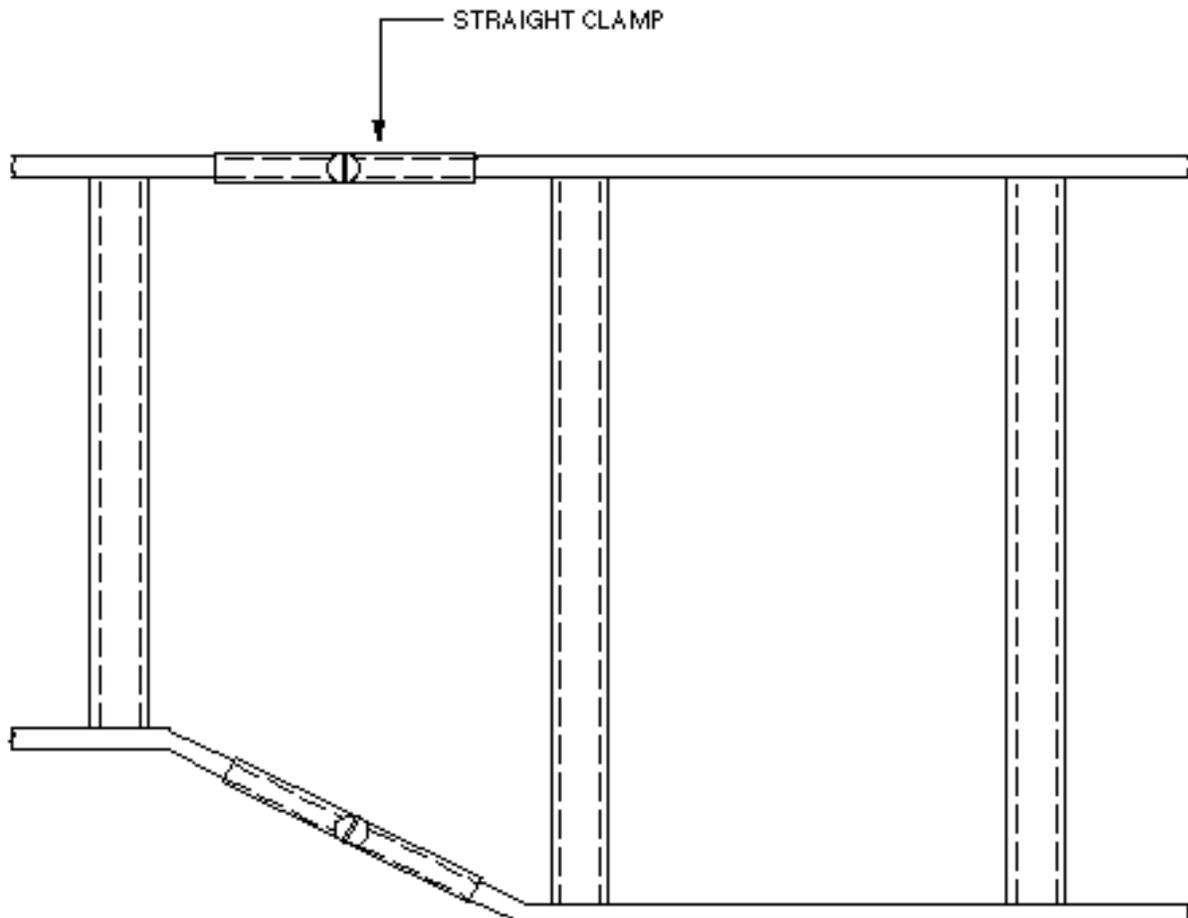


EXHIBIT 2-E1-24 (DISCONTINUED)  
JOINING 10 INCH TO 1 FOOT 0 INCH OR 1 FOOT 0 INCH TO 1 FOOT 3 INCH  
CABLE RACKS IN THE SAME PLANE USING STRAIGHT CLAMPS-SMALLER  
RACK AT ONE SIDE.

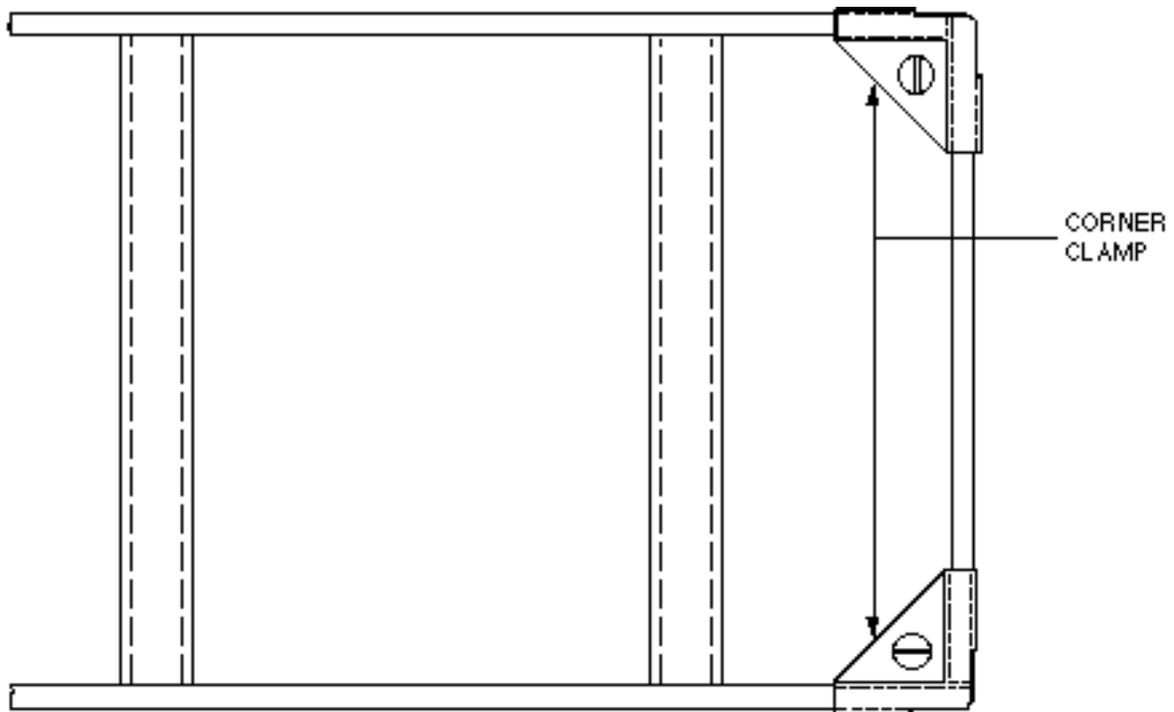


EXHIBIT 2-E1-25  
CLOSING ENDS OF LADDER-TYPE OR BAR-TYPE CABLE RACK JUNCTIONS AND  
OFFSETS-LADDER-TYPE SHOWN.

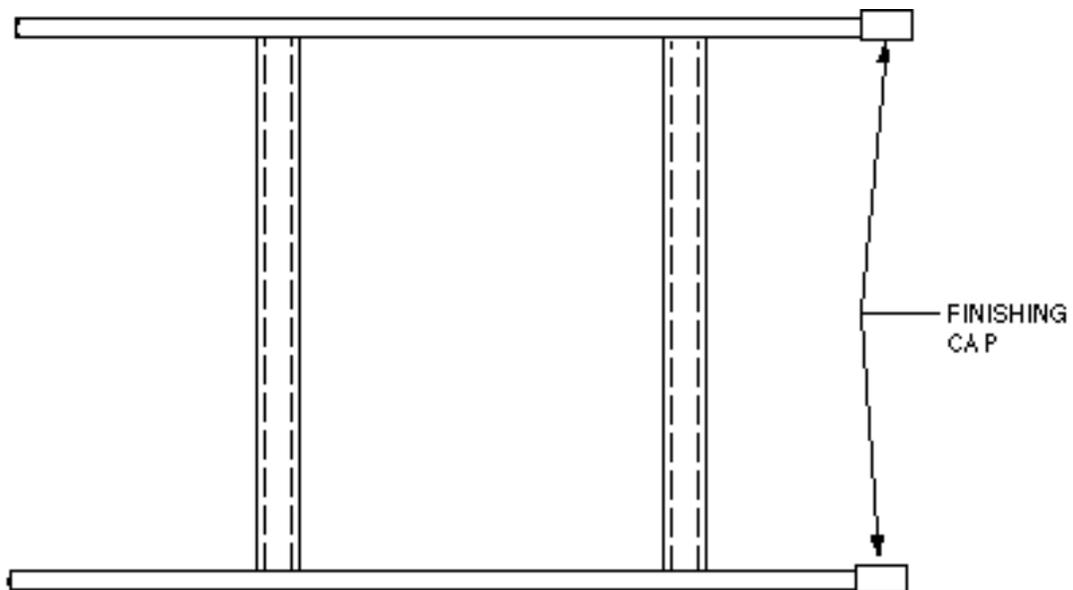


EXHIBIT 2-E1-25C  
MOUNTING RUBBER BUMPERS ON EXPOSED ENDS OF CABLE RACK STRINGERS

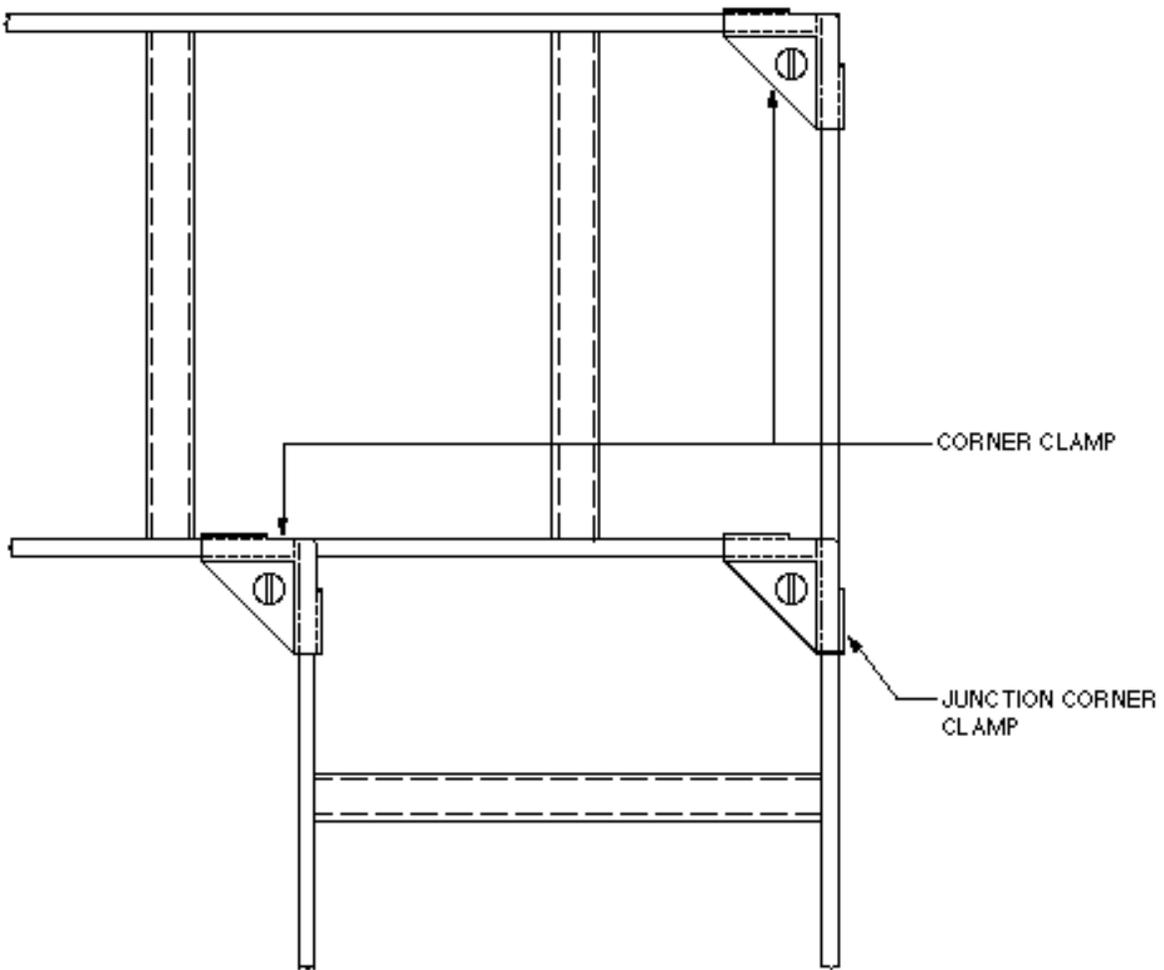


EXHIBIT 2-E1-26  
90 DEGREE TURN IN SAME PLANE

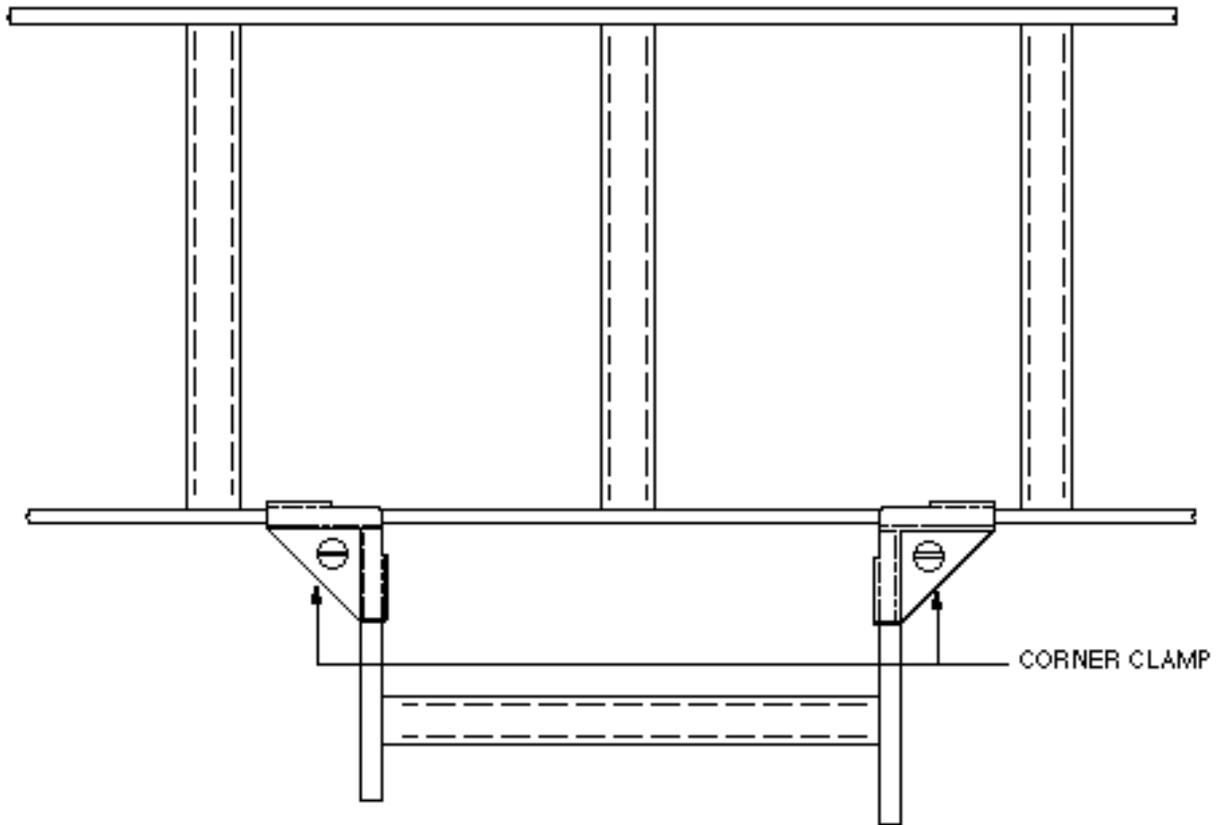
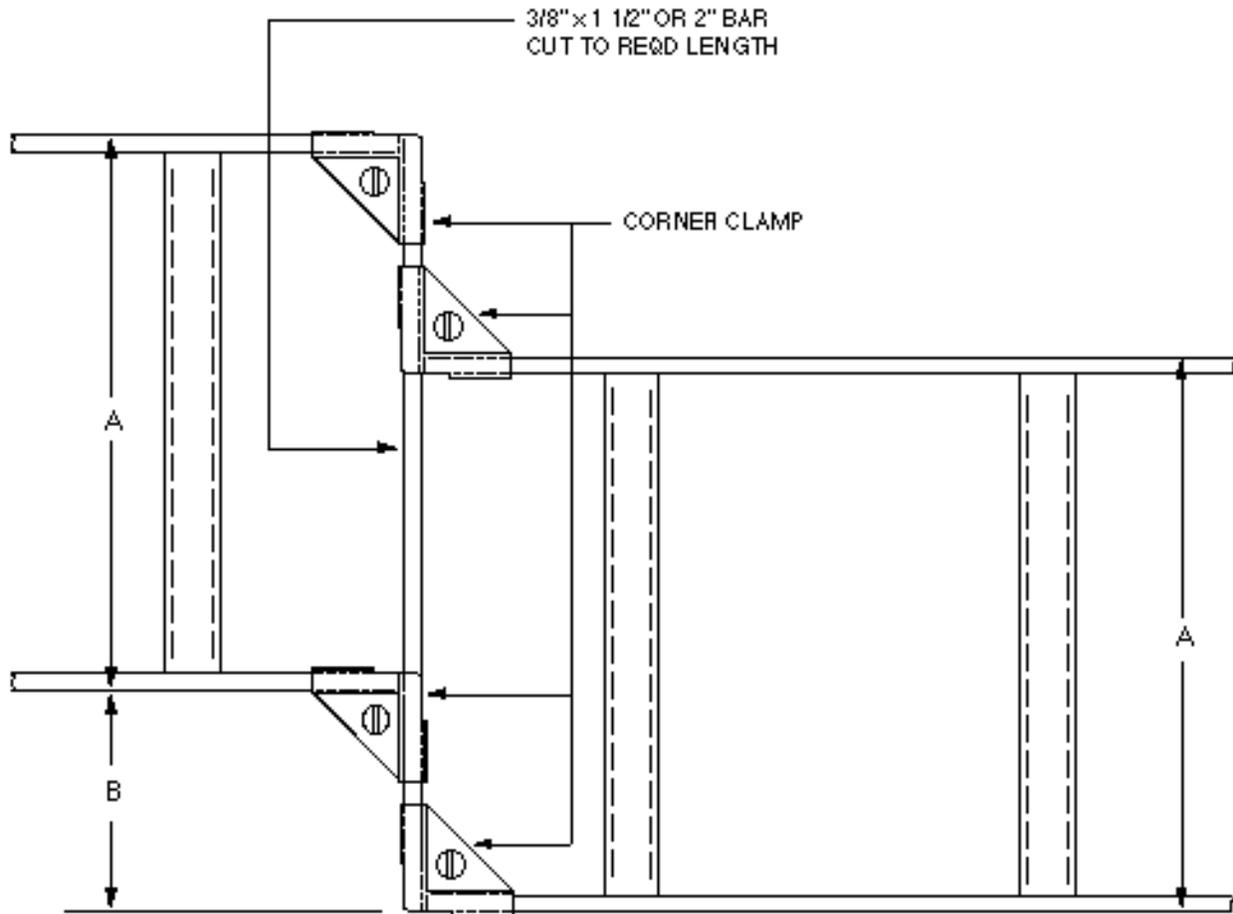


EXHIBIT 2-E1-27  
T-INTERSECTION



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

EXHIBIT 2-E1-28  
 SMALL OFFSET LESS THAN WIDTH OF RACK AND IN SAME PLANE

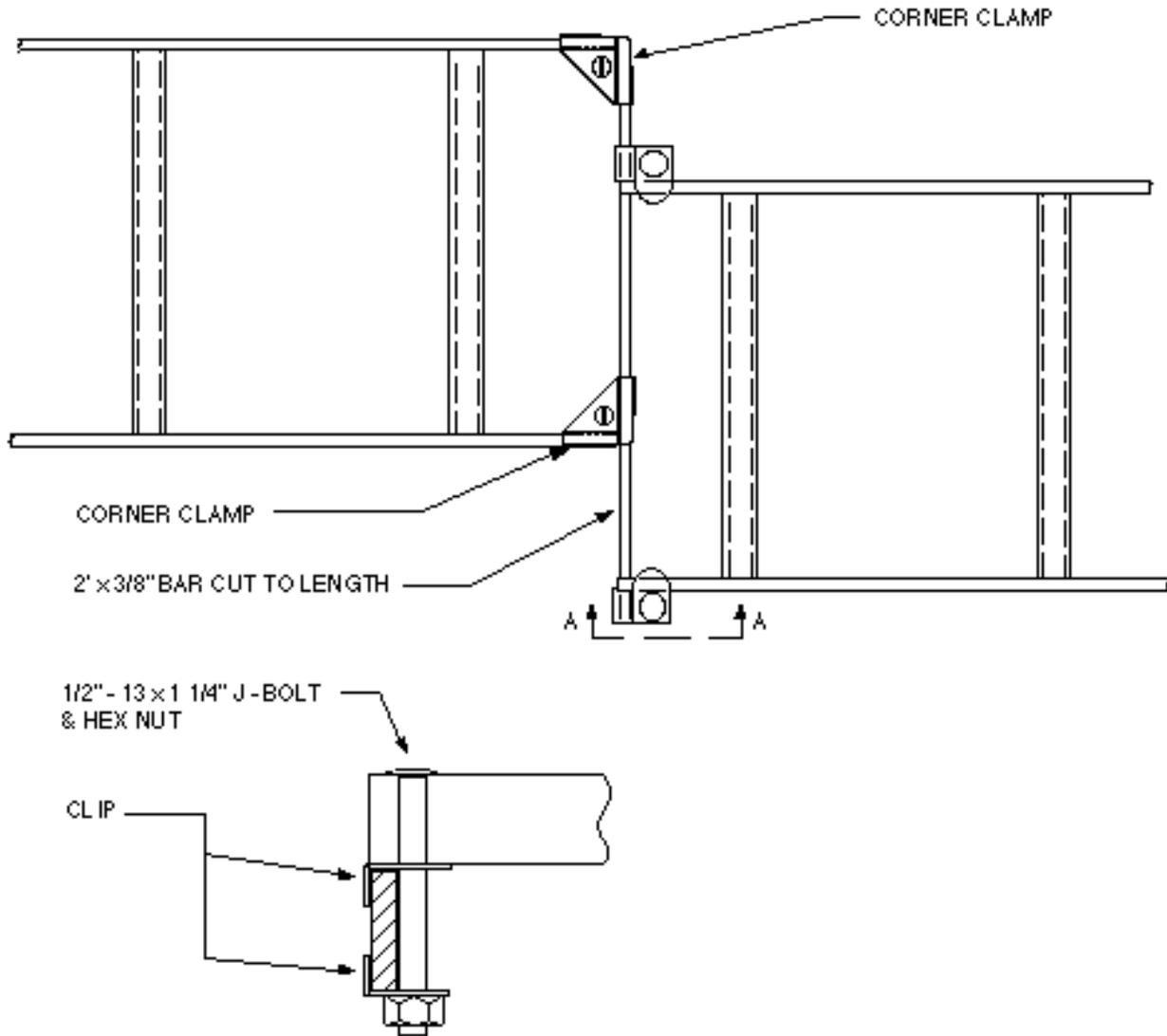


EXHIBIT 2-E1-28A  
SMALL HORIZONTAL OFFSET LESS THAN WIDTH OF RACK WITH 2 INCH  
VERTICAL OFFSET BETWEEN RACKS

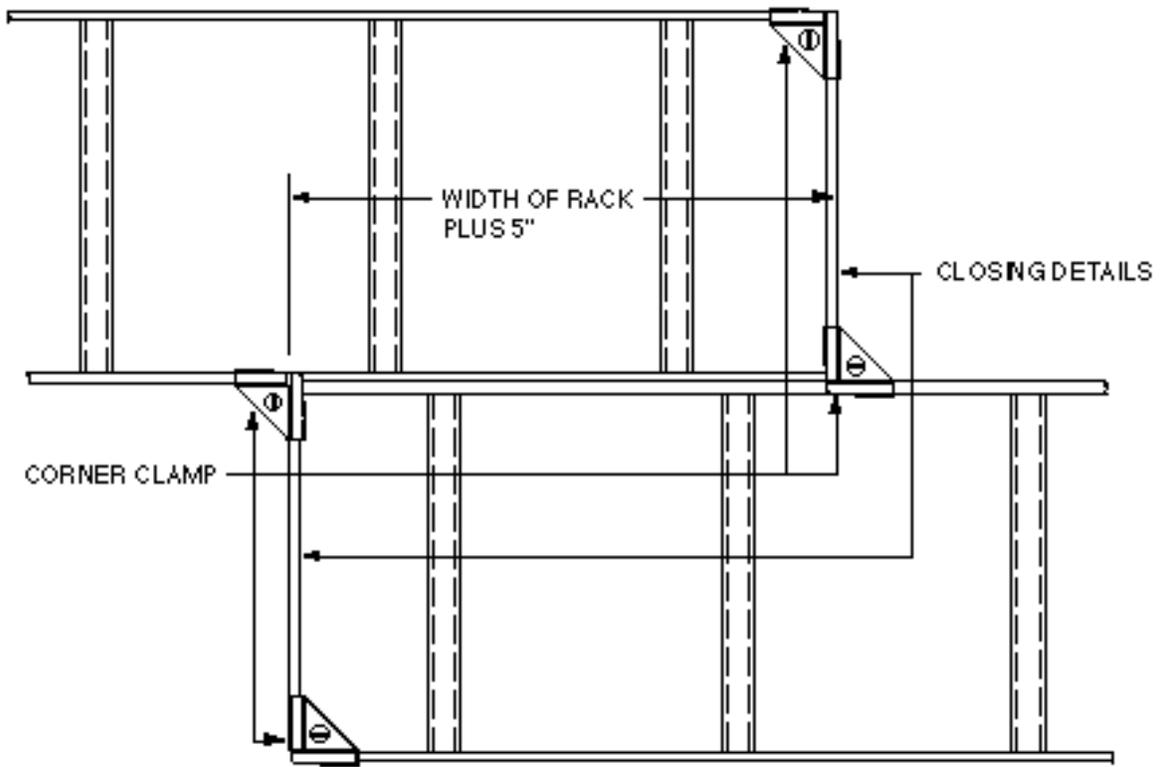


EXHIBIT 2-E1-29  
OFFSET SAME AS WIDTH OF RACK AND IN SAME PLANE BAR AND  
LADDER-TYPE RACK.

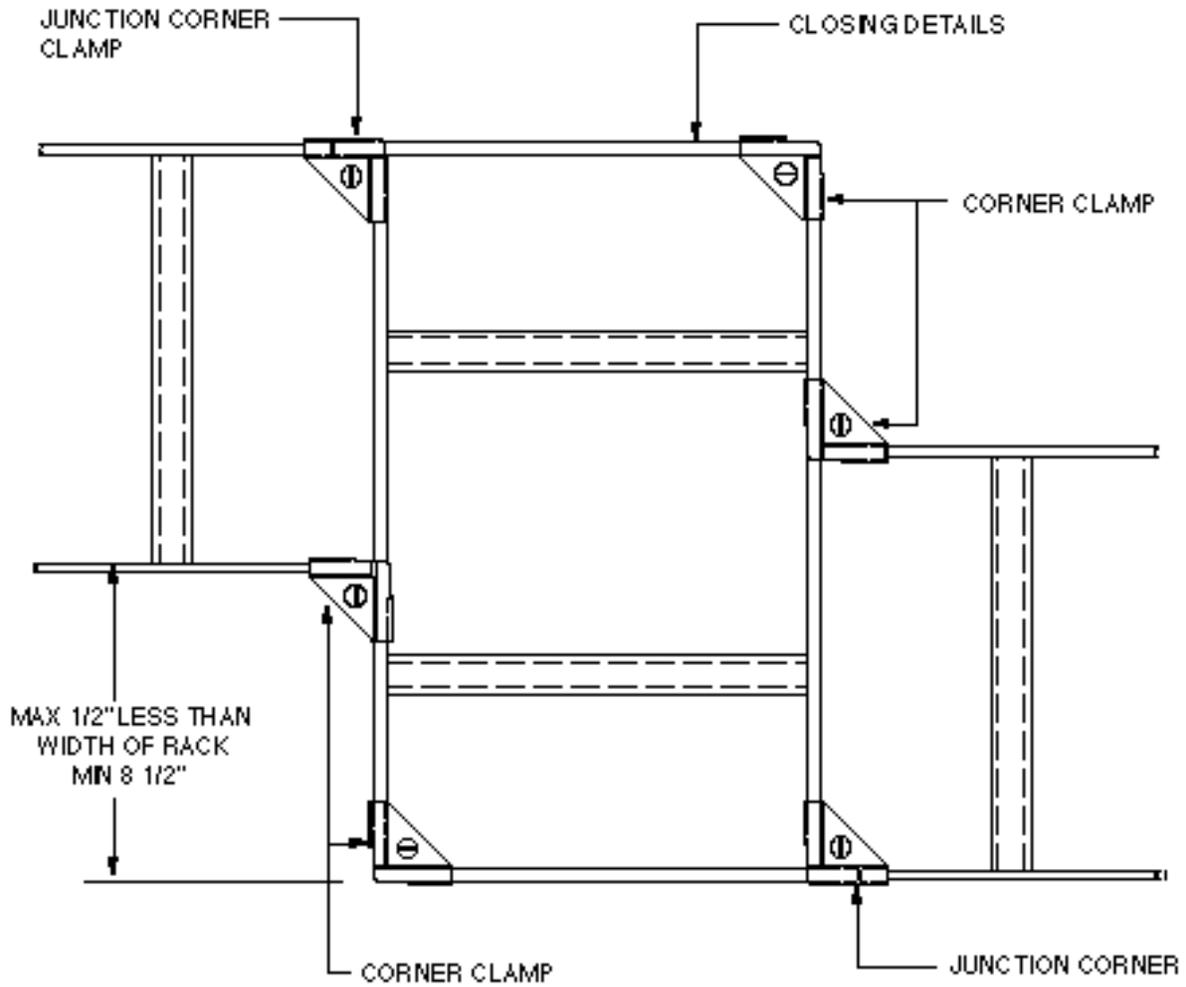


EXHIBIT 2-E1-30  
LARGE OFFSET LESS THAN WIDTH OF RACK AND IN SAME PLANE

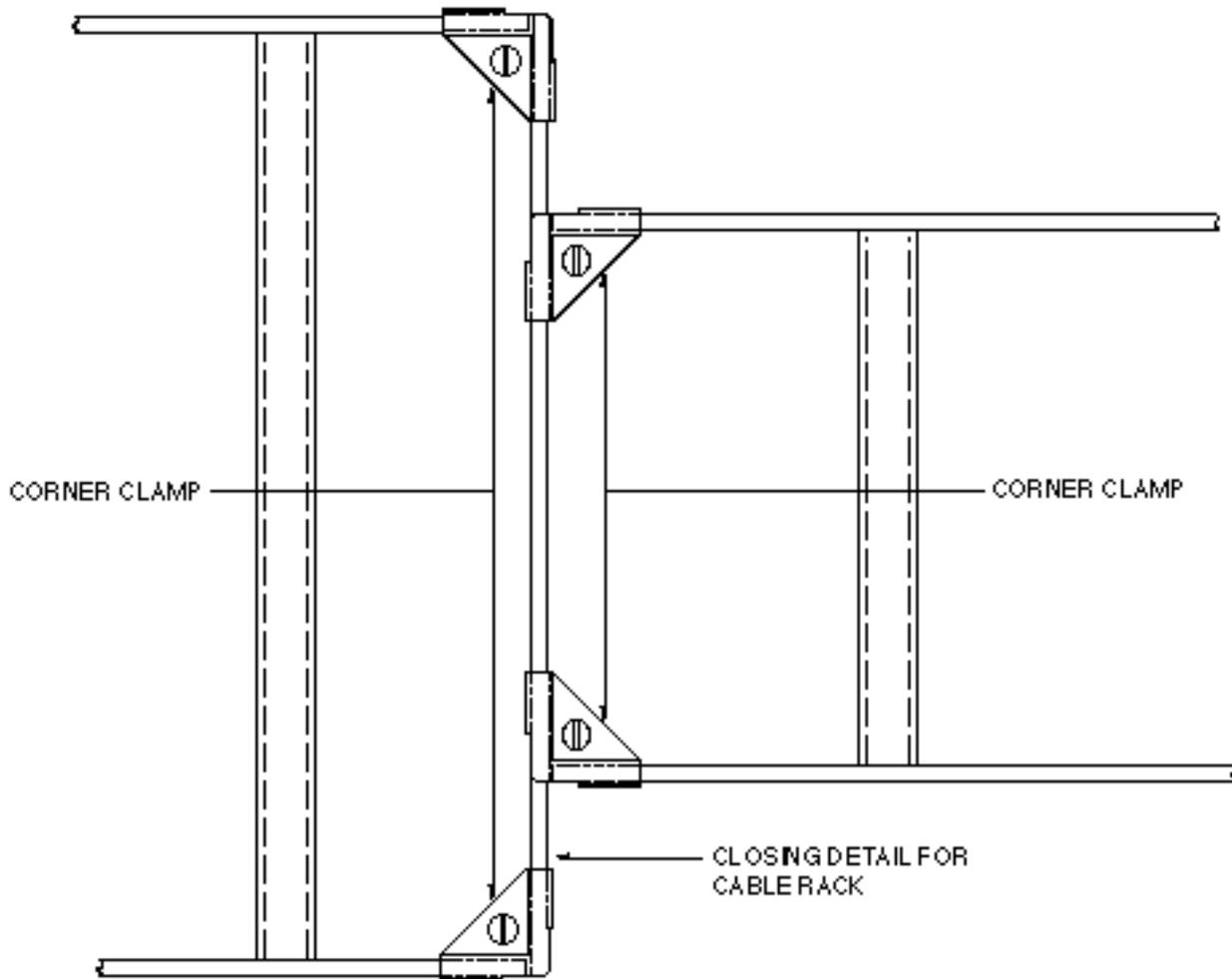


EXHIBIT 2-E1-31  
JOINING BAR AND LADDER-TYPE RACKS OF DIFFERENT WIDTHS IN SAME  
PLANE - SMALLER RACK APPROXIMATELY IN CENTER.

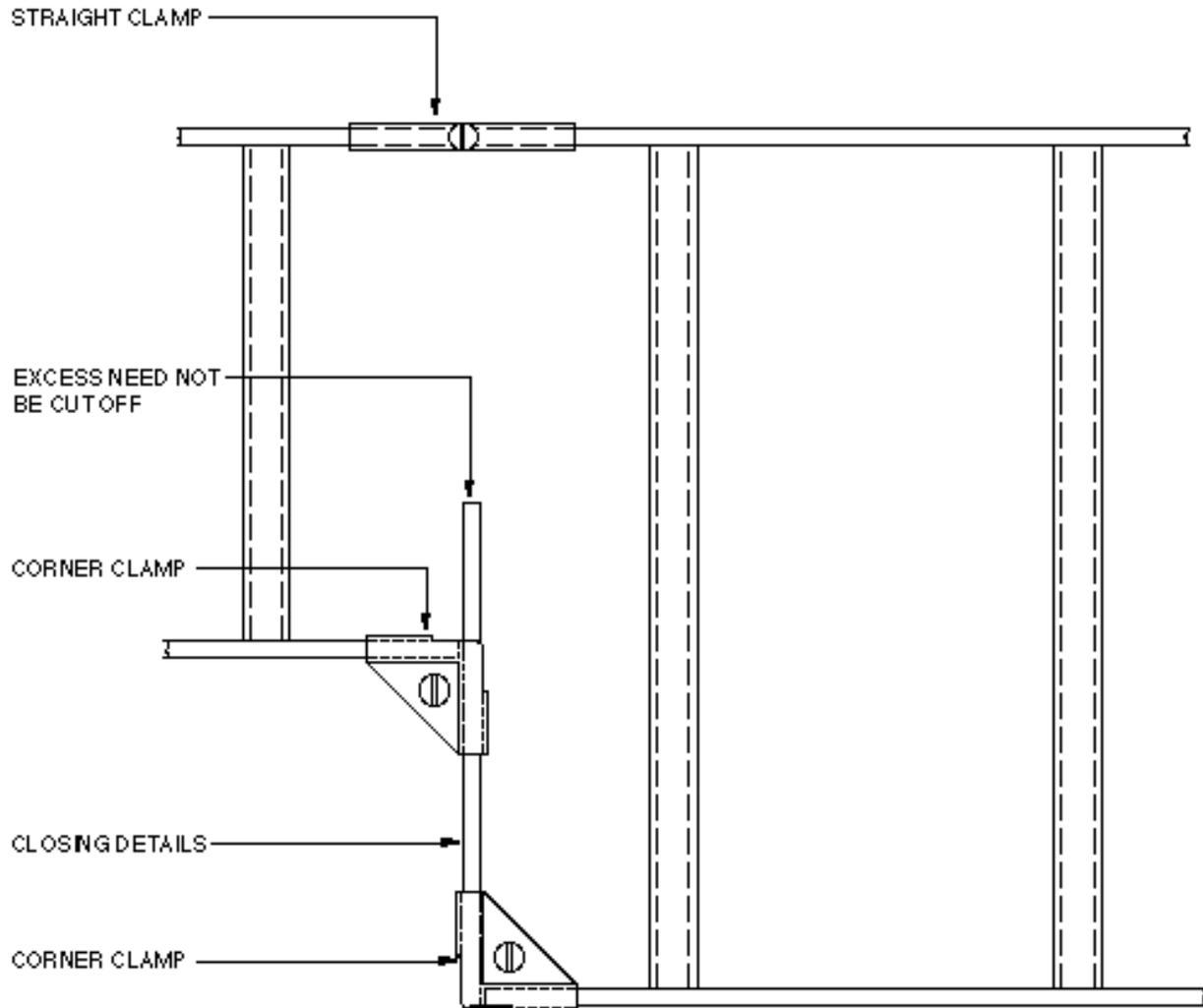


EXHIBIT 2-E1-32  
JOINING BAR AND LADDER-TYPE RACKS OF DIFFERENT WIDTHS IN SAME  
PLANE - SMALLER RACK AT ONE SIDE.

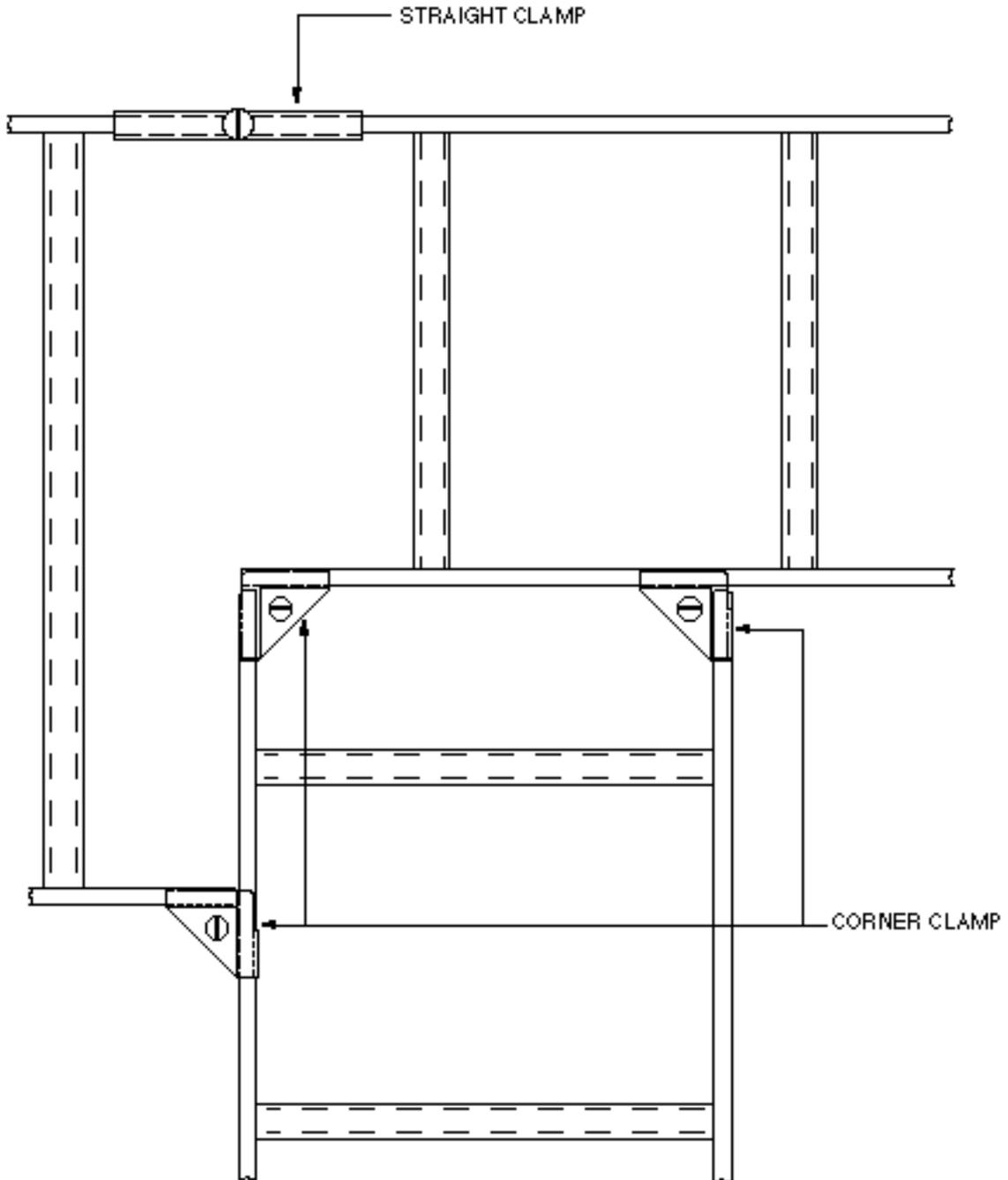
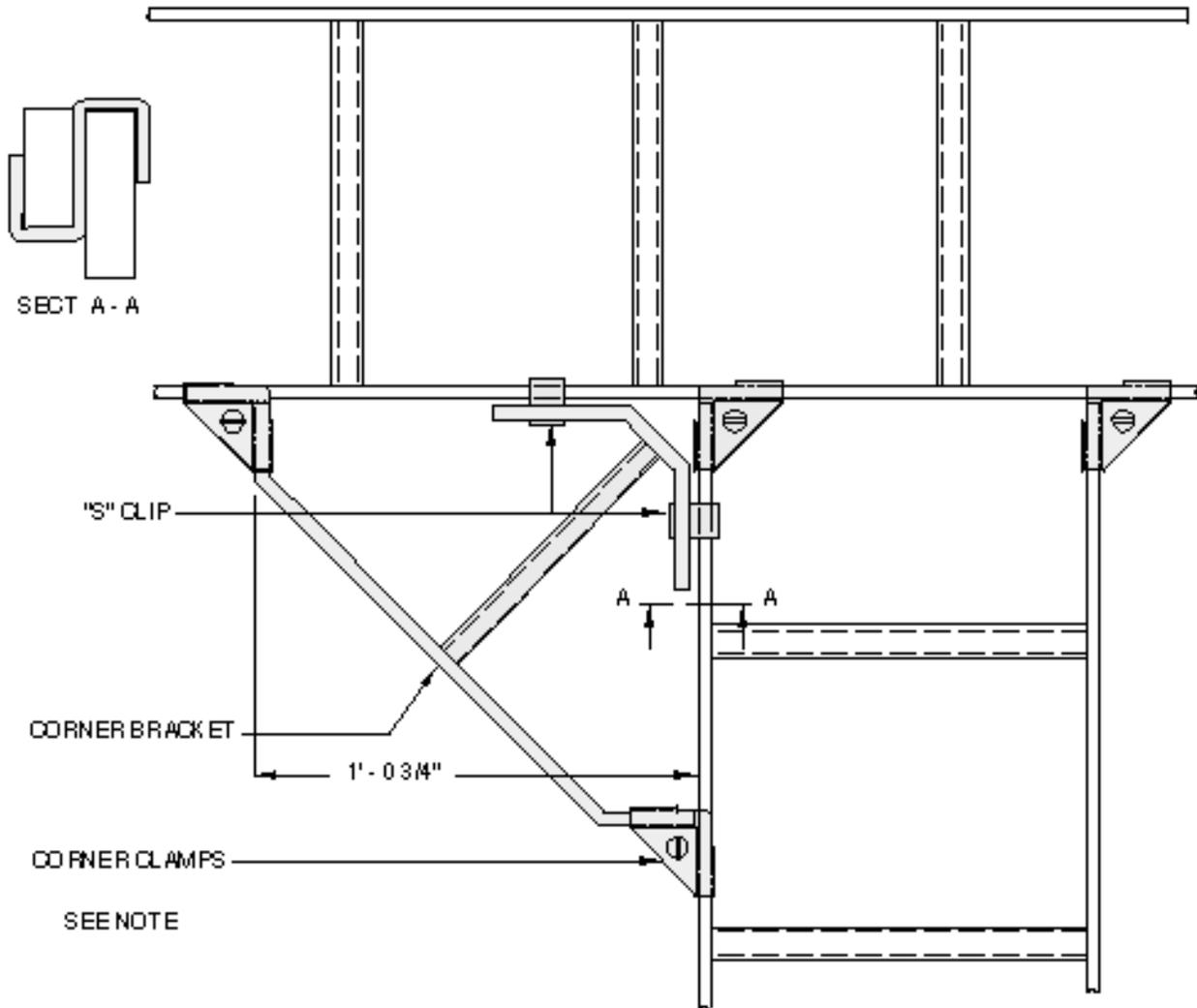


EXHIBIT 2-E1-33  
JOINING THREE RACKS OF DIFFERENT WIDTHS IN SAME PLANE



NOTE:

CORNER CLAMPS SHALL BE FASTENED TO BOTTOM OF CABLE RACK STRINGER WHEN STRINGER IS 2".

EXHIBIT 2-E1-34  
CORNER BRACKET AT TURN OF INTERSECTION

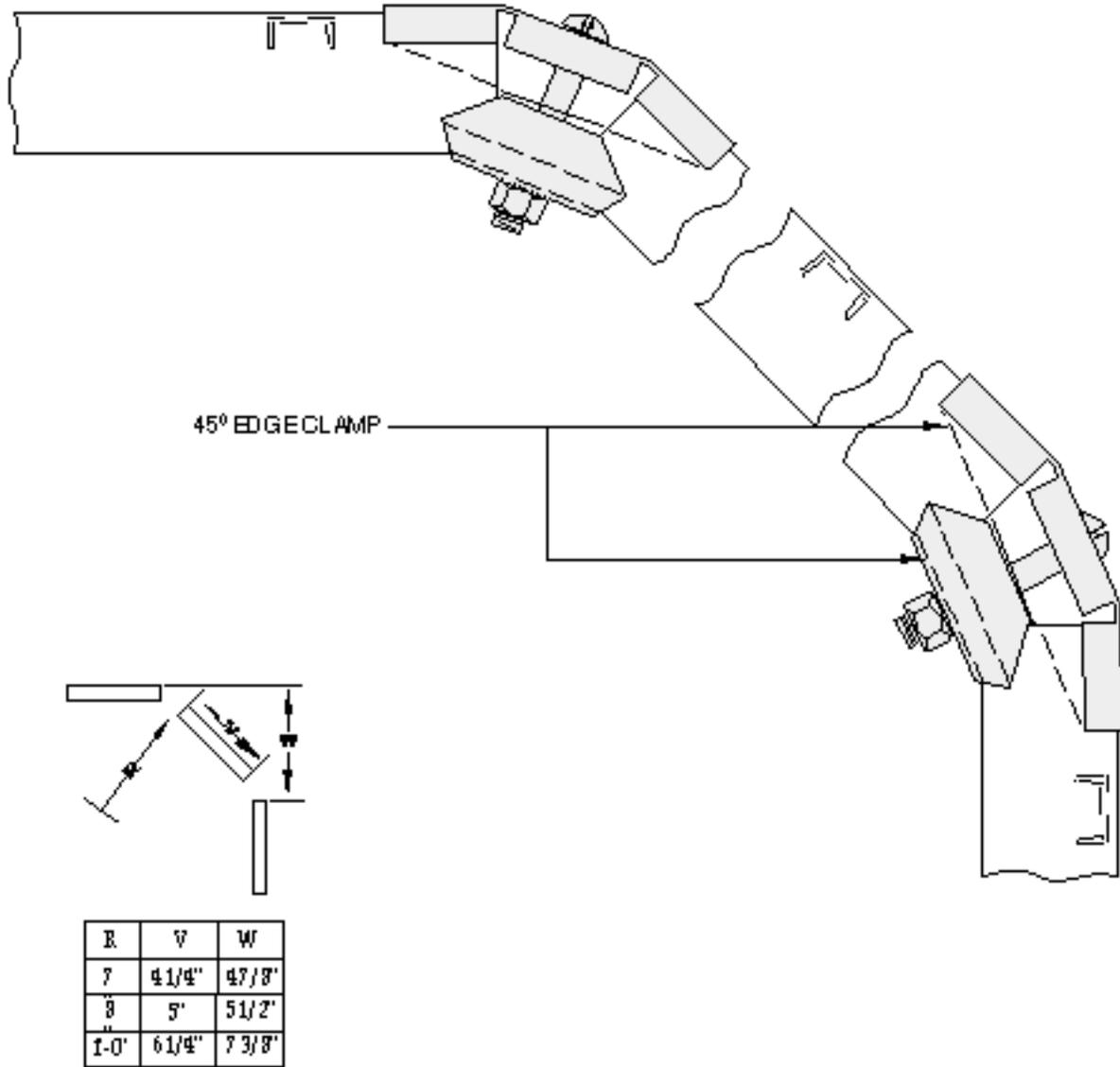
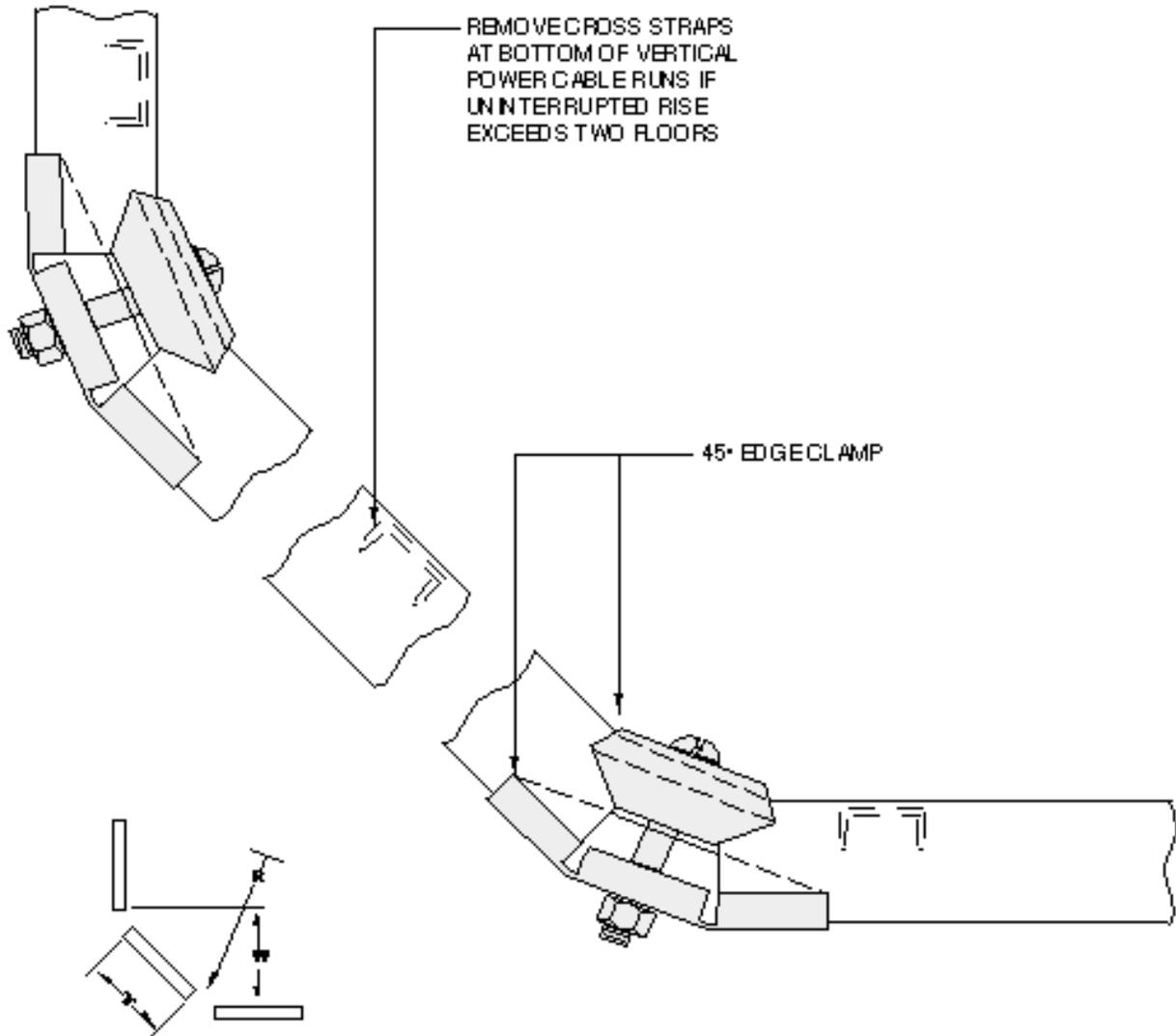


EXHIBIT 2-E1-35  
 90 DEGREE OUTSIDE TURN FOR A RADIUS OF MORE THAN 6 INCHES



R	V	W
1'-0"	9 1/2"	7 3/8"
1'-3"	1'-0"	9"
1'-6"	1'-2 1/2"	10 7/8"
1'-8"	1'-4"	11 3/4"
1'-11"	1'-6 1/2"	1'-1 3/4"
2'-1"	1'-8 1/4"	1'-3"
2'-5"	1'-11 1/2"	1'-5 1/4"

EXHIBIT 2-E1-36  
 90 DEGREE INSIDE TURN FOR A RADIUS OF MORE THAN 6 INCHES

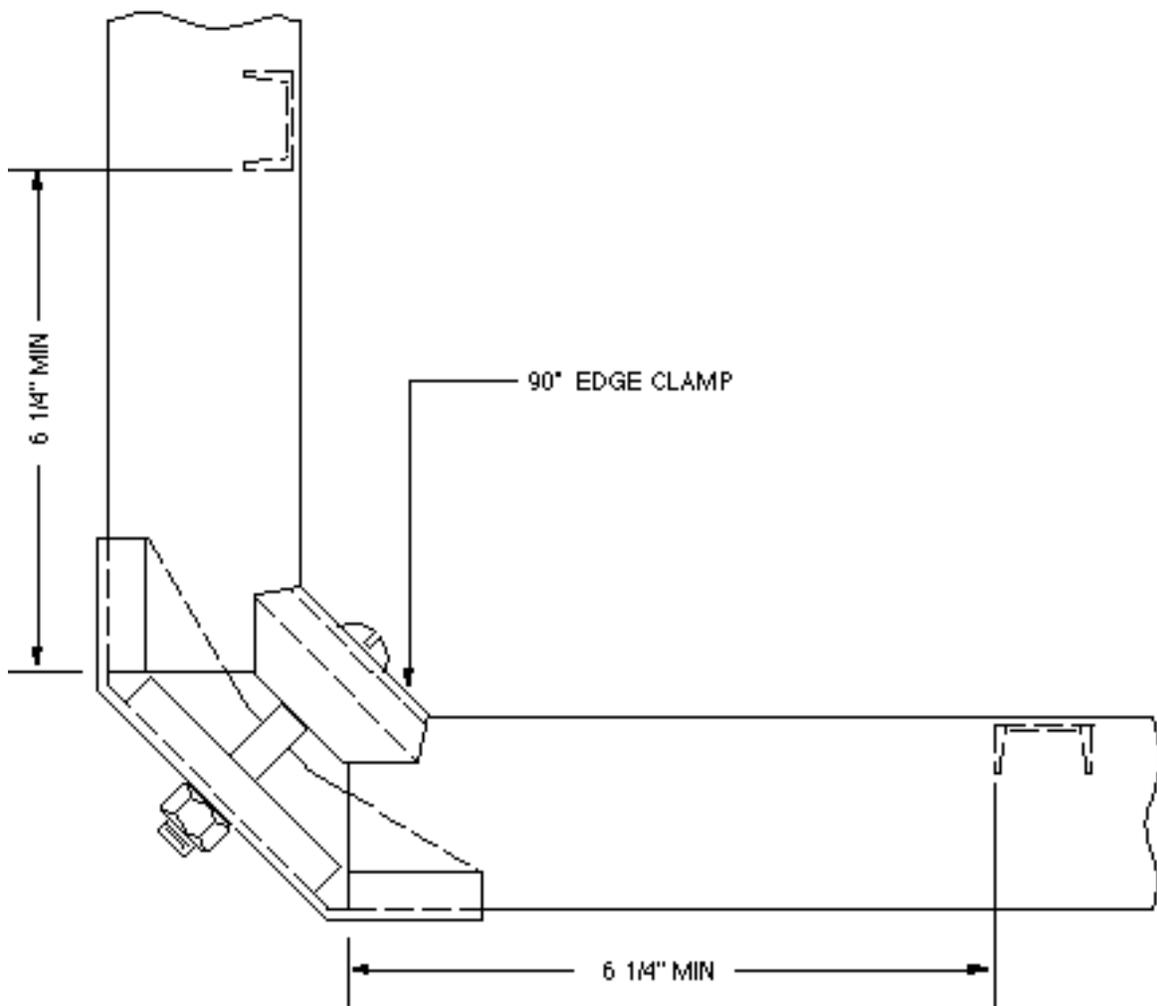


EXHIBIT 2-E1-37  
90 DEGREE INSIDE TURN FOR A RADIUS OF 6 INCHES OR LESS

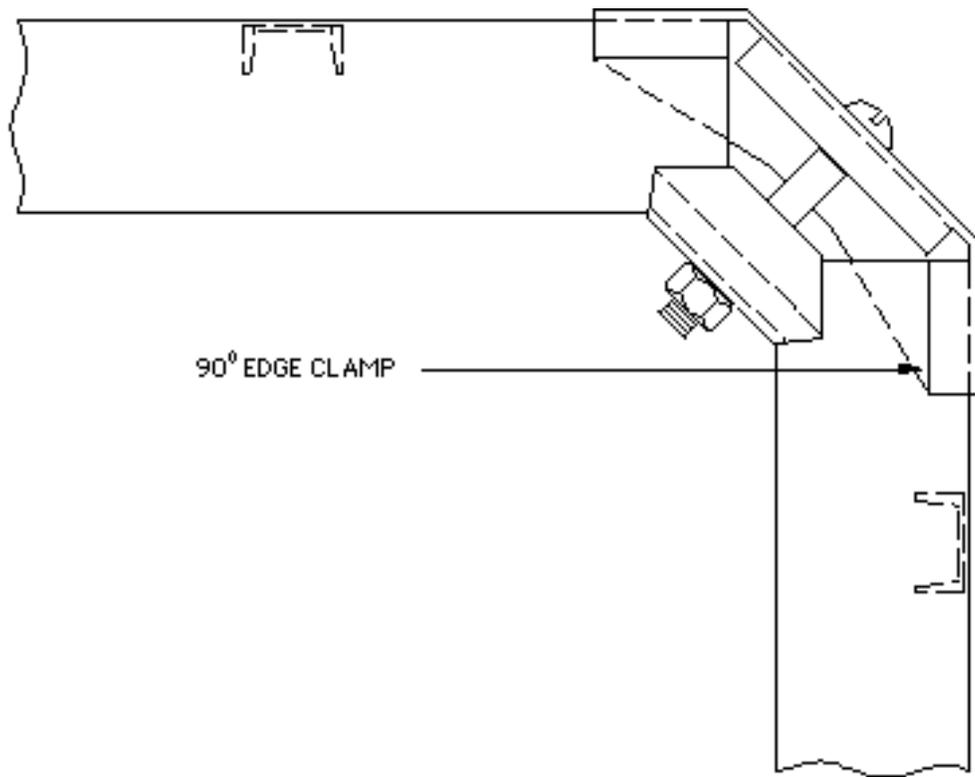


EXHIBIT 2-E1-38  
90 DEGREE OUTSIDE TURN FOR A RADIUS OF 6 INCHES OR LESS

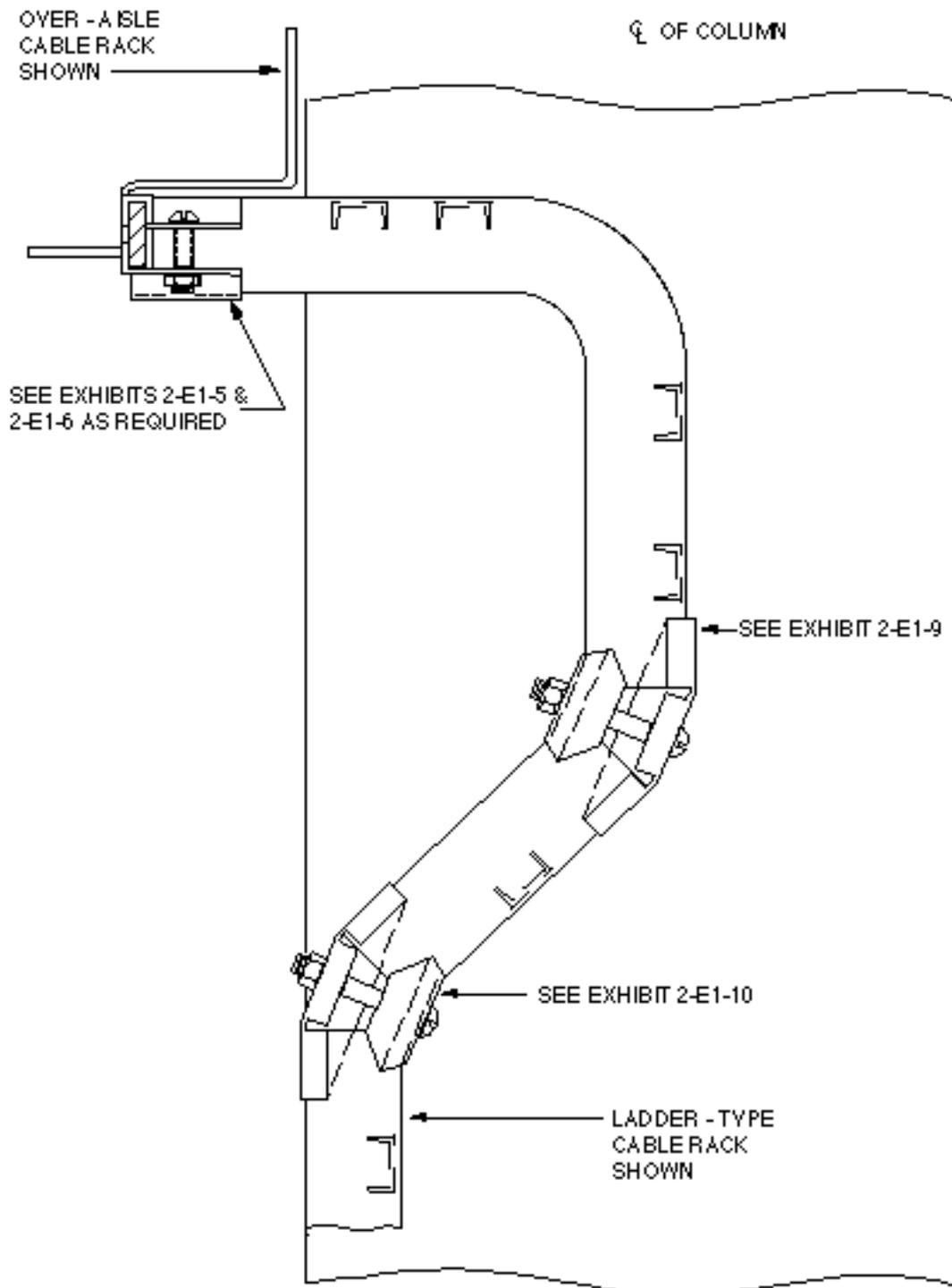


EXHIBIT 2-E1-38H  
VERTICAL LADDER-TYPE CABLE RACK DROPPING OFF THE SIDE OF BAR-TYPE  
CABLE RACK-90 DEGREE OUTSIDE TURN OF 6 INCHES OR LESS.

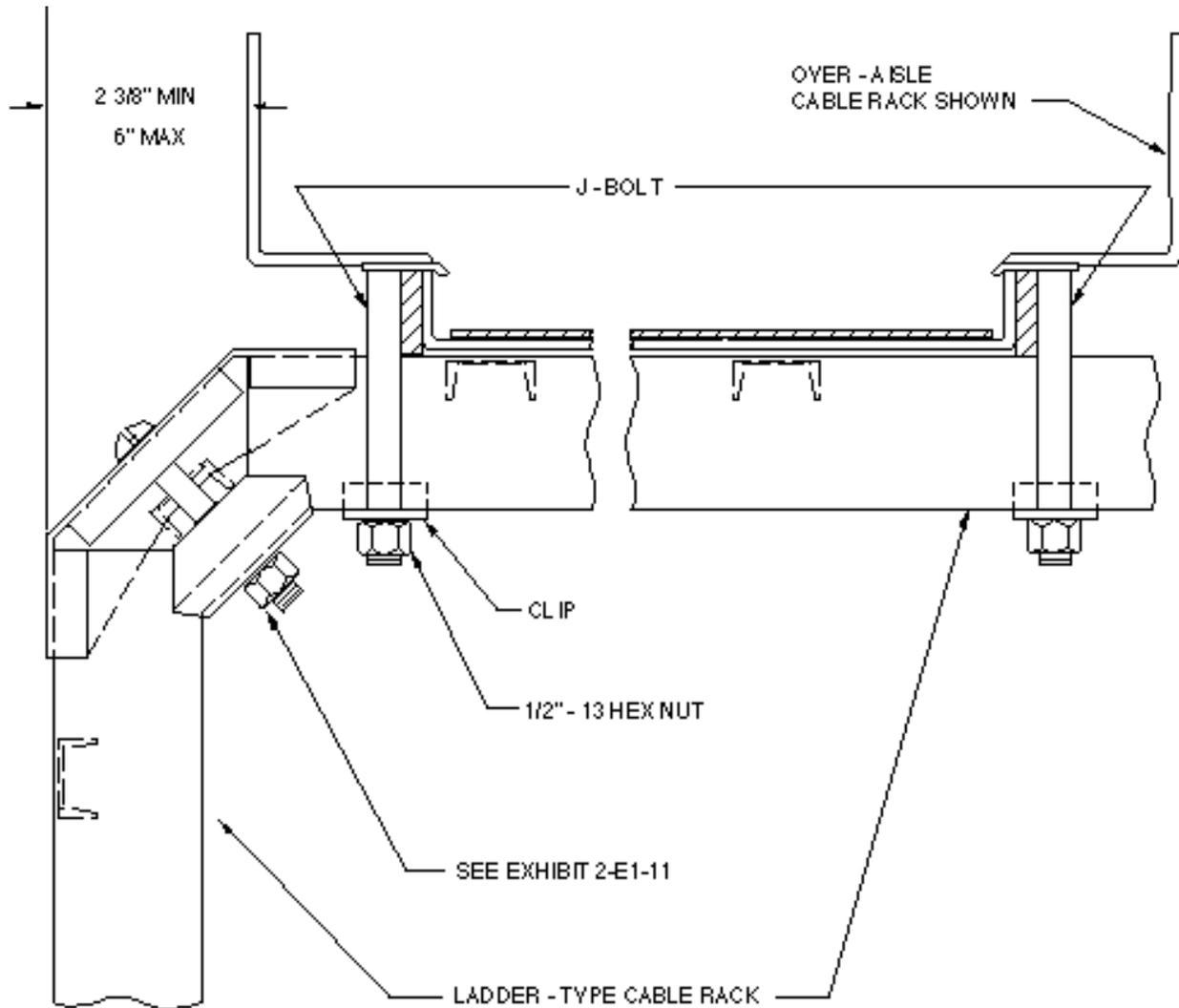
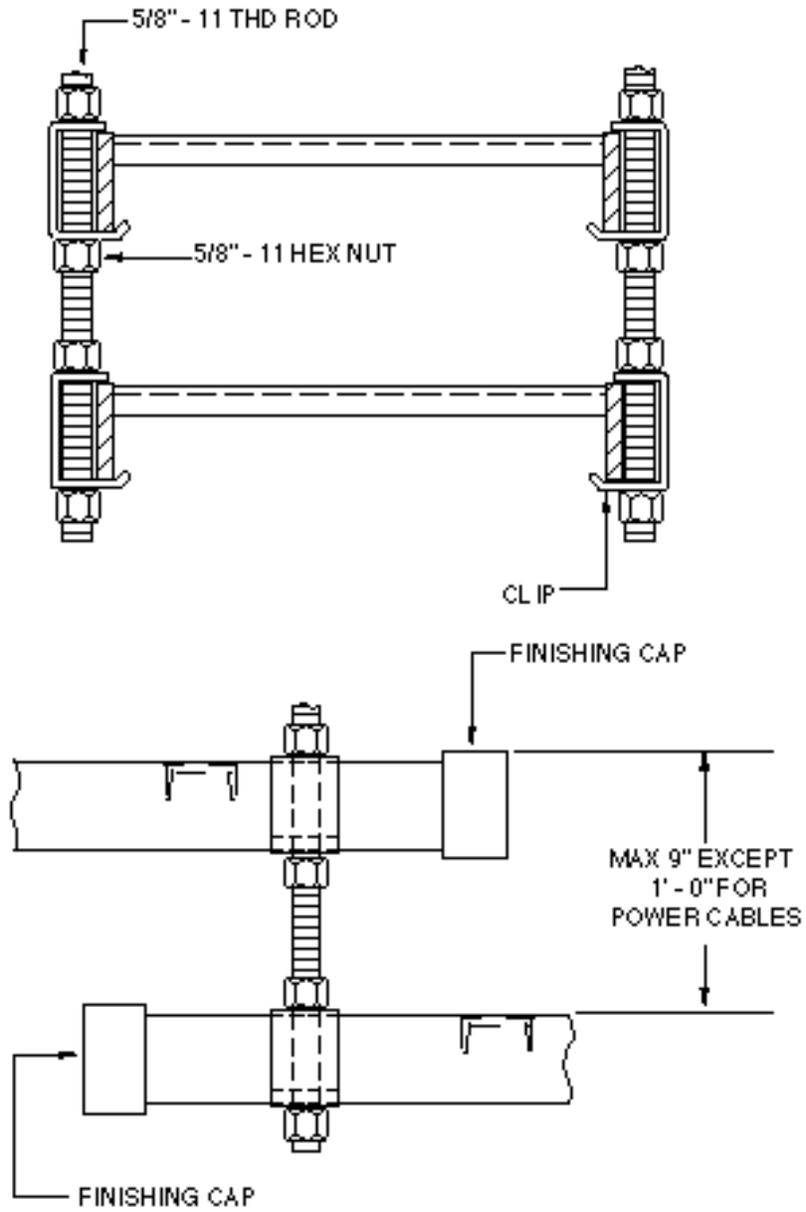
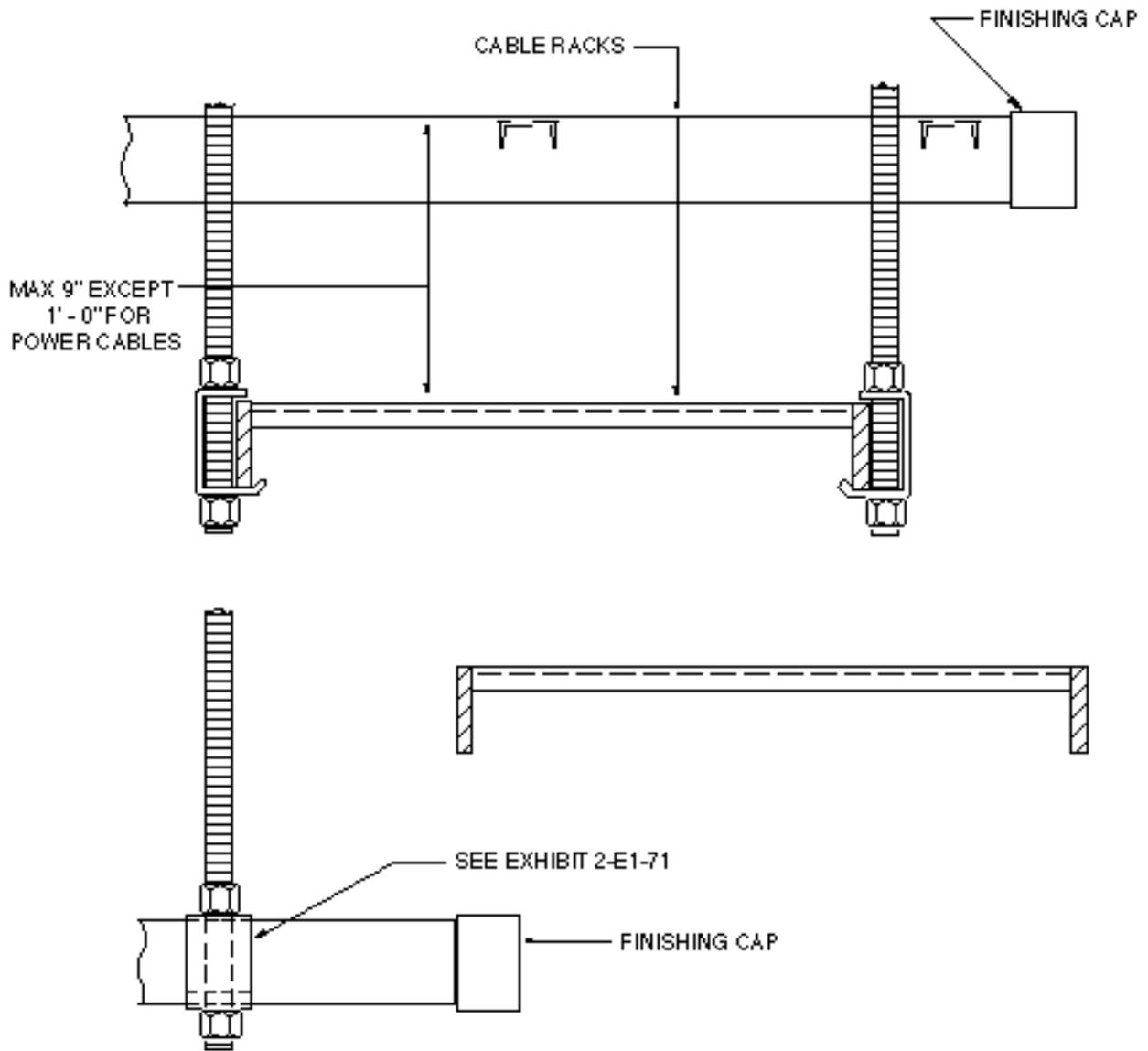


EXHIBIT 2-E1-38J (A&M)  
VERTICAL LADDER-TYPE CABLE RACK DROPPING OFF THE SIDE OF BAR-TYPE  
CABLE RACK 90 DEGREE LARGE OUTSIDE RADIUS TURN.



VIEW A

EXHIBIT 2-E1-39  
SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS



VIEW B

EXHIBIT 2-E1-39  
SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS

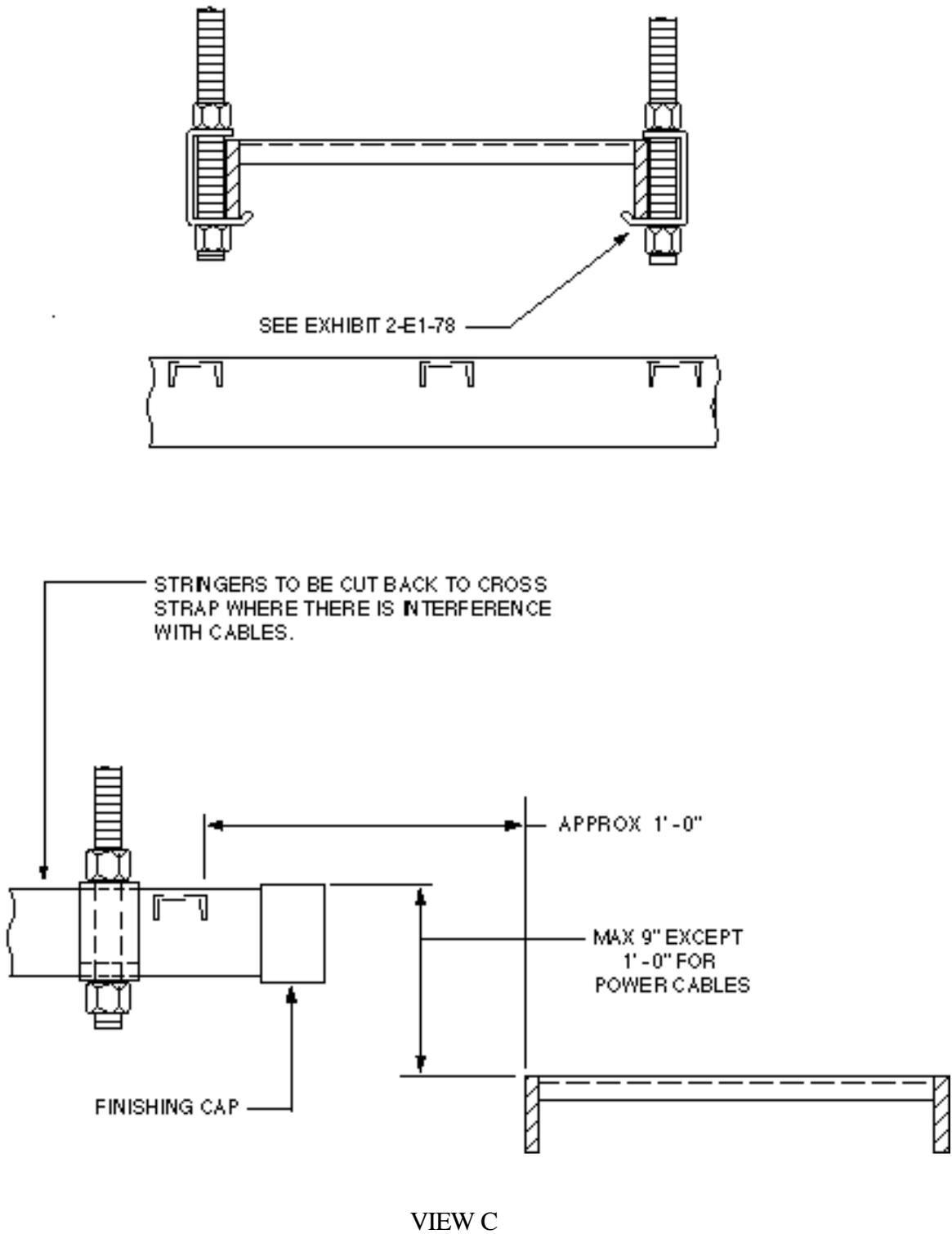


EXHIBIT 2-E1-39  
SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS

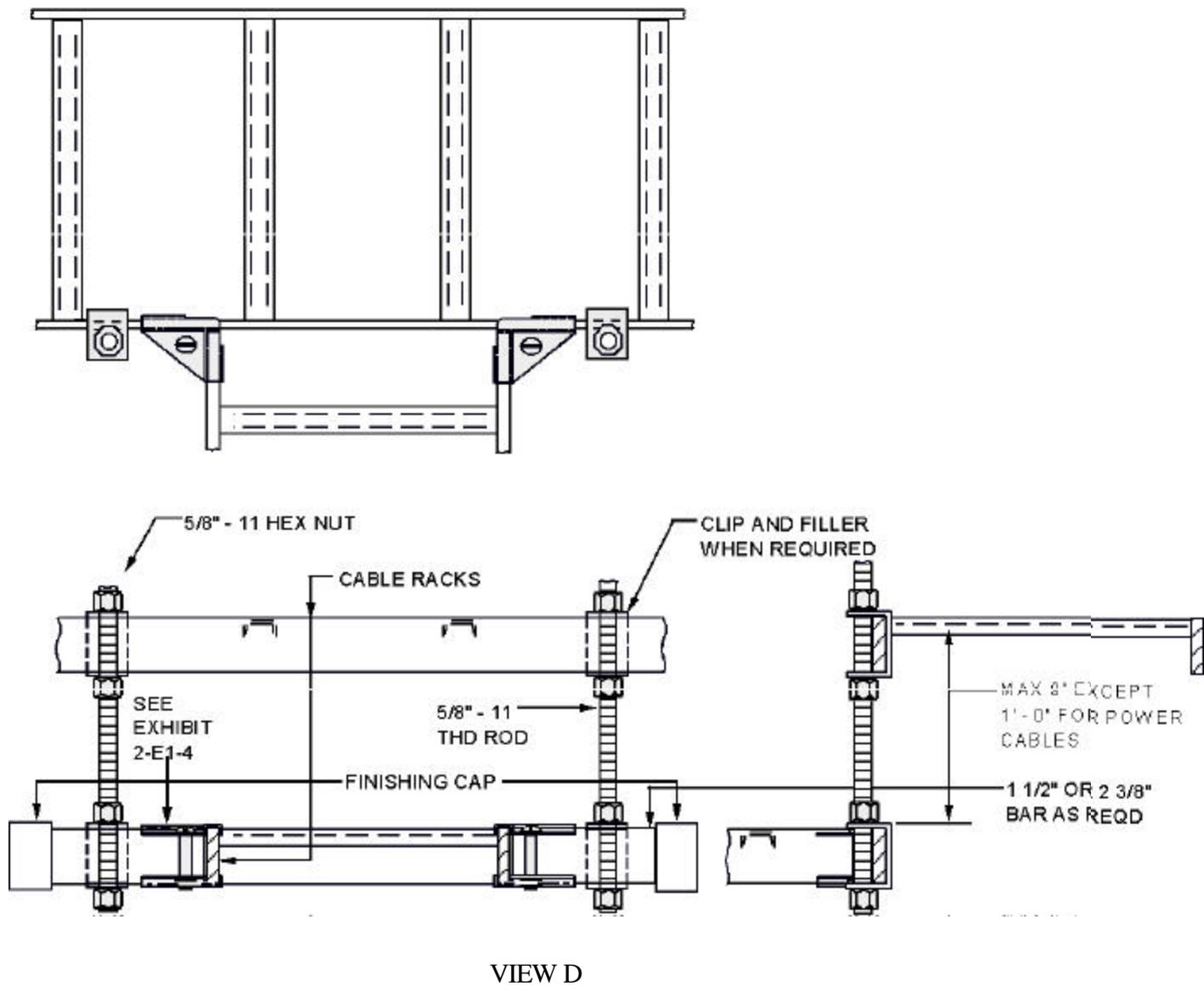
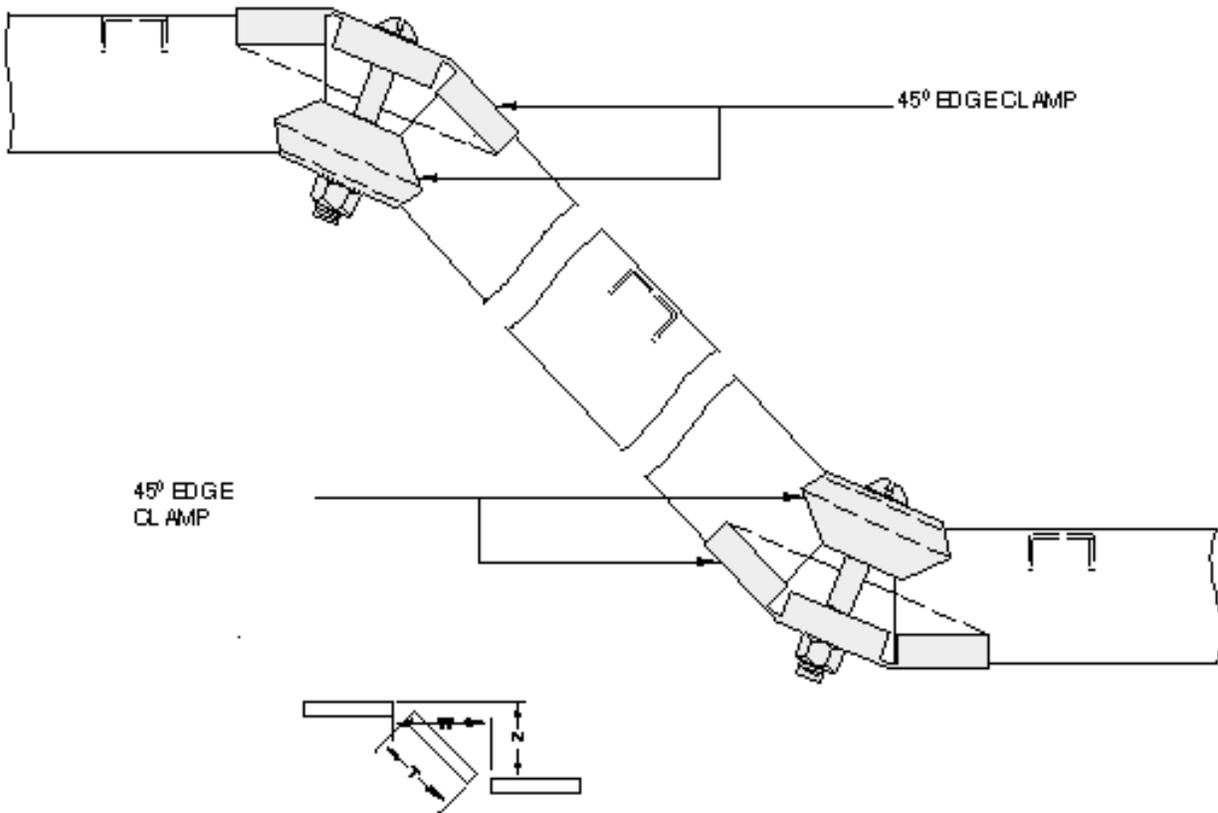


EXHIBIT 2-E1-39  
SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS

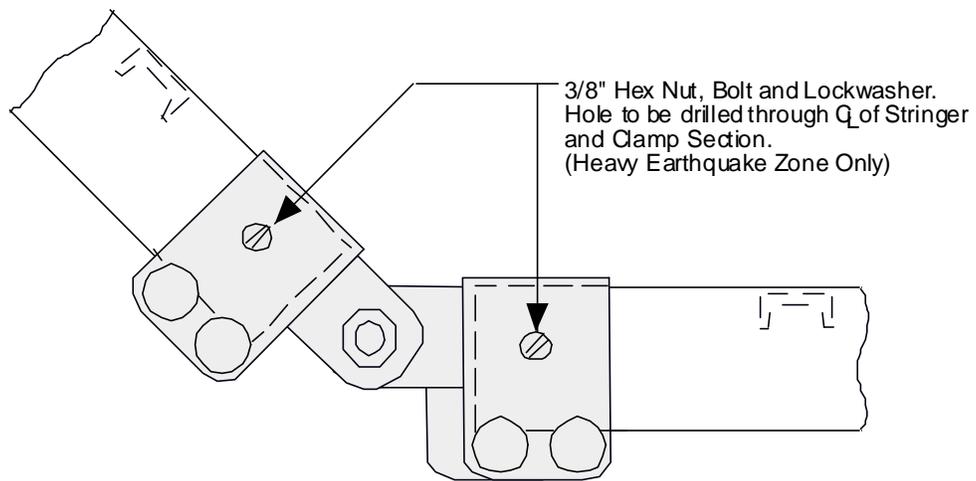


Z	Y	W
10"	1'-0 3/4"	11 1/4"
11"	1'-2 1/4"	1'-0 1/4"
1'-0"	1'-3 5/8"	1'-1 1/4"
1'-1"	1'-5"	1'-2 1/4"
1'-2"	1'-6 1/2"	1'-3 1/4"
1'-3"	1'-7 3/8"	1'-4 1/4"
1'-4"	1'-9 1/4"	1'-5 1/4"
1'-5"	1'-10 5/8"	1'-6 1/4"
1'-6"	2'-0 1/2"	1'-7 1/4"
1'-7"	2'-1 1/2"	1'-8 1/4"
1'-8"	2'-3"	1'-9 1/4"
1'-9"	2'-4 3/8"	1'-10 1/4"
1'-10"	2'-5 3/4"	1'-11 1/4"
1'-11"	2'-7 3/8"	2'-0 1/4"

Z	Y	W
2'-0"	2'-9 5/8"	2'-11 1/4"
2'-1"	2'-10"	2'-21 1/4"
2'-2"	2'-11 3/8"	2'-31 1/4"
2'-3"	3'-0 7/8"	2'-41 1/4"
2'-4"	3'-2 1/8"	2'-51 1/4"
2'-5"	3'-3 7/8"	2'-61 1/4"
2'-6"	3'-4 1/4"	2'-71 1/4"
2'-7"	3'-6 1/2"	2'-81 1/4"
2'-8"	3'-7 7/8"	2'-91 1/4"
2'-9"	3'-9 1/4"	2'-10 1/4"
2'-10"	3'-10 3/4"	2'-11 1/4"
2'-11"	4'-0 1/8"	3'-0 1/4"
3'-0"	4'-1 1/2"	3'-11 1/4"

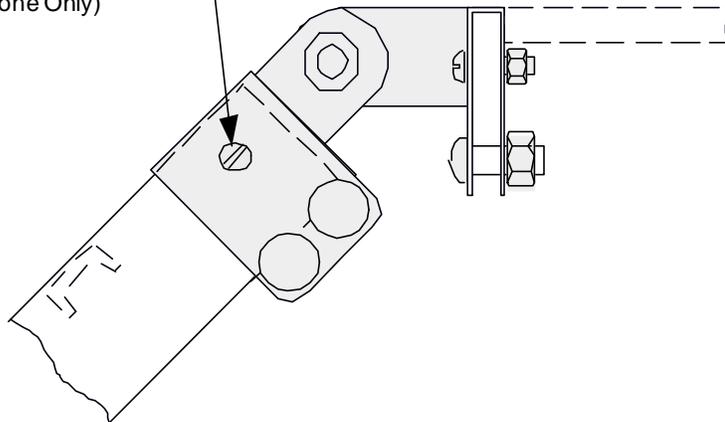
EXHIBIT 2-E1-40

OFFSET GREATER THAN 9 INCHES IN PARALLEL PLANES USING 45 DEGREE EDGE CLAMPS-LADDER-TYPE CABLE RACKS



2-E1-40A  
Adjustable Cable Rack Splice

3/8" Hex Nut, Bolt and Lockwasher.  
Hole to be drilled through  $\perp$  of Stringer  
and Clamp Section.  
(Heavy Earthquake Zone Only)



2-E1-40B  
Adjustable Cable Rack Splice, Right Angle

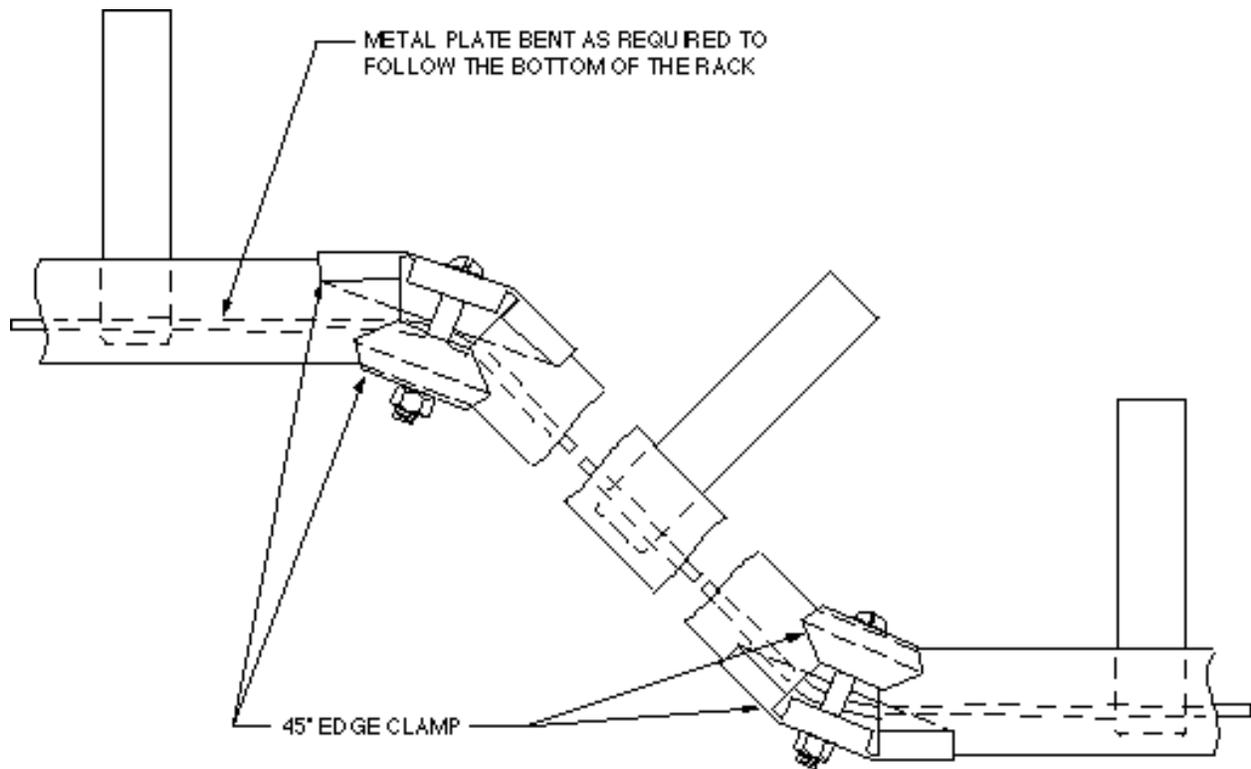


EXHIBIT 2-E1-40C (A&M)  
OFFSET GREATER THAN 9 INCHES IN PARALLEL PLANES USING 45 DEGREE EDGE  
CLAMPS-BAR-TYPE CABLE RACKS

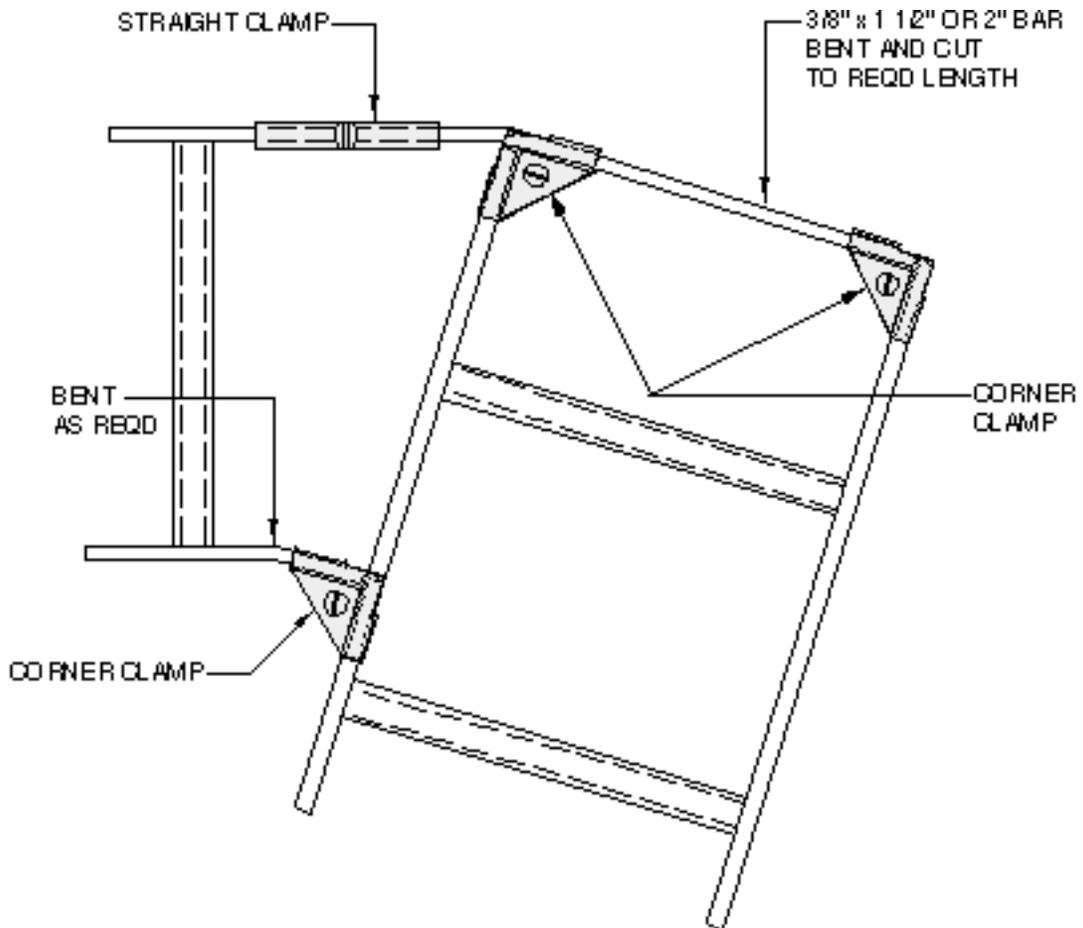


EXHIBIT 2-E1-41  
ACUTE-ANGLE TURN IN SAME PLANE

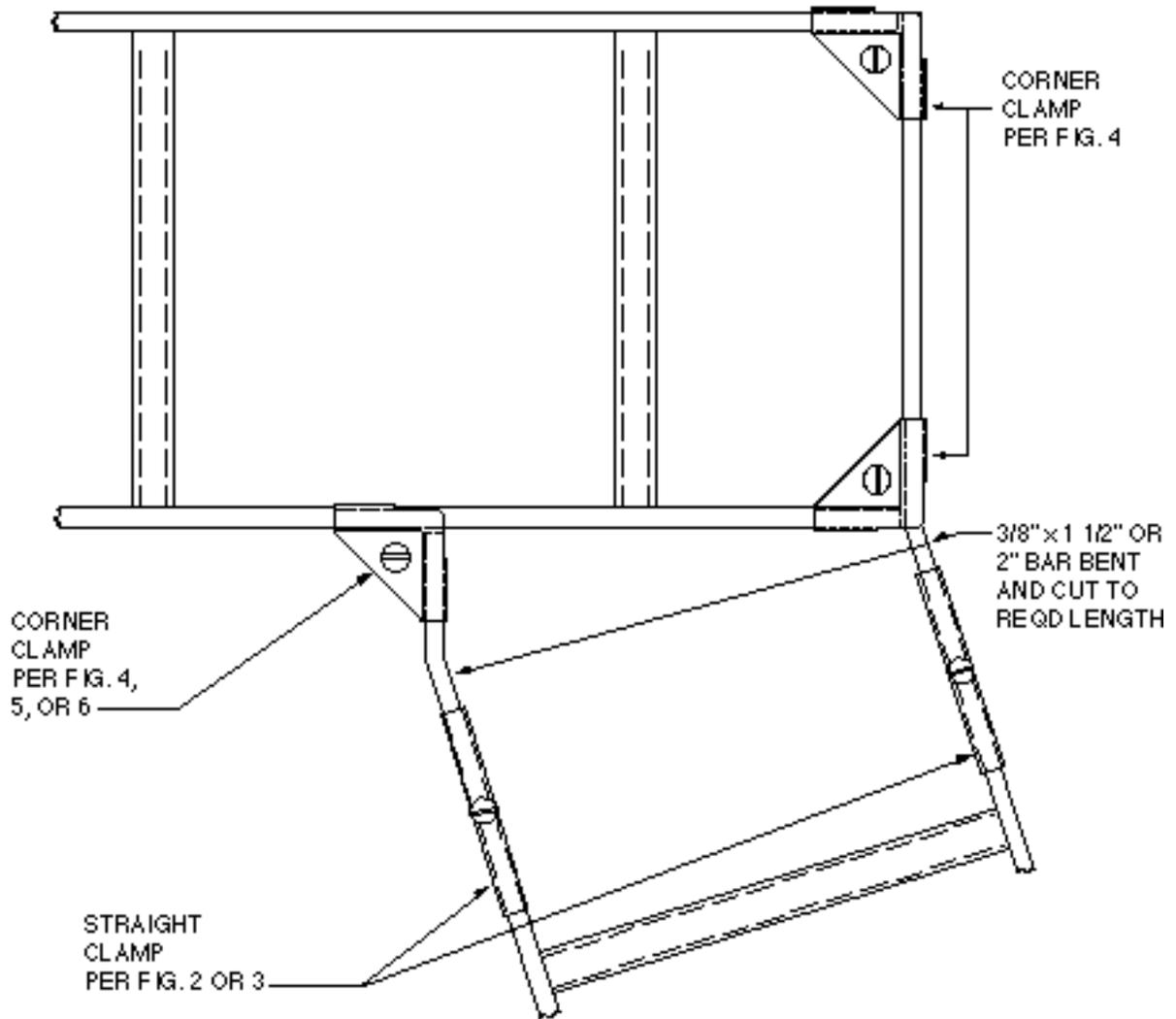


EXHIBIT 2-E1-42  
OBTUSE-ANGLE TURN IN SAME PLANE

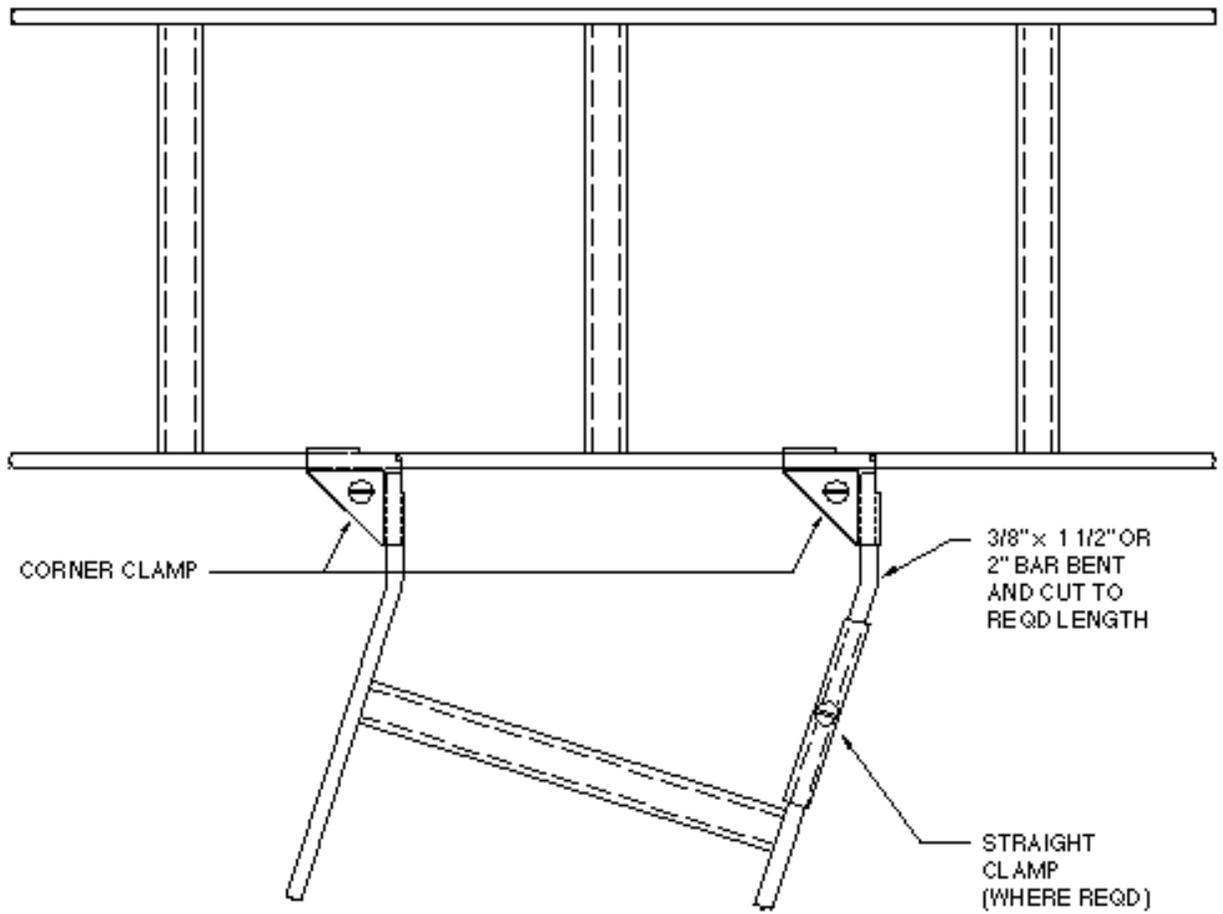
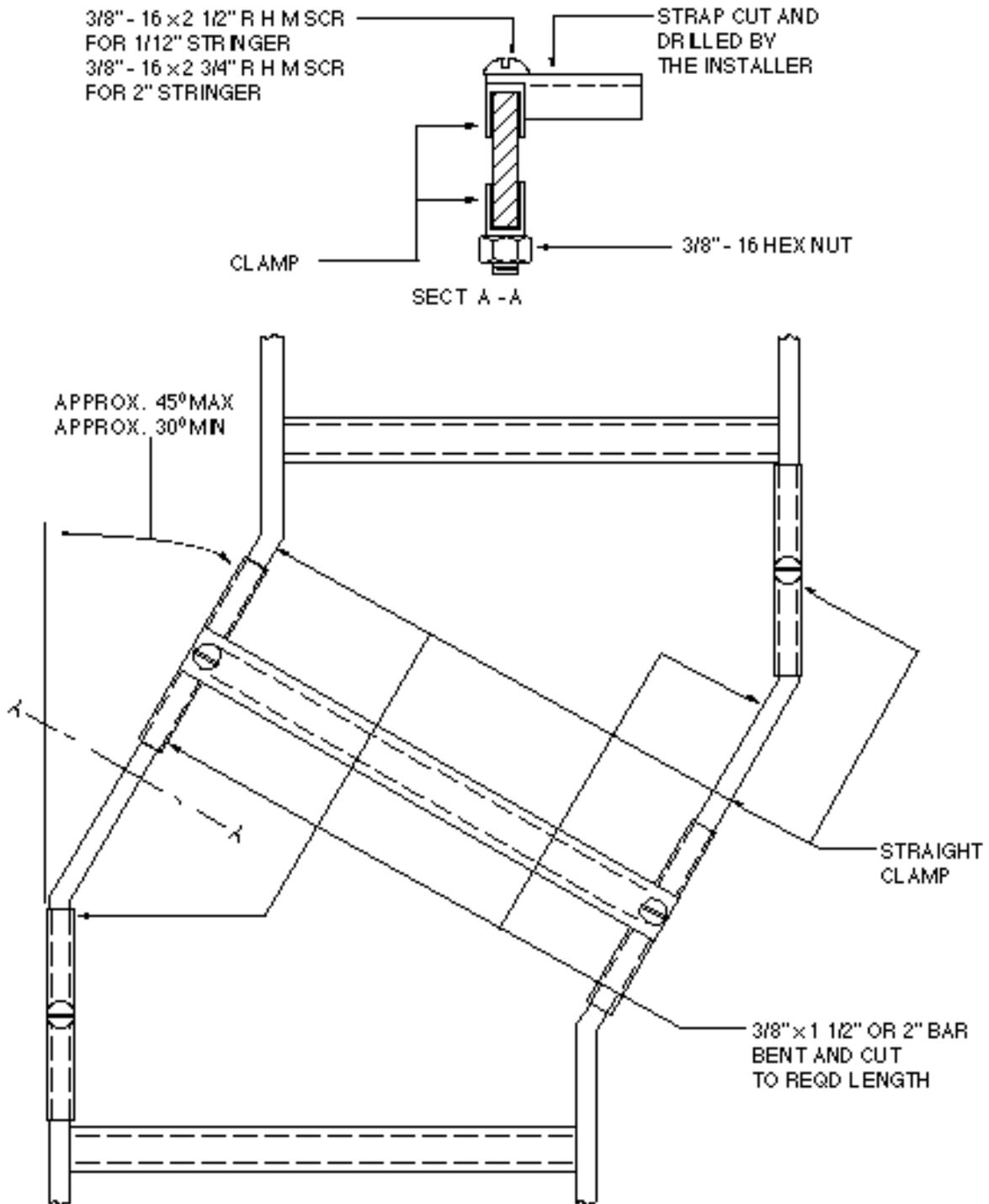


EXHIBIT 2-E1-43  
ACUTE-OR-OBTUSE-ANGLE TURN IN SAME PLANE



ONE STRAP IN OFFSET  
(A)

EXHIBIT 2-E1-52  
OFFSETS IN EXPOSED VERTICAL CABLE RACKS

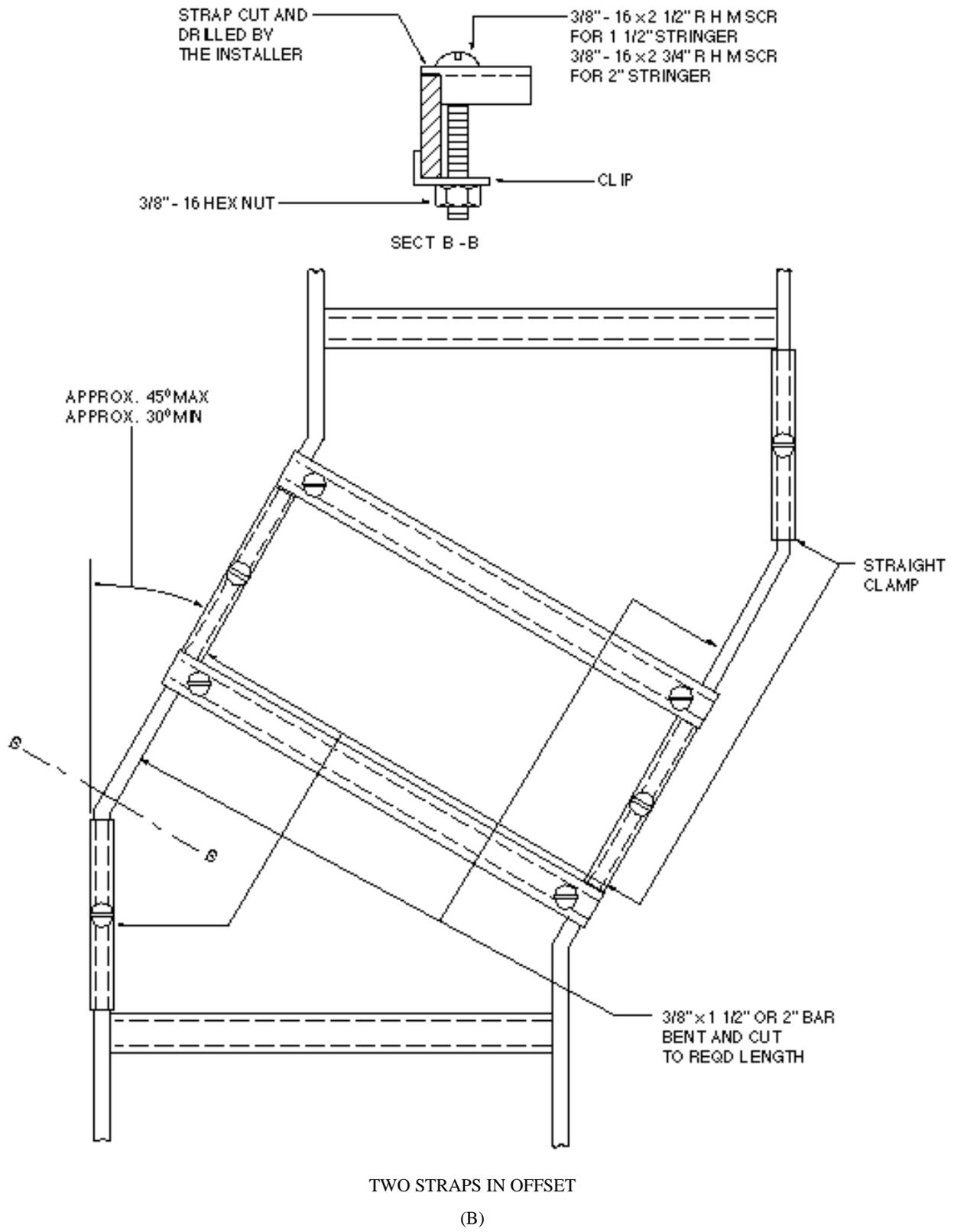
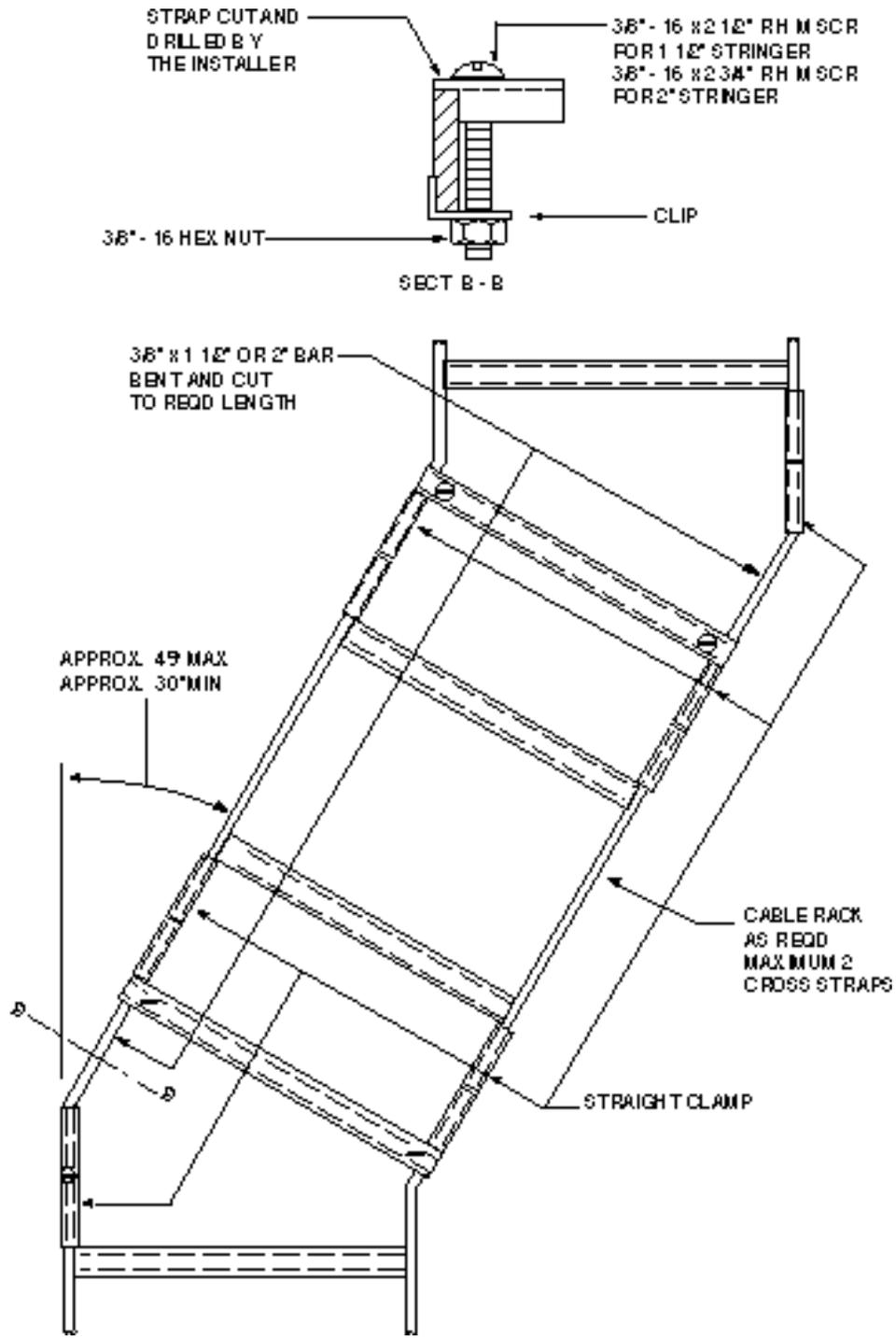
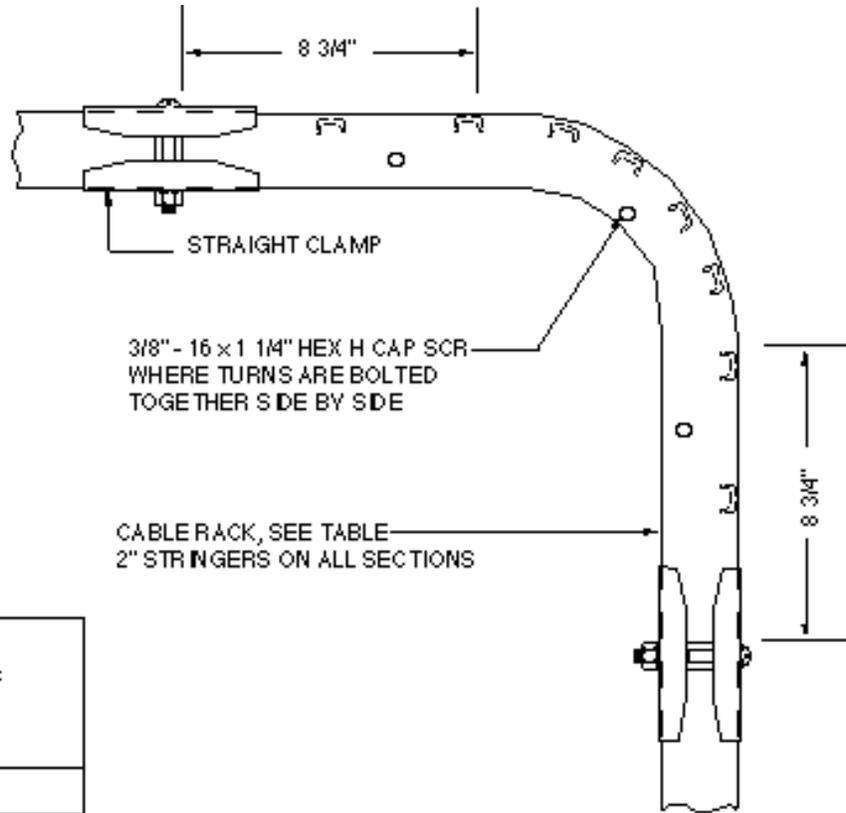


EXHIBIT 2-E1-52  
OFFSETS IN EXPOSED VERTICAL CABLE RACKS



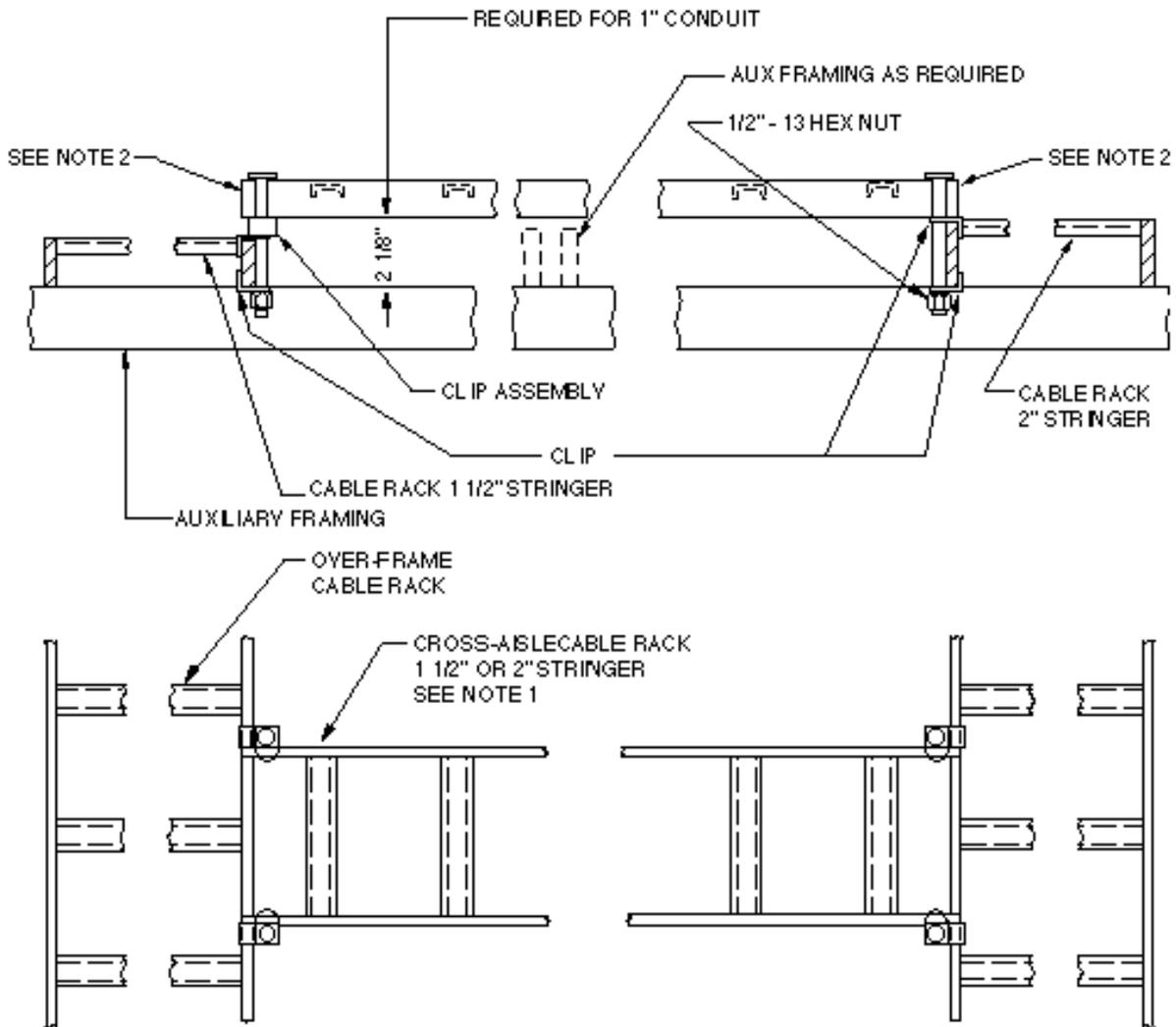
(C)

EXHIBIT 2-E1-52  
OFFSETS IN EXPOSED VERTICAL CABLE RACKS



WIDTH OF RACK	OUTSIDE RADIUS OF TURN
10"	7"
12"	7"
15"	7"
10"	14"
12"	14"
13"	14"

EXHIBIT 2-E1-53  
 CABLE RACK TURN FOR POWER CABLE RUNS



NOTES:

1. CROSS-AISLE CABLE RACKS LONGER THAN 12 INCHES SHALL HAVE AT LEAST TWO CROSS STRAPS.
2. PVC PROTECTION SHALL BE PROVIDED ON THE ENDS OF CROSS-AISLE CABLE RACK STRINGERS.

EXHIBIT 2-E1-54

CROSS-AISLE CABLE RACKS RUN NONCONTINUOUSLY OVER-AISLES AT HIGHER LEVEL THAN OVER-FRAME RACKS INTERSECTION

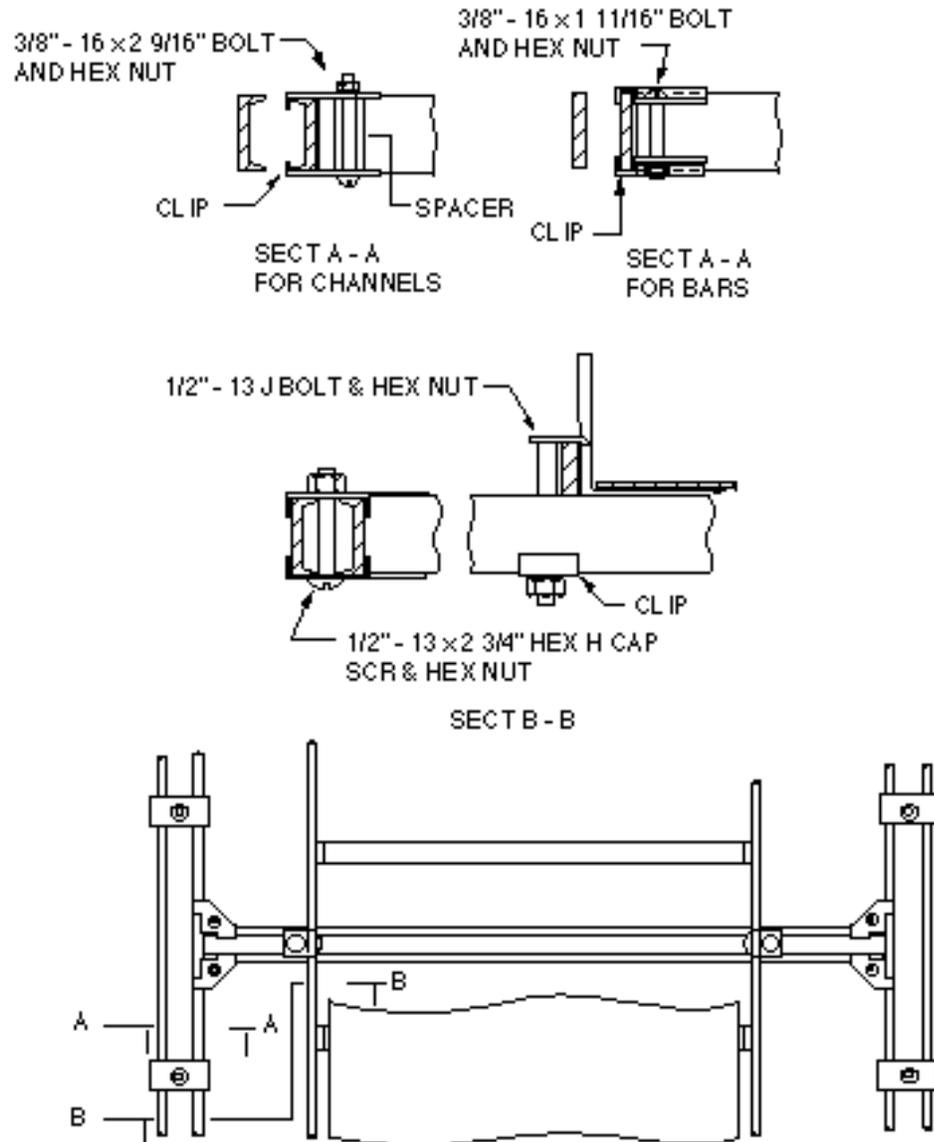
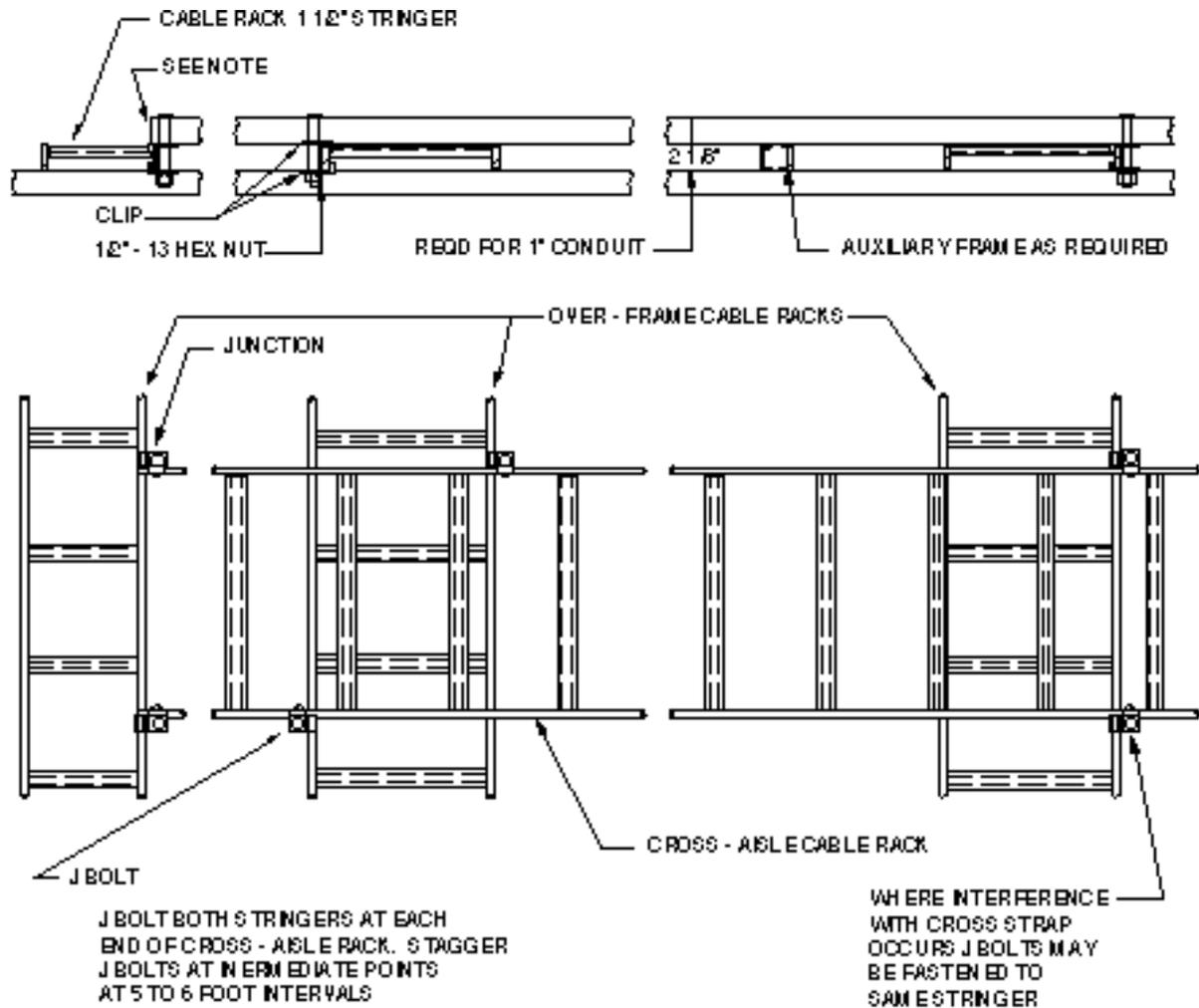


EXHIBIT 2-E1-54E (A&M)  
BAR-TYPE CROSS-AISLE CABLE RACKS SUPPORTED BY AUXILIARY FRAMING  
WHERE A ROW OF FRAMES IS OMITTED



NOTE:

PVC PROTECTION SHALL BE PROVIDED ON THE ENDS OF CROSS-AISLE CABLE RACK STRINGERS

EXHIBIT 2-E1-54F  
 CROSS-AISLE CABLE RACKS RUN CONTINUOUSLY OVER AISLE AT HIGHER  
 LEVEL THAN OVER-FRAME RACKS

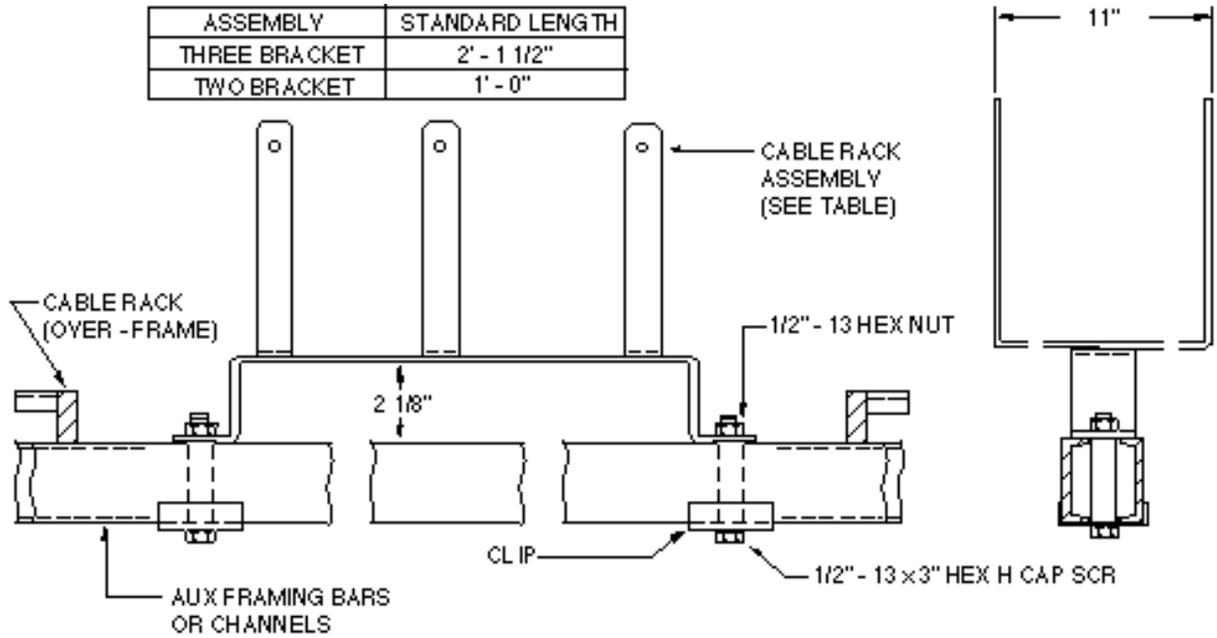


EXHIBIT 2-E1-55 (DISCONTINUED)  
 CABLE RACKS OVER AISLES WHERE CABLE IS NOT EXCEPTIONALLY HEAVY

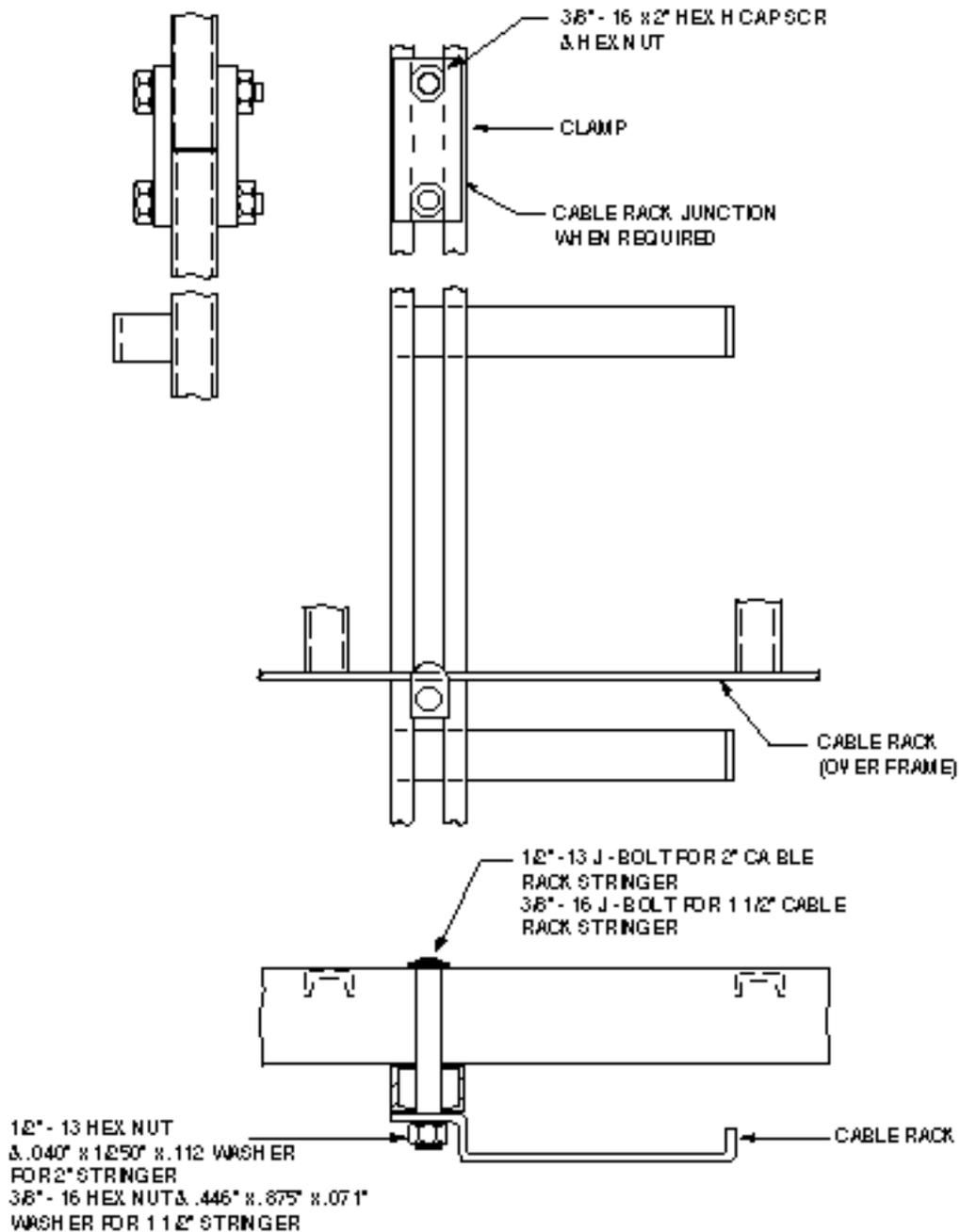


EXHIBIT 2-E1-56 (DISCONTINUED)  
CABLE RACK FOR POWER CABLES WITHOUT MAIN-AISLE OR END-AISLE  
CABLE RACK (REPLACED BY EXHIBIT 2-E1-56B)

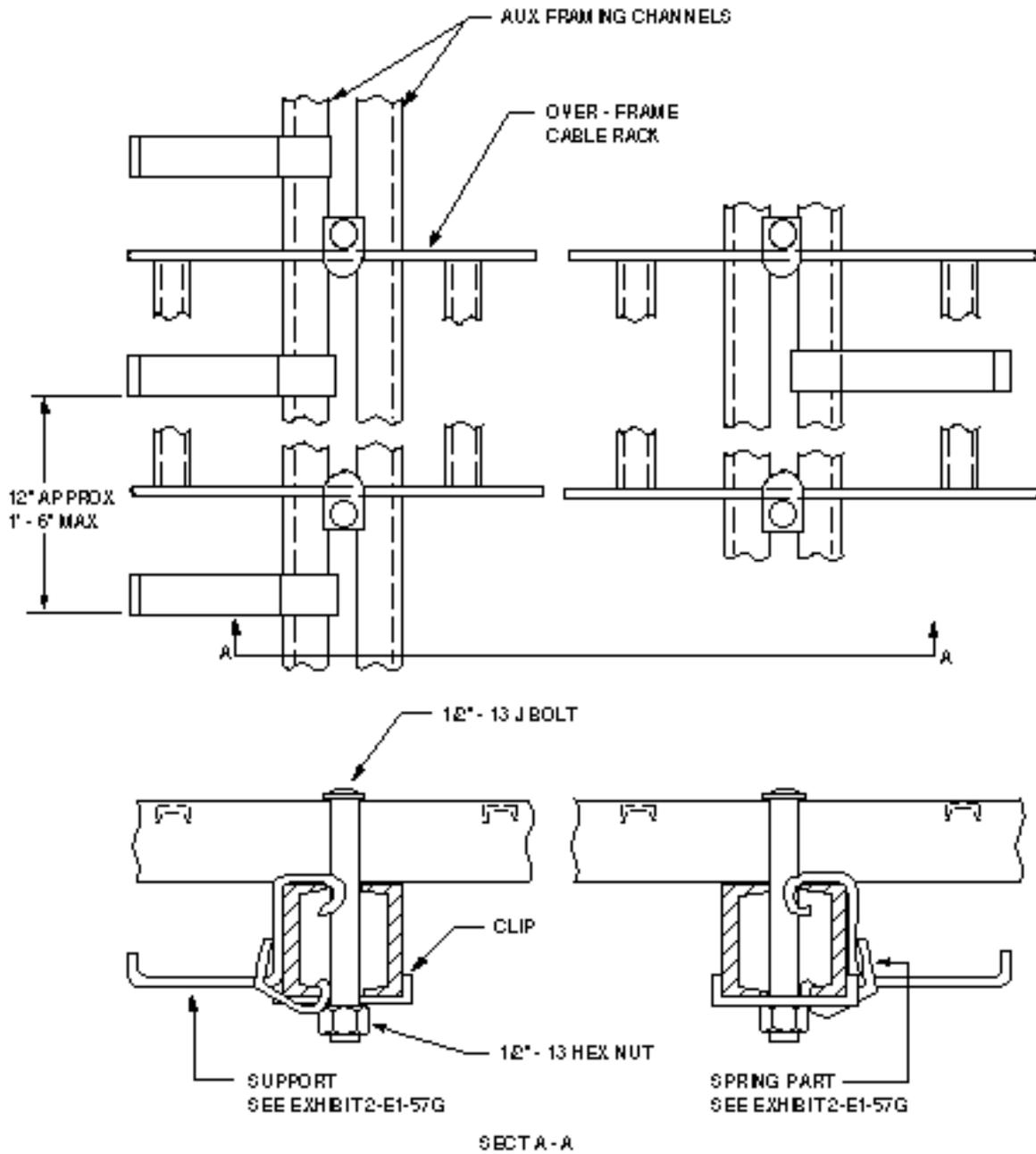
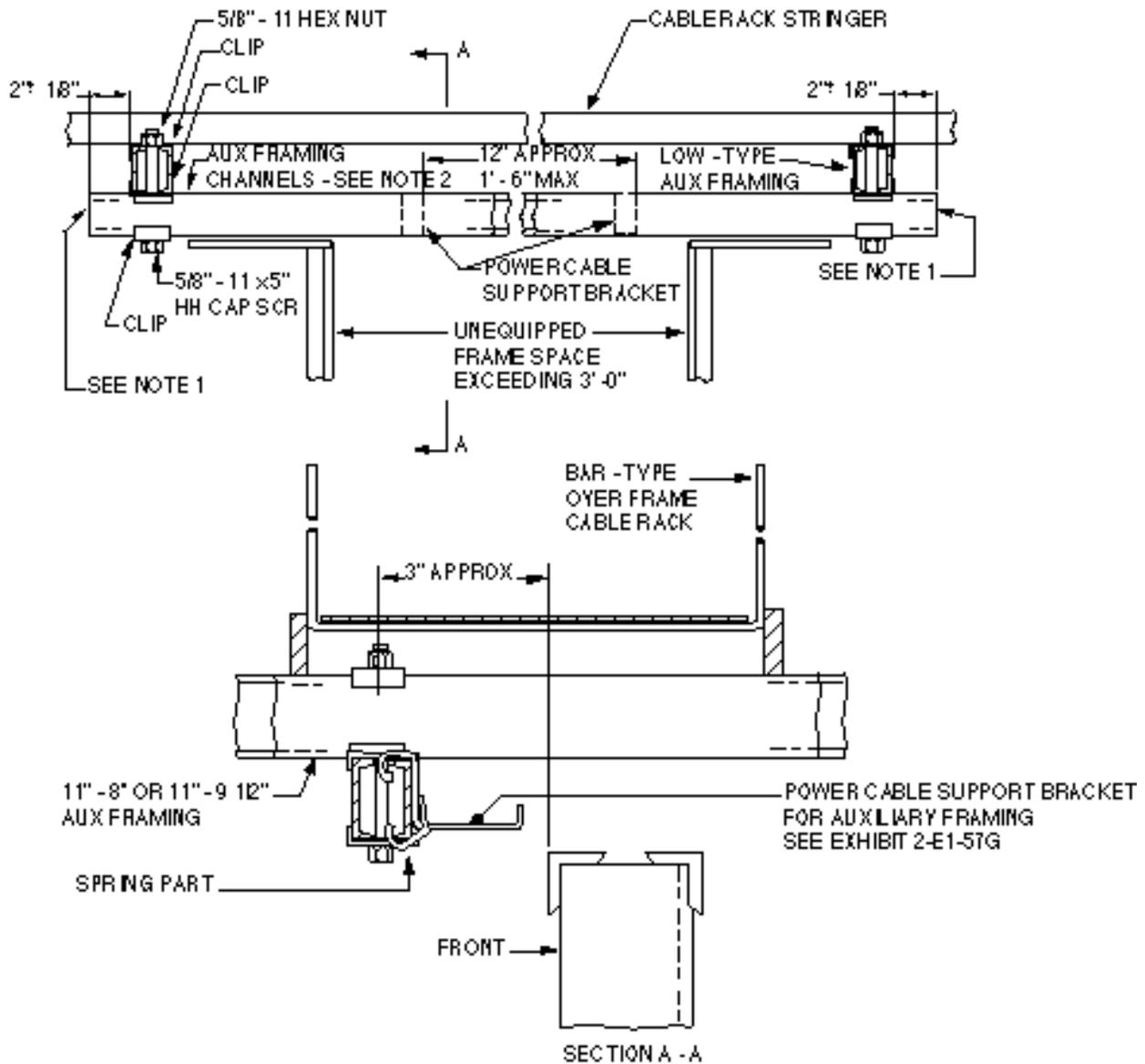


EXHIBIT 2-E1-56B  
POWER CABLE SUPPORT BRACKET FOR POWER CABLES WITHOUT MAIN-AISLE OR  
END-AISLE CABLE RACK



NOTES:

1. ENDS OF AUX FRAMING CHANNELS (FOR POWER CABLE SUPPORT BRACKETS) SHALL BE CLOSED WITH FINISHING CLIPS.
2. AUX FRAMING CHANNELS FOR POWER CABLE SUPPORT BRACKETS SHALL BE SUPPORTED FROM REGULAR AUX FRAMING AT EACH INTERSECTION. SPLICES ARE NOT REQUIRED IF POWER CABLE SUPPORT AUX FRAMING CHANNELS ARE SUPPORTED IN AT LEAST TWO PLACES. OTHERWISE, SPLICE.

EXHIBIT 2-E1-56C (A&M)

POWER CABLE SUPPORT BRACKET FOR SUPPORTING FRAME LINE POWER FEEDERS WHERE INTERMEDIATE FRAMES ARE OMITTED AND GAP EXCEEDS 3 FEET 0 INCHES-STEP-BY-STEP, NO. 1 CROSSBAR, AND CROSSBAR TANDEM SYSTEMS-11 FOOT 8 INCH OR 11 FOOT 9 1/2 INCH AUXILIARY FRAMING

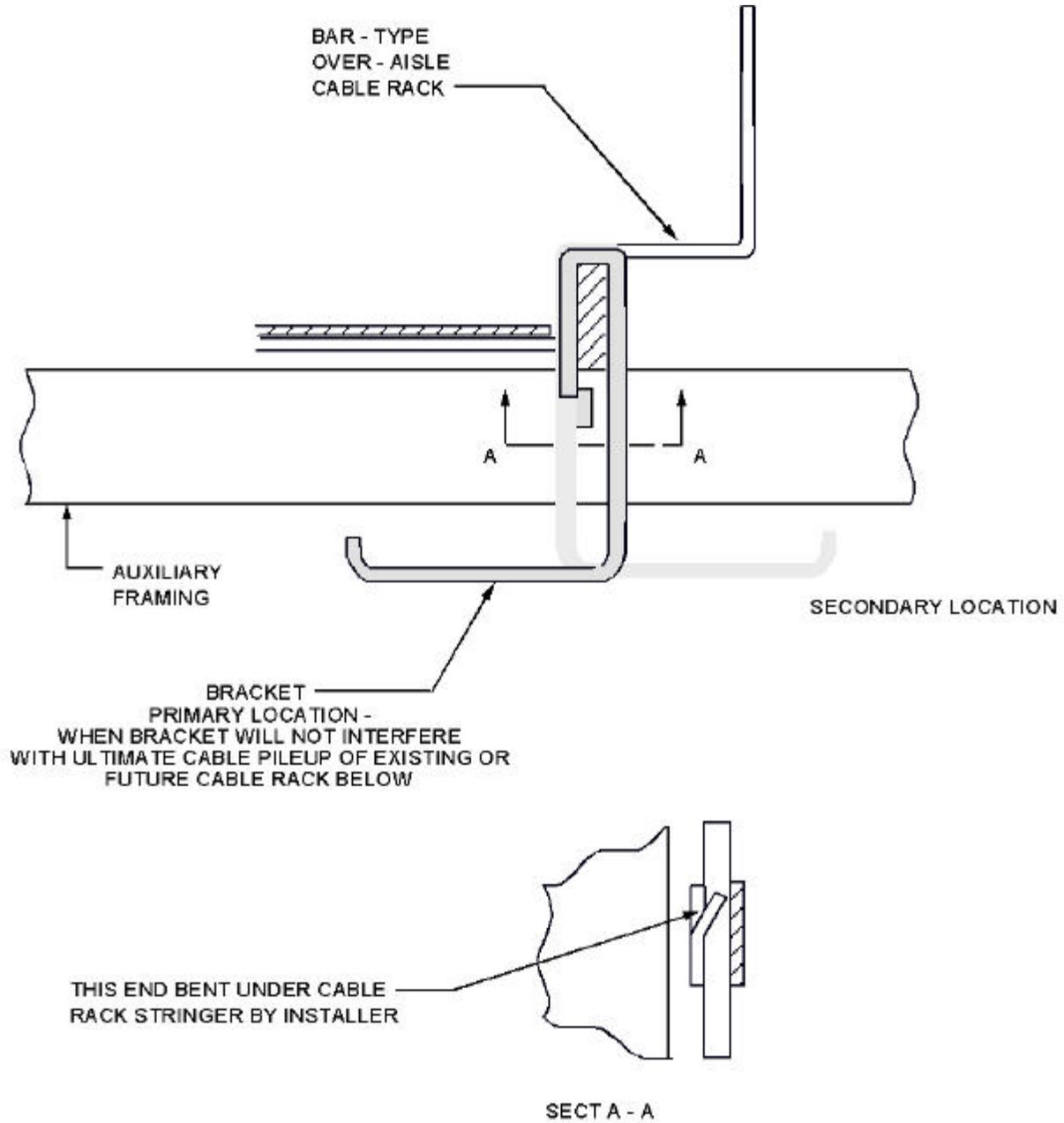


EXHIBIT 2-E1-57E (A&M)  
POWER CABLE BRACKET ATTACHED TO BAR-TYPE OVER-AISLE CABLE RACK

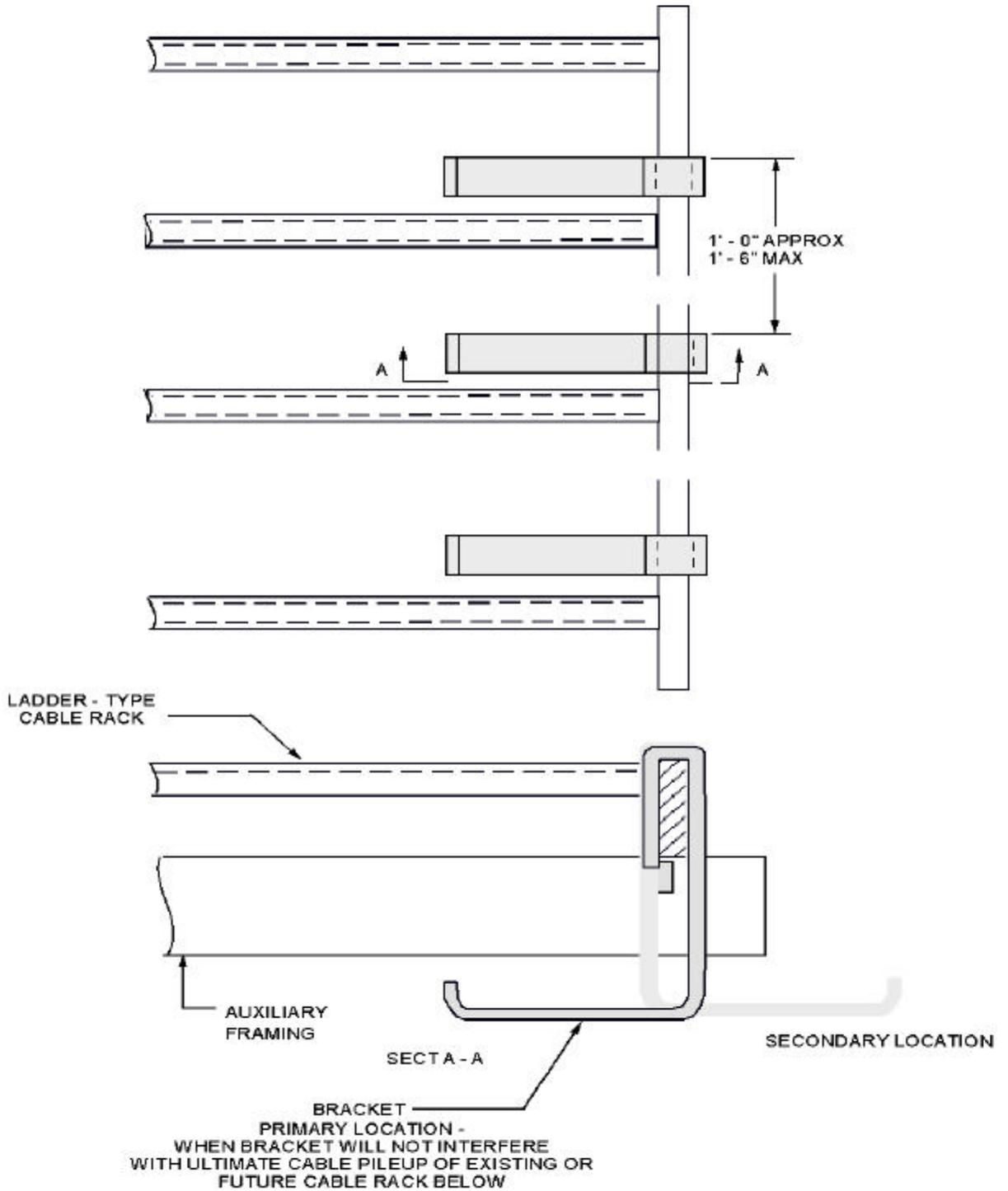
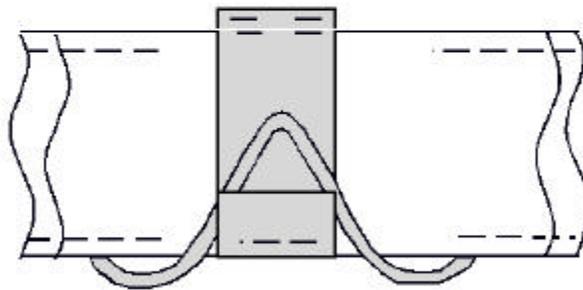
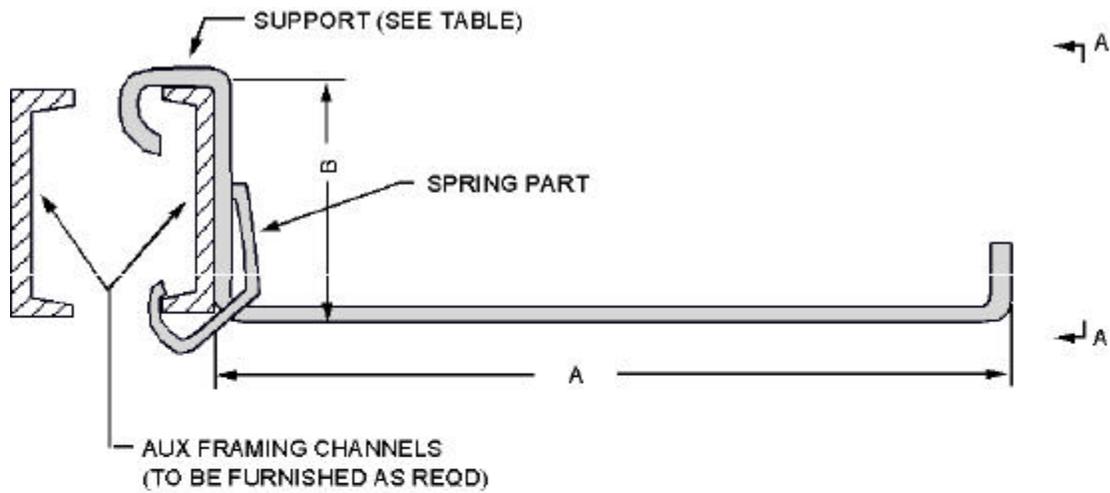


EXHIBIT 2-E1-57F  
POWER CABLE BRACKET ATTACHED TO LADDER-TYPE CABLE RACK

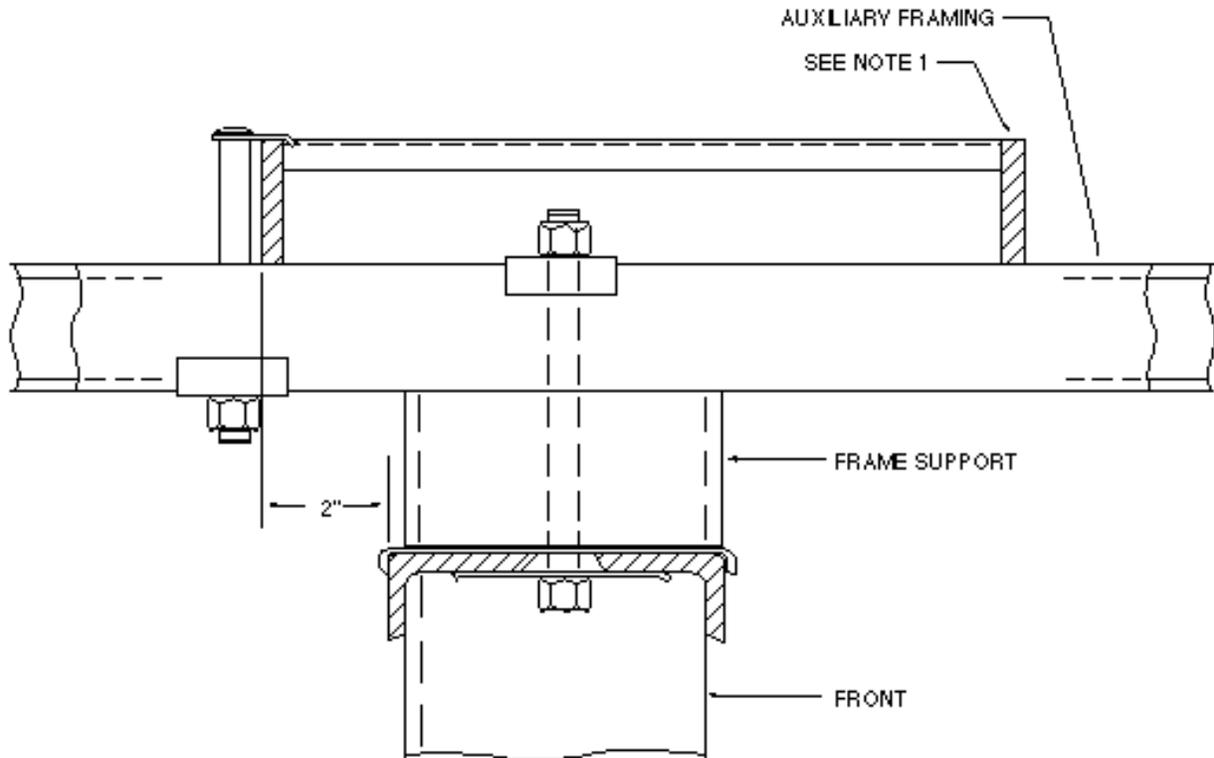


VIEW A - A

DIM A	DIM B	FRAMING HEIGHT
7.42"	3.06"	11' - 8"
2.67"	3.75"	11' - 9 1/2"

EXHIBIT 2-E1-57G  
 POWER CABLE SUPPORT BRACKET ATTACHED TO AUXILIARY FRAMING  
 WITH RETAINING SPRING





NOTE:

1. TWO J-BOLTS SHOULD BE USED WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME.

EXHIBIT 2-E1-62H (A&M)  
LOCATION OF LADDER-TYPE CABLE RACK OVER BULB-ANGLE  
TYPE FRAMES

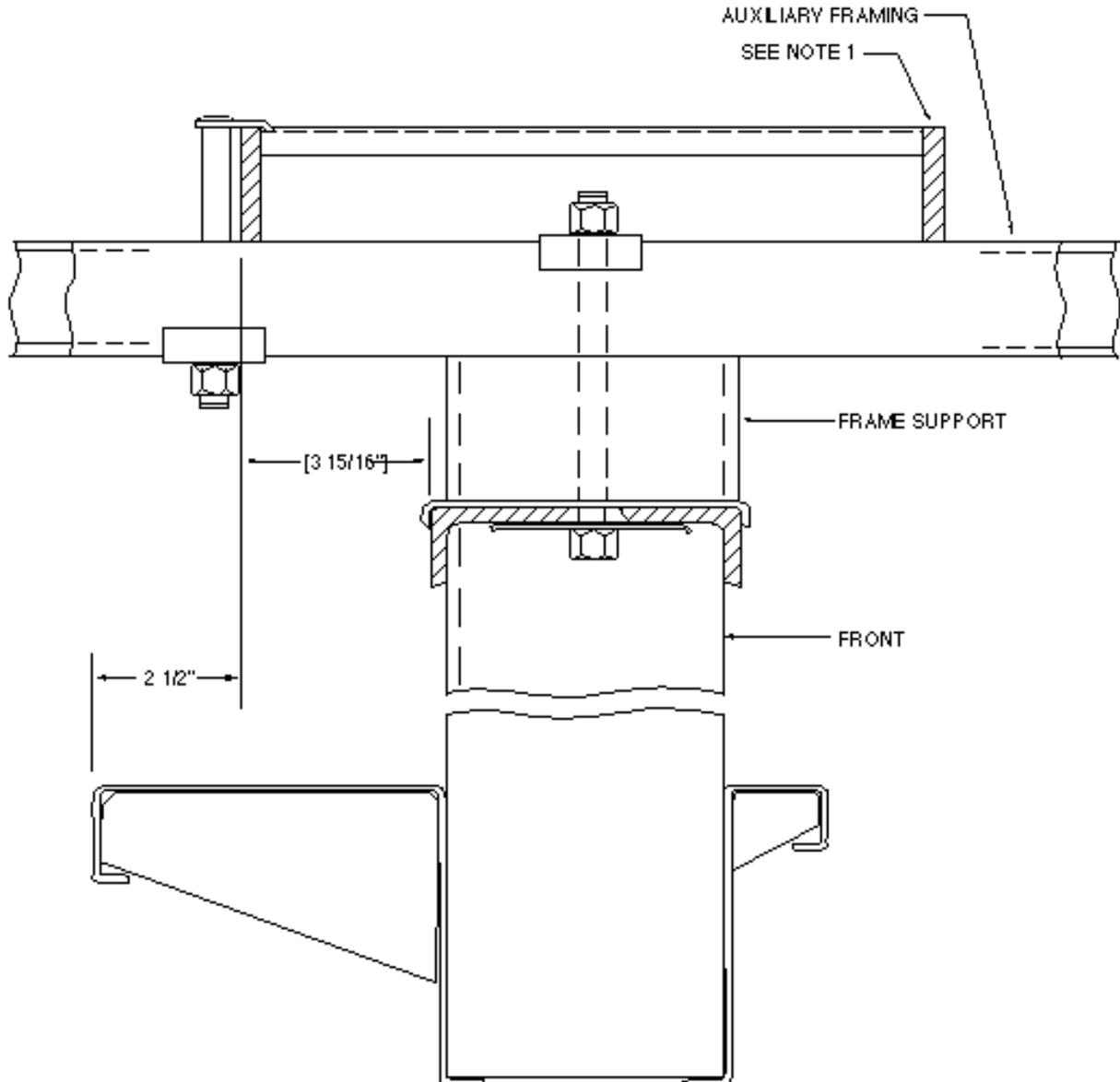


EXHIBIT 2-E1-62J (A&M)  
LOCATION OF LADDER-TYPE CABLE RACK OVER BULB-ANGLE TYPE FRAMES  
ADJACENT TO BULB-ANGLE TYPE STEP-BY-STEP FRAMES

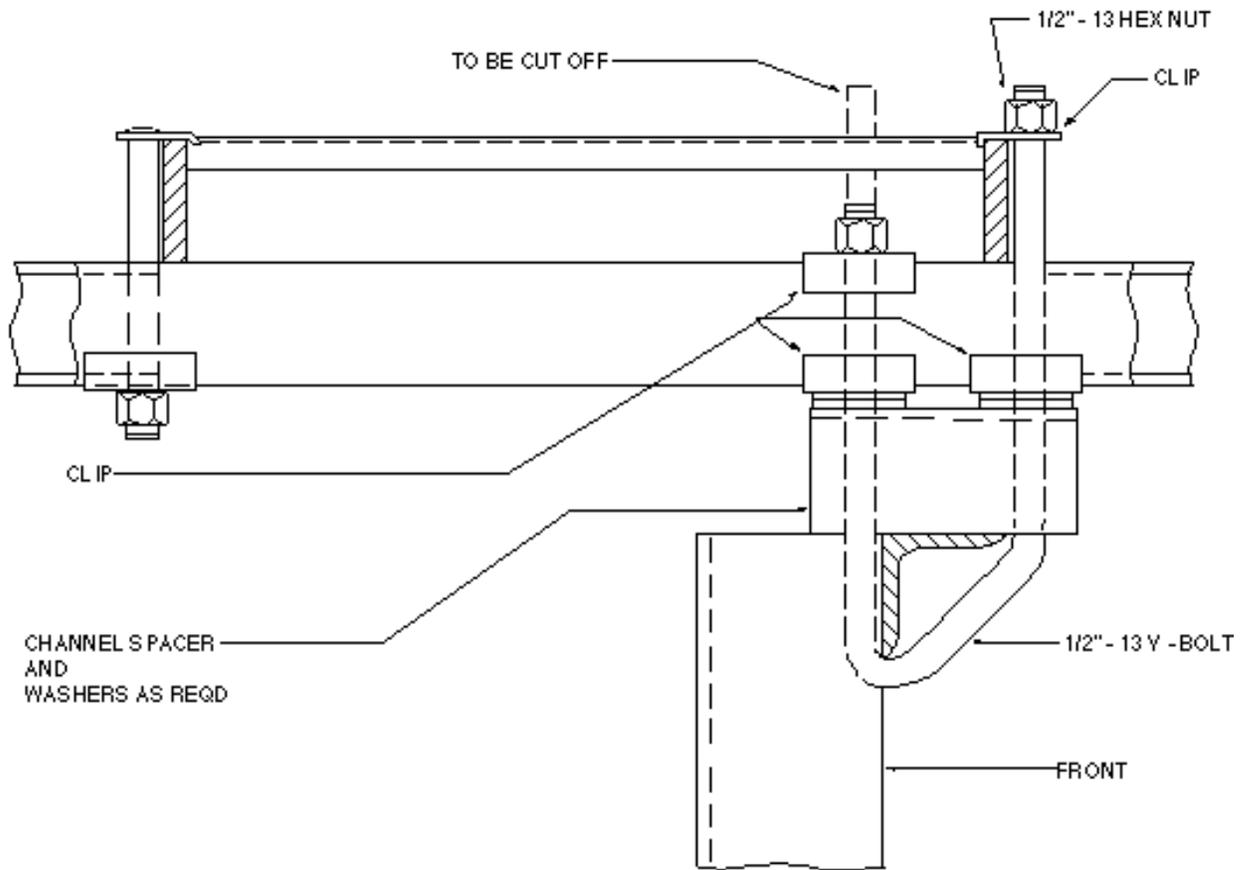
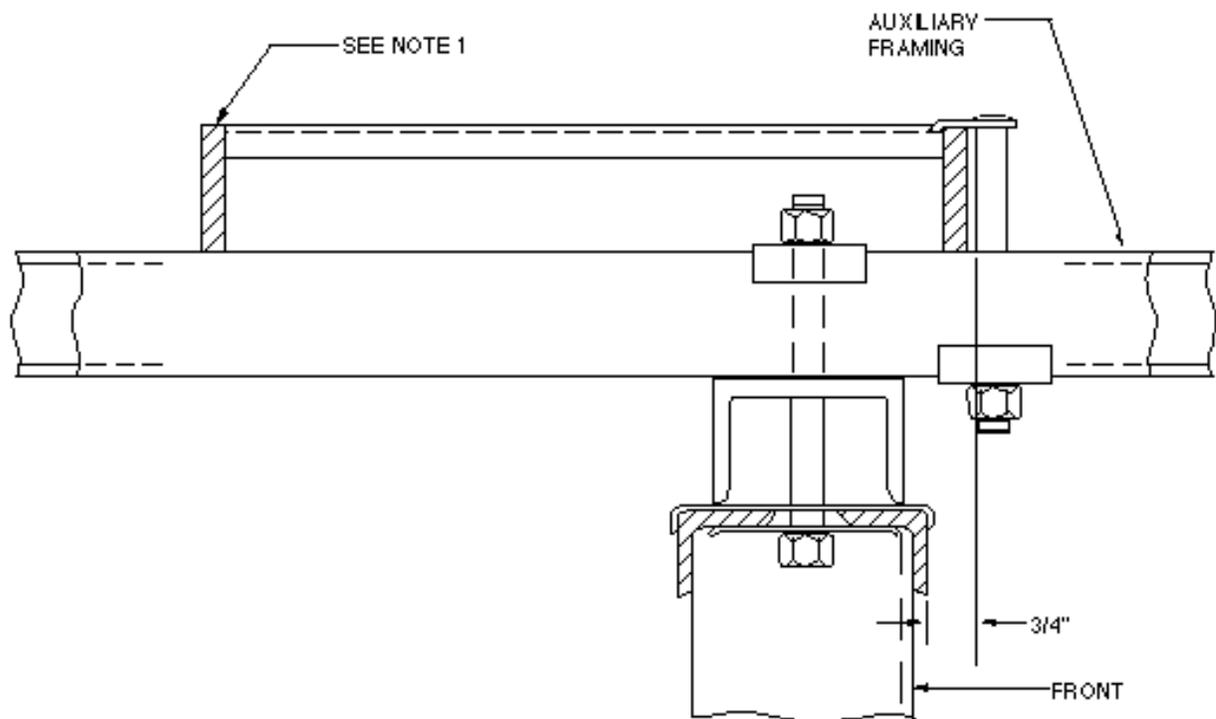


EXHIBIT 2-E1-62K  
LADDER-TYPE CABLE RACK OVER REAR OF CHANNEL-TYPE RELAY RACK-  
STEP-BY-STEP SYSTEMS-11 FOOT 8 INCH FRAMING-ADDITIONS ONLY



NOTE:

1. WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME, TWO BOLTS SHOULD BE USED.

EXHIBIT 2-E1-62L (A&M)  
CABLE RACKS OVER AISLES WHERE CABLE IS NOT  
EXCEPTIONALLY HEAVY

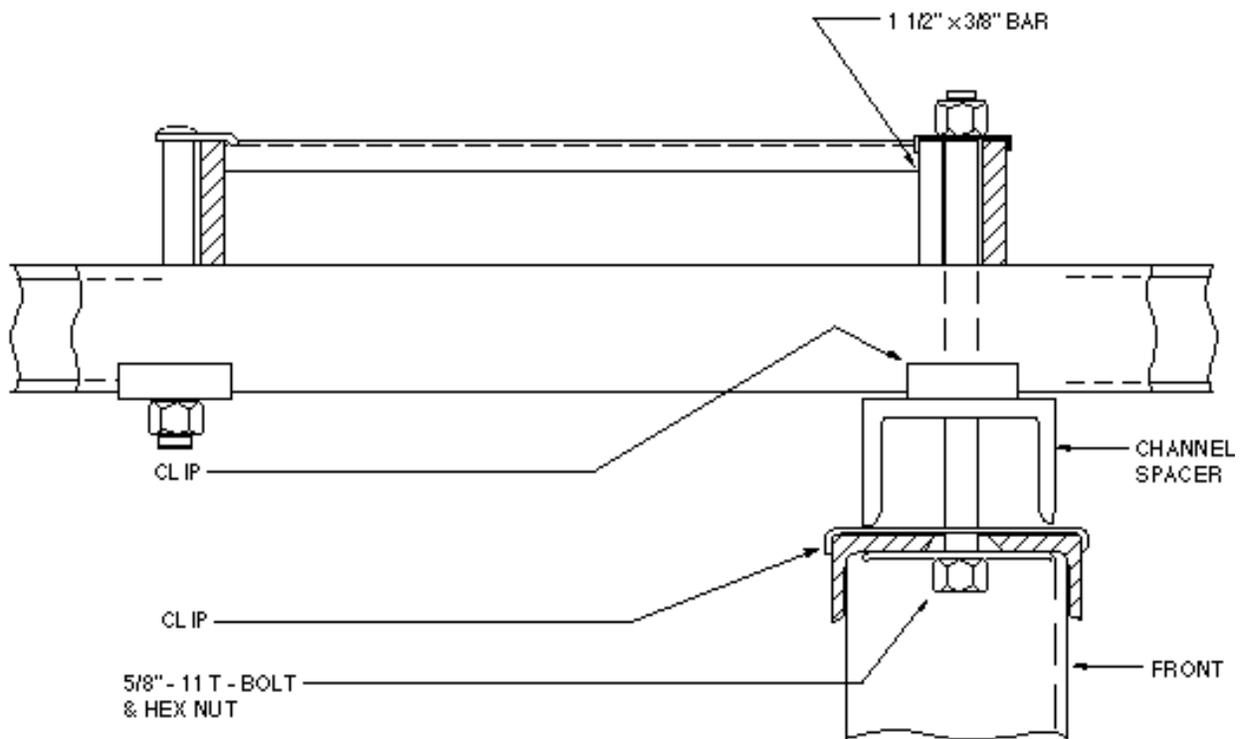


EXHIBIT 2-E1-62M (A&M)  
LADDER-TYPE CABLE RACK OVER REAR OF BULB-ANGLE TYPE FRAMES  
ADJACENT TO CHANNEL-TYPE STEP-BY-STEP FRAMES 11 FOOT 8 INCH  
FRAMING-ADDITIONS ONLY

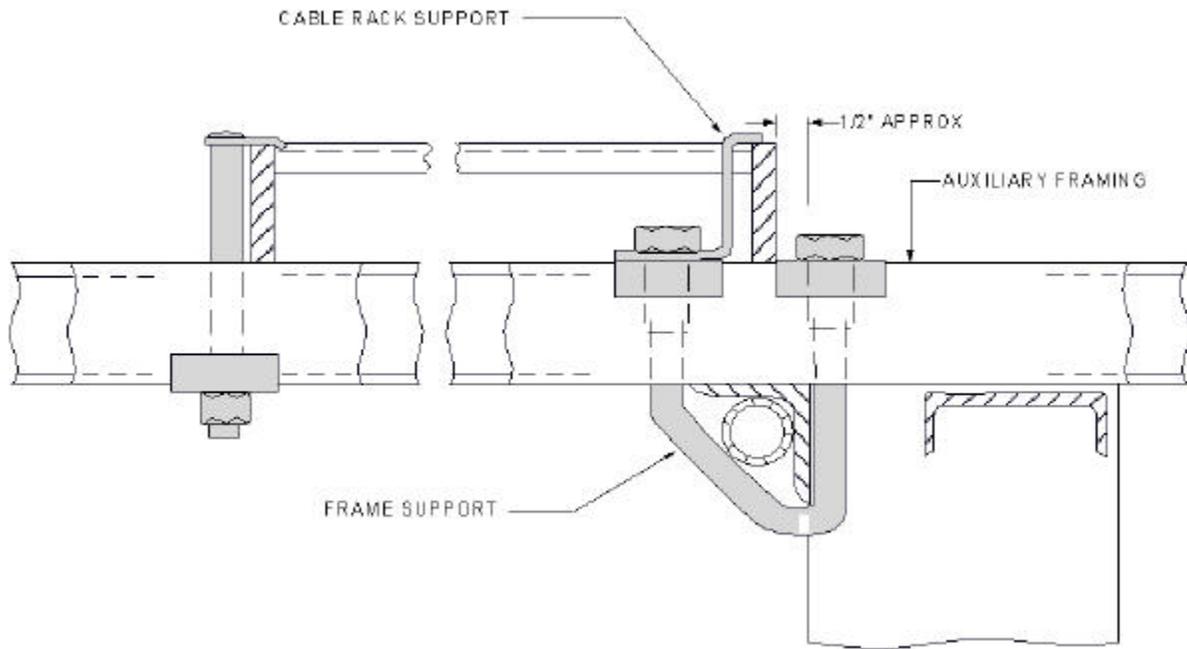


EXHIBIT 2-E1-62N  
LADDER-TYPE CABLE RACK OVER DUCT TYPE FRAMES-11 FOOT 6 INCH FRAMING

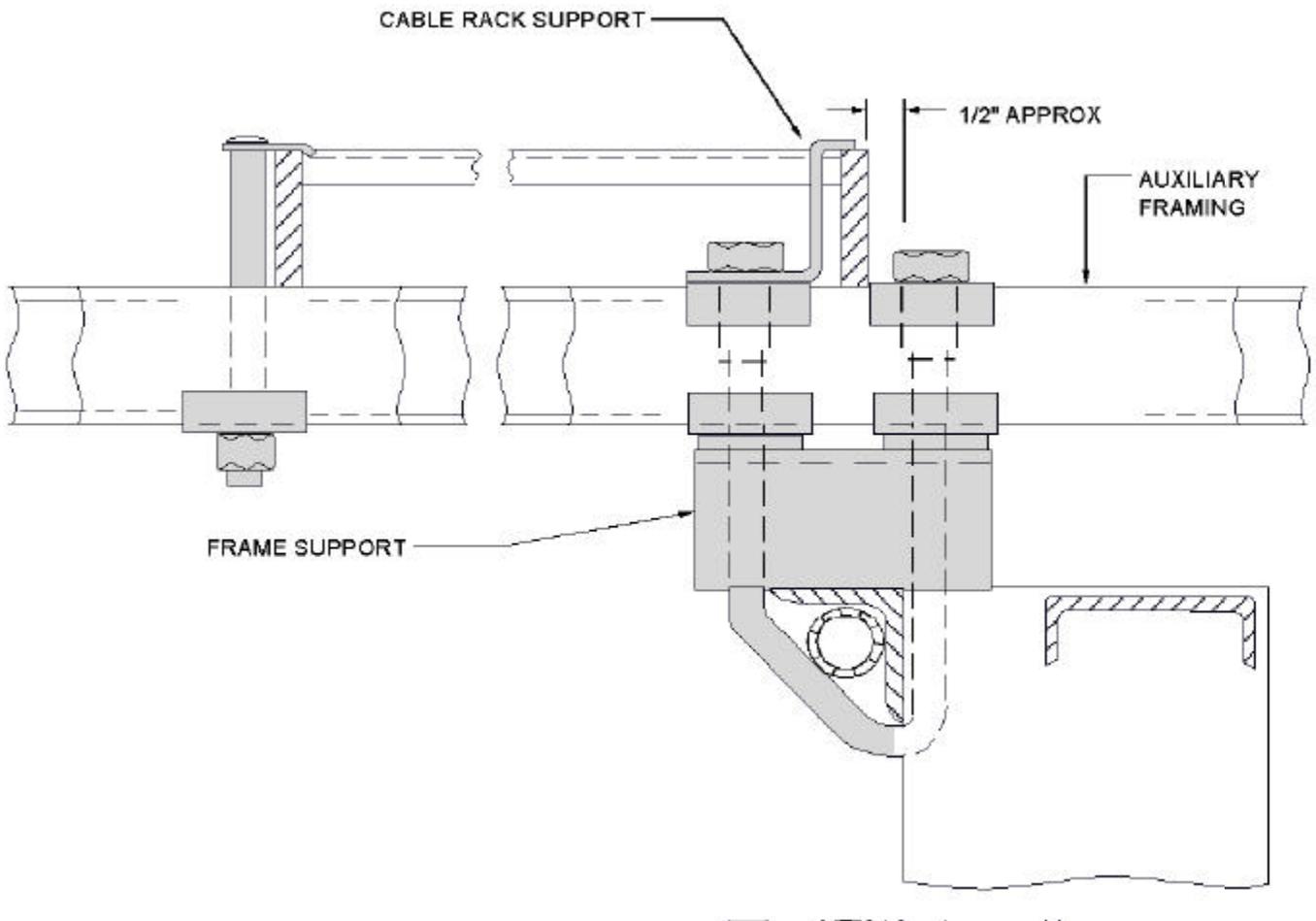
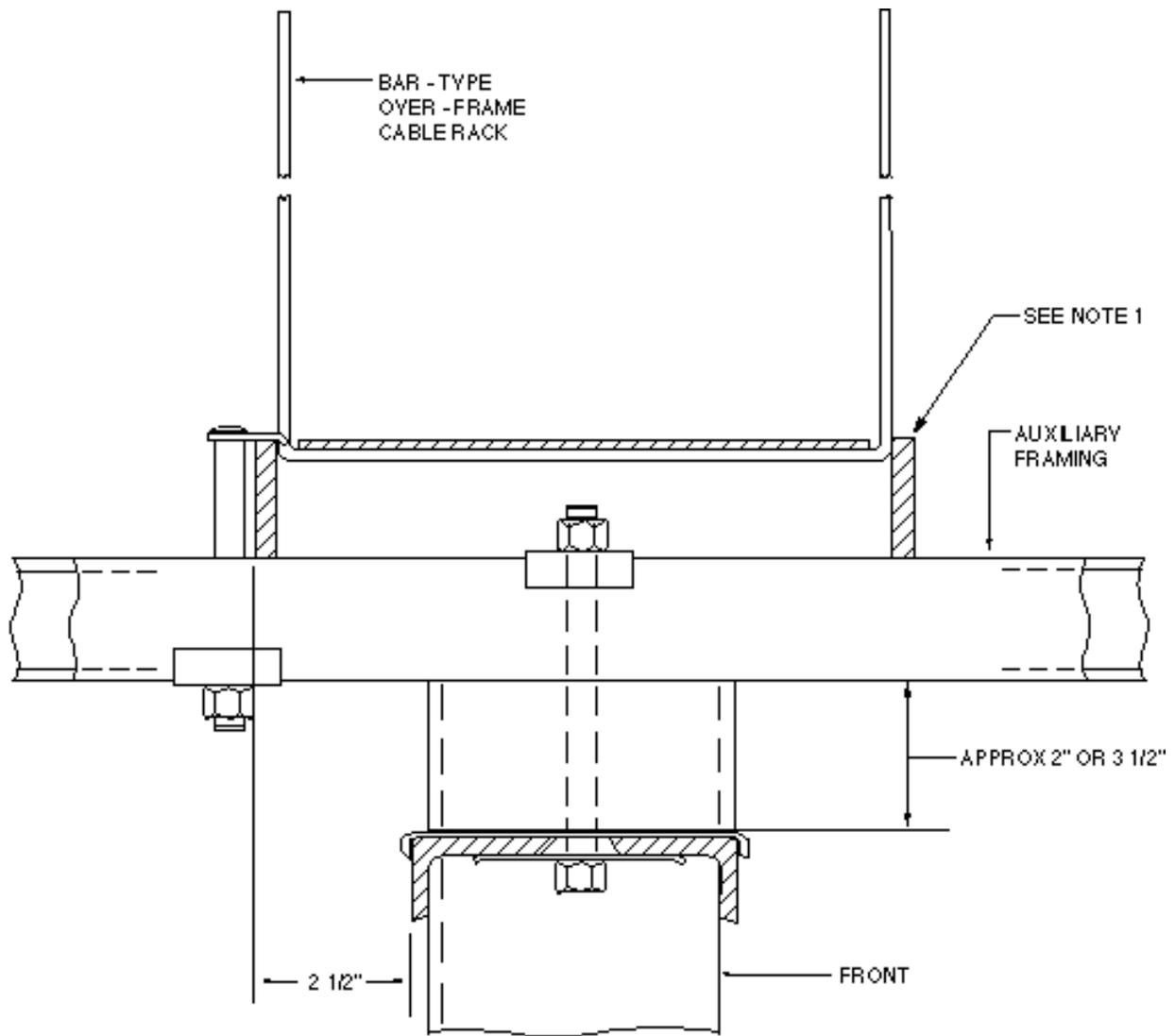


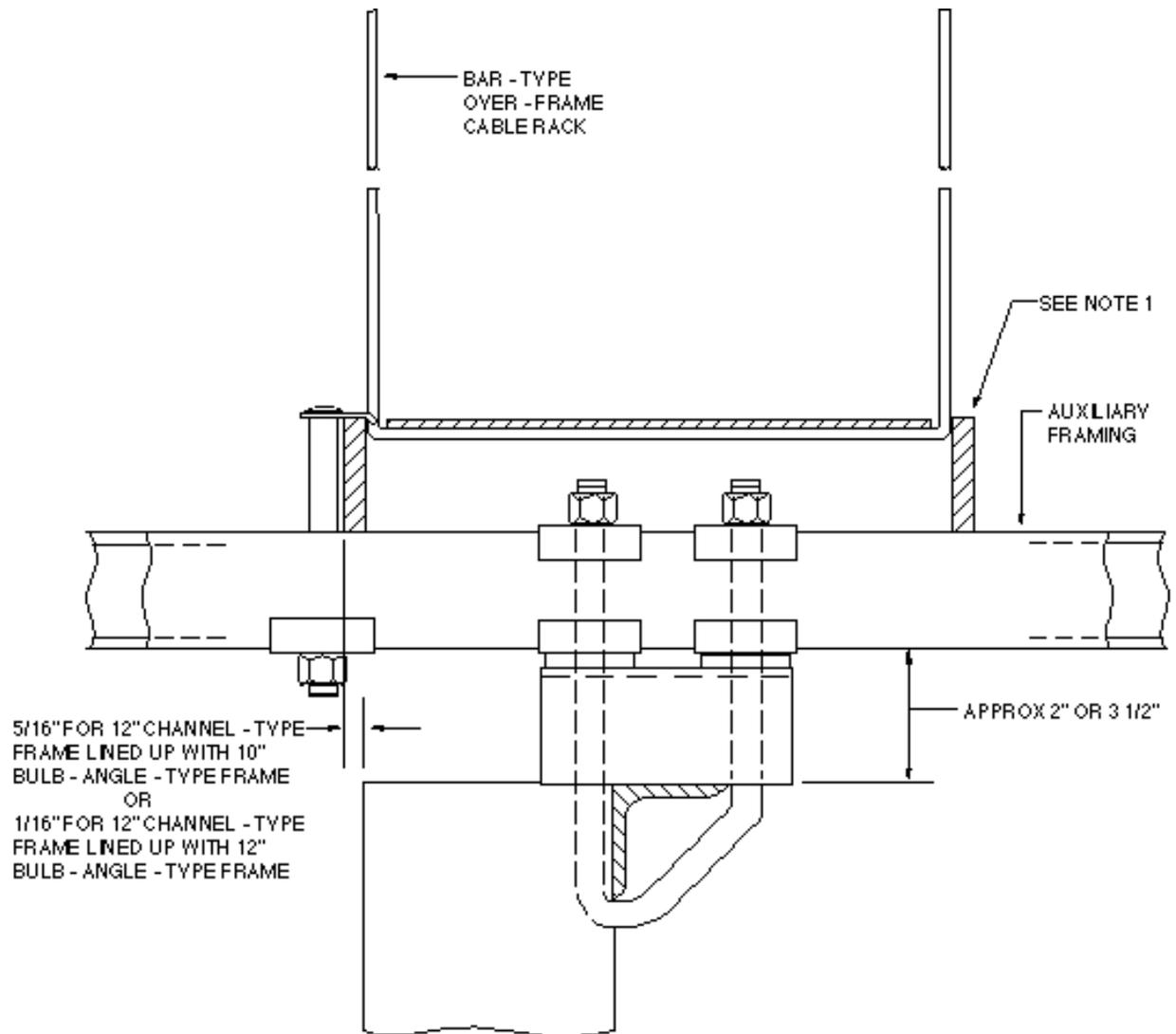
EXHIBIT 2-E1-62P  
LADDER-TYPE CABLE RACK OVER CABLE DUCT-TYPE FRAMES  
11 FOOT 8 INCH



NOTE:

1. TWO J-BOLTS SHOULD BE USED WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME.

EXHIBIT 2-E1-62Q (A&M)  
LOCATION OF BAR-TYPE OVER-FRAME CABLE RACK OVER BULB-ANGLE TYPE  
FRAMES



NOTE:

1. TWO J-BOLTS SHOULD BE USED WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME.

EXHIBIT 2-E1-62R (A&M)  
LOCATION OF BAR-TYPE OVER-FRAME CABLE RACK OVER CHANNEL-TYPE  
FRAMES-COMBINED OFFICES

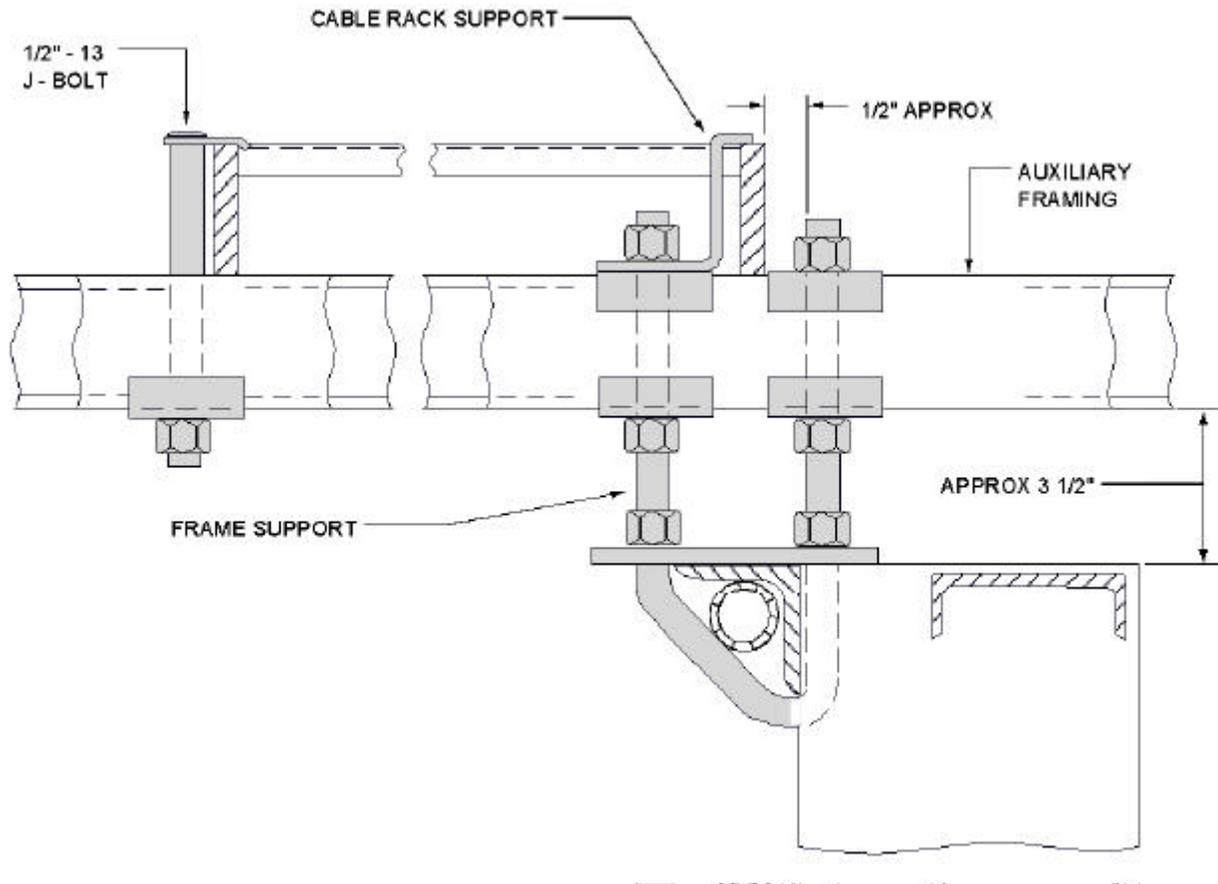


EXHIBIT 2-E1-62S  
LADDER-TYPE CABLE RACK OVER CABLE DUCT-TYPE FRAMES-11 FOOT 9 1/2 INCH  
FRAMING

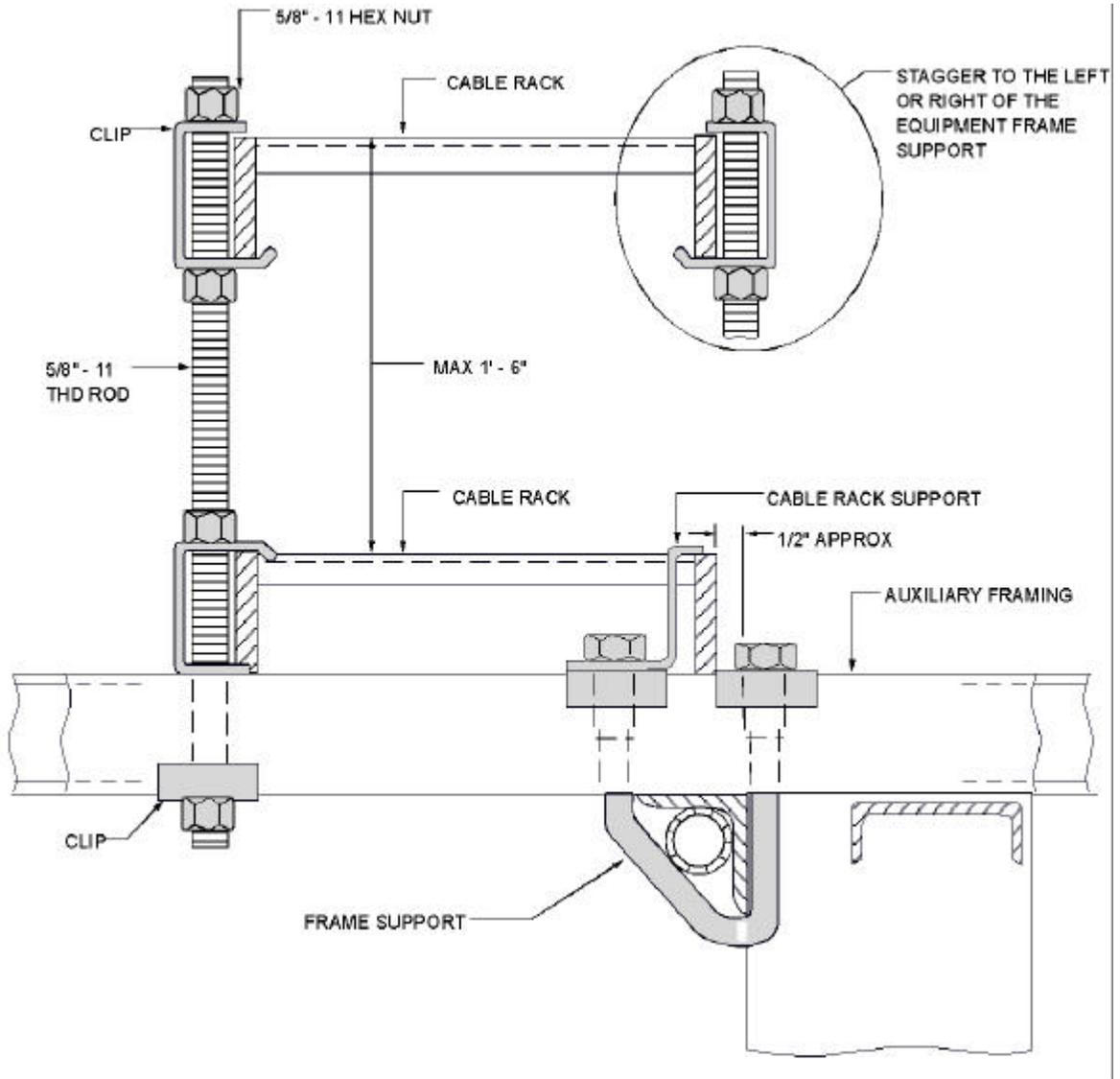


EXHIBIT 2-E1-62T  
MULTILEVEL CABLE RACK SUPPORT OVER DUCT-TYPE FRAMES-11 FOOT 6  
INCH FRAMING

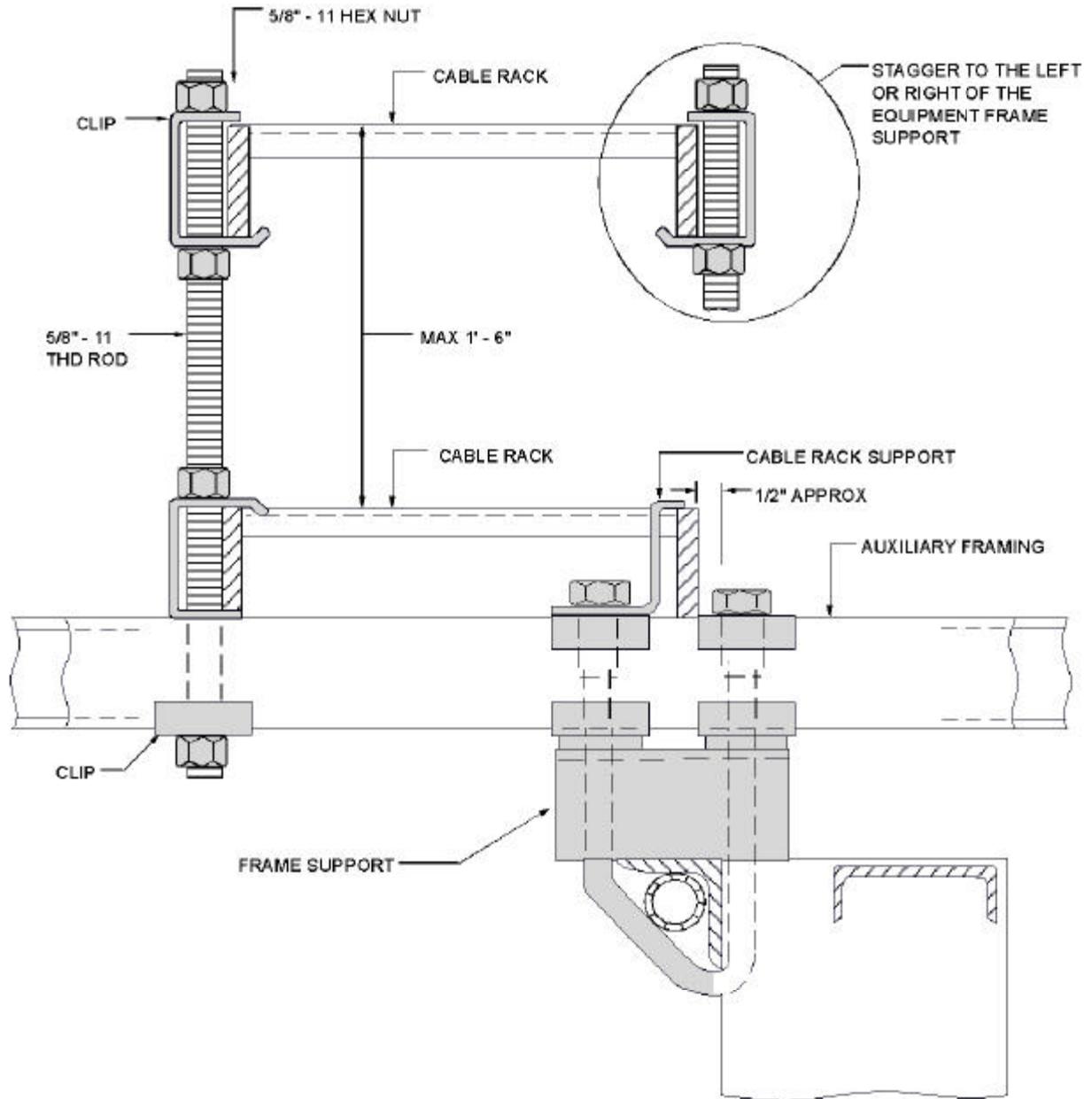


EXHIBIT 2-E1-62U  
MULTILEVEL CABLE RACK SUPPORT OVER DUCT-TYPE FRAMES-11 FOOT 8  
INCH FRAMING

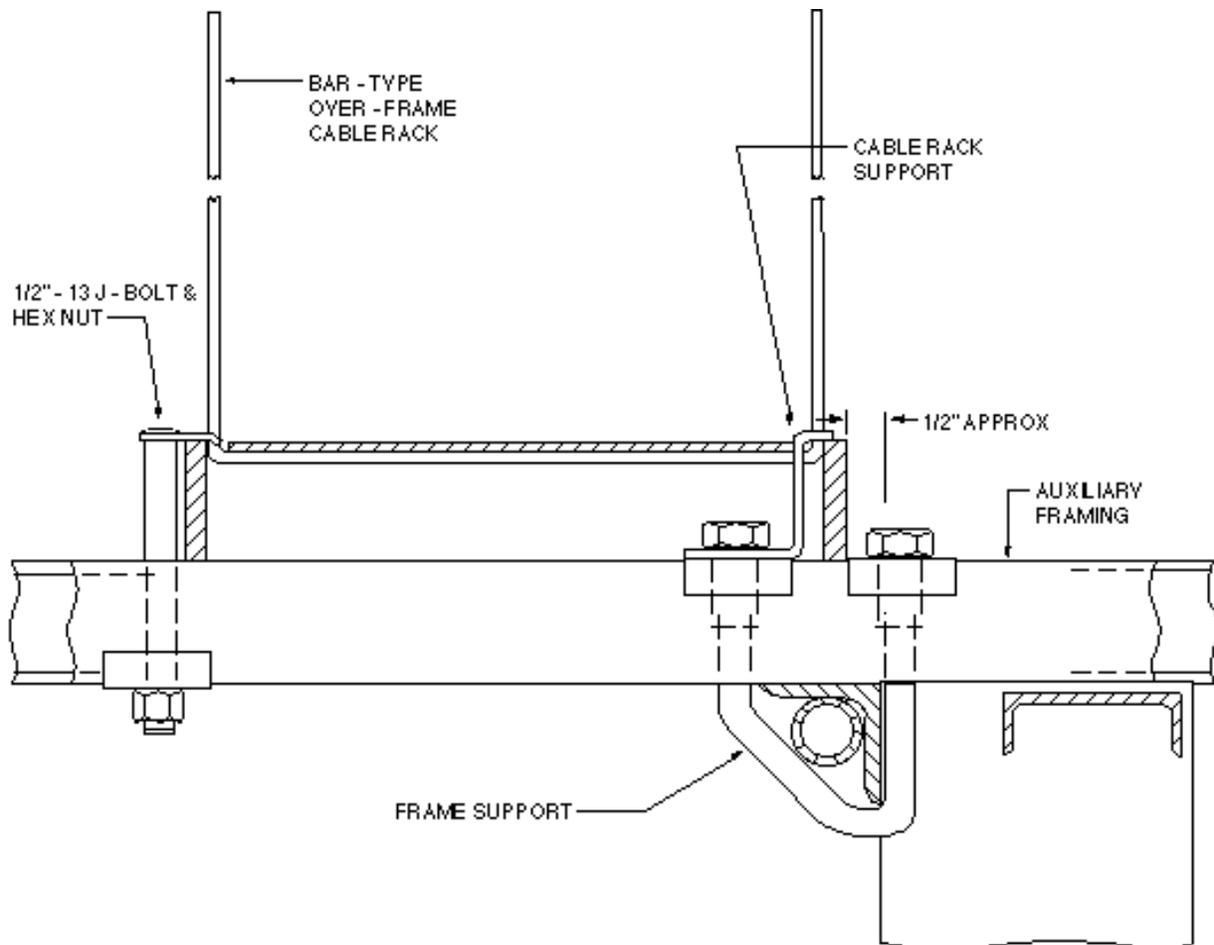


EXHIBIT 2-E1-62V (A&M)  
BAR-TYPE OVER-FRAME CABLE RACK OVER CABLE DUCT-TYPE FRAMES 11 FOOT 6  
INCH FRAMING

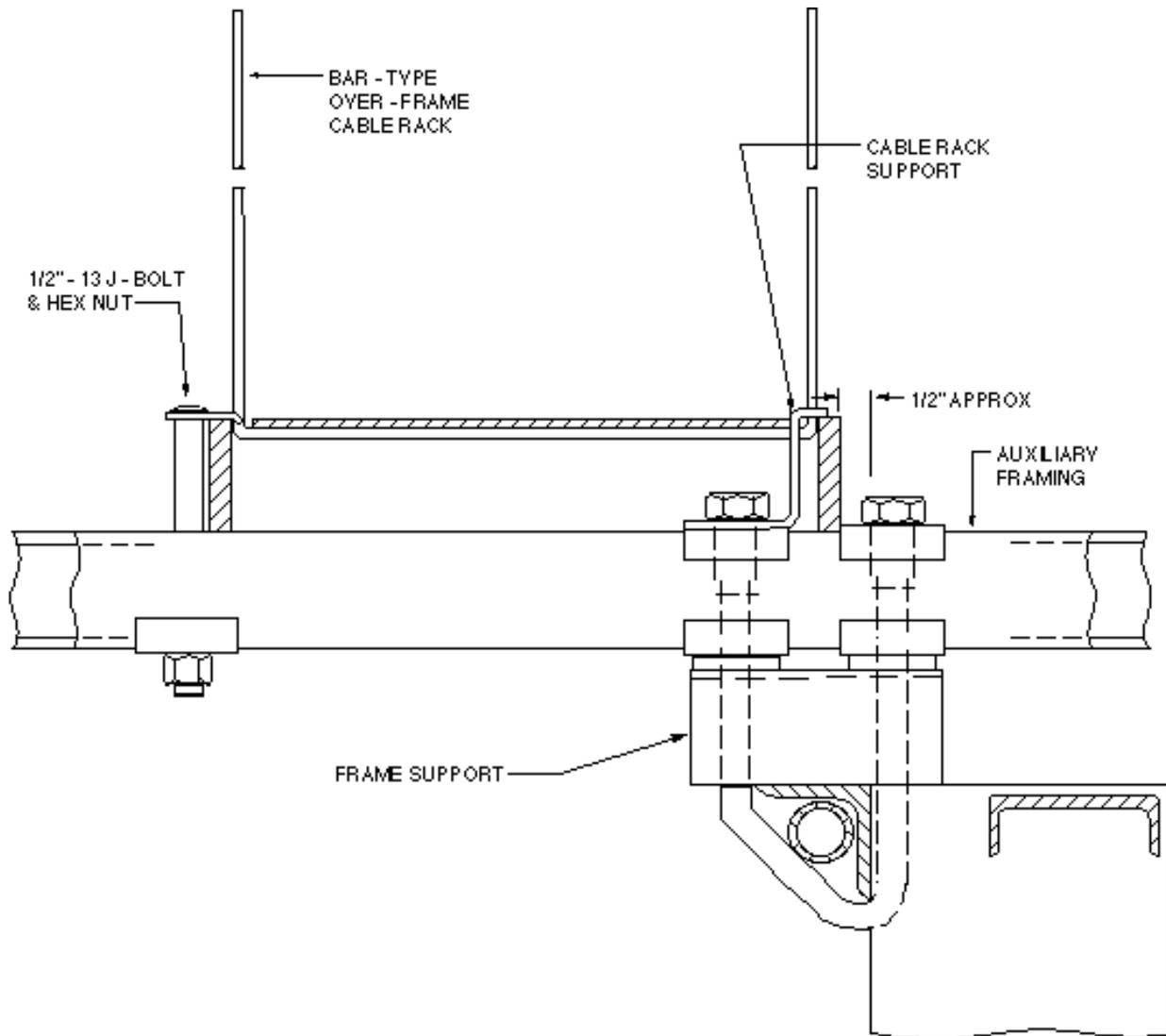
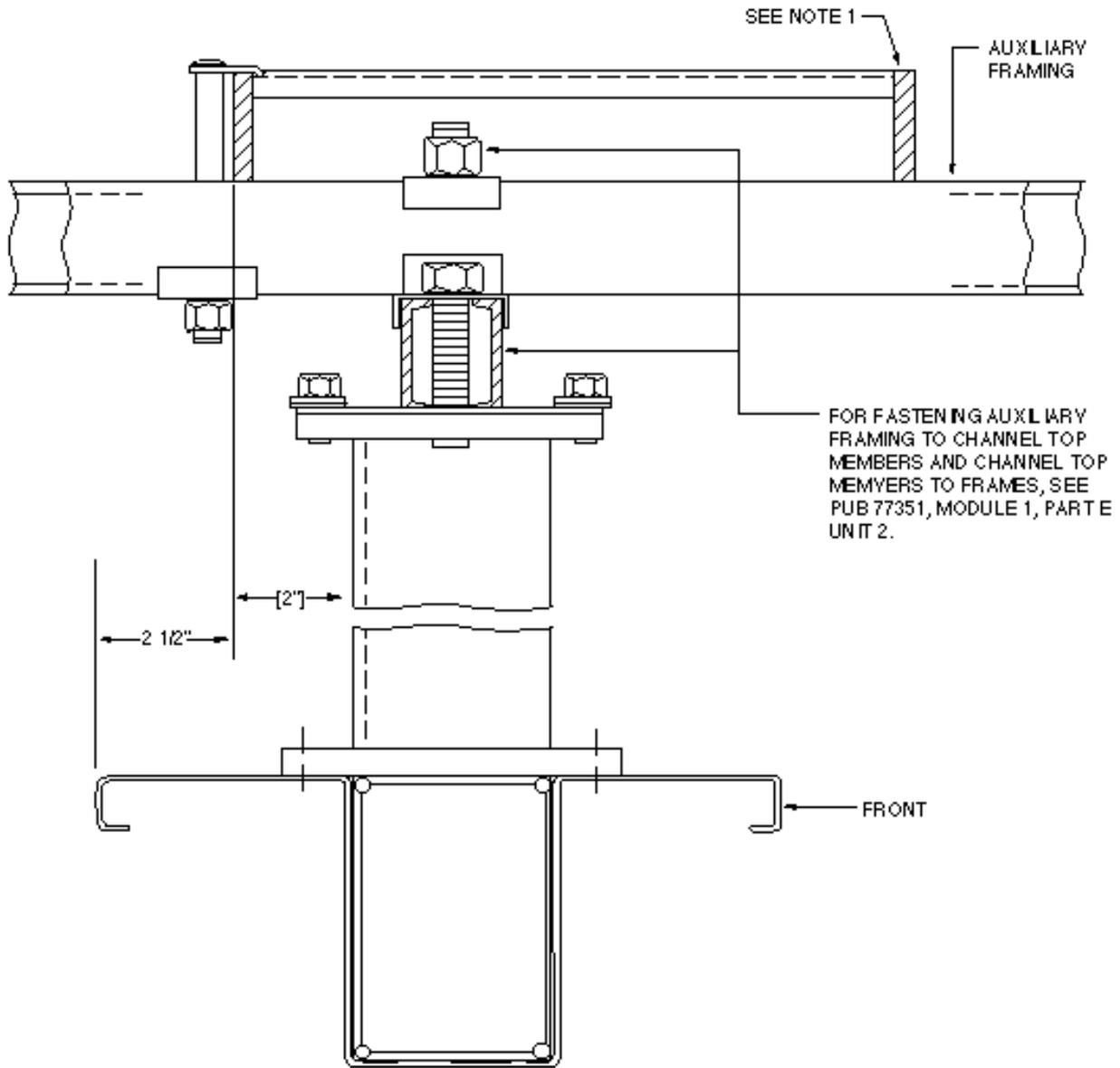


EXHIBIT 2-E1-62W (A&M)  
BAR-TYPE OVER-FRAME CABLE RACK OVER CABLE DUCT-TYPE FRAMES-11 FOOT 8  
INCH FRAMING

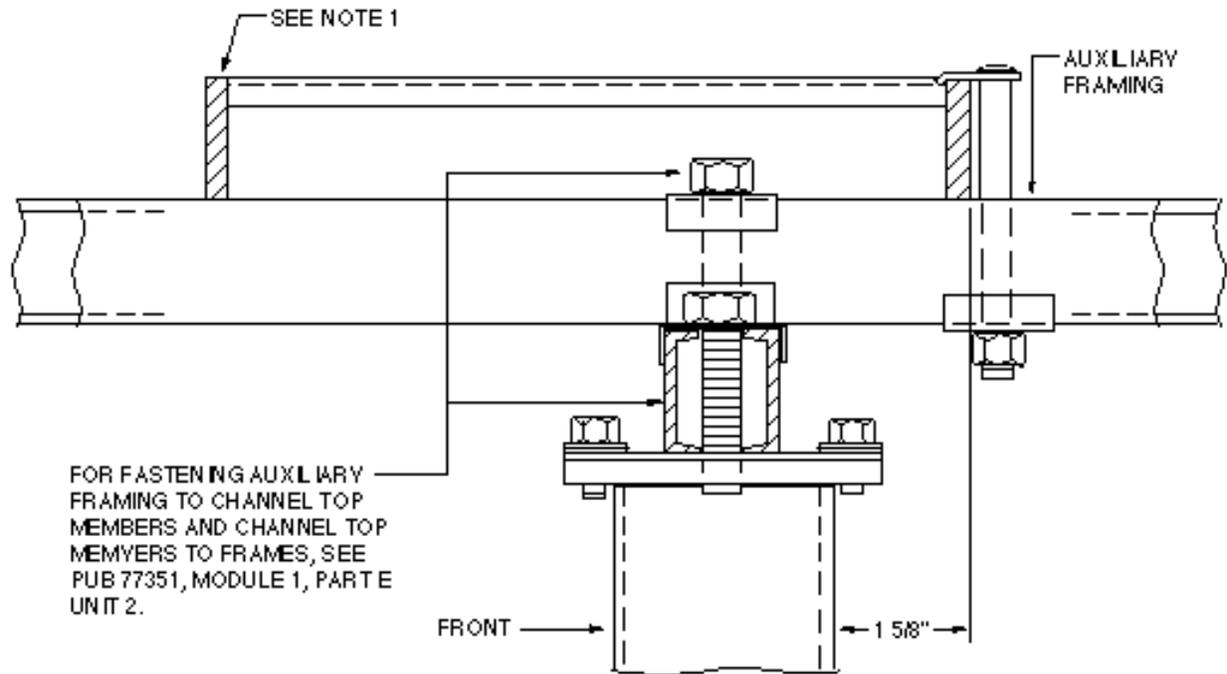


NOTE:

1. TWO J-BOLTS SHOULD BE USED WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME.

EXHIBIT 2-E1-63A (A&M)

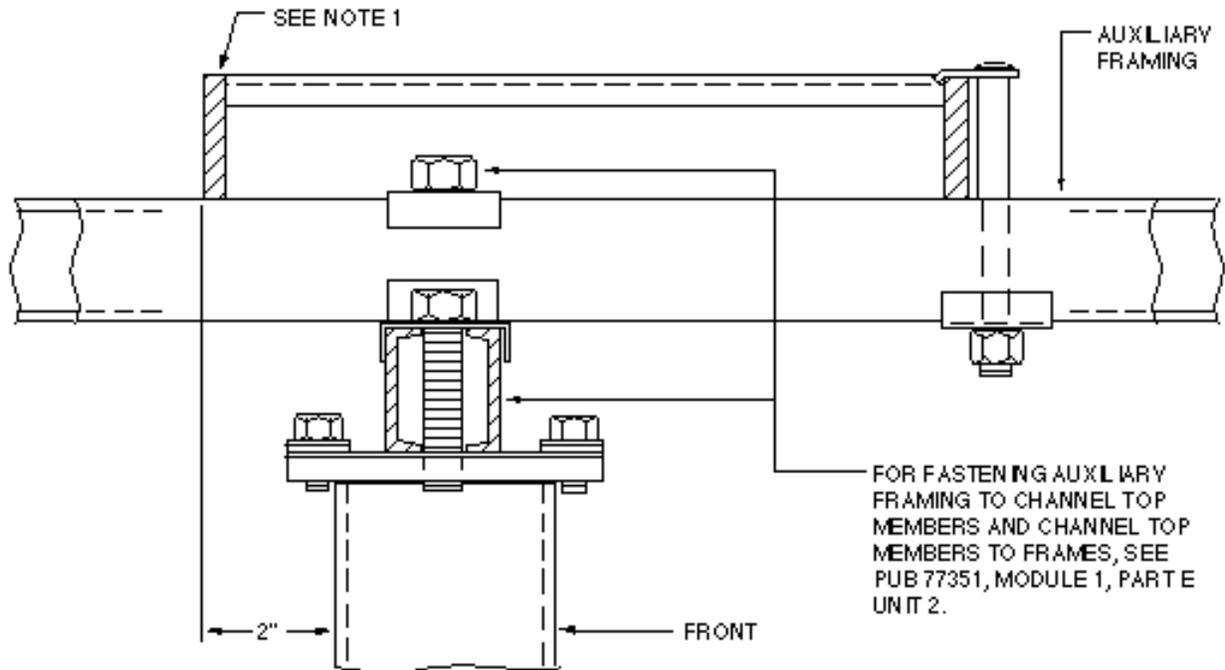
CABLE RACK SUPPORTED BY AUXILIARY FRAMING OVER BULB-ANGLE TYPE SWITCH FRAMES-STEP-BY-STEP SYSTEMS-11 FOOT 8 INCH FRAMING



NOTE:

1. WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING, OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME, TWO J-BOLTS SHOULD BE USED

EXHIBIT 2-E1-63B (A&M)  
LADDER-TYPE CABLE RACK OVER REAR OF CHANNEL-TYPE STEP-BY-STEP  
FRAMES-11 FOOT 8 INCH FRAMING-ADDITIONS ONLY



NOTE:

1. WHERE SHORT PAIRS OF FRAMING BARS OR CHANNELS ARE USED TO SUPPORT CABLE RACK EXTENDING BEYOND REGULAR FRAMING, OR ARE USED FOR THE SUPPORT OF AN ISOLATED FRAME, TWO J-BOLTS SHOULD BE USED

EXHIBIT 2-E1-63C (A&M)  
LADDER-TYPE CABLE RACK OVER FRONT OF CHANNEL-TYPE STEP-BY-STEP  
FRAMES-11 FOOT 8 INCH FRAMING-ADDITIONS ONLY

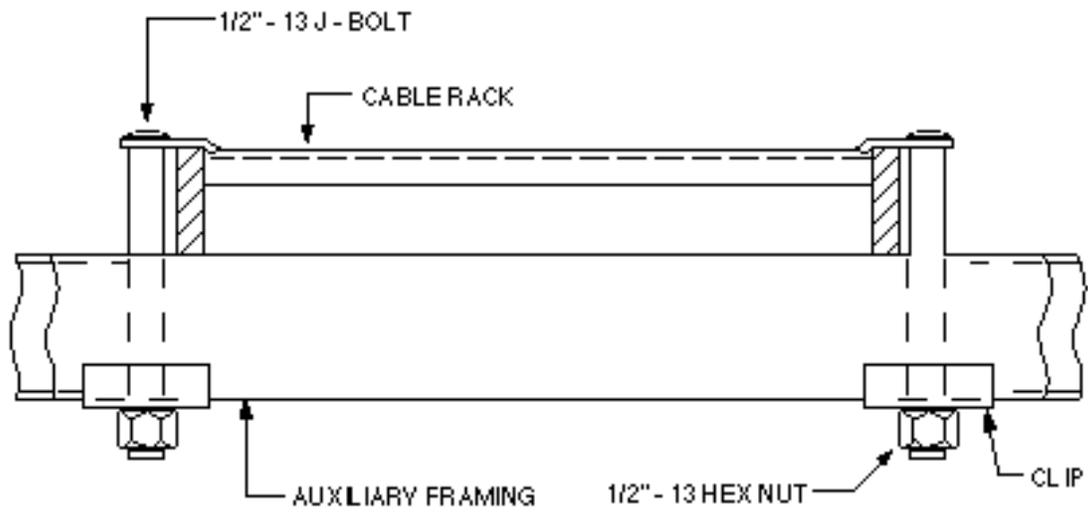


EXHIBIT 2-E1-65  
LADDER-TYPE CABLE RACK SUPPORTED BY LOW-TYPE AUXILIARY FRAMING

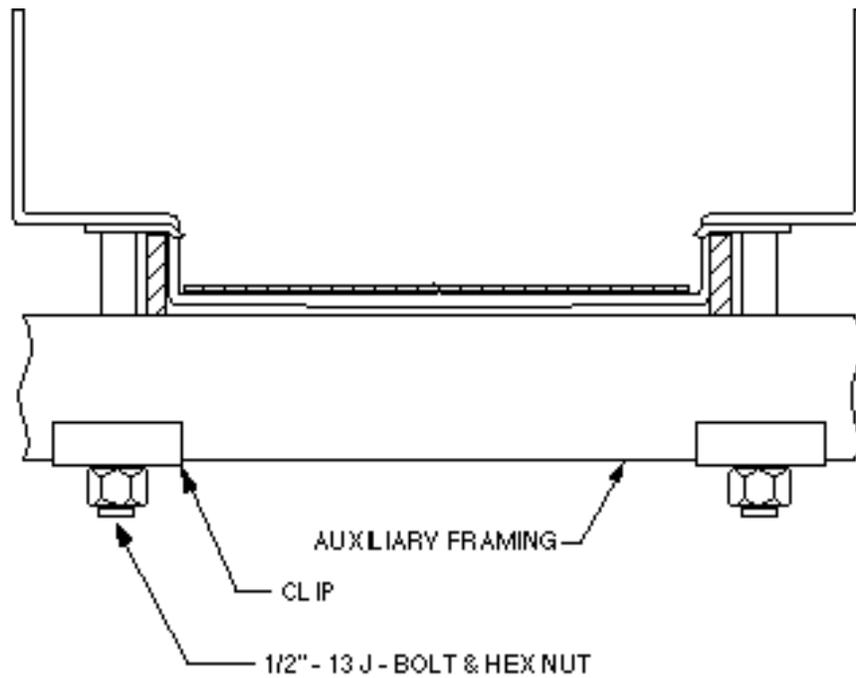


EXHIBIT 2-E1-65B (A&M)  
BAR-TYPE CABLE RACK SUPPORTED BY LOW-TYPE AUXILIARY FRAMING BAR-TYPE OVER-AISLE RACK SHOWN

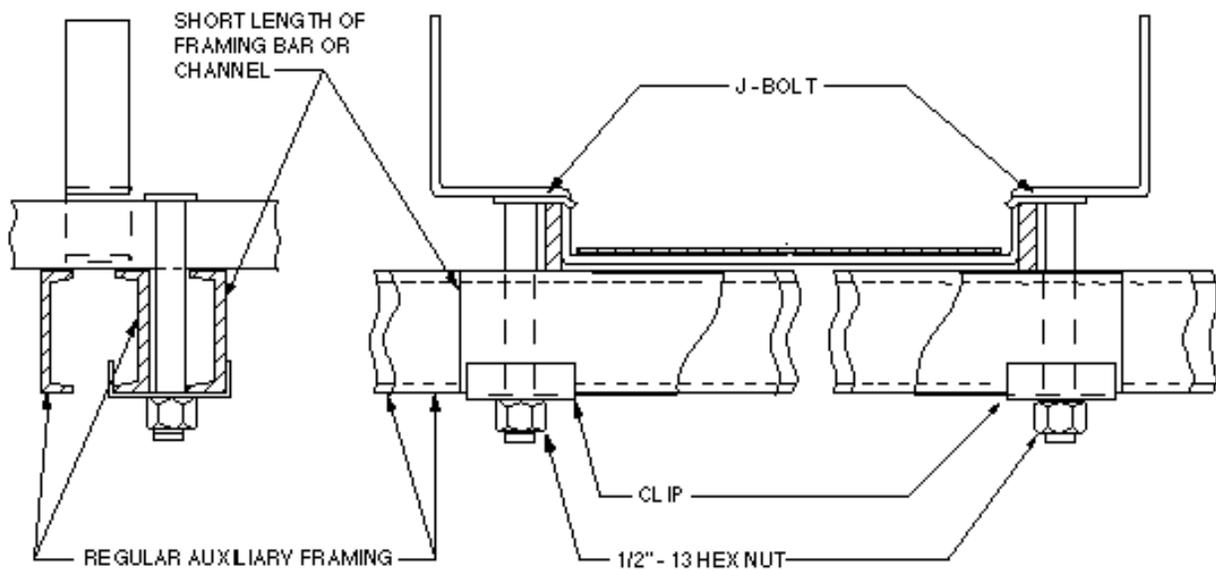


EXHIBIT 2-E1-65C (A&M)  
CABLE RACK SUPPORTED BY LOW-TYPE AUXILIARY FRAMING DIRECTLY BELOW A  
CROSS STRAP-BAR-TYPE OVER-AISLE SHOWN

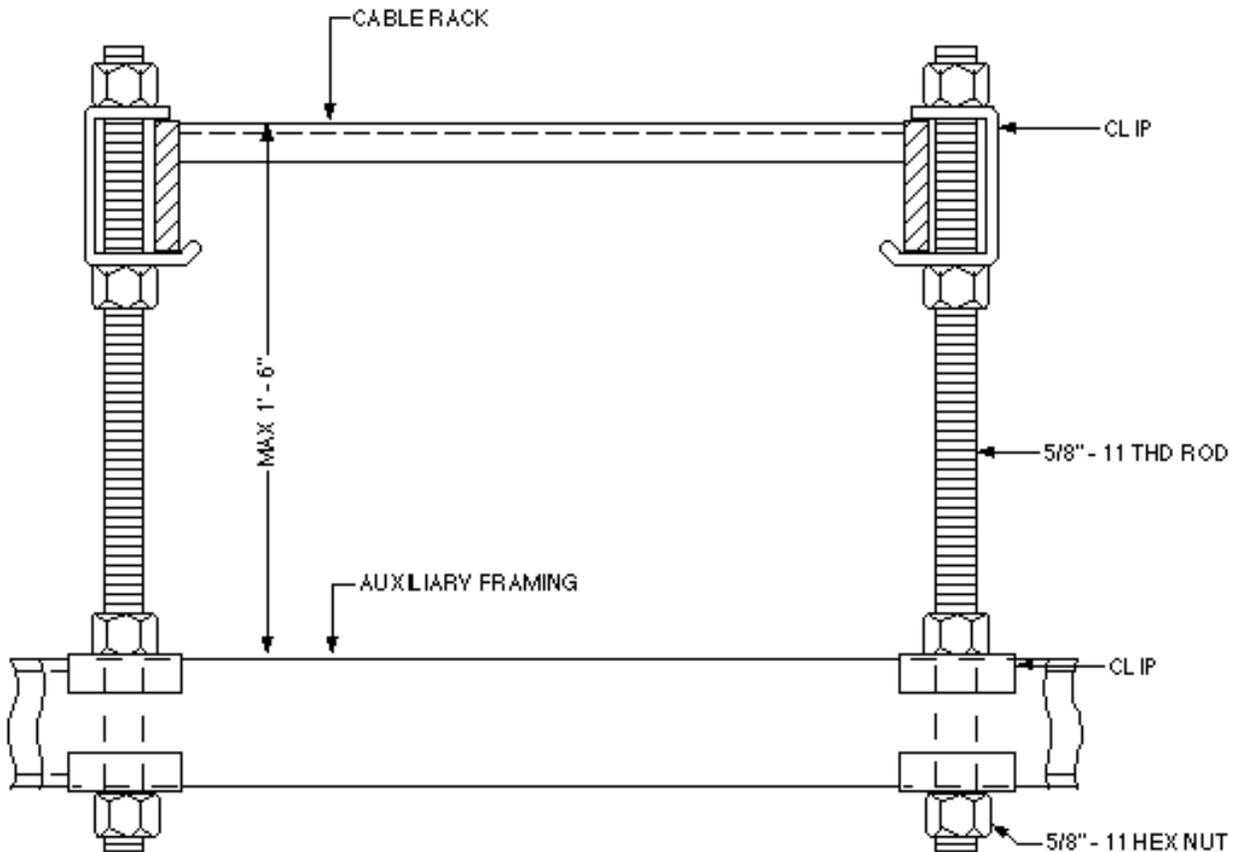
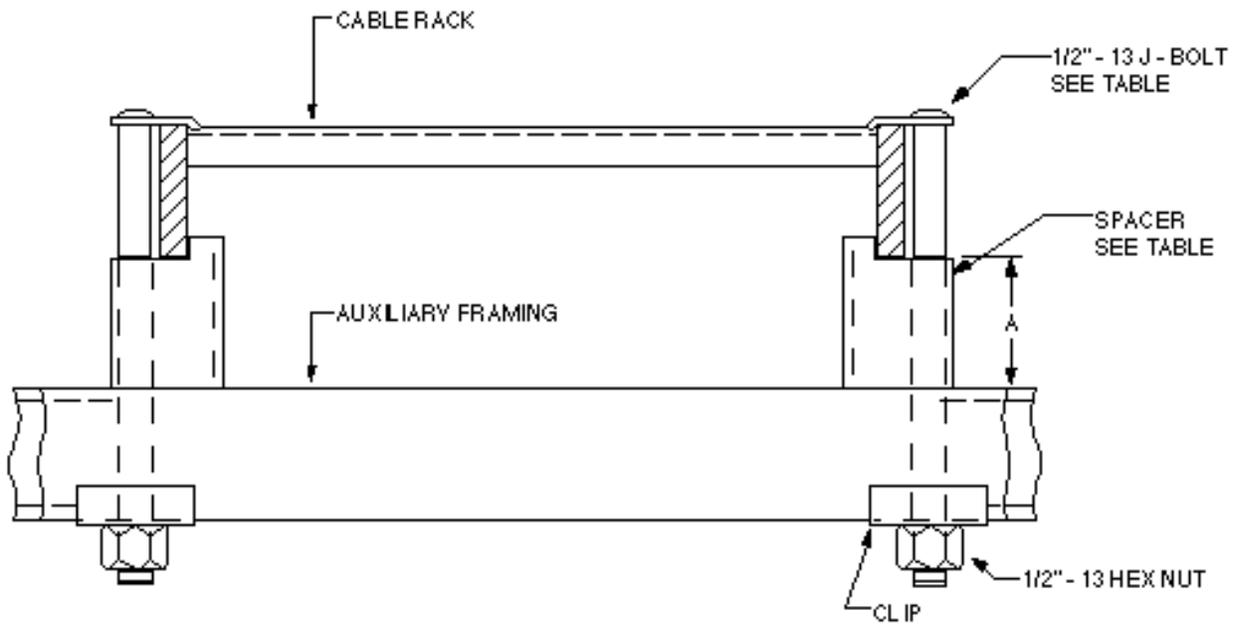


EXHIBIT 2-E1-66  
CABLE RACK SUPPORTED ABOVE LOW-TYPE AUXILIARY FRAMING BY THREADED  
RODS



CABLE RACK STRINGER SIZE	SPACER		1/2" - 13 J - BOLT	
	DIM A		LENGTH	
1 1/2"	1"		5 1/4"	
	2"		6 1/4"	
2"	1"		5 3/4"	

EXHIBIT 2-E1-66A  
 CABLE RACK SUPPORTED ABOVE LOW-TYPE AUXILIARY FRAMING BY  
 SPACERS

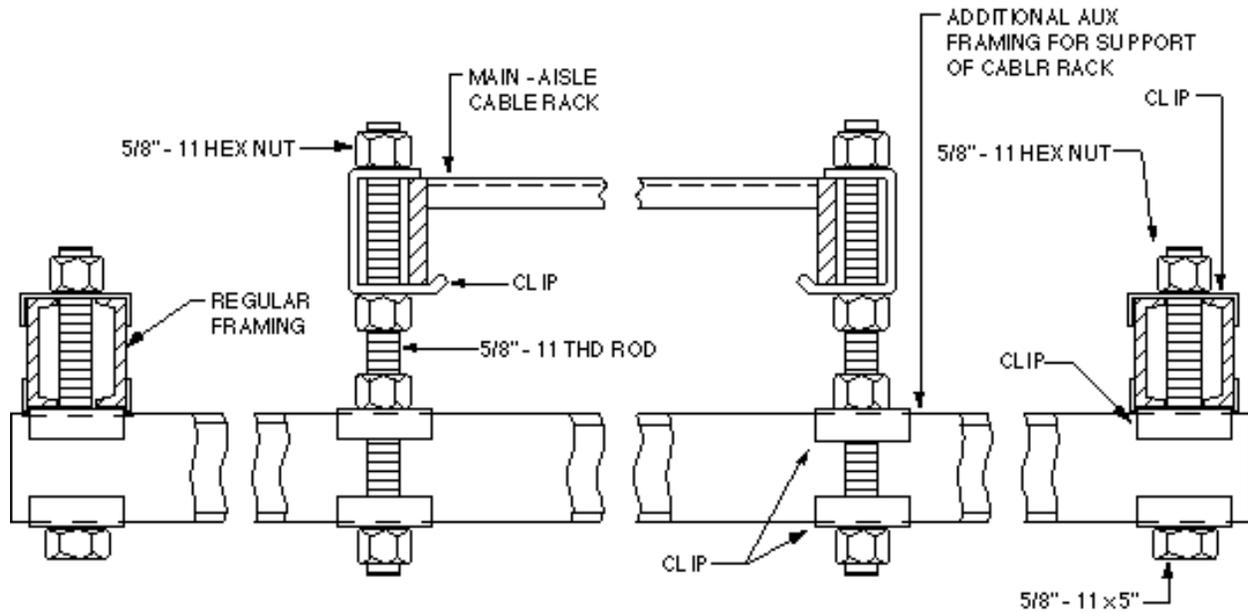
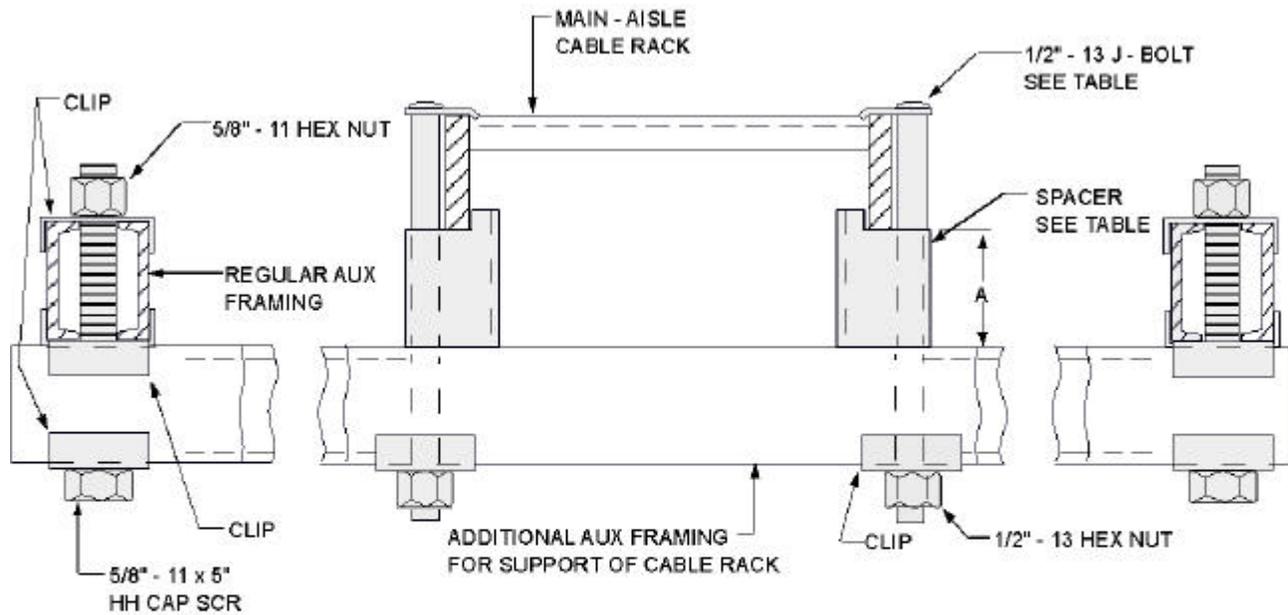


EXHIBIT 2-E1-67

MAIN OR X-AISLE CABLE RACK SUPPORTED BY ADDITIONAL AUXILIARY FRAMING BELOW REGULAR FRAMING-USING THREADED RODS ADDITIONS ONLY- REPLACED BY EXHIBIT 2-E1-67A



CABLE RACK STRINGER SIZE	SPACER	1/2" - 13 J - BOLT
	DIM A	LENGTH
2"	1"	5 3/4"
	2"	6 3/4"

EXHIBIT 2-E1-67A  
 MAIN-AISLE CABLE RACK SUPPORTED BY ADDITIONAL FRAMING BELOW REGULAR FRAMING-USING SPACERS

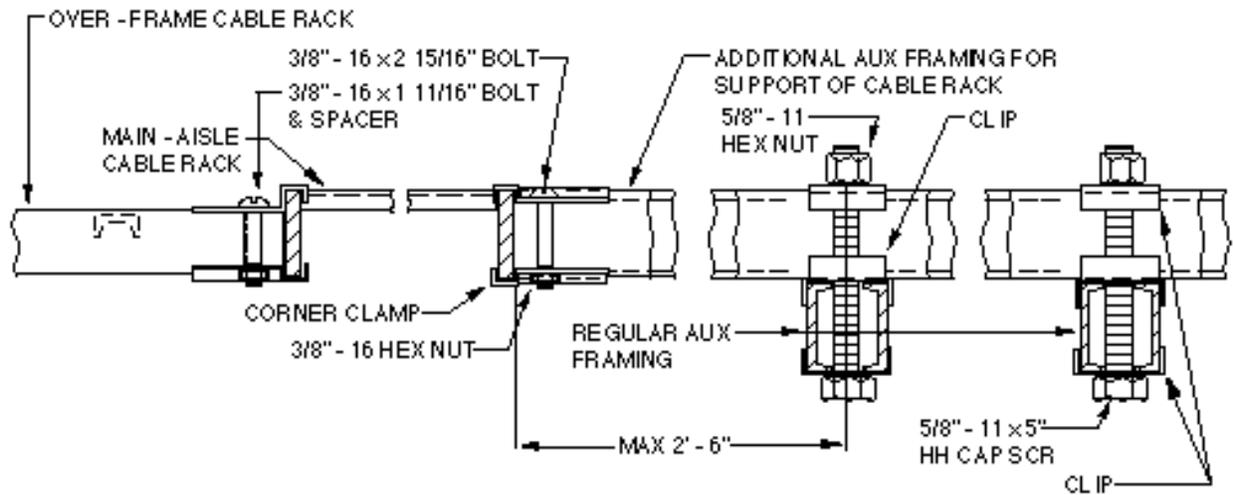


EXHIBIT 2-E1-68  
MAIN OR X-AISLE CABLE RACK SUPPORTED BY ADDITIONAL AUXILIARY FRAMING  
ABOVE REGULAR FRAMING

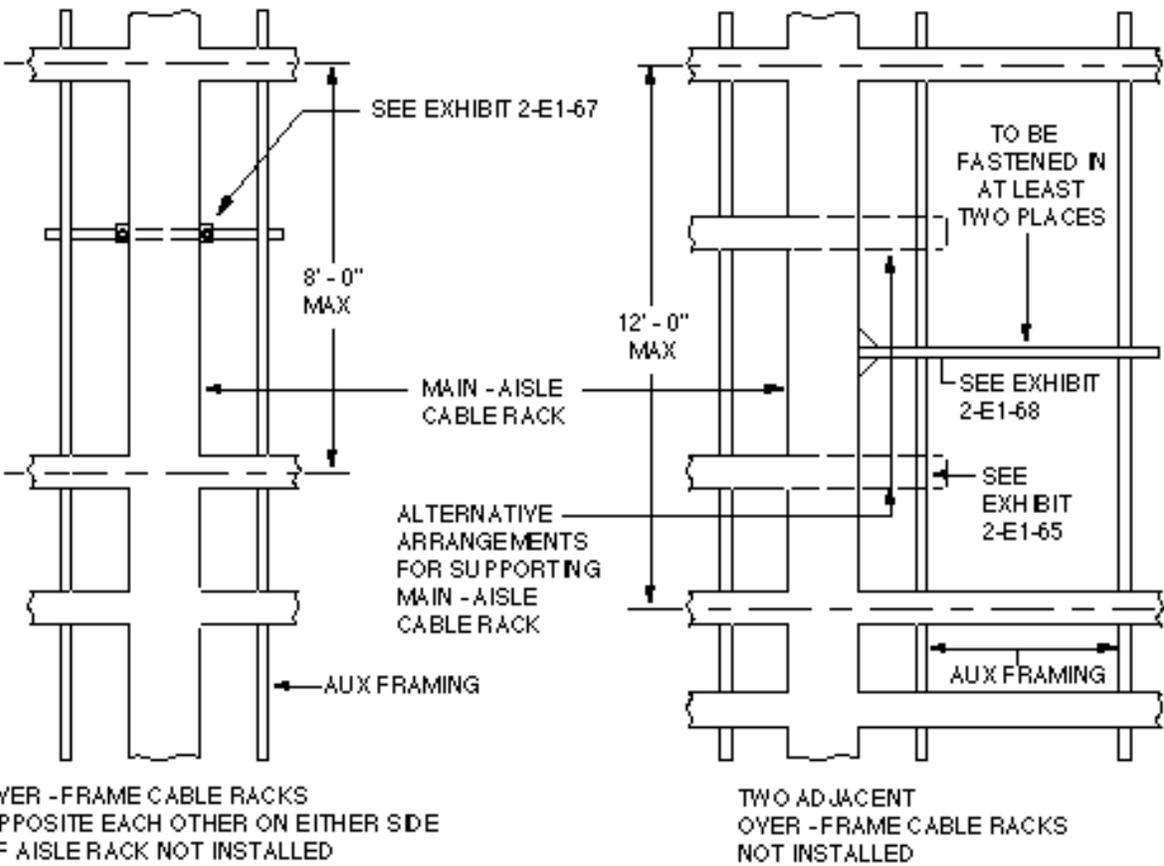
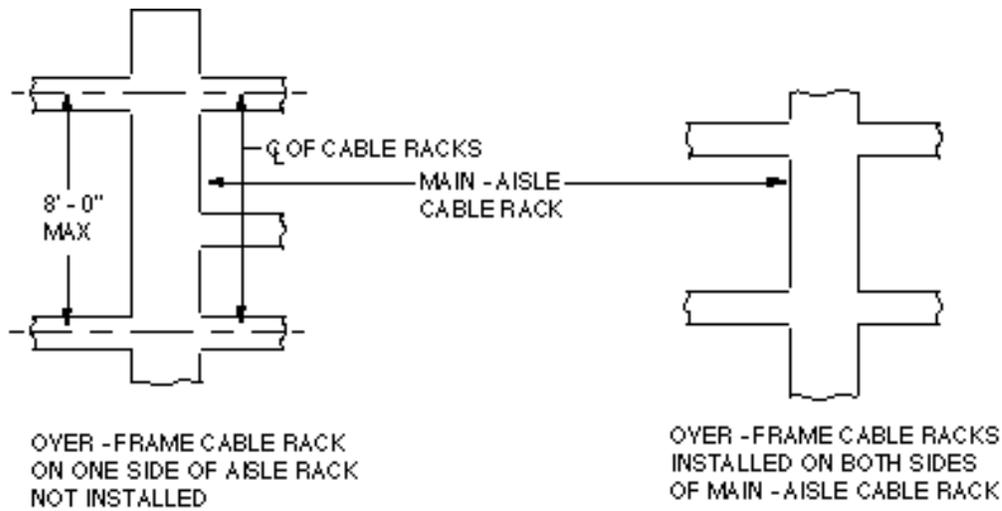


EXHIBIT 2-E1-69  
 CABLE RACKS OVER MAIN AISLES

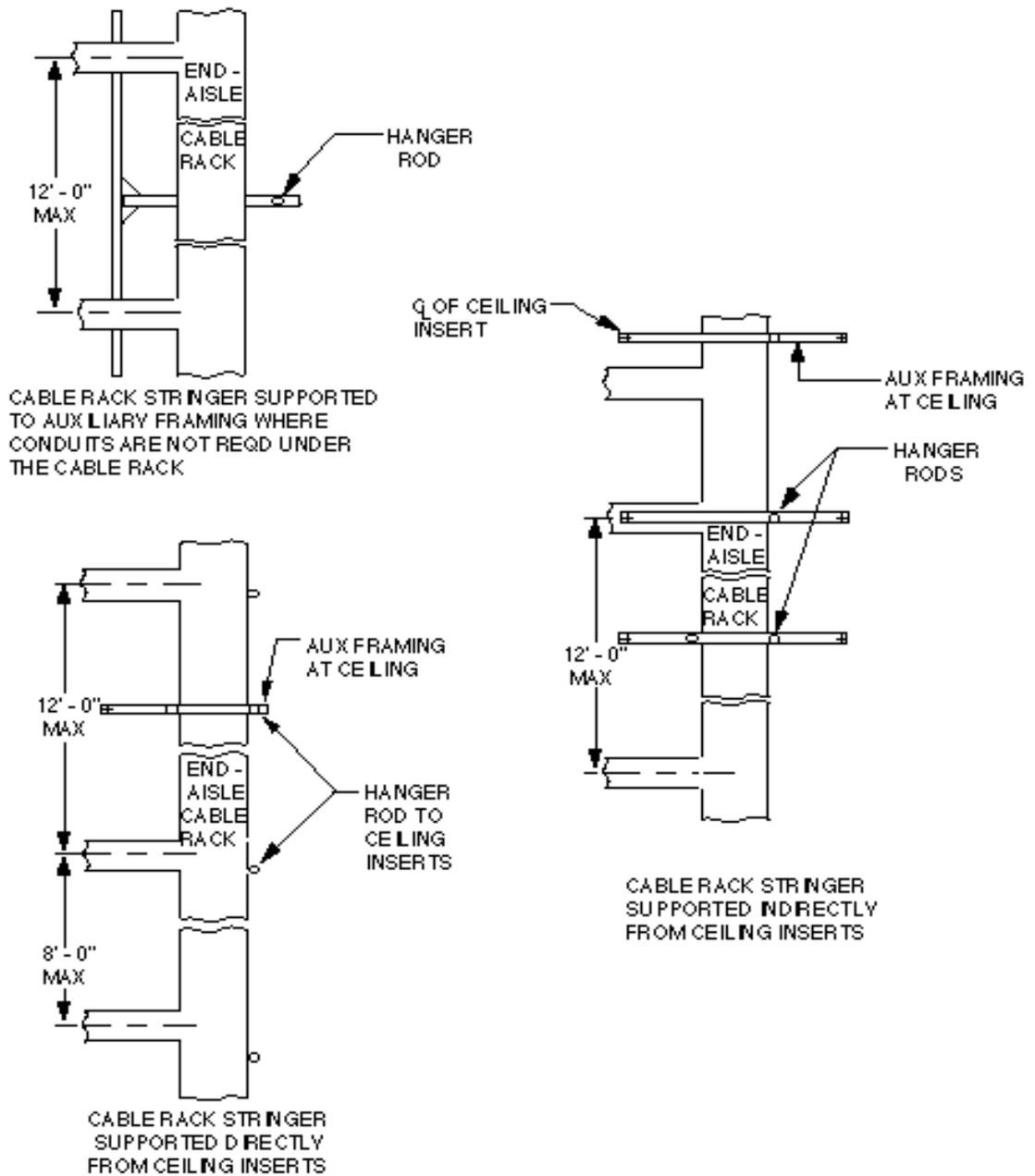


EXHIBIT 2-E1-70 (A&M)  
 CABLE RACKS OVER END AISLES

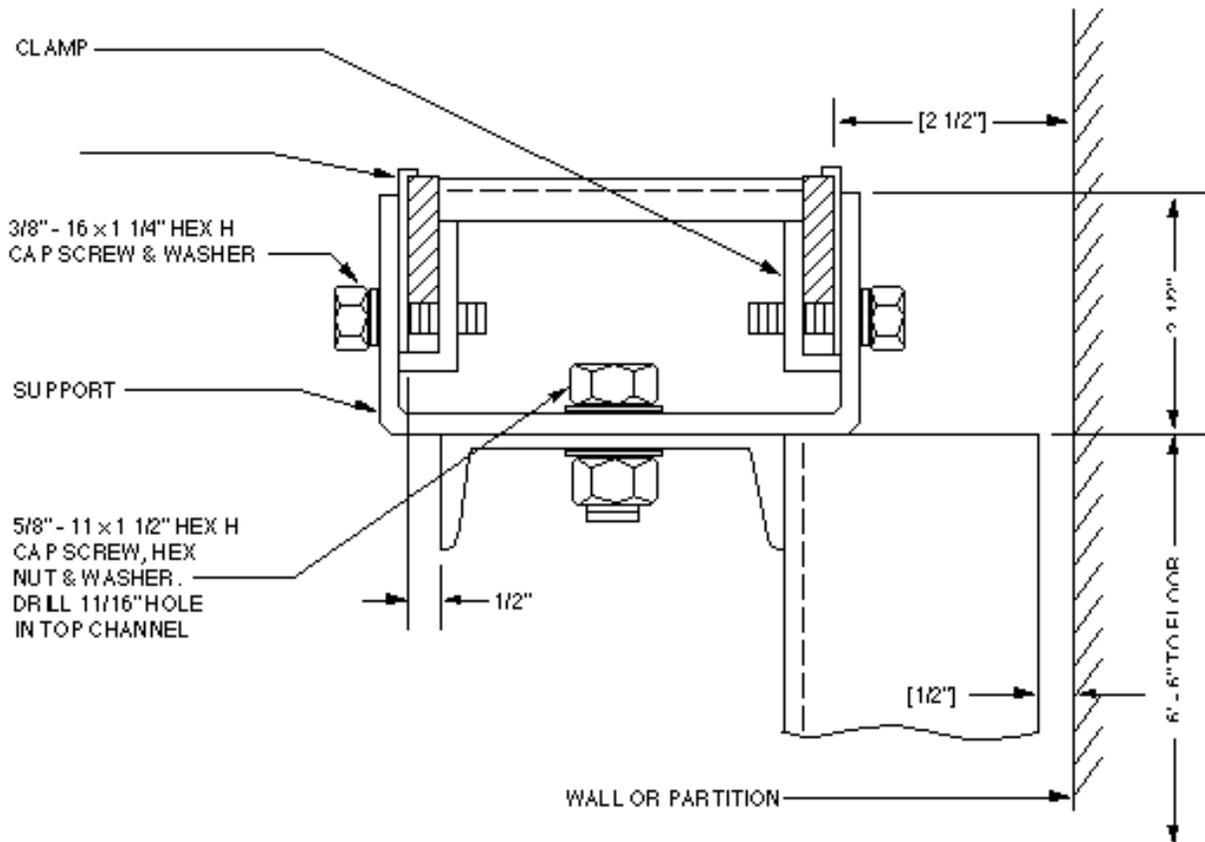


EXHIBIT 2-E1-70A  
CABLE RACKS ATTACHED TO TRAFFIC REGISTER CABINET

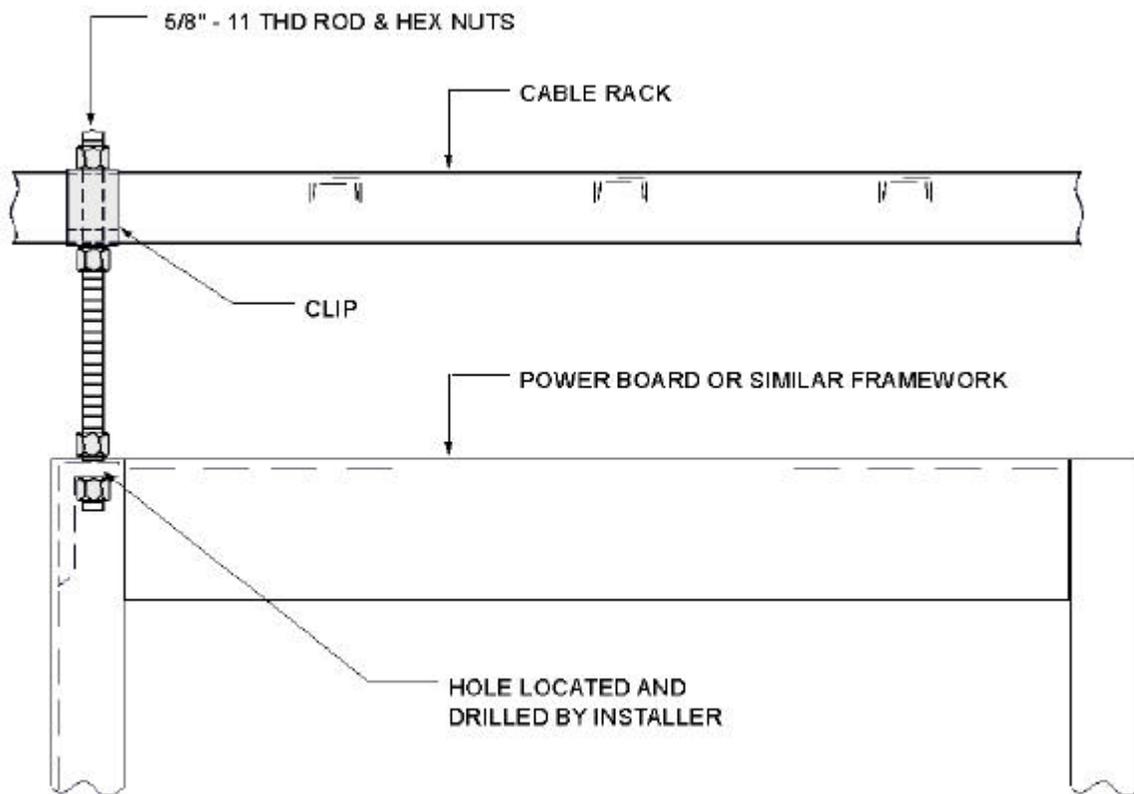


EXHIBIT 2-E1-71  
CABLE RACK ATTACHED TO POWER BOARD OR SIMILAR FRAME WORK

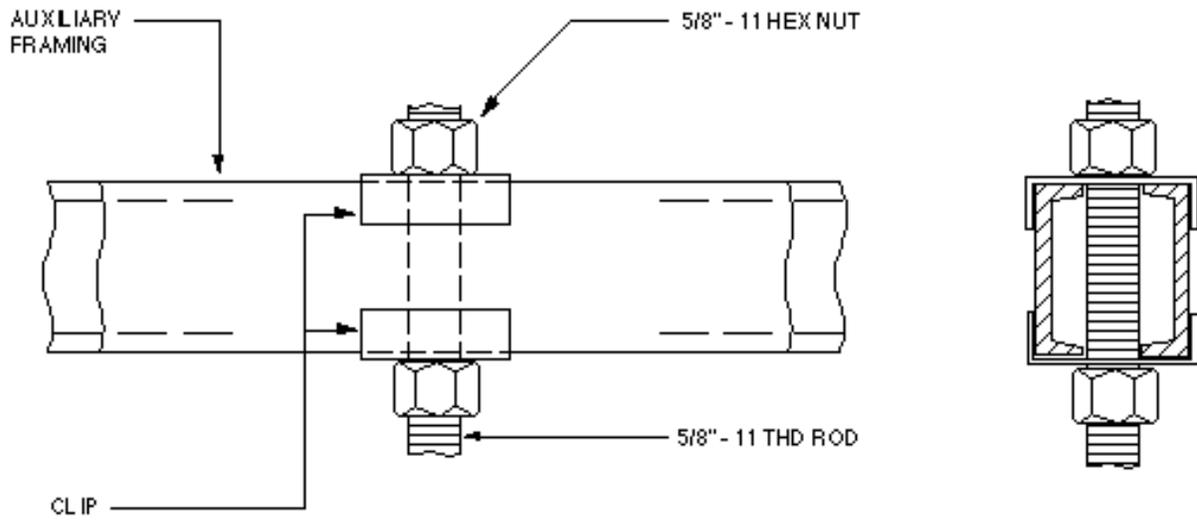


EXHIBIT 2-E1-72  
HANGER ROD ATTACHED TO AUXILIARY FRAMING

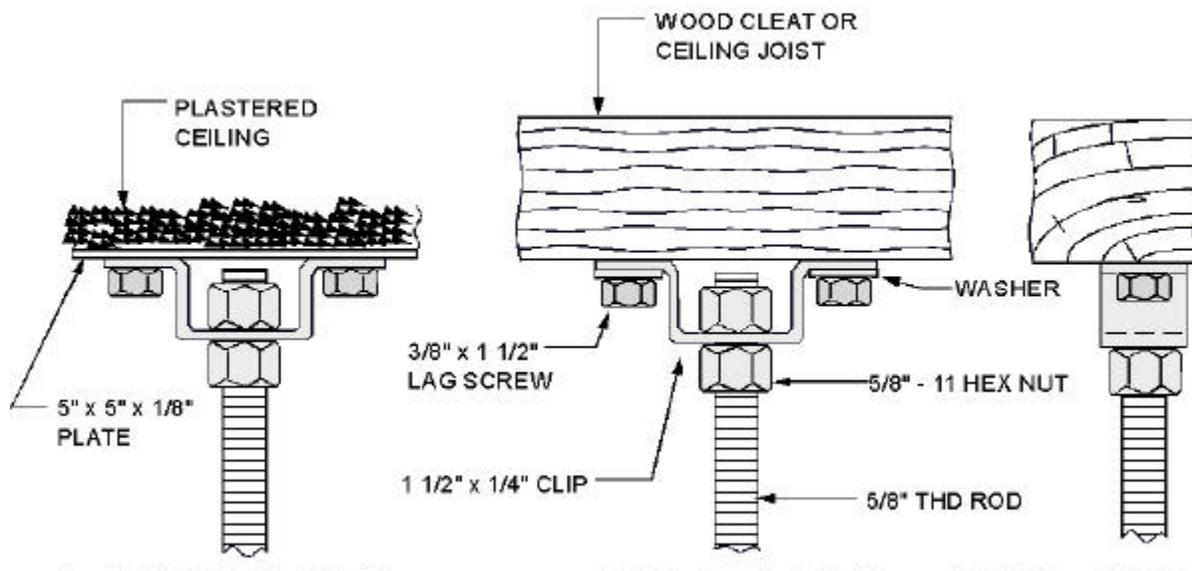


EXHIBIT 2-E1-73  
HANGER ROD ATTACHED DIRECTLY TO CEILING

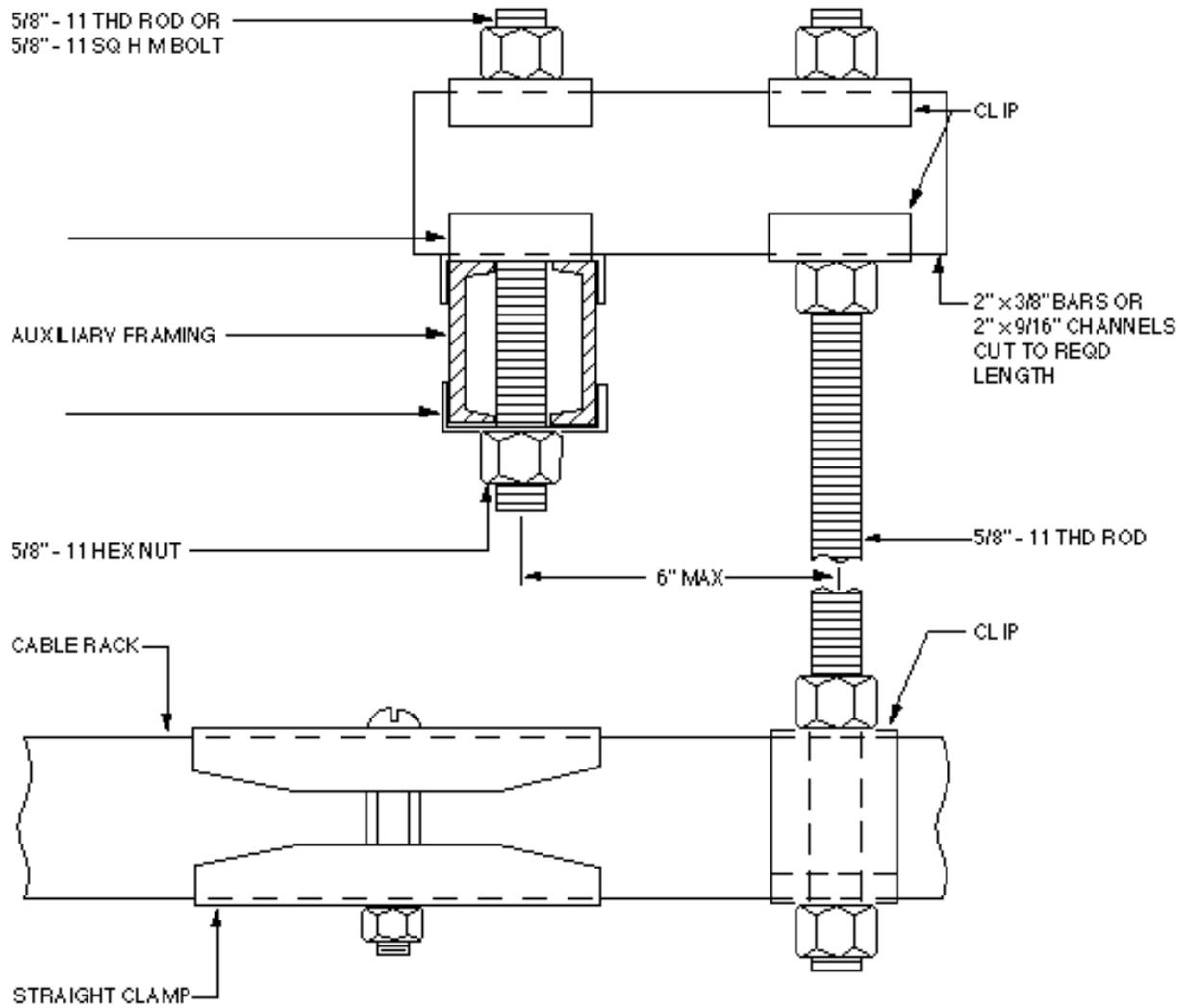


EXHIBIT 2-E1-74  
HANGER ROD OFFSET TO CLEAR CABLE RACK CLAMP, CABLE RACK STRAP, OR  
OTHER OBSTRUCTION

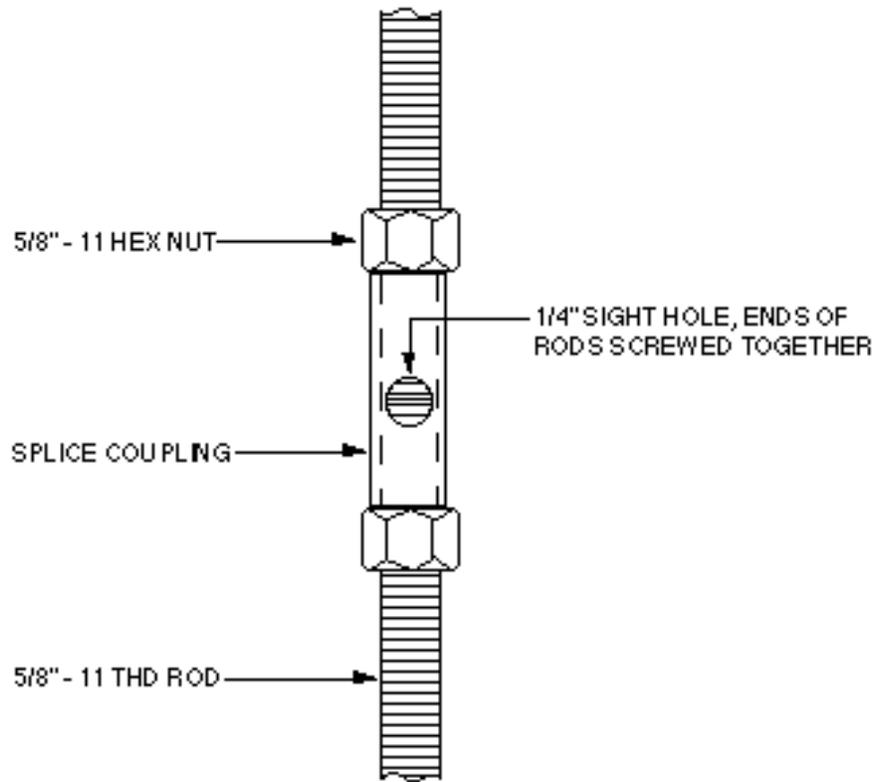


EXHIBIT 2-E1-75  
HANGER ROD EXTENDED WITH SPLICED COUPLING

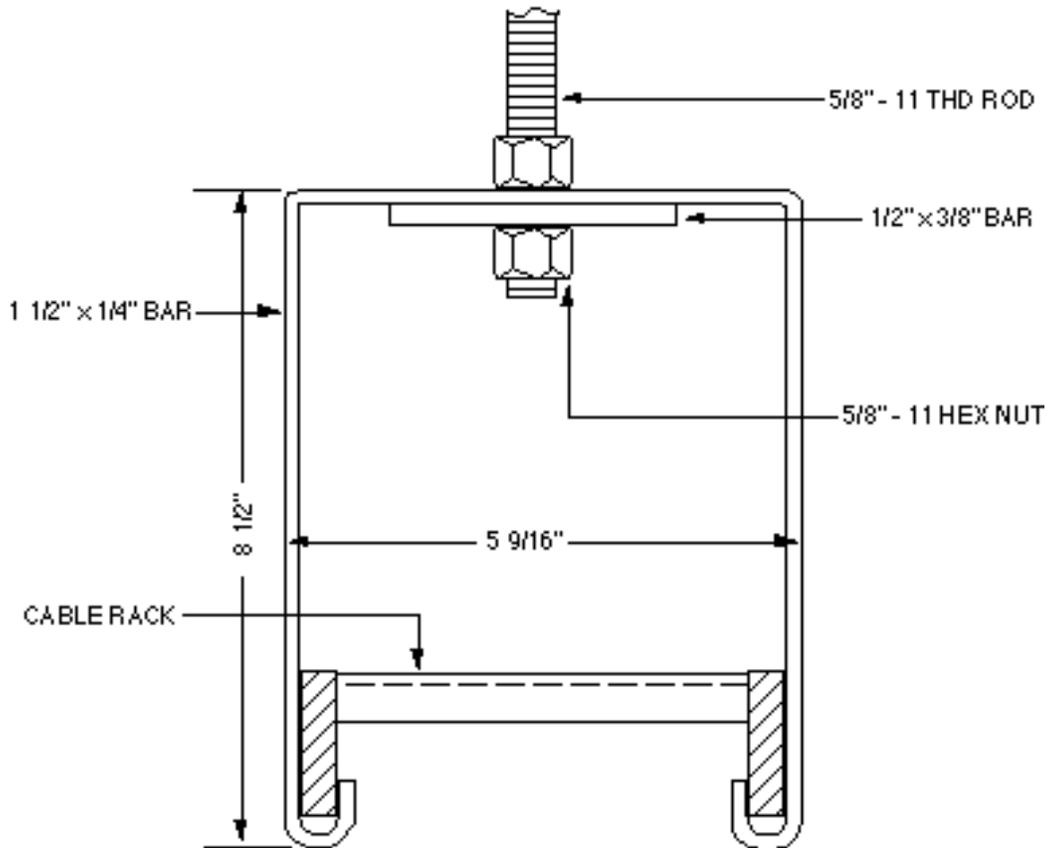


EXHIBIT 2-E1-76  
SUPPORTING RACKS 5 INCHES WIDE

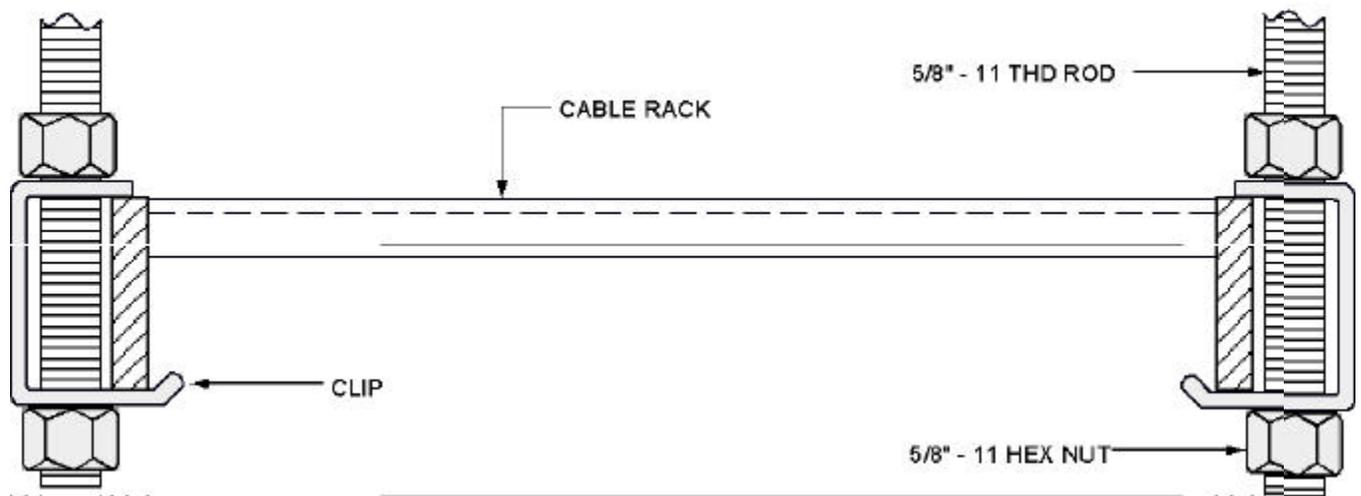


EXHIBIT 2-E1-77  
CABLE RACK SUPPORT BELOW AUXILIARY FRAMING WITH HANGER RODS

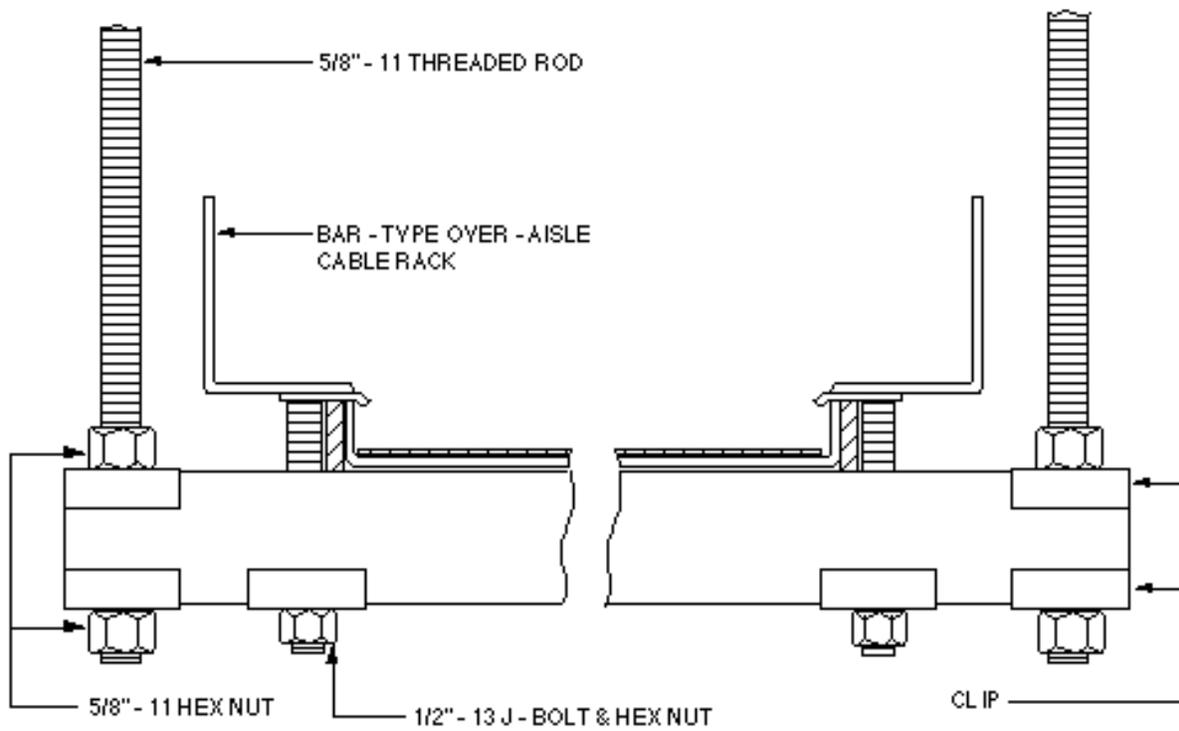


EXHIBIT 2-E1-77B  
SUPPORT BAR-TYPE OVER-AISLE CABLE RACK WITH HANGER RODS

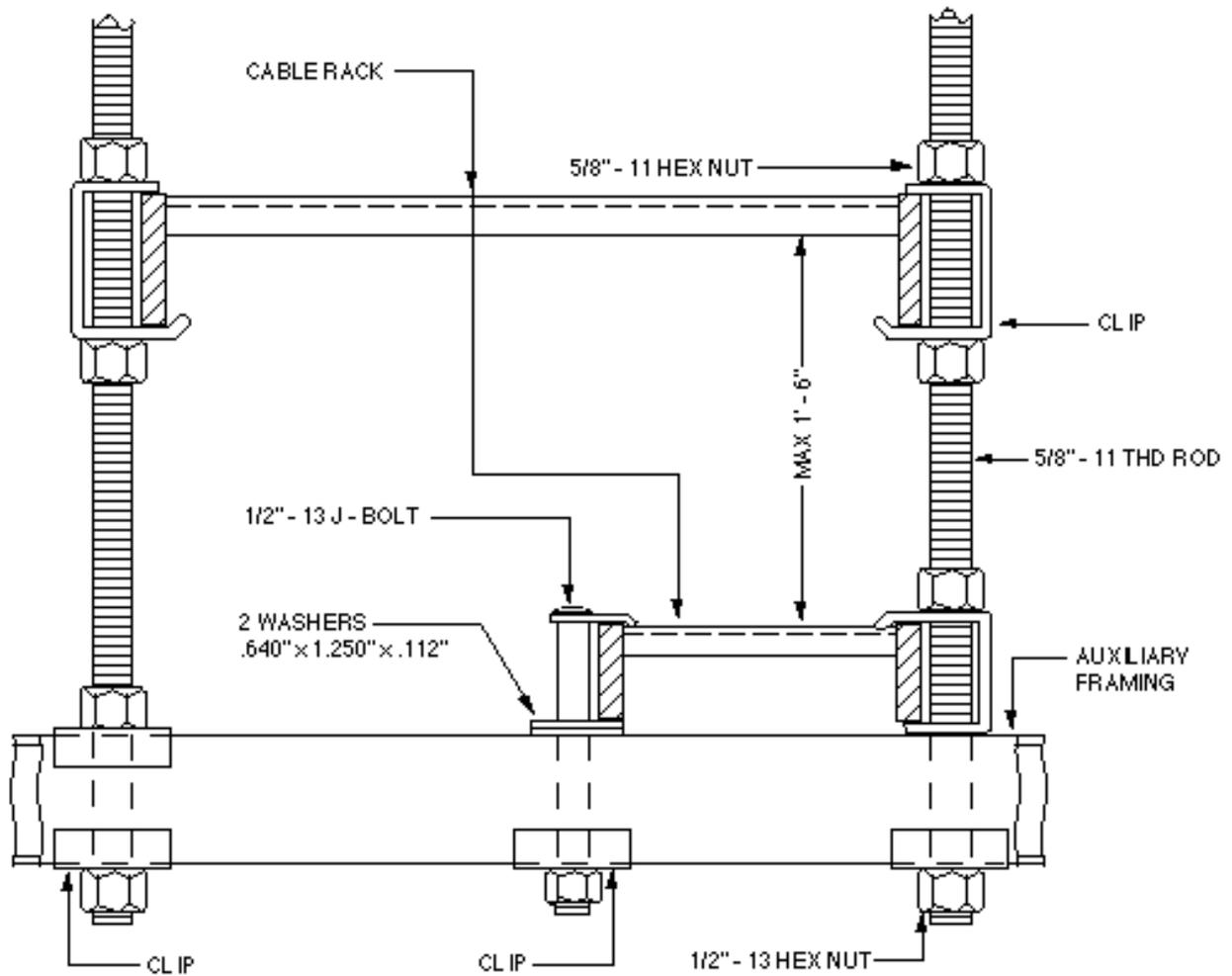


EXHIBIT 2-E1-81  
SUPPORTING ONE RACK ABOVE ANOTHER RACK-LARGE RACK ABOVE

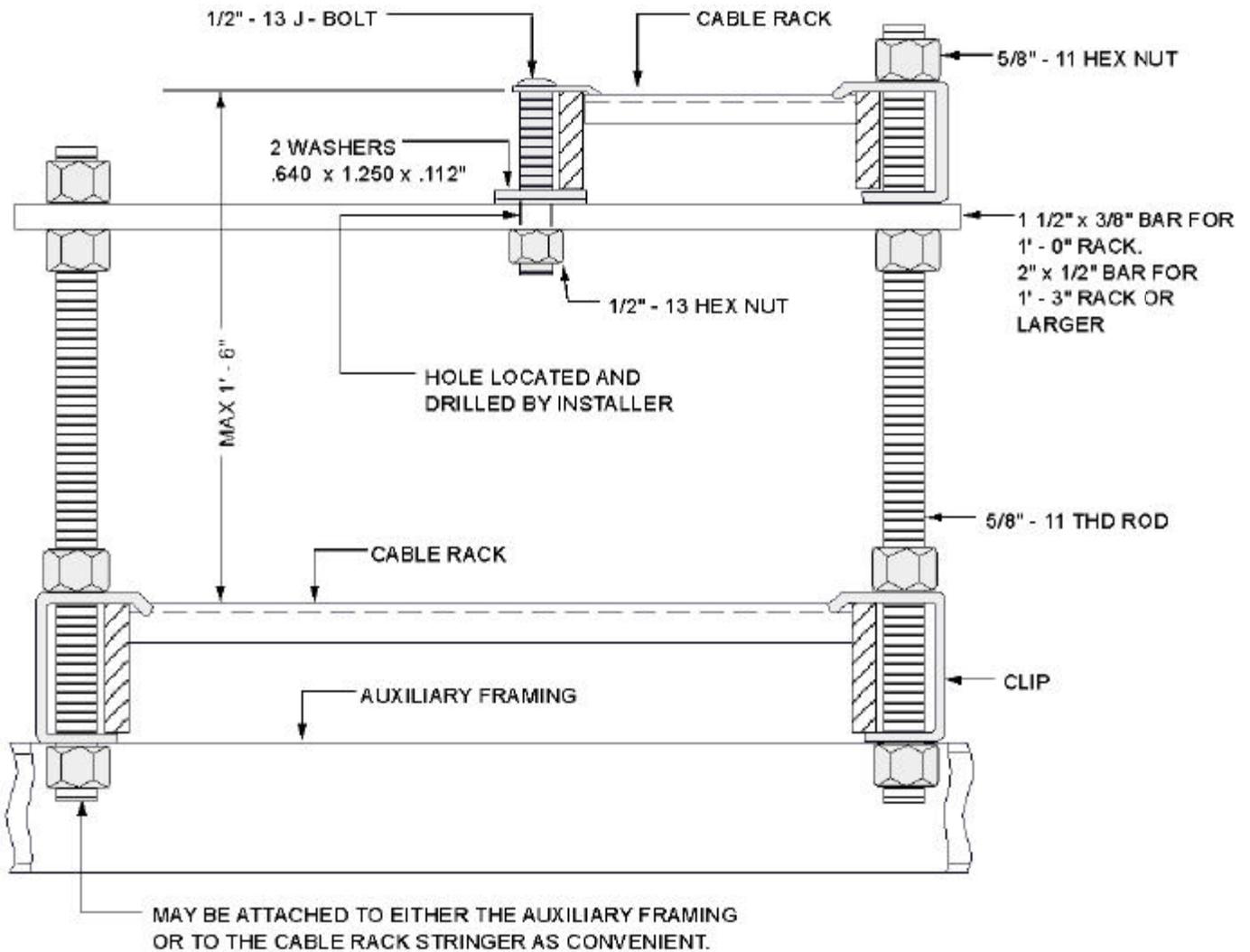


EXHIBIT 2-E1-82

SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK-LARGER RACK BELOW

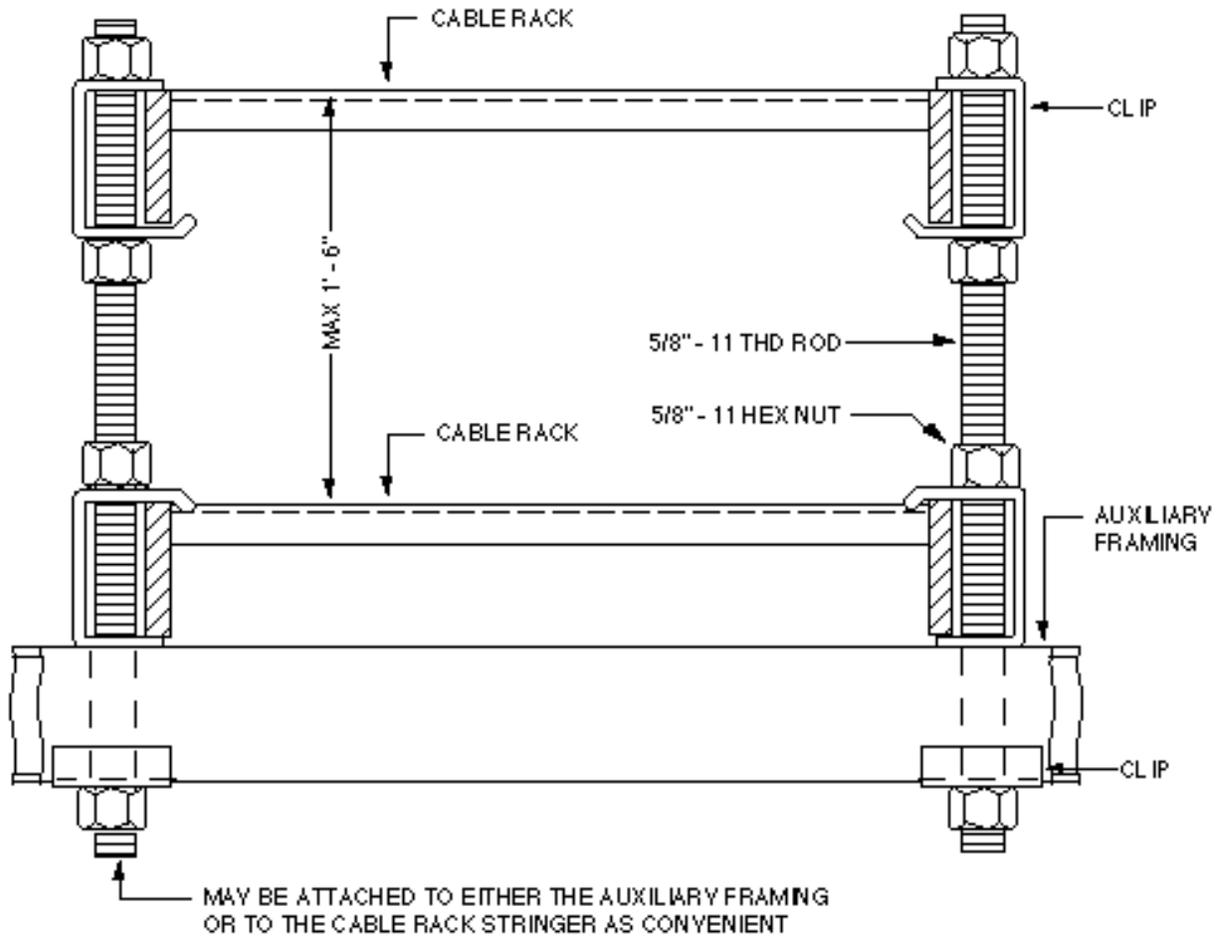


EXHIBIT 2-E1-83  
SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK-RACKS SAME  
SIZE

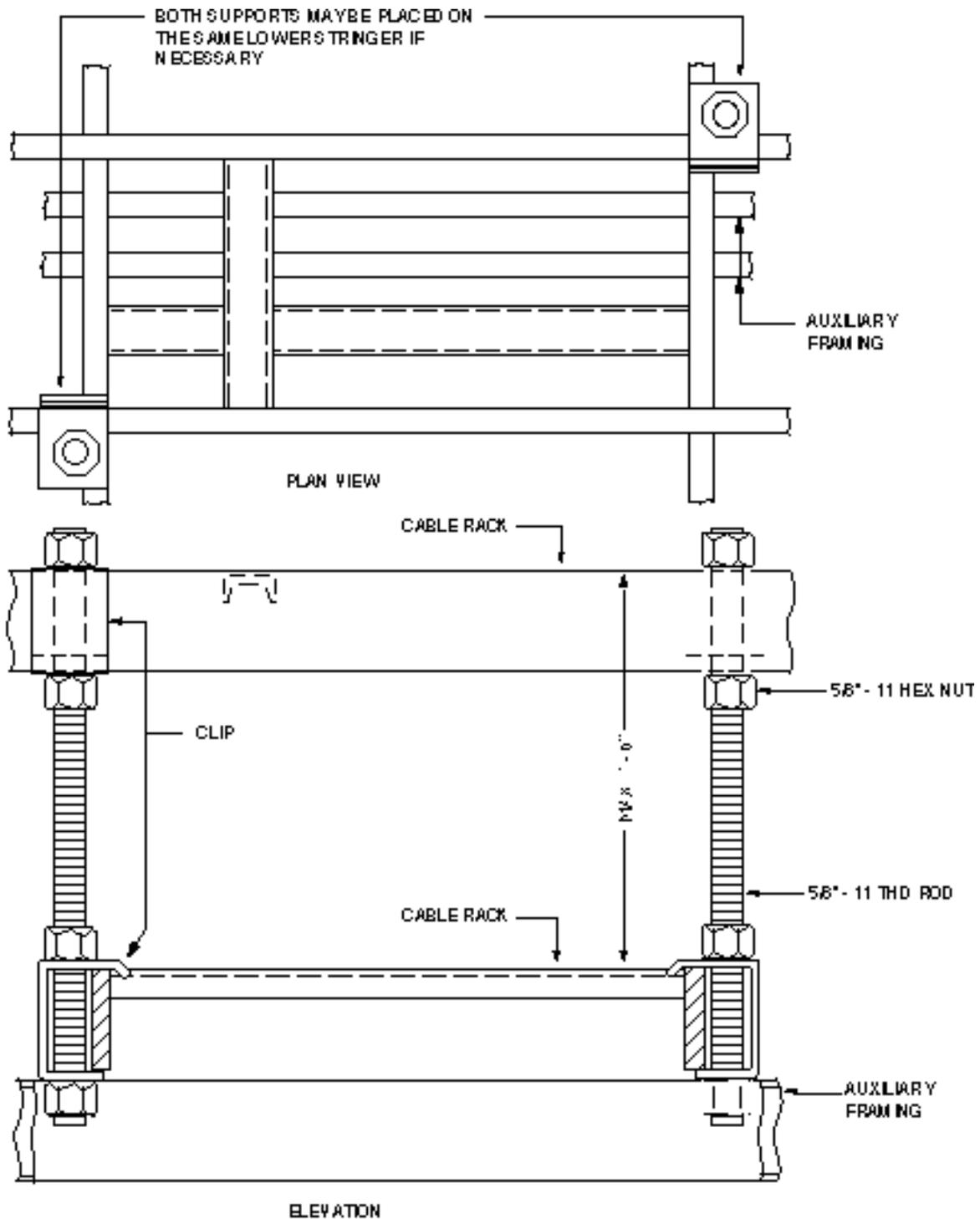


EXHIBIT 2-E1-84  
SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK-CABLE RACKS AT  
RIGHT ANGLES

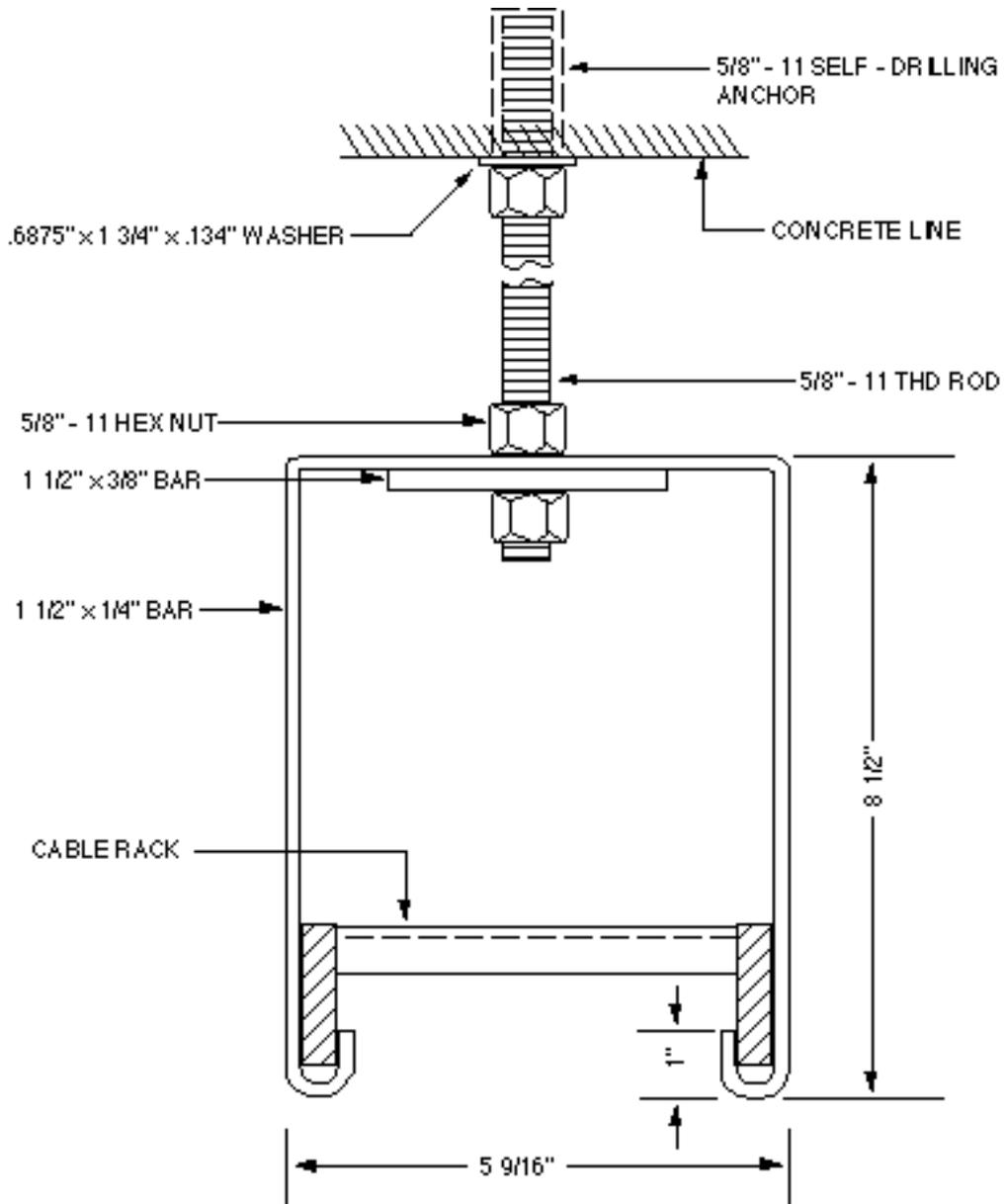
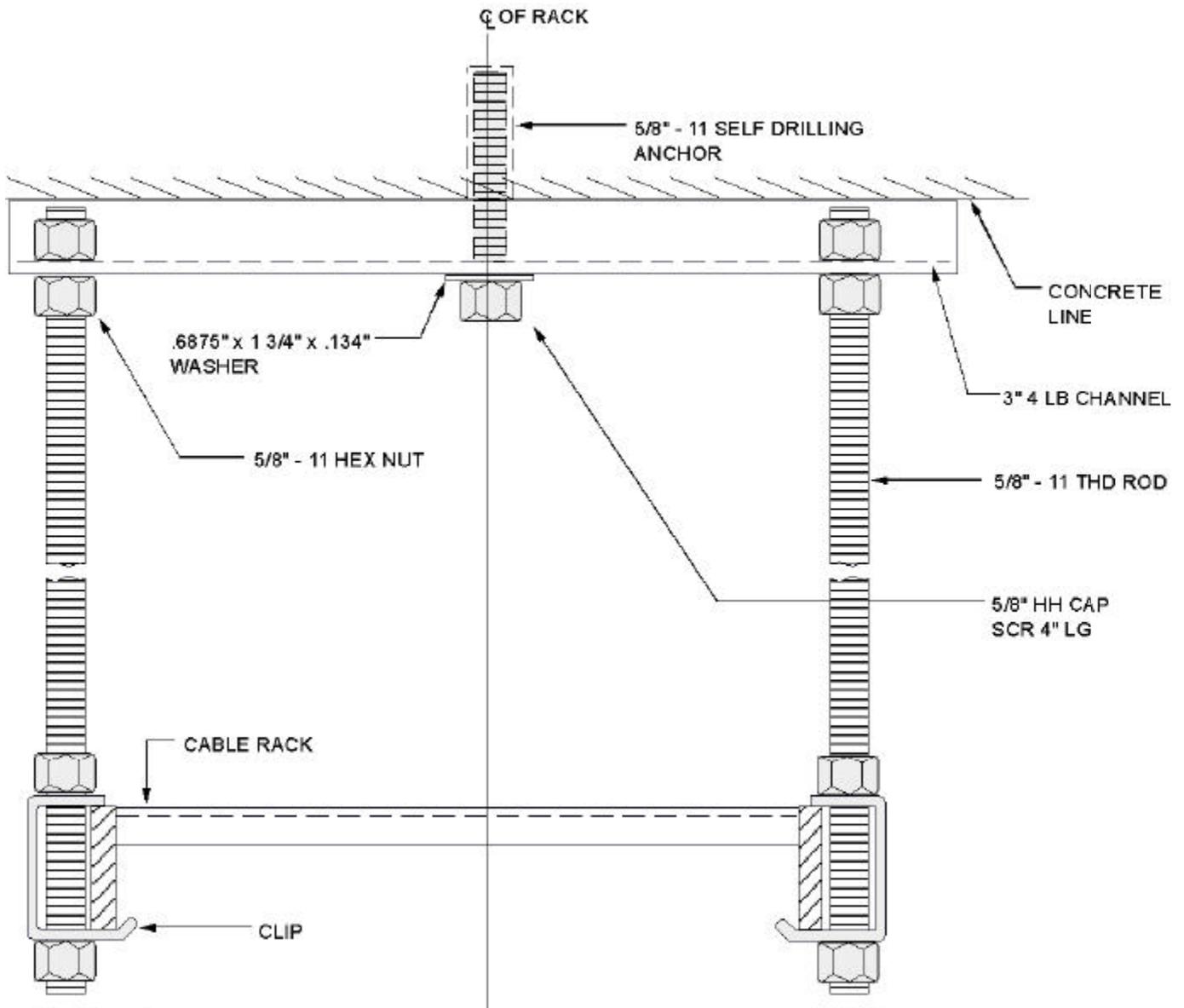


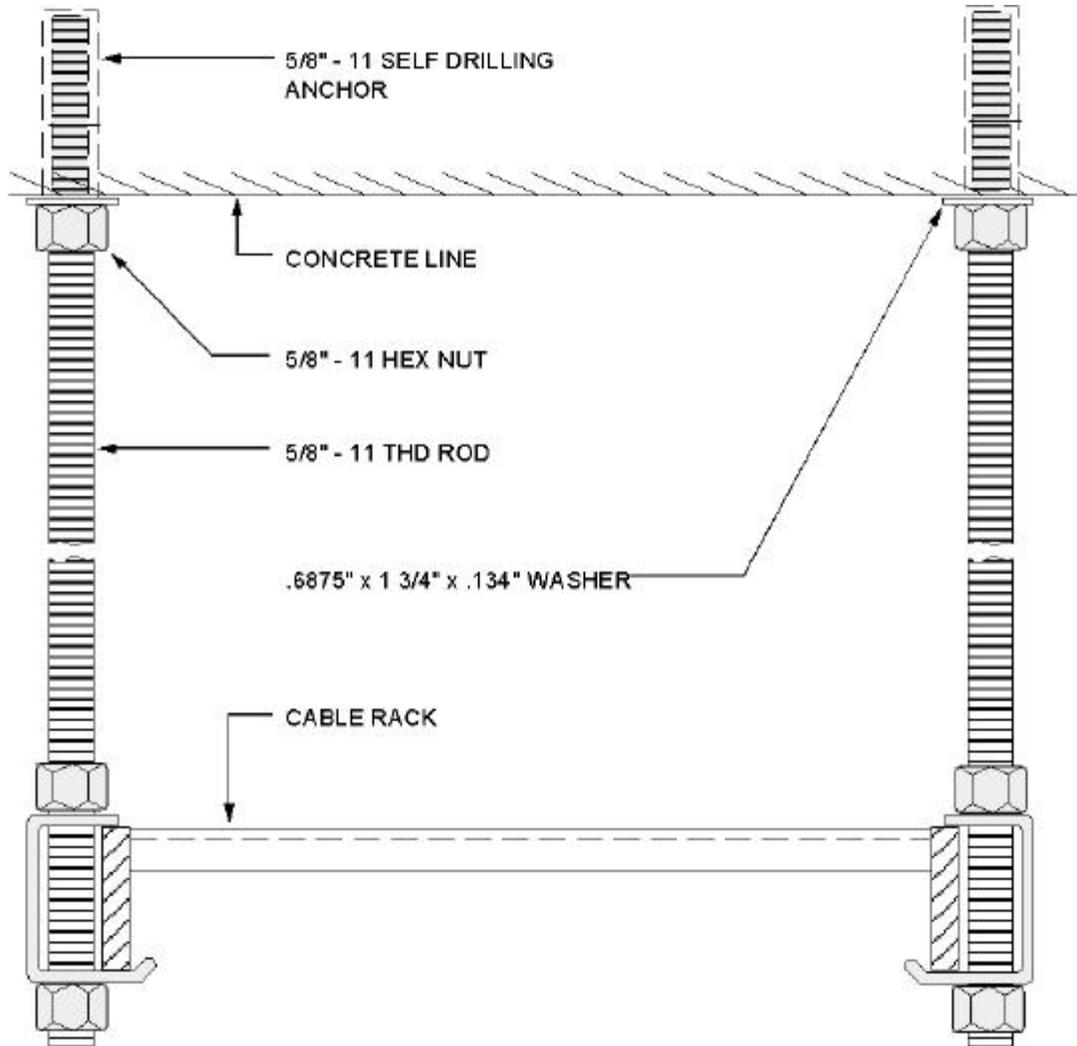
EXHIBIT 2-E1-85  
SUPPORTING 5 INCH CABLE RACK EMBEDDED INSERT IN CEILING



NOTE:

1. WHERE THE CEILING IS PLASTERED THE CHANNEL MAY BE ALLOWED TO REST ON THE PLASTER. THE EXPANSION SHIELD, HOWEVER, SHALL BE EMBEDDED ITS FULL LENGTH IN SOLID CONCRETE.

EXHIBIT 2-E1-86  
SUPPORTING 1 FOOT AND 1 FOOT 3 INCH CABLE RACKS FROM EMBEDDED OR  
EXPOSED CEILING CHANNEL



NOTE:

1. EXHIBIT 2-E1-86 IS THE PREFERRED METHOD OF SUPPORT FOR 1 FOOT 3 INCH CABLE RACKS. HOWEVER, WHERE THE RUN IS HEAVY THE EXTRA SUPPORT PER THIS FIGURE MAY BE USED.

EXHIBIT 2-E1-87  
SUPPORTING CABLE RACKS FROM EMBEDDED INSERT IN CEILING

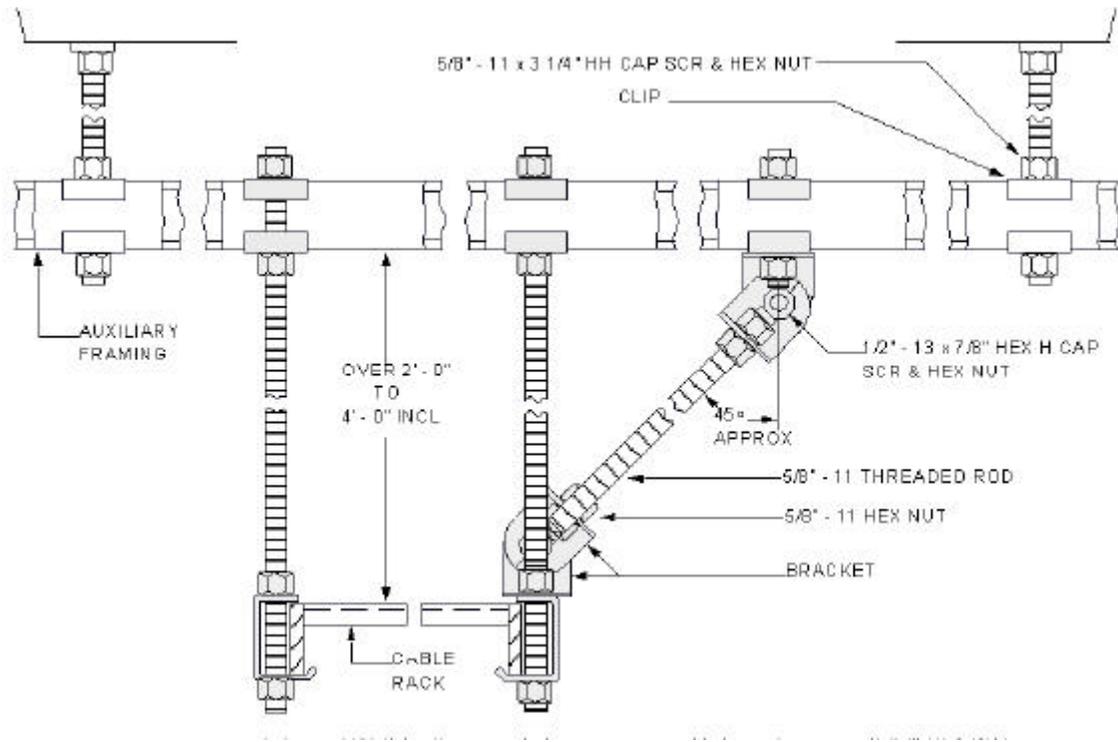


EXHIBIT 2-E1-88  
BRACING HANGER ROD-SUPPORTED CABLE RACK WITH ROD-TYPE BRACING

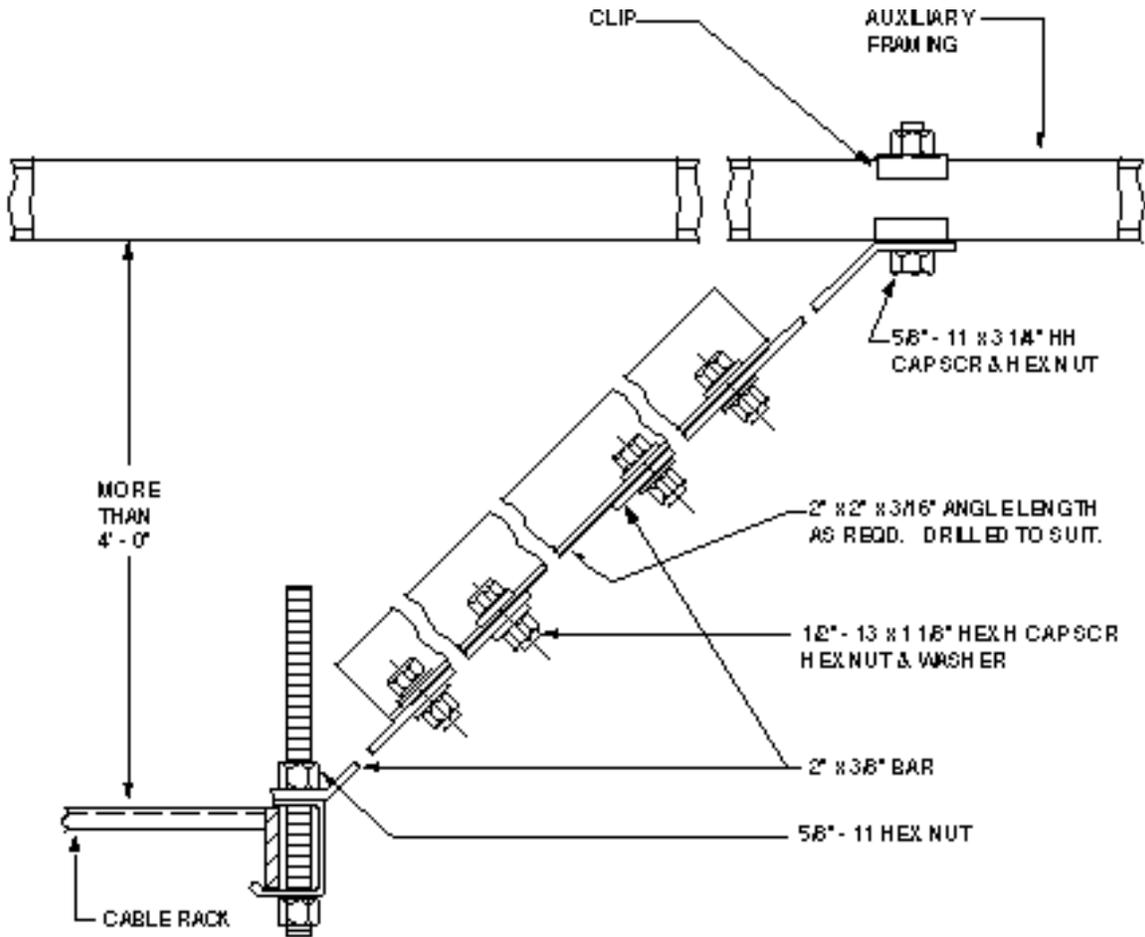


EXHIBIT 2-E1-89  
BRACING HANGER ROD-SUPPORTED CABLE RACK WITH ANGLE TYPE BRACING

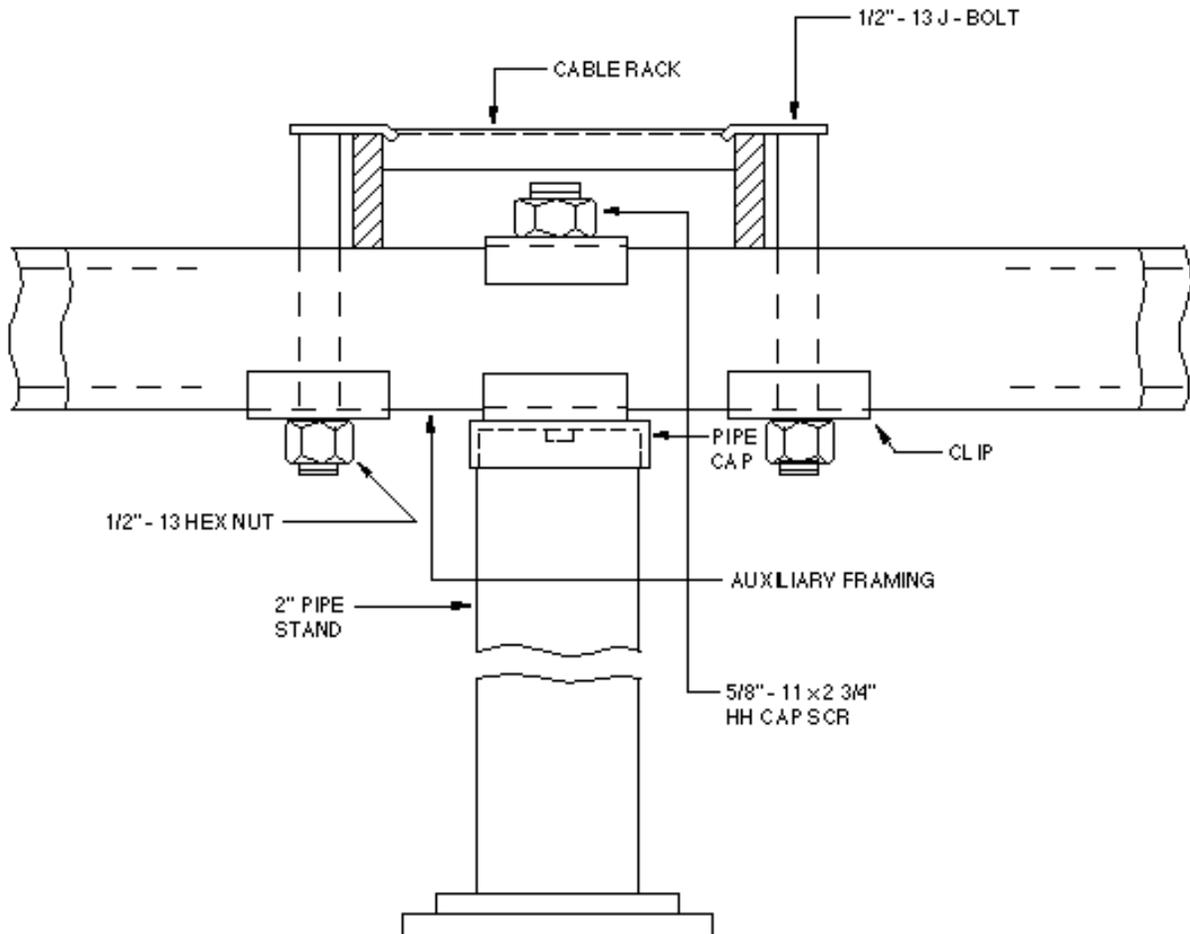


EXHIBIT 2-E1-90  
PIPE SUPPORTED CABLE RACK OVER LOW-TYPE AUXILIARY FRAMING

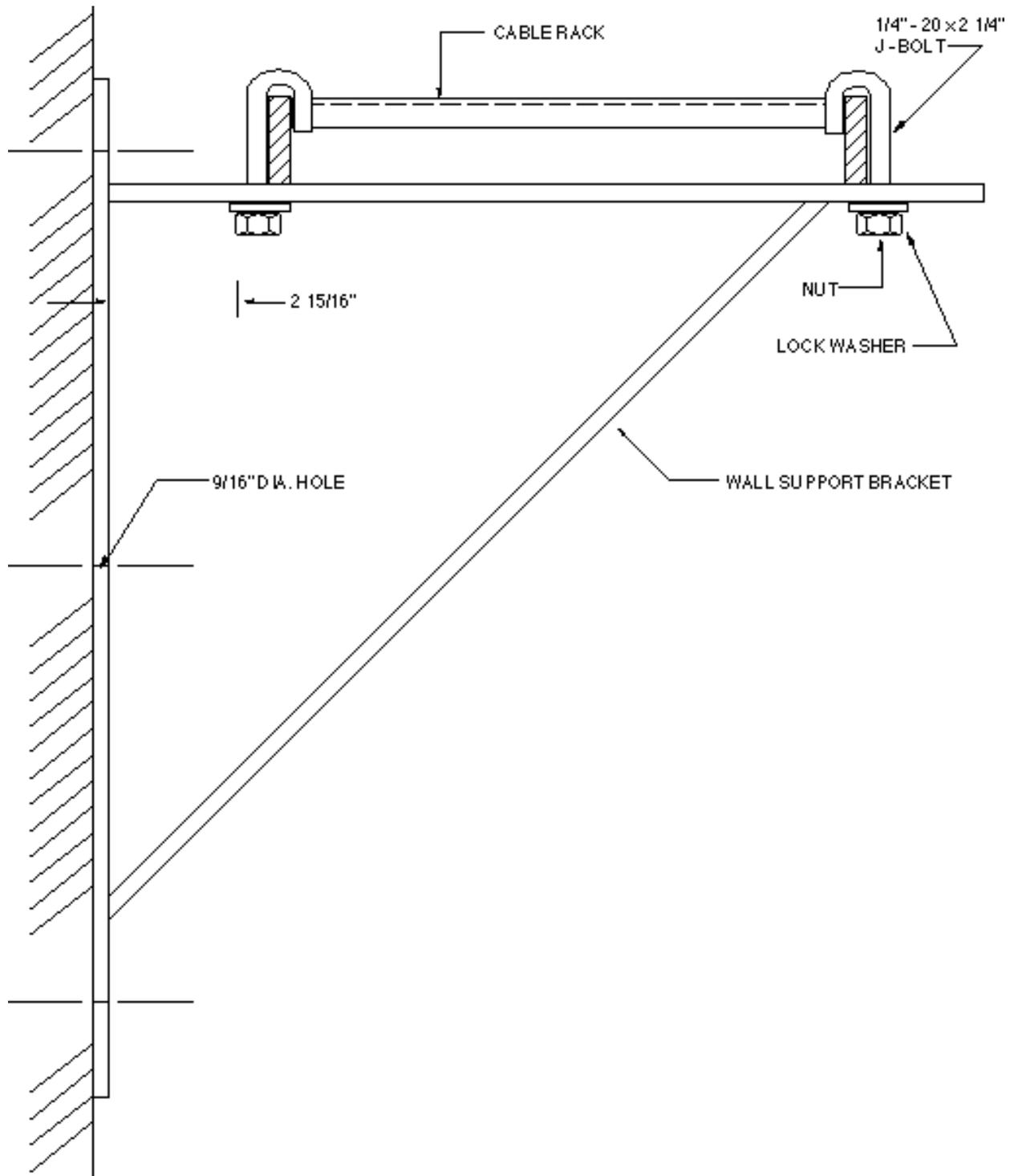


EXHIBIT 2-E1-91  
WALL SUPPORT BRACKET FOR 5 INCH-15 INCH CABLE RACK

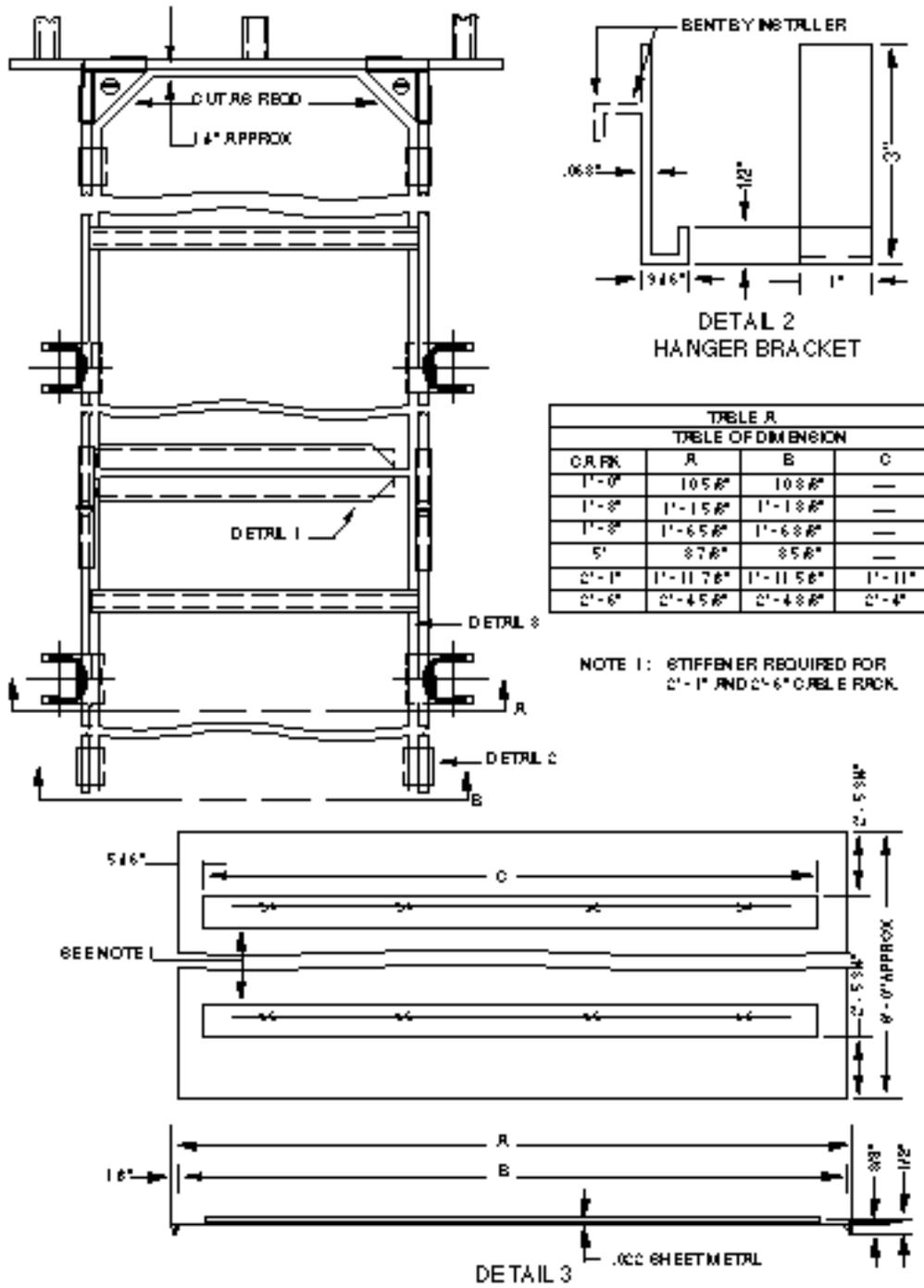


EXHIBIT 2-E1-92 (PAGE 1 OF 2)  
 SCREEN ASSEMBLY FOR UNDERSIDE OF 5 INCHES-30 INCHES LADDER-TYPE CABLE RACK

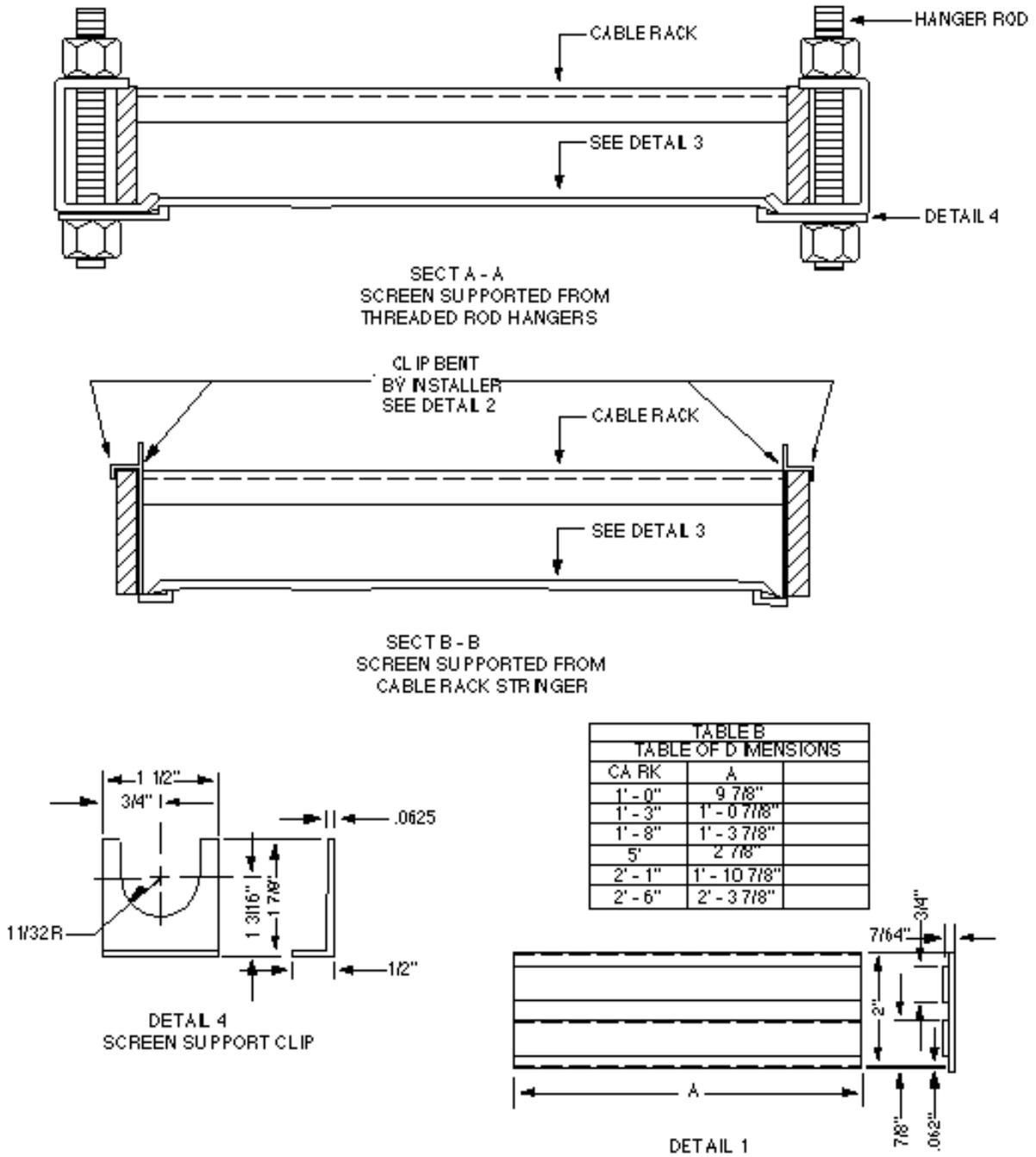


EXHIBIT 2-E1-92 (PAGE 2 OF 2)  
 SCREEN ASSEMBLY FOR UNDERSIDE OF 5 INCHES-30 INCHES LADDER-TYPE  
 CABLE RACK

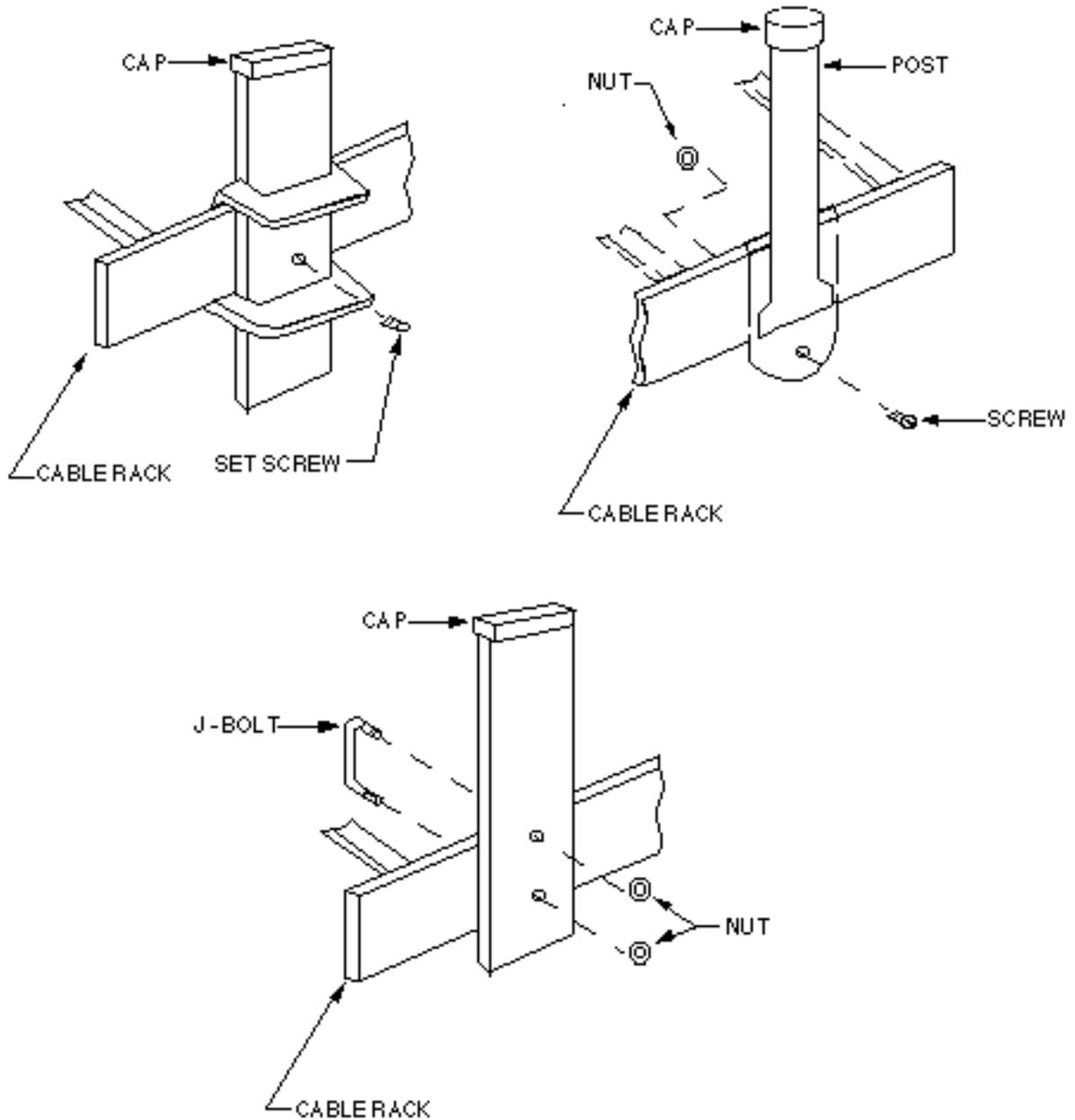


EXHIBIT 2-E1-93  
EXAMPLES OF CABLE RETAINING BRACKETS

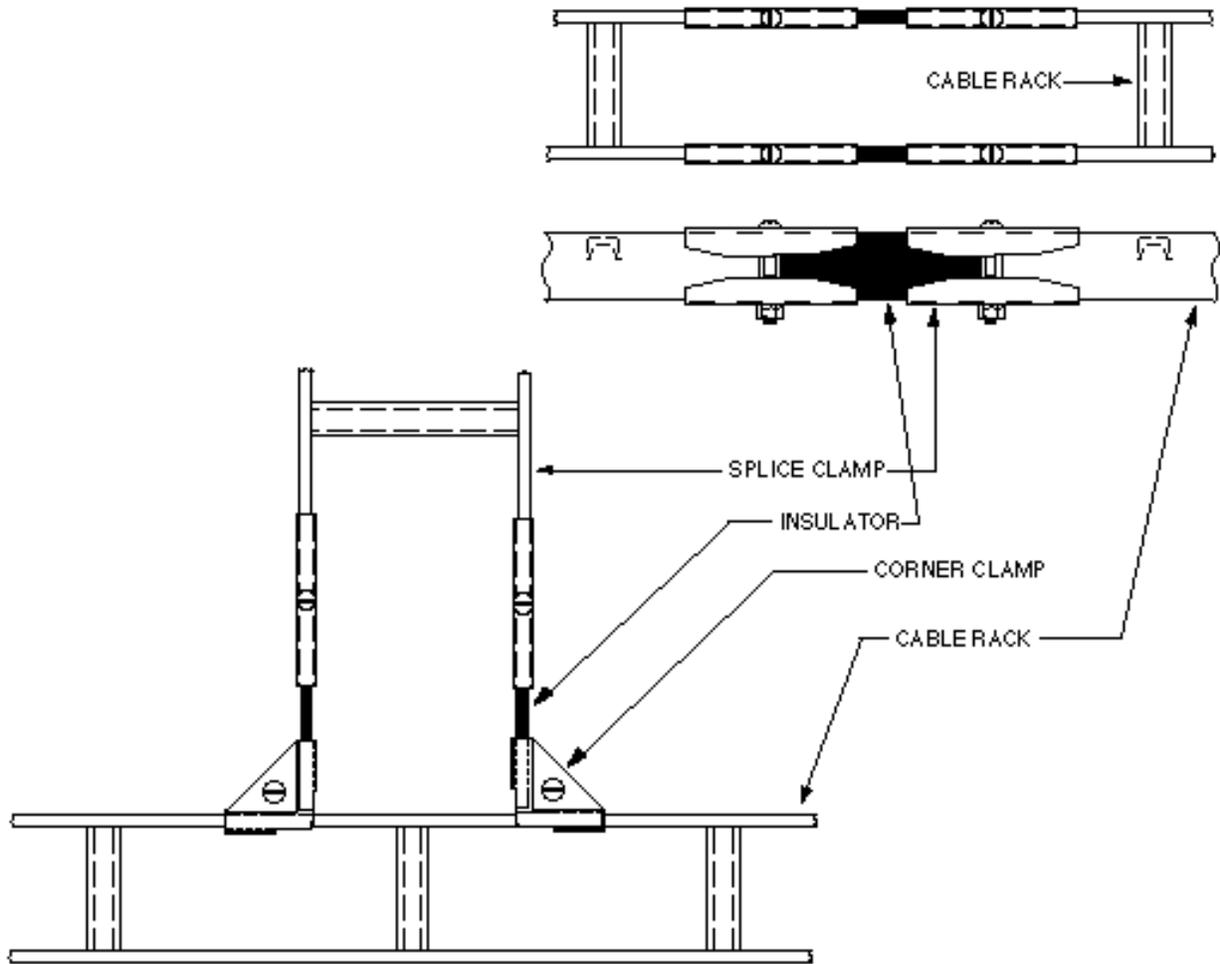


EXHIBIT 2-E1-94  
INSULATING JUNCTION FOR CABLE RACK

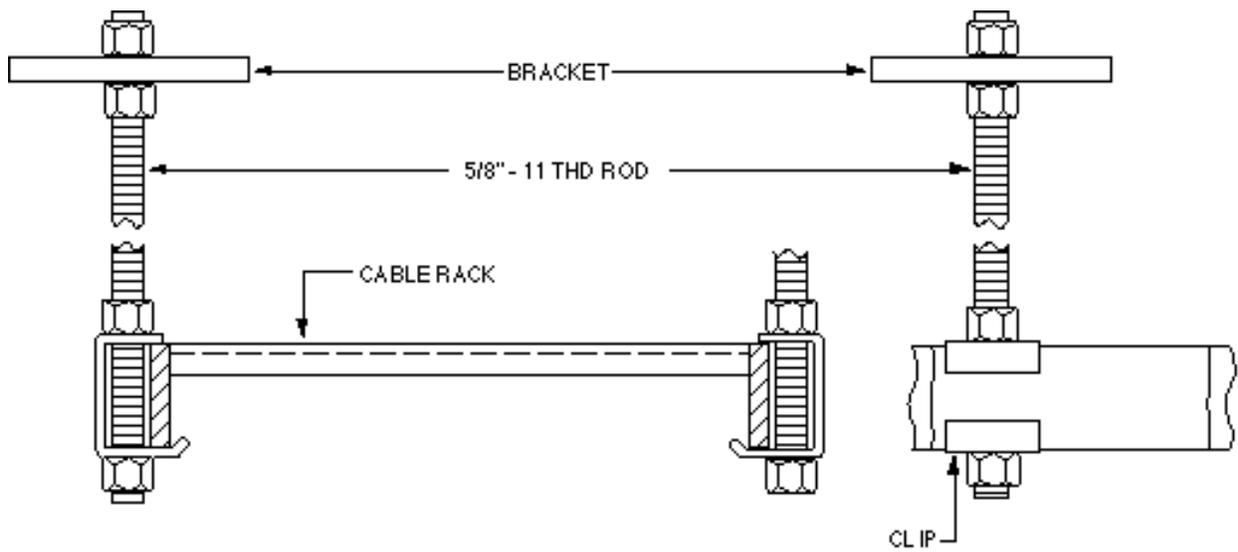


EXHIBIT 2-E1-95  
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## **6. Cable Rack and Auxiliary Framing**

### **6B. Auxiliary Framing - Low Type**

#### **6B.1 General**

This unit covers the engineering of auxiliary framing over line-ups of transmission and power equipment. Refer to the chapter on high type framing for additional requirements on ceiling suspended auxiliary framing.

Auxiliary framing requirements, methods of support and assembly, along with Exhibits in this chapter, illustrate approved methods of providing auxiliary framing in a Central Office.

Alternate methods of auxiliary framing support and assembly, not identified herein, are generally not approved. Authorization shall be obtained from the QWEST representative for Common Systems Standards prior to providing custom arrangements.

- Low type auxiliary framing in earlier environments such as Crossbar and Step-by-Step is the framing directly above and perpendicular to the equipment lineups.
- One inch galvanized support pipe is provided perpendicular to the auxiliary framing and is an integral part of the rigidity of low type auxiliary framing.
- Where bracing is required low-level framing is braced directly to walls or ceiling components. Restrictions on bracing to walls are contained in the chapters on auxiliary framing.
- Where multiple levels of framing are required also refer to the chapter on high type framing.

Auxiliary framing shall be provided for support of equipment, cable racks, frame lighting and other apparatus in the Central Office (CO).

- Framing parts shall be directly butted. All measurements shown in Exhibits indicate maximum or minimum allowable gap tolerances.

Safe load limitations for embedded ceiling inserts, expansion anchors, hanger rods, and auxiliary framing are covered in the unit on Cable Rack Requirements.

Self-drilling anchors shall not be used to secure frames or secure ironwork to ceilings, walls or floors. Substitute appropriate lag bolts for attaching frames or ironwork to wooden ceilings, walls, or floors. Where embedded inserts or expansion anchors are shown substitute torque indicating anchors.

Refer to the "Auxiliary Framing - High Type" section for additional requirements concerning "Ceiling Fastening Arrangements" or "Ceiling Hanger Rods".

Refer to the "Earthquake and Disaster Bracing" section for additional auxiliary framing requirements in earthquake heavy zones.

Auxiliary framing arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

## 6B.2 Description

Channel type auxiliary framing is 2 inches by 9/16 of an inch by 3/16 of an inch and is manufactured in various lengths.

- Channels are paired with the backs of the channels to the outside as shown in Exhibit 2-E2-11J.
- In order to obtain maximum rigidity, framing bars or channels shall be installed in stock lengths (20 feet) wherever possible.

Note: It is the intent of this document to maintain the rigidity of the ironwork support system as much as possible. This includes installing auxiliary framing in full sections and replacing short sections of framing where appropriate. For example, where 15 feet of framing is required it is not recommended to splice 10 feet and 5 feet together. An exception could be where framing is cut back to allow for future growth and stagger splices. The 5 feet section would then be replaced when extending the framing.

To prevent corrosion, framing bars and channel should be a non-corrosive plated type, or painted, preferably gray. Framing bar and channel assembly hardware shall be of a non-corrosive plated type.

Where channels and hardware are intended to provide an electrical bond, refer to QWEST Communications, Inc. Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines" and QWEST Communications, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

## 6B.3 Engineering Requirements

The requirements in this section apply to both high and low type auxiliary framing.

- The space required to access, add, or remove equipment and components, shall be taken into consideration when determining locations of auxiliary framing and supports.

Auxiliary framing shall not be located within the maintenance area of an equipment environment.

- The maintenance area is defined as that area below the top of the framework (including extenders) and in a front or rear aisle (guard rail to guard rail).
- Where environments of differing heights, such as 7 foot and 11 foot 6 inch, intersect, the auxiliary framing of the 7 foot floor supported environment may encroach into the other environment as long as it does not interfere with rolling ladders and normal C.O. activities.

Auxiliary framing shall be engineered and installed for the ultimate layout or arrangement whenever possible.

- Framing bars or channels for an area covered by continuous rows of framing shall be approximately the same level.

Separate areas of primary and secondary framing, where possible, should be of a consistent design so that when extended to each other and joined they shall be of a constant level.

- Auxiliary framing used exclusively for the support of cable rack shall be consistent with existing levels of framing where possible.

Framing bars or channels shall, at a minimum, be flush with clips similar to Exhibit 2-E2-9E.

In the placing of auxiliary framing a minimum clearance of 6 inches shall be maintained between the ends of the framing bars or channels and any building obstruction.

When auxiliary framing and associated equipment are located within the isolated ground plane, separation from all integrated ground plane members must be maintained as specified in U S WEST Communications, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

**THREADED RODS:** Auxiliary framing support arrangements shall be such that threaded rods will not pass through cable racks.

**STIFFENING CLIPS:** Channels are not as rigid as bars and may become bent during installation. Where required, additional clips shall be provided to hold the channels parallel similar to Exhibit 2-E2-10.

**FINISHING DETAILS:** Low type bars or channels shall be equipped with finishing caps, Exhibit 2-E2-23C, or clips, Exhibit 2-E2-10, except where bars or channels are within 6 inches of a wall, column, or vertical surface.

**VENDER SPECIFIC FRAMING ARRANGEMENTS:** Framing arrangements for the support of frameworks and system racking for switch systems, such as #5ESS and DMS, shall be per individual system requirements. Via racking support required for these systems shall be per QWEST requirements.

### **6B.3.1 Auxiliary Framing Support**

Auxiliary framing shall be located on centers of approximately 5 feet, and in no case exceed 6 feet.

- Auxiliary framing shall be located so that they will not interfere with cable rack, supports, cabling, lighting fixtures, conduit, or other equipment.
- Each auxiliary framing section shall have a least one point of support. Junctions and bracing fabrications shall not be considered a point of support.
- Framing bars or channels shall be located so that they do not exceed 2 feet 6 inches from last point of support. Where this distance exceeds 2 feet 6 inches, the framing shall be extended to the next row of primary bars, channels, or hanger rod.
- No pair of bars or channels used for the direct support of vertical loads shall have fewer than two points of support.

Note: A "vertical load" may be a load either "pushing" down on auxiliary framing from above, or a load "pulling" on the auxiliary framing from below. Cable rack and most auxiliary framing arrangements would exert vertical loads. Conduit, used for equipment lighting and outlets, is an example of a component that would not exert a vertical load.

- Auxiliary framing shall not be supported from the ceiling by ventilating ducts or other obstructions. The framing shall be supported from the main ceiling, beams, or girders.

Low-level framing shall be supported to high-level framing, as shown in Exhibit 2-E2-9E.

Where pairs of auxiliary framing bars or channels running at right angles to each other are at the same level and are to be junctioned, the fastenings shall be made as shown in Exhibits 2-E2-9F and 2-E2-9G

ISOLATION: Where isolation between two levels of channel is required, assembly shall be similar to Exhibit 2-E2-27. See Chapter 6 Unit F of this module for applications over Cable Distribution Systems.

### **6B.3.2 Extending Auxiliary Framing**

Where only one additional lineup of frames can be installed, the auxiliary framing shall be extended to allow for cable rack, ladder track, lighting conduit, etc.

Auxiliary framing shall be extended similar to Exhibit 2-E2-9M.

- An alternate method of extending bar or channel framing for additions to existing equipment, which eliminate the necessity for cutting back the existing bars or channels, is shown in Exhibit 2-E2-9D. This method is prohibited where existing framing sections are less than 6 feet long to the end or to a splice point. Framing sections shorter than 6 feet shall be replaced with stock sections.

Framing bars or channels shall extend approximately 3 inches beyond the last set of clips, to provide for splicing where additional framing would be ultimately installed.

Support for auxiliary framing, in buildings where ceiling support systems cannot be added, may be installed per Exhibit 2-E2-29 by attaching auxiliary framing to outside block or framed walls.

- Consideration of this method must be addressed prior to completion of the building construction to assure that proper load requirements have been met for the attachment of the wall channel or wood plates. All wood must meet QWEST Environmental Standards for fire treated lumber.

### **6B.3.3 Splicing Auxiliary Framing**

Auxiliary framing shall be spliced using 3-hole splice plates as shown in Exhibit 2-E2-9J.

- The splices shall be staggered as shown in Exhibit 2-E2-9M to obtain a rigid junction.
- Multi-level framing shall stagger the splicing, especially in heavy seismic zones.
- Splices in the same aisle of adjacent pairs of bars or channels of auxiliary framing shall be avoided. Splices shall be placed at least one aisle apart and positioned as to not interfere with clips used to fasten ladder tracks, lighting conduit, or cable racks.

- The use of 3-hole splice plates permits splicing at support locations such as lighting, cable rack, tops of frames, ladder track, etc. Exhibit 2-E2-9L illustrates common applications.
- A space may be left between the ends of paired channels to compensate for variations in length provided that a minimum overlap of 2 inches is maintained at the clip.
- Where required, alternate pairs of existing channels shall be cut back just beyond the next to the last row of frames, so that added channels can be fastened to the last two rows of existing frames to obtain a rigid junction. Subsequent splices in auxiliary framing bars shall be staggered.
- 11 foot 8 inch framing extended by 11 foot 9 and 1/2 inch framing shall be spliced to the existing 11 foot 8 inch framing per Exhibit 2-E2-9H. Staggering is not required.

#### **6B.3.4 Auxiliary Framing at Cable Holes**

Auxiliary framing shall be provided at cable holes and other openings in floors or walls as required for the support of cable rack.

- Care shall be taken that framing will not interfere with the cabling at these openings.

#### **6B.4 Top Support Arrangements**

All frames or cabinets shall have top support.

- Frameworks require a minimum of two top supports per bay, while cabinets require four (one on each of the cabinet's four corners)
- Distributing frames shall be supported at approximately 5-foot intervals, consistent with auxiliary framing arrangements.
- All frames, bays, and cabinets shall not be free standing but shall include top support to an overhead structure.

Top support shall be understood to mean: fastening with approved hardware to bars, channel or cable rack, independent of the frame itself, which are so constructed as to maintain the top positioning of the frame.

- Junction hardware between frames or frame base filler details (spacers) shall not be considered as top support.

In some cases, the top angles of adjacent frames in a line-up cannot be junctioned, as for example adjacent frames facing in opposite directions or adjacent frames separated from each other for cabling reasons with frame base filler details. Where the top angle junctions cannot be made, the frames involved shall be attached to the framework support structure so that each frame has at least two points of top support.

Frames that extends more than 2 feet 6 inches beyond the regular auxiliary framing support need to be supported to the cable rack.

Isolated frames must be provided with two top supports. Isolated frames shall be understood to mean frames that cannot be fastened to adjacent frames with junctioning hardware.

Top support references for discontinued switch systems (Step-by-Step and Crossbar) and older frameworks (channel and bulb-angle) have been removed from this publication. Exhibits have been retained for additions and maintenance only.

#### **6B.4.1 Floor Supported Environments**

Low type framing engineered in conjunction with 7-foot floor supported systems shall be located above framework lineups as illustrated in Exhibits 2-E2-32.

- Frameworks shall be supported per Exhibit 2-E2-32A.
- Frameworks requiring an offset shall be supported per Exhibit 2-E2-32B.
- Framework shall be supported per Exhibit 2-E2-33A in a U-channel system.
- A BDFB shall be supported per Exhibit 2-E2-32C.
- Distributing frames shall be ceiling supported.

#### **6B.4.2 Ceiling or Wall Supported Environments**

Support pipe shall be utilized where practical for top support of 9 foot and 11 foot 6 inch tall frameworks. Support pipes shall be 1 inch galvanized steel and installed in 20 foot stock lengths wherever possible. See Exhibits 2-E2-6F, 6J, 6L, 6M, and 6R.

- The 1-inch junction pipe shall be attached to auxiliary framing at intervals of 5 feet, not to exceed 6 feet.
- Where the 1-inch junction pipe extends beyond the end of the cable duct-type frames, the end of the pipe shall be capped with a finishing cap.

Where auxiliary framing does not align with the top of equipment frames, support may be provided per Exhibits 2-E2-30 and 2-E2-31. This configuration should be provided only where standard auxiliary framing methods cannot be employed.

When framing bars or channels do not align with the top of a frame or when additional framing is required, such as in the case of an isolated frame, short pairs of bar or channel shall be added above the frame.

In Central Offices (COs) where frames having installed in regular rows and are of a uniform height, the auxiliary framing shall be fastened to the frames per the following Exhibits.

Frame / Framing Height	Primary	Alternate
<b>Duct-Type Frameworks w/top angles</b>		
7-0, 9-0, 11-6	2-E2-6J	2-E2-6
7-2, 9-2, 11-8	2-E2-6M	2-E2-7A, 2-E2-7C
7-3 1/2, 9-3 1/2, 11-9 1/2	2-E2-6R	2-E2-7E
<b>Distributing Frames *</b>		
7-0, 9-0, 11-6	2-E2-6	-
7-2, 9-2, 11-8	2-E2-7A	2-E2-7C
7-3 1/2, 9-3 1/2, 11-9 1/2	2-E2-7 E	2-E2-7D
<b>BDFB</b>		
7-0, 9-0, 11-6	2-E2-18A	
7-2, 9-2, 11-8	2-E2-18B	
7-3 1/2, 9-3 1/2, 11-9 1/2	2-E2-18C	

\* The auxiliary framing used for supporting distributing frames more than 11 feet 6 inches high shall be engineered in accordance with the requirements for high-type auxiliary framing.

- In offices where the auxiliary framing level is 11 feet 6 inches above the floor, the framing may be extended to include 11 foot 6 inch distributing frames. The level of the framing over the distributing frames where a partial cross-arm extends the terminal strip on the vertical side to within 3 inches of the top shall be raised as shown in Exhibit 2-E2-13.
- Where an 11 foot 6 inch distributing frame, equipped with jack boxes above the vertical side, is supported by low-type auxiliary framing, the framing shall be located to avoid interference with the mounting of the boxes.

Where a frame or line-up extends more than 2 feet 6 inches beyond the last auxiliary framing bars or channels, it shall be attached to the cable rack with short pieces of framing, as shown in Exhibits 2-E2-5 and per appropriate top support.

**CONVENTIONAL DISTRIBUTING FRAMES:** Distributing Frames (DF) and Protector Frames (PF) shall be ceiling supported and braced.

**BDFB:** Auxiliary framing over a BDFB or power board shall be installed where required for the support of bus bars or a cable rack above the power board.

**POWER BOARD:** The auxiliary framing shall be fastened to supports attached to the power board, as shown in Exhibit 2-E2-18. Where the power board is equipped with rear doors, the auxiliary framing support must be mounted on top of the bay with a bracket as shown in Exhibit 2-E2-18D.

**BUS BARS:** An example of auxiliary framing arrangements at battery stands to support bus bars and cable rack is shown in Exhibit 2-E2-20. Short pairs of bus bars over battery stands shall be supported per Exhibit 2-E2-28.

## **6B.5 Floor Supported Environments**

Floor supported systems are generally considered to be framing arrangements above 7 foot frames and not attached to a ceiling, wall, or column supported auxiliary framing system.

Floor supported environments will be engineered where conditions permit.

- Less than two parallel lineups are not sufficient for framework or racking support.
- Ceiling supported environments and floor support arrangements per Exhibit 33 and 33A shall be discontinued where practical
- An area of existing high level auxiliary framing does not preclude the engineering of a 7 feet low-level environment.

Areas usually appropriate for the engineering a 7 foot environment

- Areas where a minimum of two adjacent parallel lineups can be engineered for an initial planned lineup length of at least ten feet.
- Individual lineups engineered with more than one support environment (i.e. 7 foot with 11 foot 6 inch) is prohibited
- Lineups should be facing each other when establishing a new floor supported environment.

Areas inappropriate for engineering a 7 foot environment

- In existing partial lineups of 9 foot or 11 foot 6 inch bays.
- Where only one lineup can be planned in the area available and adjacent lineups are not planned for removal.

Floor supported environments are dependent on maintaining the rigidity of the ironwork arrangement (i.e. cable rack and auxiliary framing). In order to obtain maximum rigidity, cable rack and framing bars shall be installed in stock lengths or the longest lengths practical wherever possible.

- Splicing multiple short lengths of framing is prohibited. When extending framing where there is existing short lengths of framing bars (less than approximately 6 feet sections) the short bars shall be removed and replaced with the longer bars (stock lengths) where appropriate.

### **6B.5.1 Ironwork Support**

Auxiliary framing above 7-foot floor supported systems shall be supported by bays, framework stanchions, and/or approved stanchions per the following requirements and guidelines:

Note: Equipped bays may be used in place of any pipe or framework stanchion. Also, framework stanchions may be used as equipment bays.

- Auxiliary framing shall run parallel to and above the lineups as illustrated in Exhibit 2-E2-32 and consistent with designed aisle spacing. Secondary framing shall be run above and perpendicular to the lineup framing and supported on centers of approximately 5 feet. In no case shall the spacing exceed 6 feet.
- A clearance of approximately 8 inches shall be provided between the bottom of the framing and the tops of the frames for floor supported toll offices per Exhibit 2-E2-32.

- Pipe type stanchions shall be 7 feet 8 inches in height.
- Framework stanchions shall be included at the beginning of a lineup, on the left side when entering the front aisle and the right side when exiting.

#### LIGHT SEISMIC ZONES:

- Framework stanchions and approved pipe type stanchions shall be located similar to Exhibit 2-E2-2F.
- Framework stanchions in individual lineups shall not be located further than 20 feet apart.

#### HEAVY SEISMIC ZONES:

- Framework stanchions and approved pipe type stanchions shall be located similar to Exhibit 2-E5-4.
- Framework stanchions in individual lineups shall not be located further than 10 feet apart.

### **6B.6 Ceiling or Wall Supported Environments**

Ceiling, wall, or column supported framework environments shall be discontinued where practical (refer to the section on Floor Supported Environments) except above Distributing Frames and Power Rooms.

- Ceiling support: Ironwork level(s) and bracing extend from the top of frameworks to the ceiling. May include column bracing in older environments.
- Wall support: Framing extends to walls for support but usually not to ceilings. May include column bracing in older environments.

The following requirements will be applied where completing existing ceiling or wall supported lineups.

- Framework additions shall be supported in a manner similar to that used for existing frames.
- Where existing ceiling supported environments must be extended, standard arrangements of framing, racking, lighting, etc shall be followed.
- Framing bars or channels for an area covered by continuous rows of framing shall be approximately the same level.
- Secondary framing shall be used to add stiffening to the primary framing where cable racks have not been provided or extended.

In general, regular auxiliary framing shall not be placed over main or end aisles. Where support of main or end aisle cable racks extending into or across aisles is required, the framing shall be arranged as indicated in the unit covering cable racks.

Uprights of frames in offices having 11 foot 8 inch or 11 foot 9 and 1/2 inch framing shall be tied together at the top with 2 inch framing channels in stock lengths, wherever practicable.

- When auxiliary framing is slightly offset (approximately 1 inch) over junctions of frames, it is permissible to employ a supplementary framing bar or channel similar to Exhibits 2-E2-7C or 2-E2-7D.

Auxiliary framing that is adjacent to main or end cross-aisle cable rack shall be located as close to the frame uprights as practicable except at aisles containing conduit runs, cable brackets, or cable rack. In those cases the framing shall be set back a minimum of 9 inches from the extreme end of the line-up.

- Exceptions occur in Central Offices where the auxiliary framing has been set back a minimum of 6 inches. In these instances, the additional framing shall be installed to conform to the existing arrangement. In offices where bar-type cable racks are employed, the horns of the cable racks shall be located no closer than 3 inches to the auxiliary framing.

Locating the auxiliary framing under ceiling inserts will facilitate supporting the framing structure where frames are omitted. In the installation of 11 foot 8 inch or 11 foot 9 and 1/2 inch framing, it is the practice to install auxiliary framing and cable racks prior to the erection of the frames. By locating alternate lines or sets of auxiliary framing immediately under the ceiling inserts, the auxiliary framing and cable rack can be temporarily supported by means of hanger rods.

### **6B.7 Stanchions**

Auxiliary framing may be supported by approved stanchions in floor supported equipment environments or when necessary to provide additional support in ceiling supported environments where ironwork and cabling safe loads may have been exceeded.

- Only seismically approved stanchions are allowed in heavy seismic zones.
- Stanchions shall be placed at approximately 5 feet intervals, not to exceed 6 feet, and located so as not to interfere with existing or future aisles or egress route.
- The preferred location of stanchions in floor supported environments is at the intersection of the primary and secondary framing.
- Stanchions with a 10 inches or smaller square base shall be anchored using two anchors in light seismic zones and four anchors in heavy seismic zones.
- Stanchions with square bases larger than 10 inches shall be anchored using four anchors in all seismic zones.
- The height of pipe type stanchions shall be matched to the height of the auxiliary framing/cable rack being supported so that the auxiliary framing is laid on the top of the pipe stanchion.

When a pipe stanchion can not be installed under the intersection of primary and secondary auxiliary framing due to fluctuations in the floor level the pipe stanchion may be relocated under the higher auxiliary framing. A threaded rod may be used in this circumstance. In this case the distance from the top of a pipe type stanchion to the bottom of auxiliary framing shall not exceed 2 inches.

- Stanchions, as illustrated in Exhibit 2-E2-11A, may be used to support framing bars or channels in those buildings where ceilings can not be used for support. The stanchion arrangement must provide a rigid support system.
- In limited circumstances, and as a last resort, stanchion arrangements supporting ironwork may include attachment to walls.

### 6B.8 Bracing

**FLOOR SUPPORTED ENVIRONMENTS:** Floor supported auxiliary framing structures do not require bracing when appropriately engineered and installed per requirements.

- Bracing is required where the established heights of ironwork arrangements have been exceeded. This is not applicable to those areas where minor adjustments are made for variations in the floor.

**CEILING SUPPORTED ENVIRONMENTS:** The entire auxiliary framing structure shall be braced with ceiling braces of the threaded rod or angle type. The braces shall be located at approximate building column intervals or about 20 feet in both directions in a building not having columns. Both primary and secondary framing shall be braced. Refer to Exhibit 2-E2-2E.

Where ceiling type braces are used to brace low-level framing the braces shall be attached to the ceiling and to the auxiliary framing as follows:

DISTANCE BETWEEN CEILING AND AUXILIARY FRAMING	TYPE OF BRACE	EXHIBIT
1 foot 6 inches or less	Single-rod brace	2-E2-24
Over 1 foot 6 inches through 4 feet	Double-rod brace	2-E2-25
Over 4 feet *	Double-angle brace	2-E2-25A

\* Provide high type framing and bracing where distances between auxiliary framing and ceilings exceed 5 feet.

The above bracing requirements address only situations between low type (primary and secondary) auxiliary framing and ceilings. Refer to Auxiliary Framing - High Type for bracing requirements for multiple levels of auxiliary framing.

While Exhibits 2-E2-25 and 2-E2-25A show double braces sloping from the same point of attachment to the auxiliary framing, it may be necessary to attach these braces at separate points along the framing in order to avoid interference. In such cases, the points of attachment to the auxiliary framing shall be kept as close as possible. Another alternative may be braces sloping from a common point on the ceiling to two points on the auxiliary framing.

Where continuous rows of embedded ceiling channel are provided, the braces shall be fastened as shown in Exhibits 2-E2-26A.

**BRACING TO WALLS:** Support for 9 foot and higher auxiliary framing in buildings where ceiling anchoring systems can not be provided may be obtained per Exhibit 2-E2-8C by attaching auxiliary framing to outside block or framed walls.

**BRACING TO COLUMNS:** Supports attached to columns are not approved.



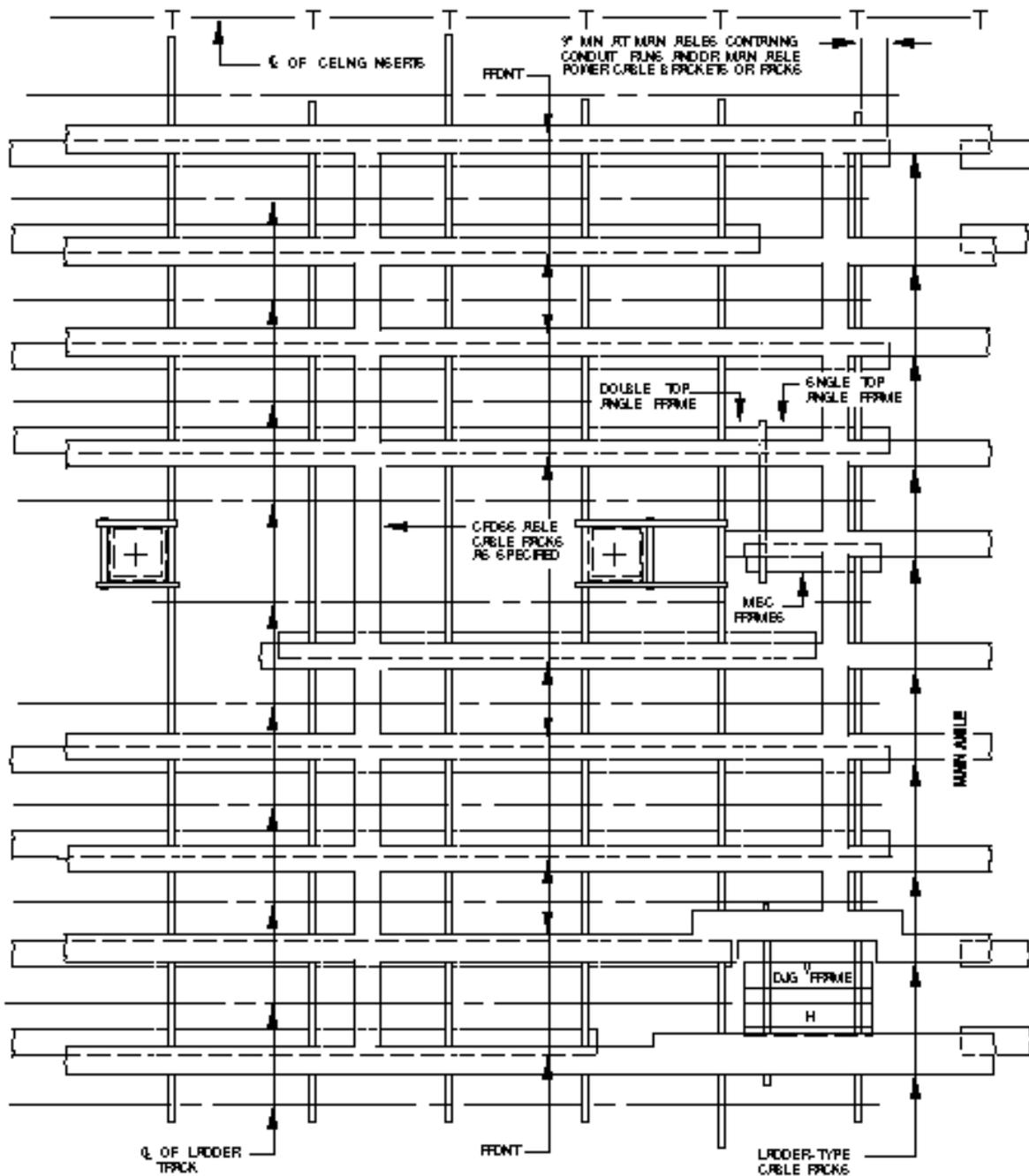


EXHIBIT 2-E2-2A (A&M)  
TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR NO. 1 CROSSBAR AND NO.4 TOLL SWITCHING OFFICES 11 FOOT 8 INCH FRAMING-LADDER-TYPE CABLE RACK OVER LINEUP OF FRAMES



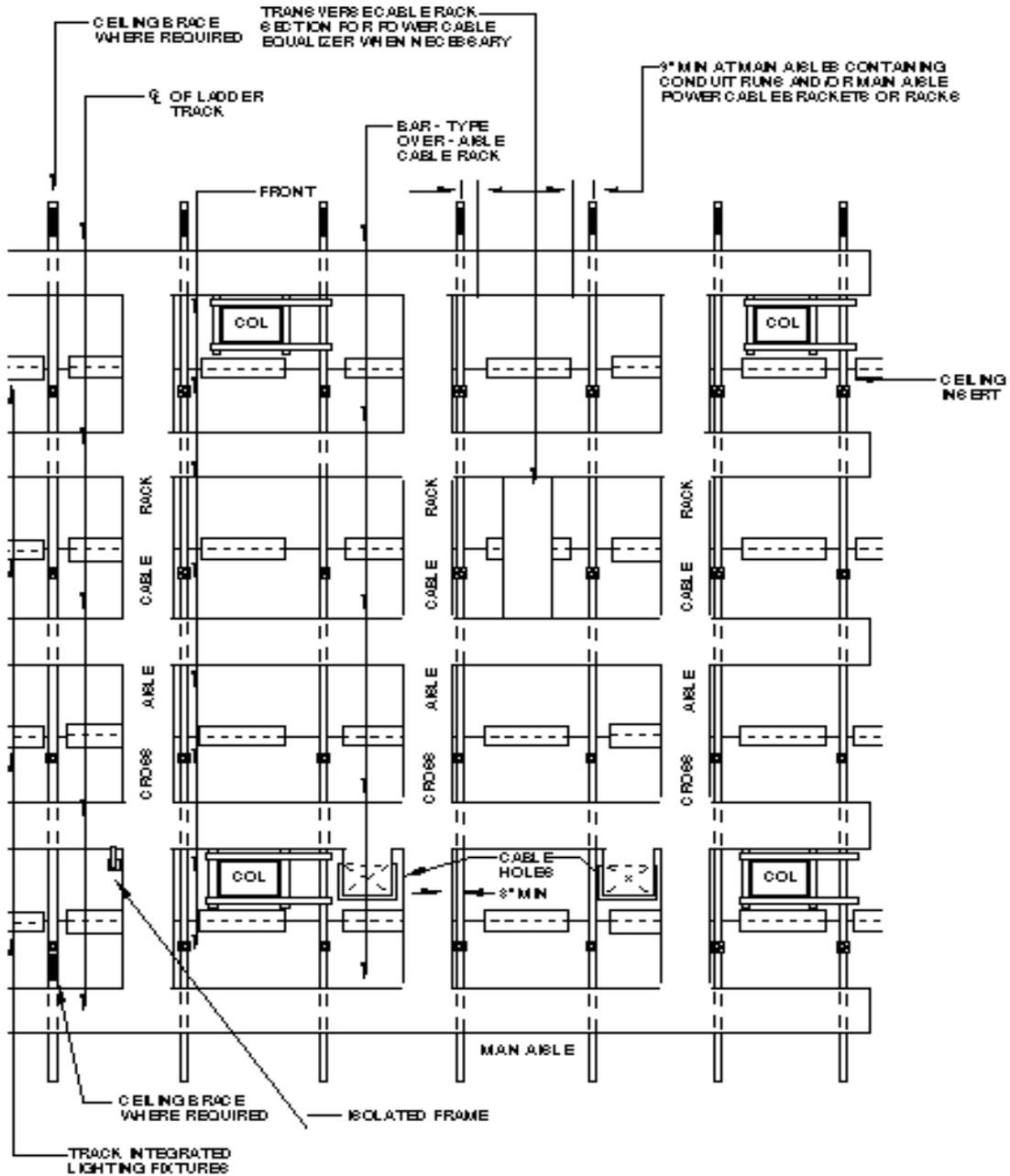


EXHIBIT 2-E2-2C (A&M)

TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR CROSSBAR, AND STEP-BY-STEP OFFICES-ALSO COMBINED CROSSBAR AND TOLL OR STEP-BY-STEP AND TOLL OFFICE-11 FOOT 9 and 1/2 INCH FRAMING-BUILDING COLUMNS AND CEILING INSERTS PREARRANGED TO FACILITATE PRECABLING

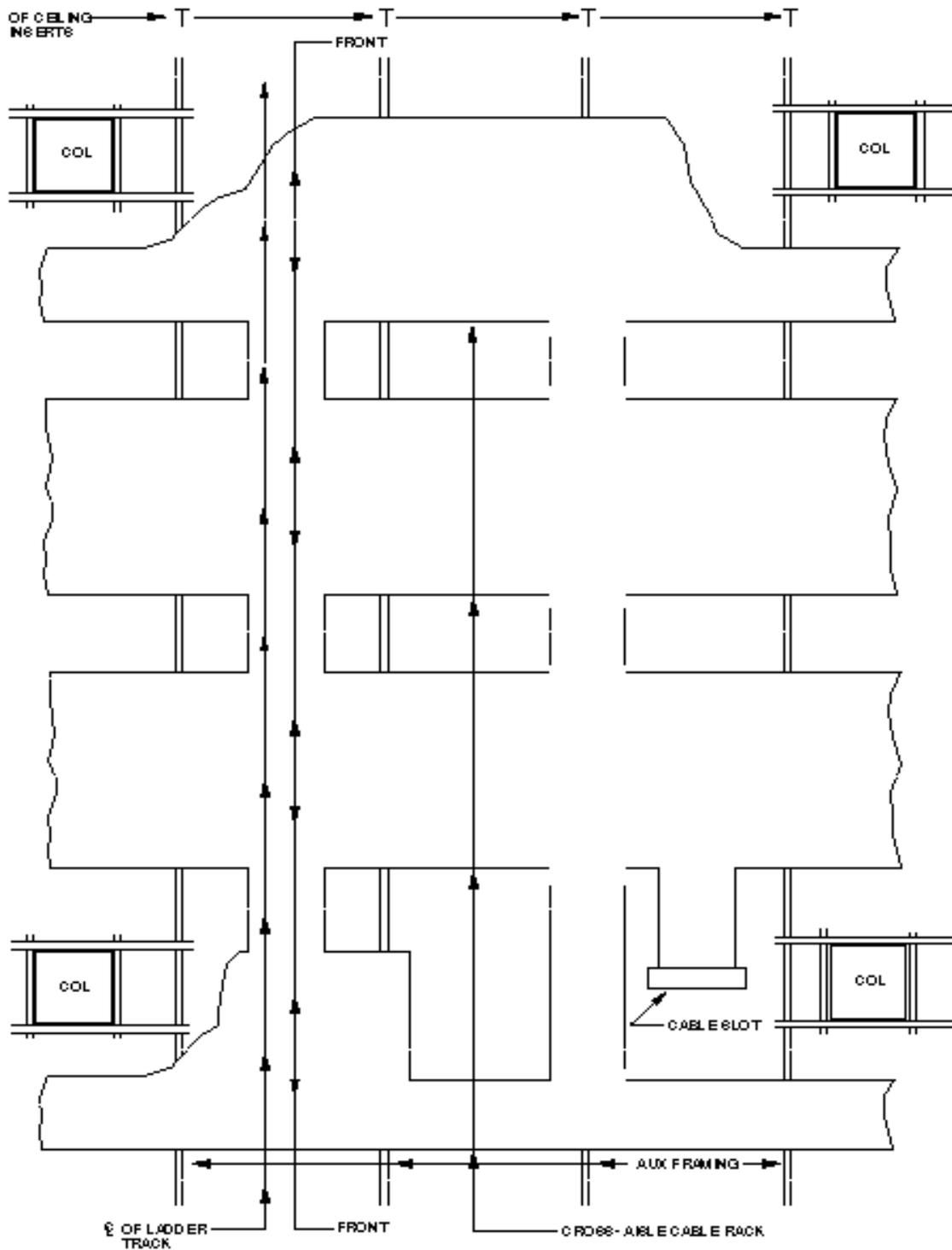


EXHIBIT 2-E2-2D (A&M)  
TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR NO. 4A TOLL SWITCHING  
OFFICES-11 FOOT 9 and 1/2 INCH FRAMING-4A WIDE CABLE RACK

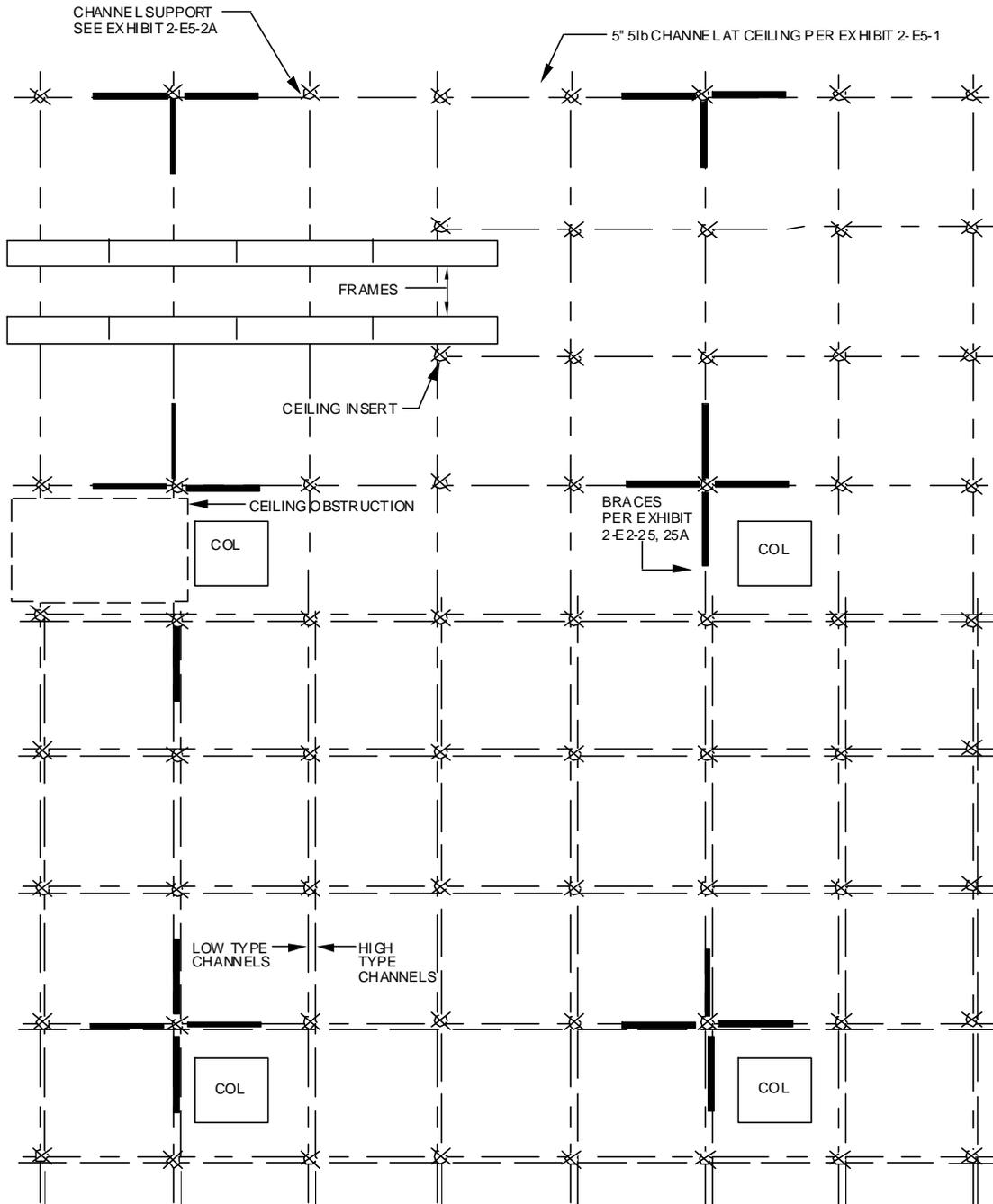
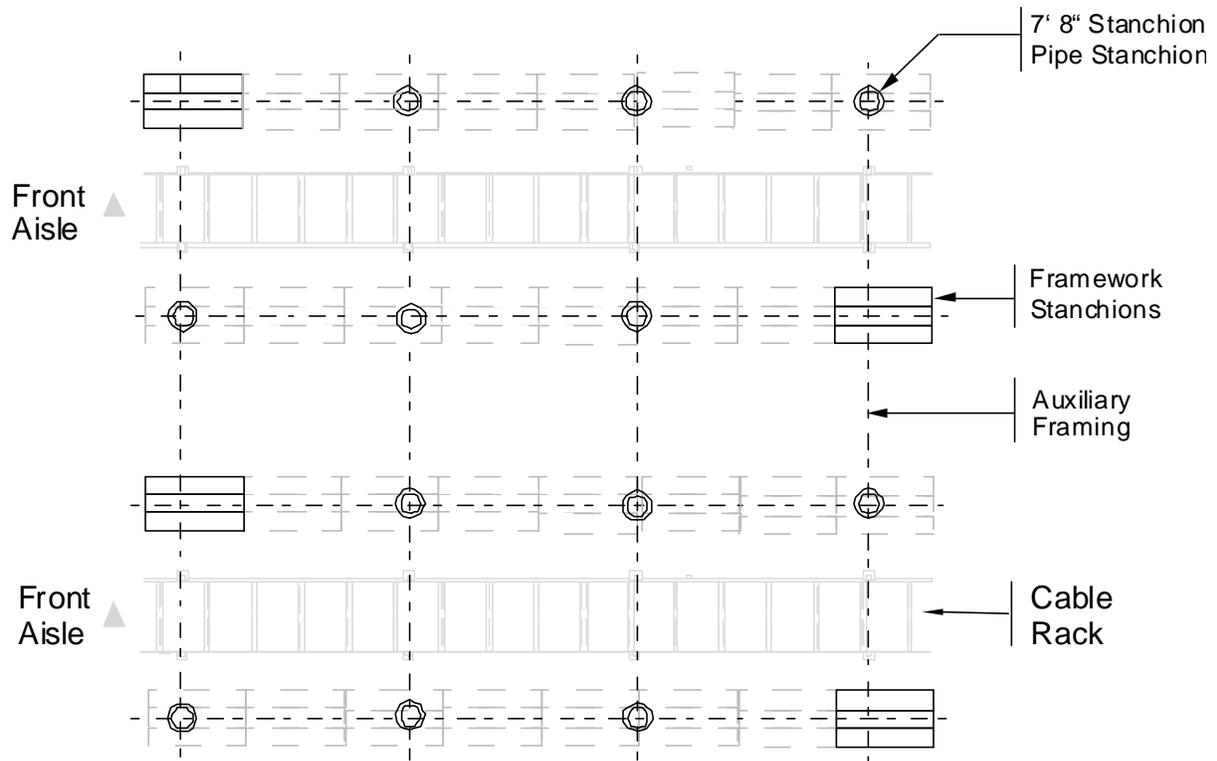


EXHIBIT 2-E2-2E  
TYPICAL BRACING SCHEME - LIGHT



**Seismic Zones 0,1,2**

2-E2-2F

TYPICAL STANCHION ARRANGEMENT - LIGHT

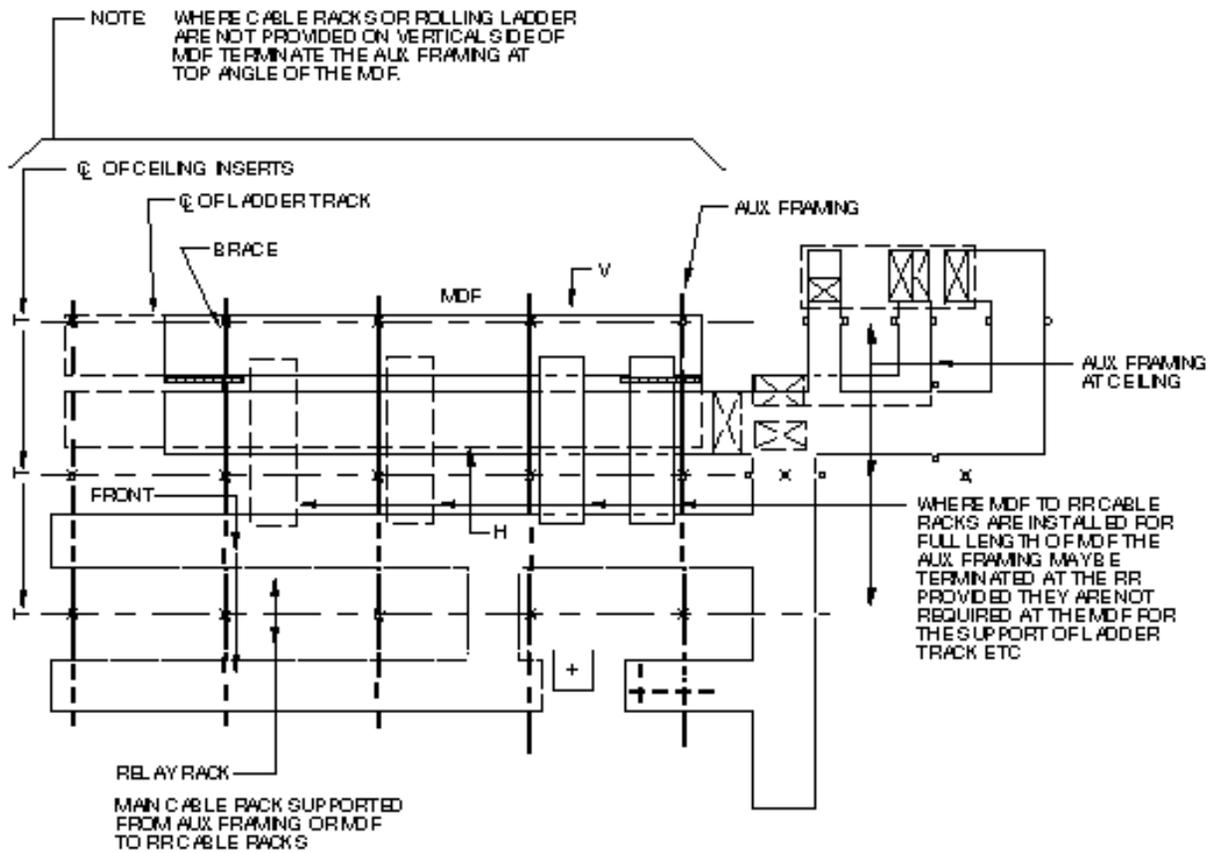


EXHIBIT 2-E2-4A (A&M)  
TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR NO. 11 OFFICES-11 FOOT 8  
INCH FRAMING-OVER FRAME CABLE RACKS

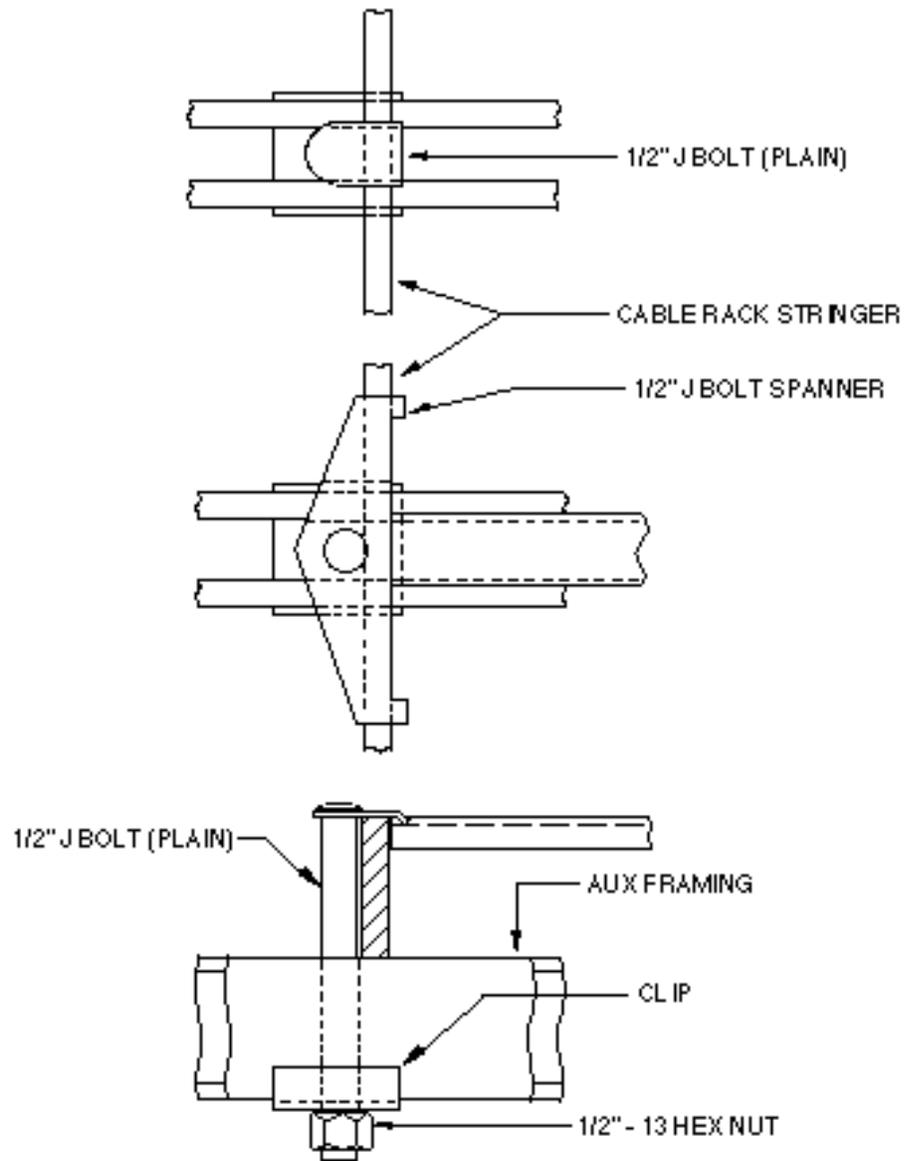


EXHIBIT 2-E2-5  
AUXILIARY FRAMING FASTENED TO UNDERSIDE OF CABLE RACK

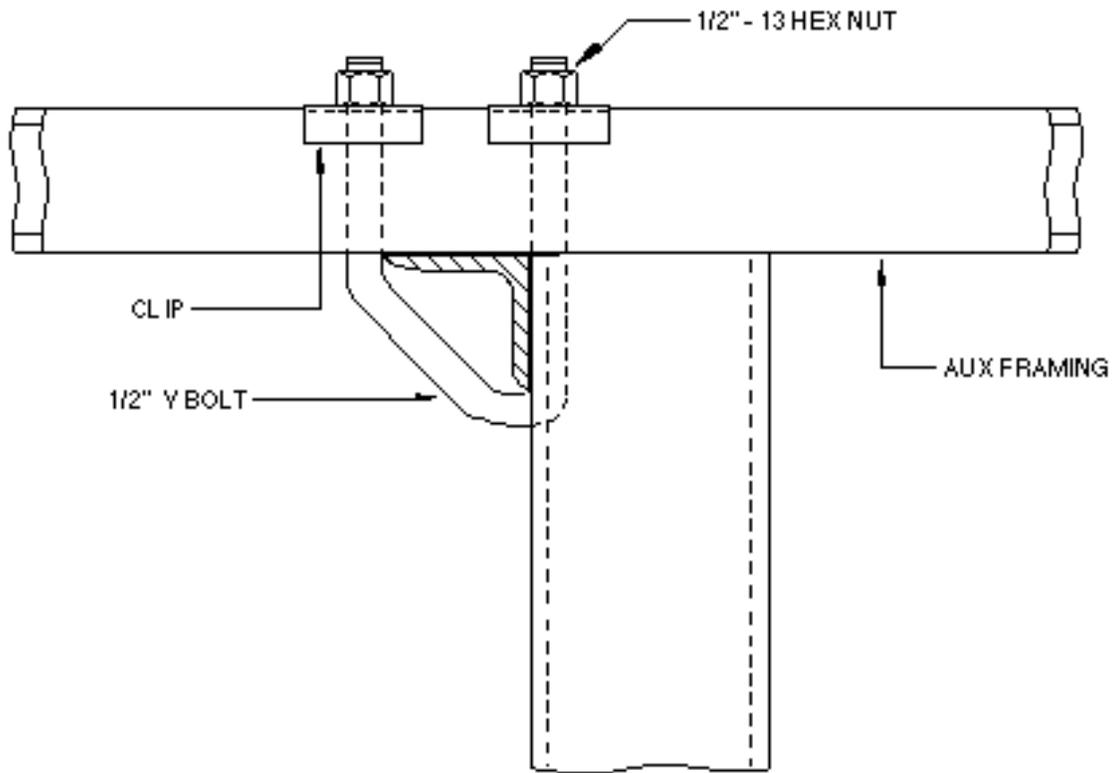


EXHIBIT 2-E2-6  
AUXILIARY FRAMING FASTENED DIRECTLY TO TOP ANGLES

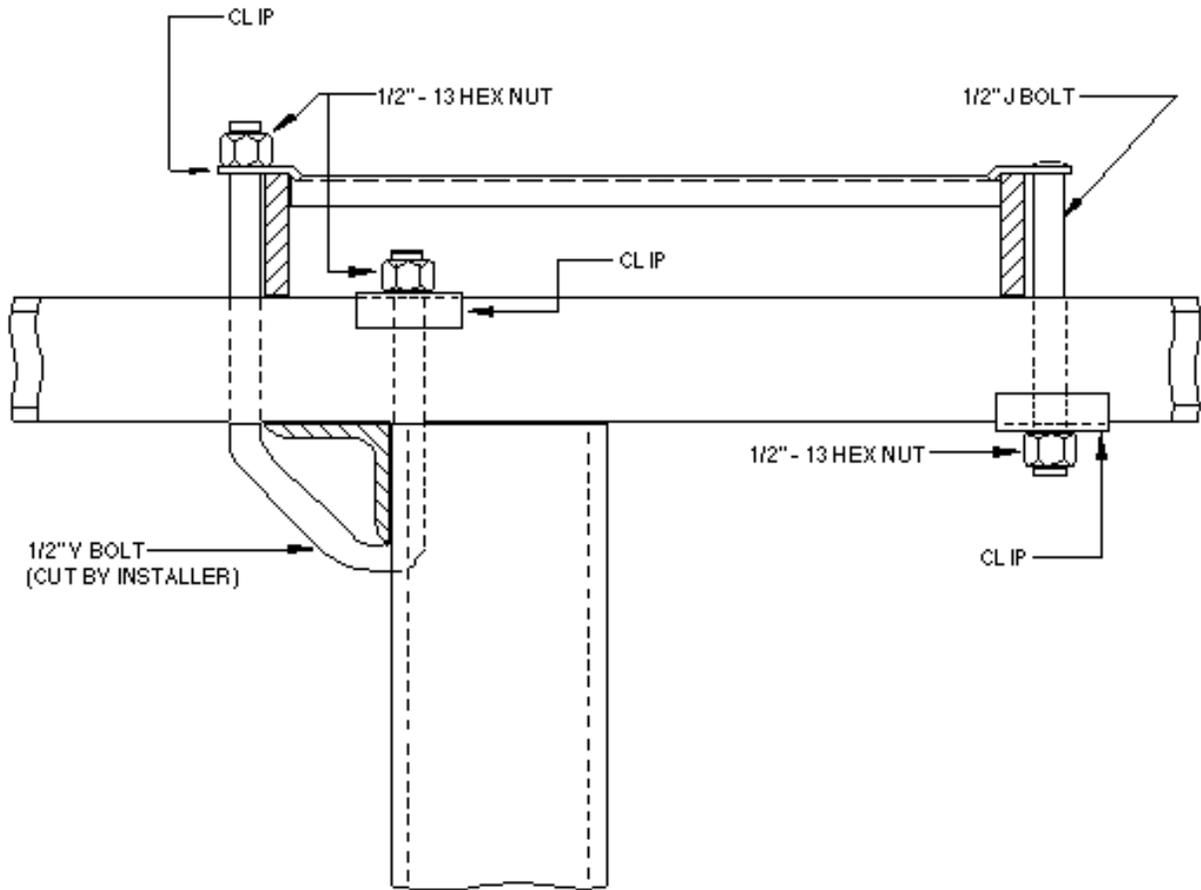


EXHIBIT 2-E2-6A  
AUXILIARY FRAMING FOR TOP-ANGLE FRAMES IN LINE WITH STEP-BY-STEP  
FRAMES-9 FOOT AND 11 FOOT 6 INCH FRAMING-ADDITIONS ONLY

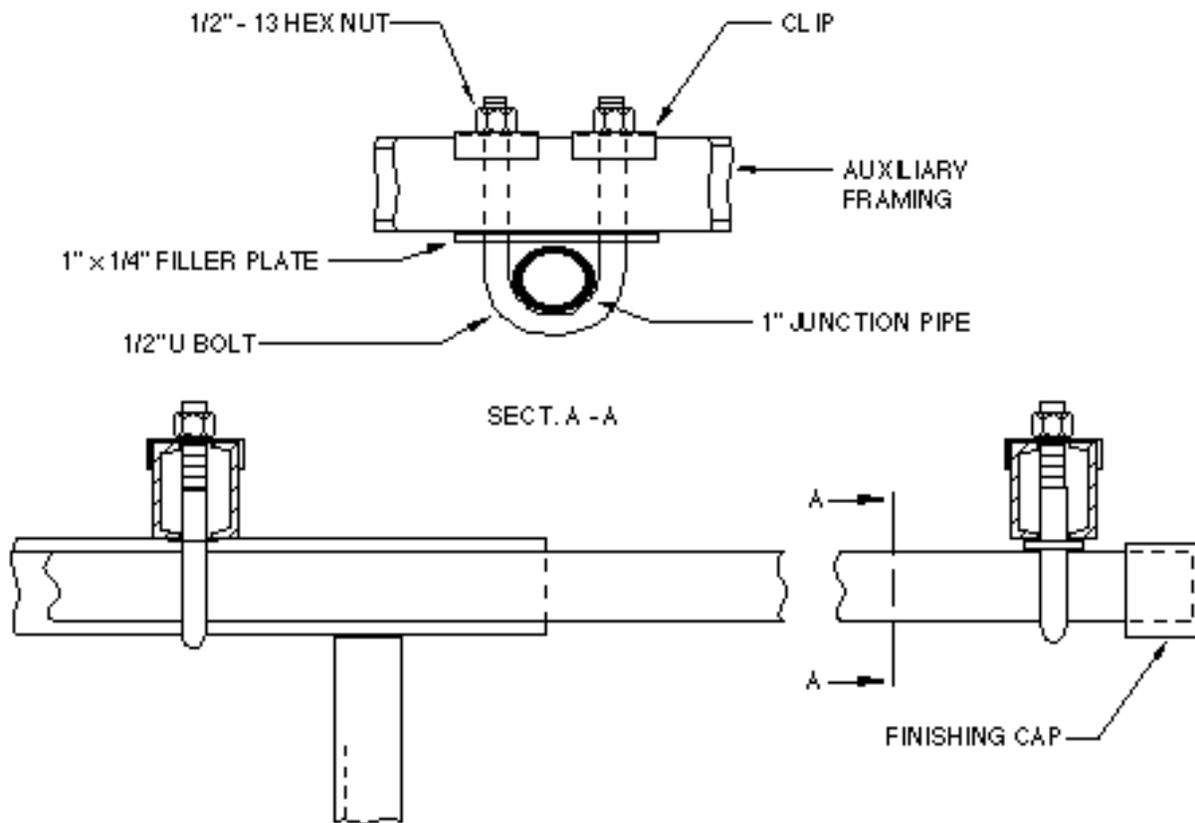
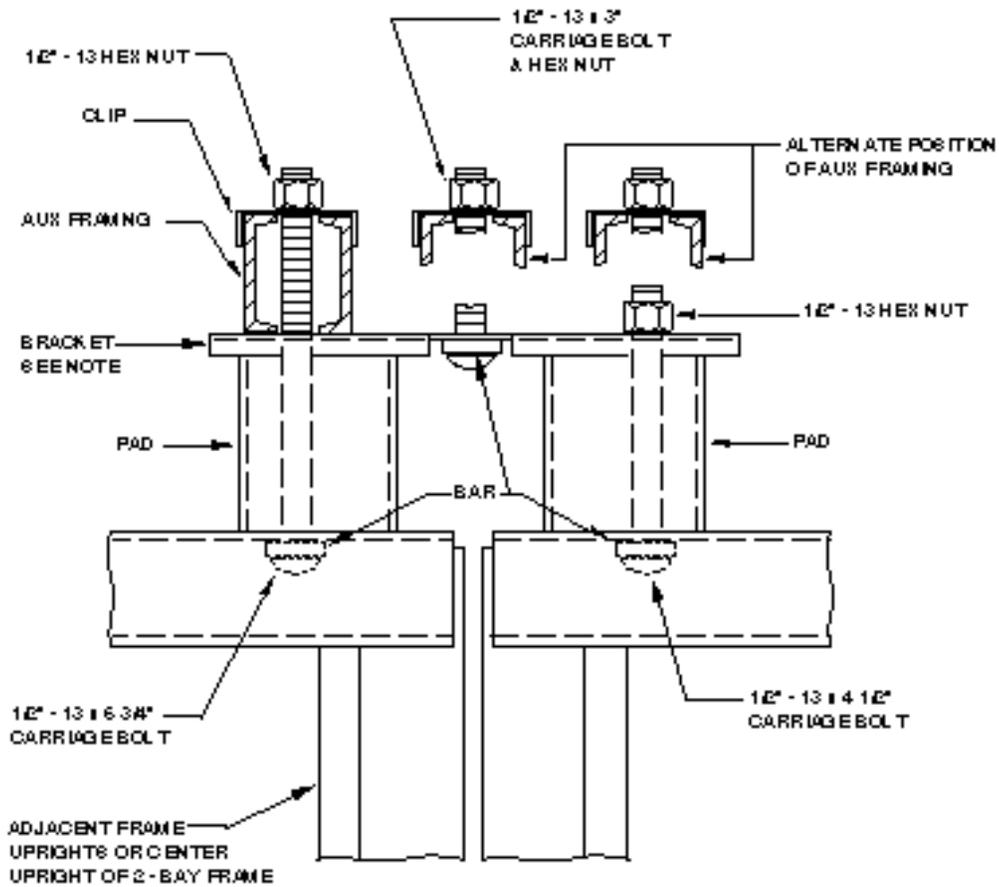


EXHIBIT 2-E2-6F  
AUXILIARY FRAMING ATTACHED TO 1-INCH JUNCTION PIPE EXTENDED BEYOND  
THE END OF CABLEDUCT-TYPE FRAME 7 FOOT AND 11 FOOT 6 INCH FRAMING



NOTE:  
WHEN AUXILIARY FRAMING IS FASTENED TO TOP MEMBERS AT OTHER THAN FRAME JUNCTIONS,  
THE BRACKET WILL NOT BE REQUIRED AND THE PAD SHALL BE CENTRALLY LOCATED UNDER THE  
AUXILIARY FRAME.

EXHIBIT 2-E2-6G  
AUXILIARY FRAMING FASTENING FOR CERTAIN CROSSBAR FRAMES

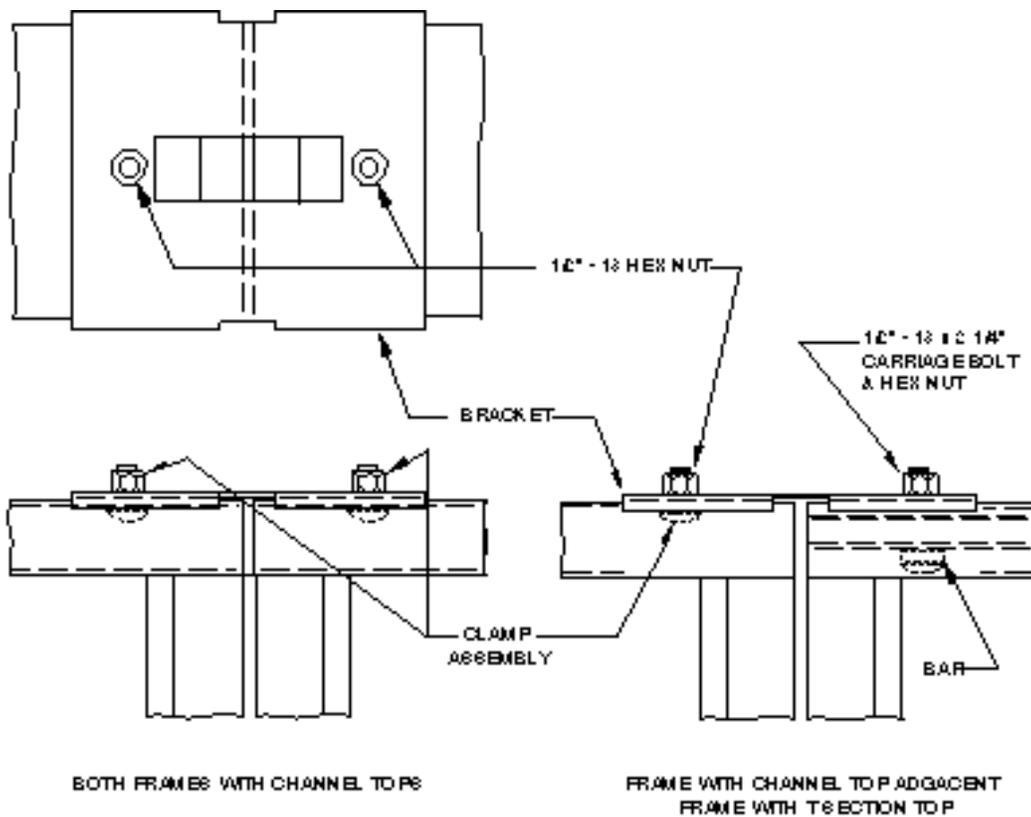


EXHIBIT 2-E2-6H (A&M)  
JUNCTIONING TOPS OF ADJACENT CERTAIN CROSSBAR FRAMES

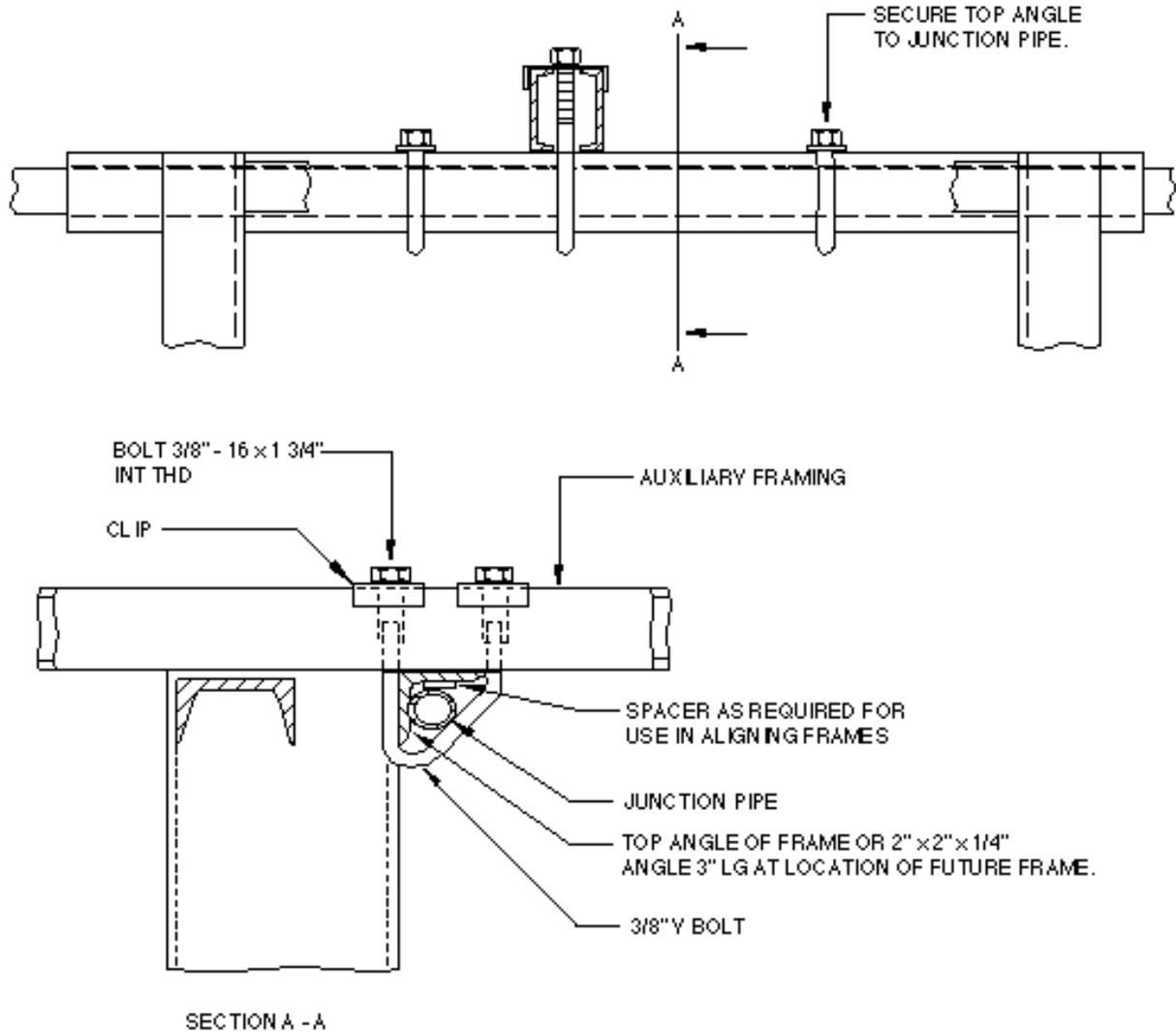


EXHIBIT 2-E2-6J

AUXILIARY FRAMING ATTACHED DIRECTLY TO CABLE DUCT-TYPE FRAMES OR TO JUNCTION PIPE AT LOCATION OF FIXTURE FRAME 7 FOOT AND 11 FOOT 6 INCH AUXILIARY FRAMING

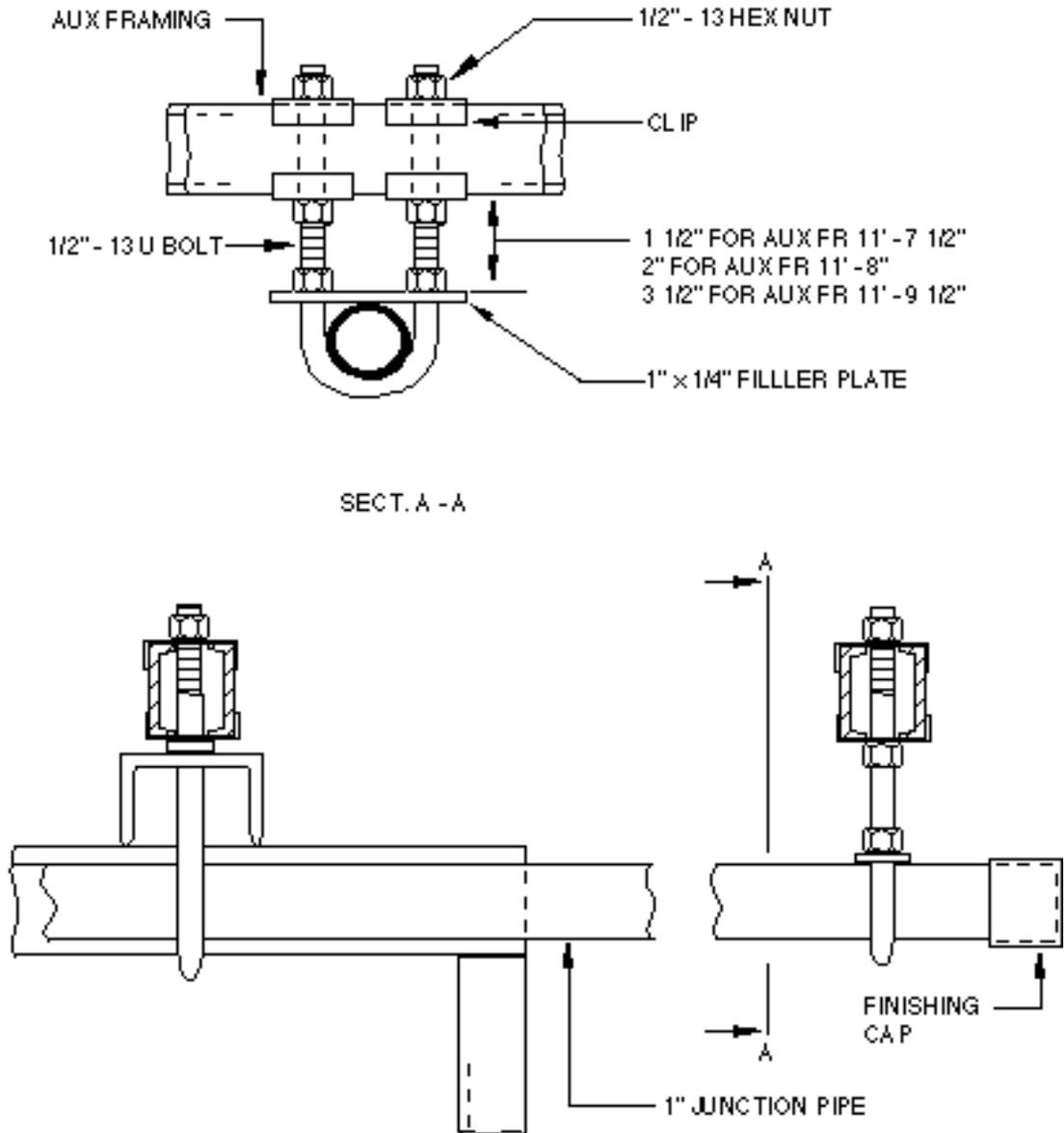


EXHIBIT 2-E2-6L

SUPPORT FOR FRAME JUNCTION PIPE EXTENDING BEYOND END OF CABLE DUCT-  
TYPE FRAME-9 FOOT 3 and 1/2 INCH, 11 FOOT 7 and 1/2 INCH, 11 FOOT 8 INCH, AND 11  
FOOT 9 and 1/2 INCH AUXILIARY FRAMING

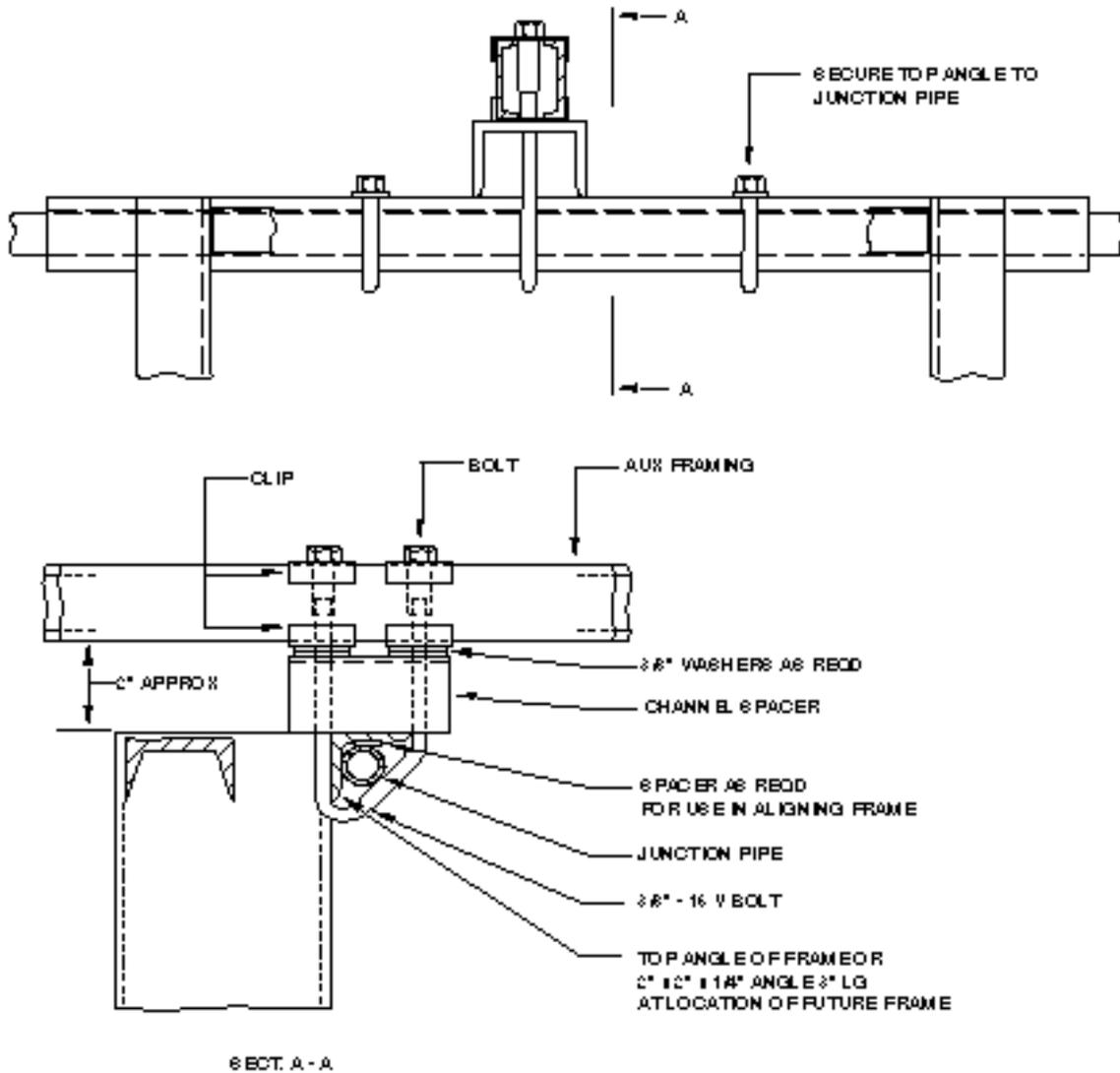


EXHIBIT 2-E2-6M  
 AUXILIARY FRAMING ATTACHED TO CABLE DUCT-TYPE FRAME OR TO JUNCTION  
 PIPE AT LOCATION OF FUTURE FRAME-9 FOOT 2 INCH AND 11 FOOT 8 INCH  
 AUXILIARY FRAMING

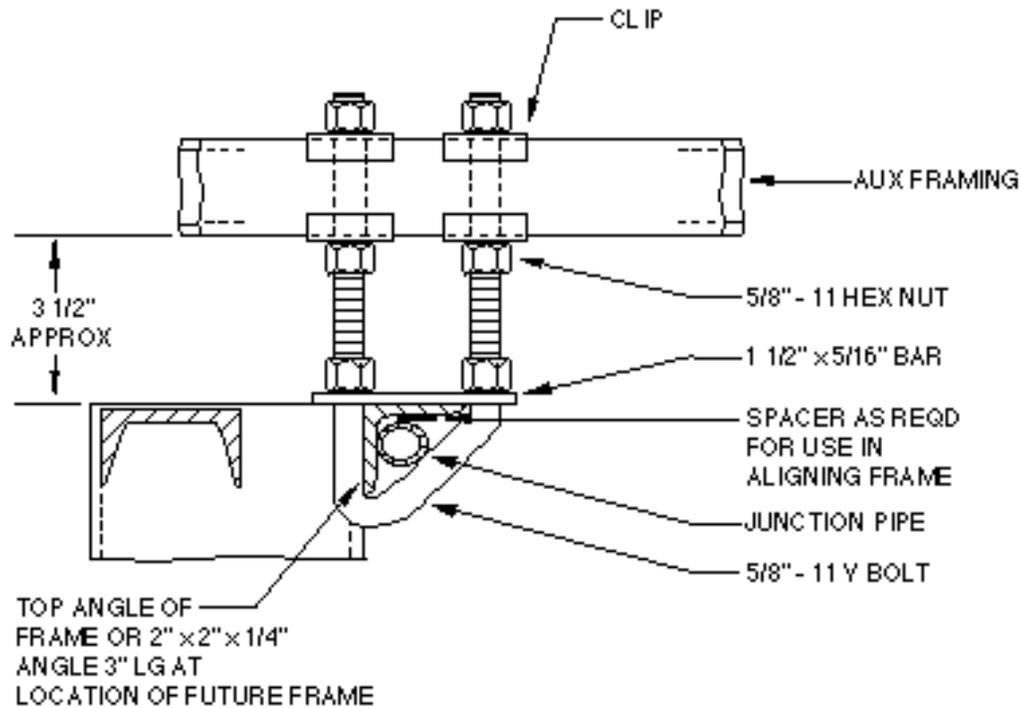


EXHIBIT 2-E2-6R

AUXILIARY FRAMING FASTENED TO CABLE DUCT-TYPE FRAME OR TO JUNCTION PIPE AT LOCATION OF FUTURE FRAME-9 FOOT 3 and 1/2 INCH AND 11 FOOT 9 and 1/2 INCH AUXILIARY FRAMING

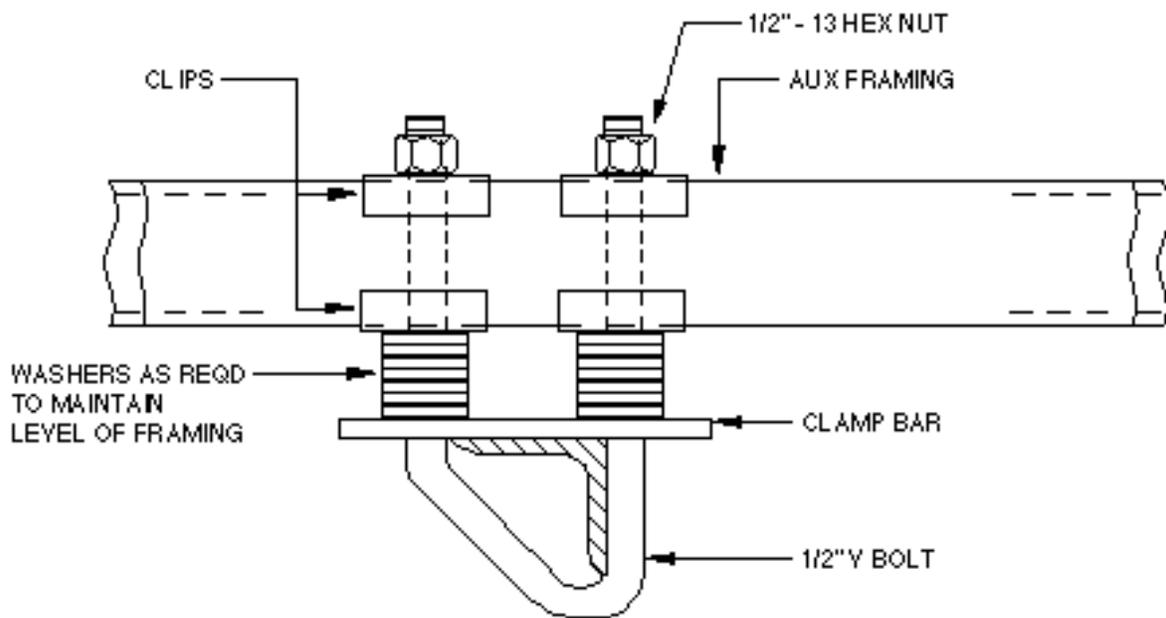


EXHIBIT 2-E2-7  
AUXILIARY FRAMING FASTENED TO TOP-ANGLES AT A LOWER LEVEL

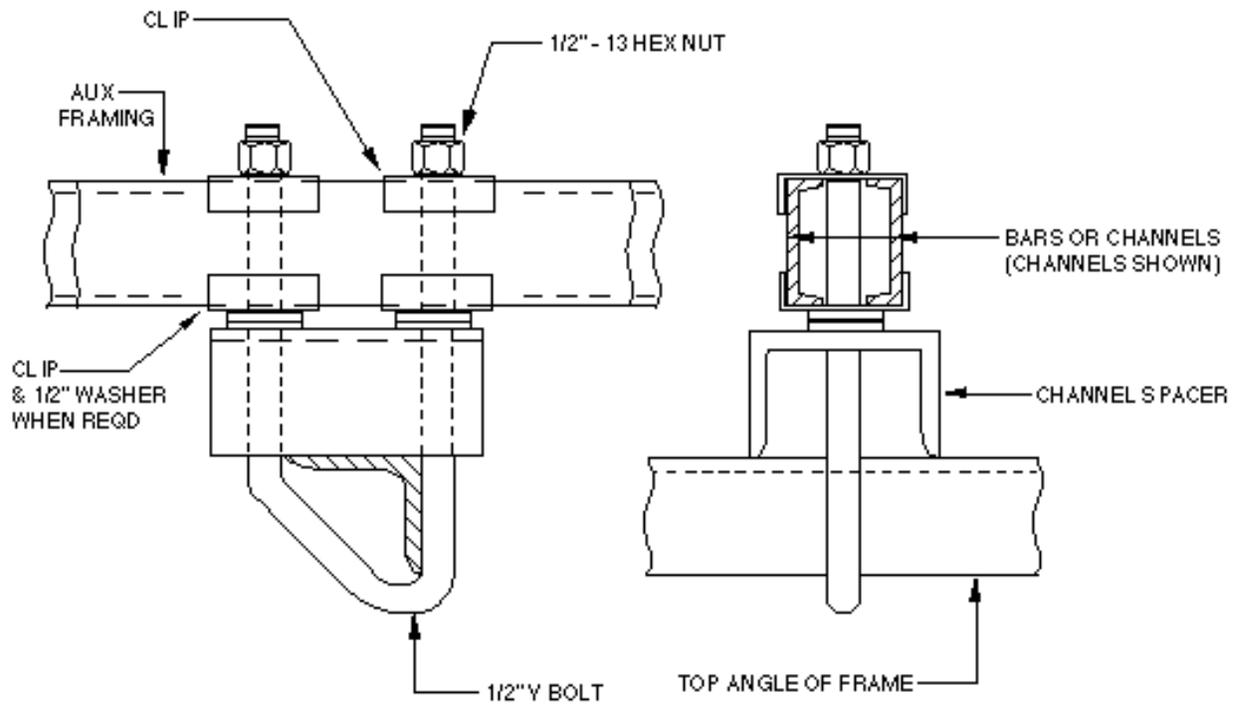


EXHIBIT 2-E2-7A

AUXILIARY FRAMING FASTENED TO SINGLE TOP-ANGLE FRAMES 7 FOOT 2 INCH, 9 FOOT 2 INCH, AND 11 FOOT 8 INCH FRAMING

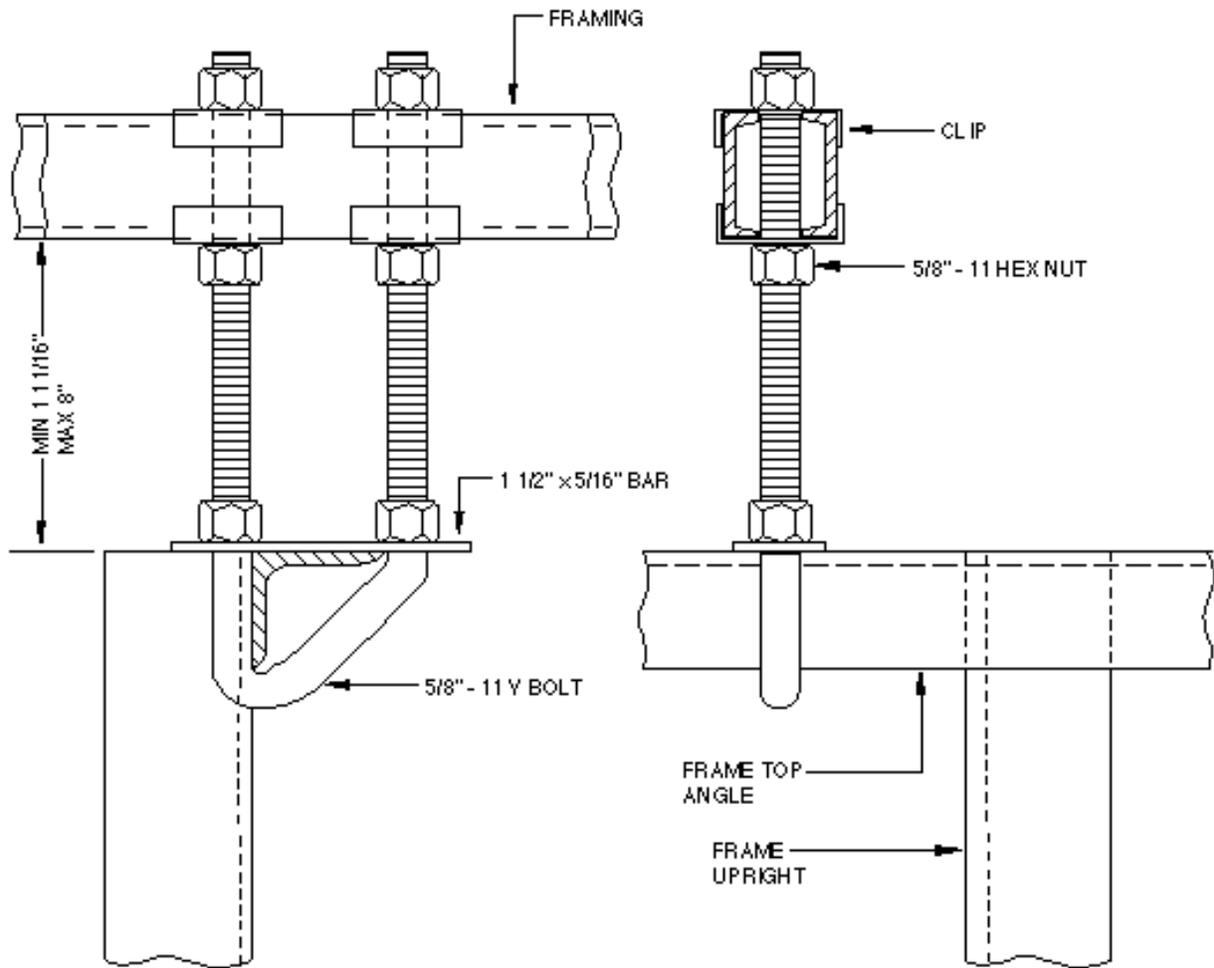


EXHIBIT 2-E2-7B  
V-BOLT FRAME SUPPORT ASSEMBLY

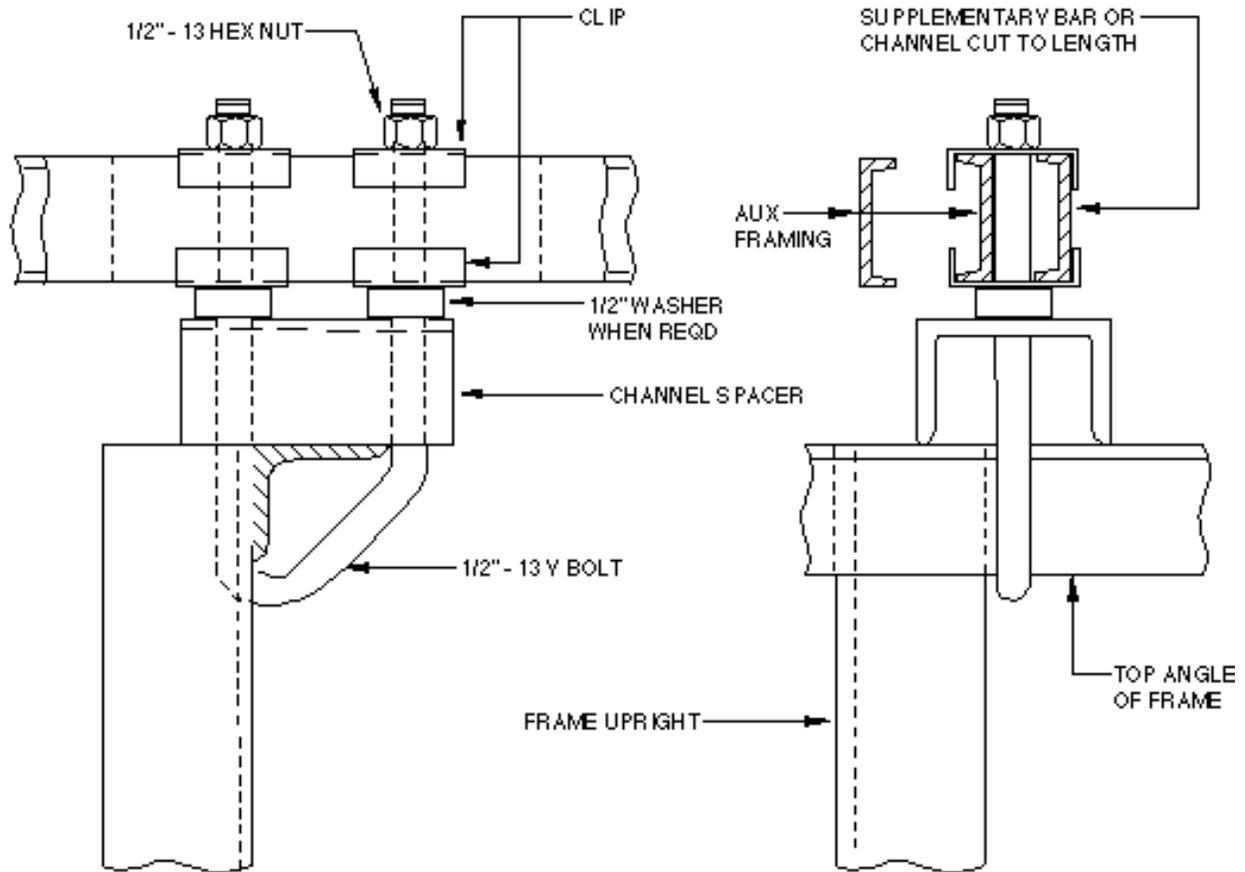


EXHIBIT 2-E2-7C

AUXILIARY FRAMING FASTENED TO SINGLE TOP-ANGLE FRAMES-9 FOOT 2 INCH  
AND 11 FOOT 8 INCH FRAMING SUPPORT OFFSET TO CLEAR FRAME UPRIGHT

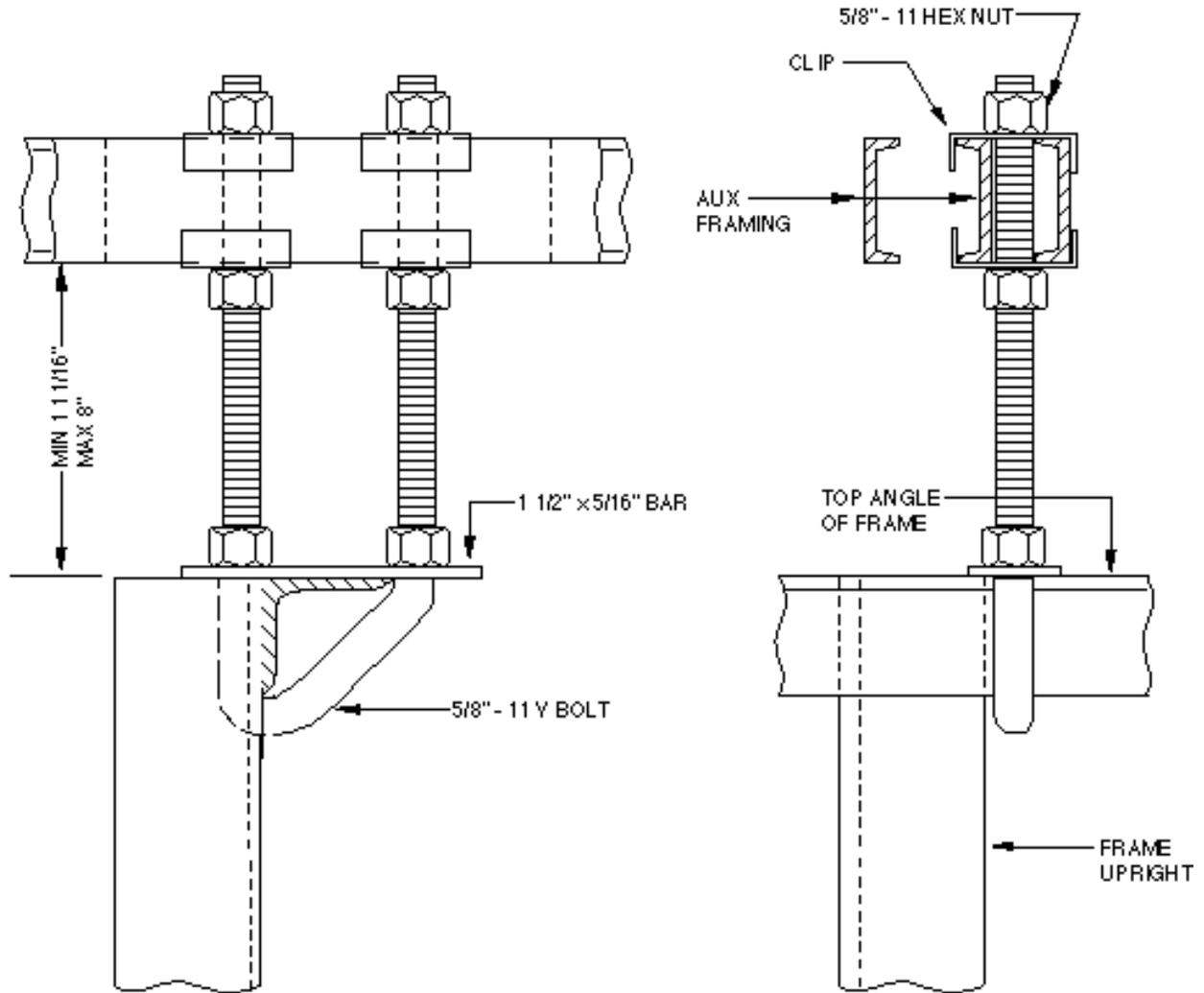


EXHIBIT 2-E2-7D  
V-BOLT FRAME SUPPORT OFFSET TO CLEAR FRAME UPRIGHT

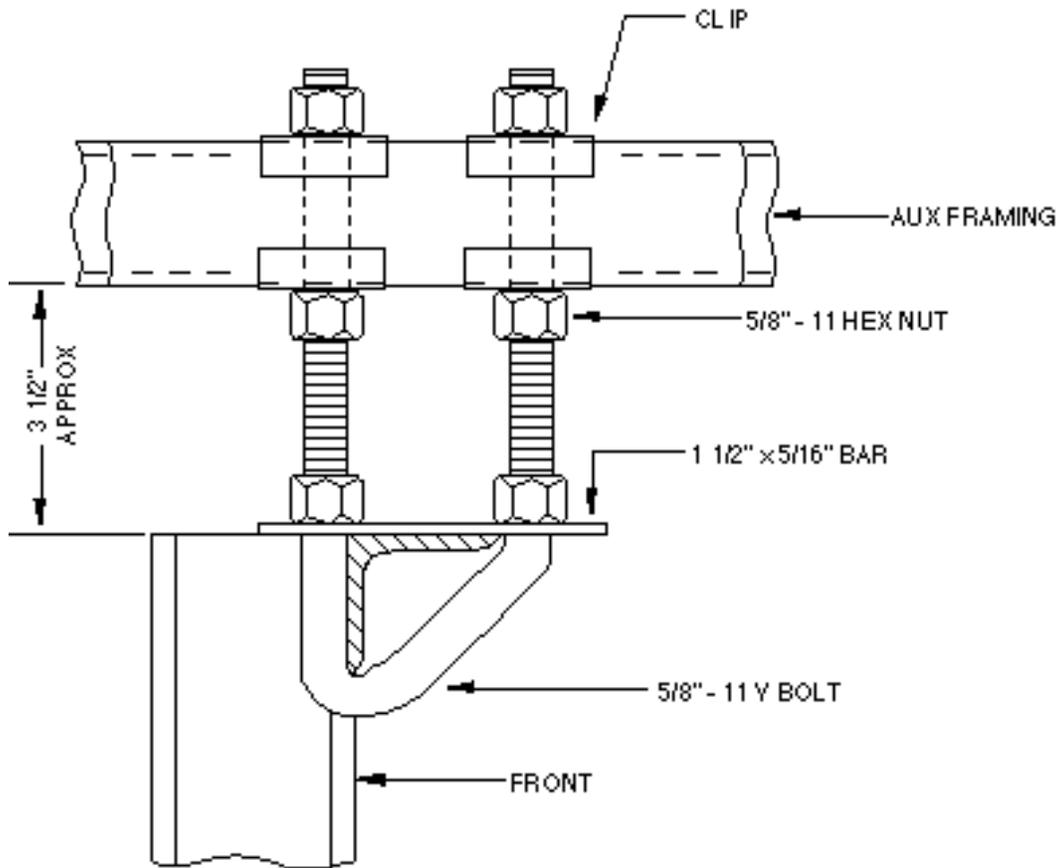


EXHIBIT 2-E2-7E  
AUXILIARY FRAMING FASTENED TO SINGLE TOP-ANGLE FRAMES-11 FOOT 9 and 1/2  
INCH FRAMING

ARRANGEMENT	EXTENSION OF FRAMING BEYOND LAST LINE OF FRAMES					
	SYSTEM					
	STEP BY STEP	PANEL	TOLL TERMINAL	TOLL SWBD & NO. 11 MAN.	NO. 1 CSB F CSB R TDM NO. 4 TOLL	NO. 5 C CROSS-BAR
FRONT OF FUTURE LINE FACES OUTSIDE AISLE	4'-4 1/2"		6'-0"	5'-3"	4'-6 1/2"	4'-5 1/2" Δ
REAR OF FUTURE LINE FACES OUTSIDE AISLE	4'-11"		7'-7 1/2"	5'-11"	4'-10" □	5'-2" □
FRONT OF INSTALLED ULTIMATE LINE FACES OUTSIDE AISLE	1'-5"		3'-0"	2'-4 1/2"	1'-6"	1'-4"
REAR OF INSTALLED ULTIMATE LINE FACES OUTSIDE AISLE	1'-5 1/2"		2'-6"	2'-6"	1'-8 1/2"	2'-0 1/2"
PROVISION FOR INSTALLING ULTIMATE LINE OF DOUBLE SIDED FRAMES		6'-7"				
ULTIMATE LINE OF DOUBLE SIDED FRAMES INSTALLED		2'-5"				
FRONT OF FUTURE SINGLE SIDED FRAMES FACE OUTSIDE AISLE		6'-9"				
REAR OF FUTURE SINGLE SIDED FRAMES FACE OUTSIDE AISLE		6'-11 1/2"				
FRONT OF INSTALLED ULTIMATE SINGLE SIDED FRAMES FACE OUTSIDE AISLE		2'-6"				
REAR OF INSTALLED ULTIMATE SINGLE SIDED FRAMES FACE OUTSIDE AISLE		2'-9 1/2"				
<p>NOTES:</p> <ol style="list-style-type: none"> <li>1. WHERE HIGH INTENSITY LIGHTING IS INSTALLED IN PANEL SYSTEMS 1 1/2" SHALL BE ADDED TO THE PANEL FIGURES.</li> <li>2. WHERE NO. 1 CROSSBAR FRAMES ARE INSTALLED IN STEP BY STEP SYSTEMS, THE CROSSBAR FIGURES SHALL APPLY FOR THESE FRAMES.</li> <li>3. Δ THIS DIMENSION APPLIES WHERE WIRING AISLES ARE 1 FOOT 11 INCHES. SUBTRACT 2 INCHES WHERE WIRING AISLES ARE 1 FOOT 9 INCHES.</li> <li>4. □ THIS DIMENSION APPLIES WHERE APPARATUS AISLES ARE 2 FEET 6 INCHES. ADD 6 INCHES WHERE APPARATUS AISLES ARE 3 FEET.</li> </ol>						

EXHIBIT 2-E2-8  
SUPPORT OF ENDS OF AUXILIARY FRAMING-EXTENSIONS OF BAR OR CHANNELS  
BEYOND THE LAST LINE OF FRAMES

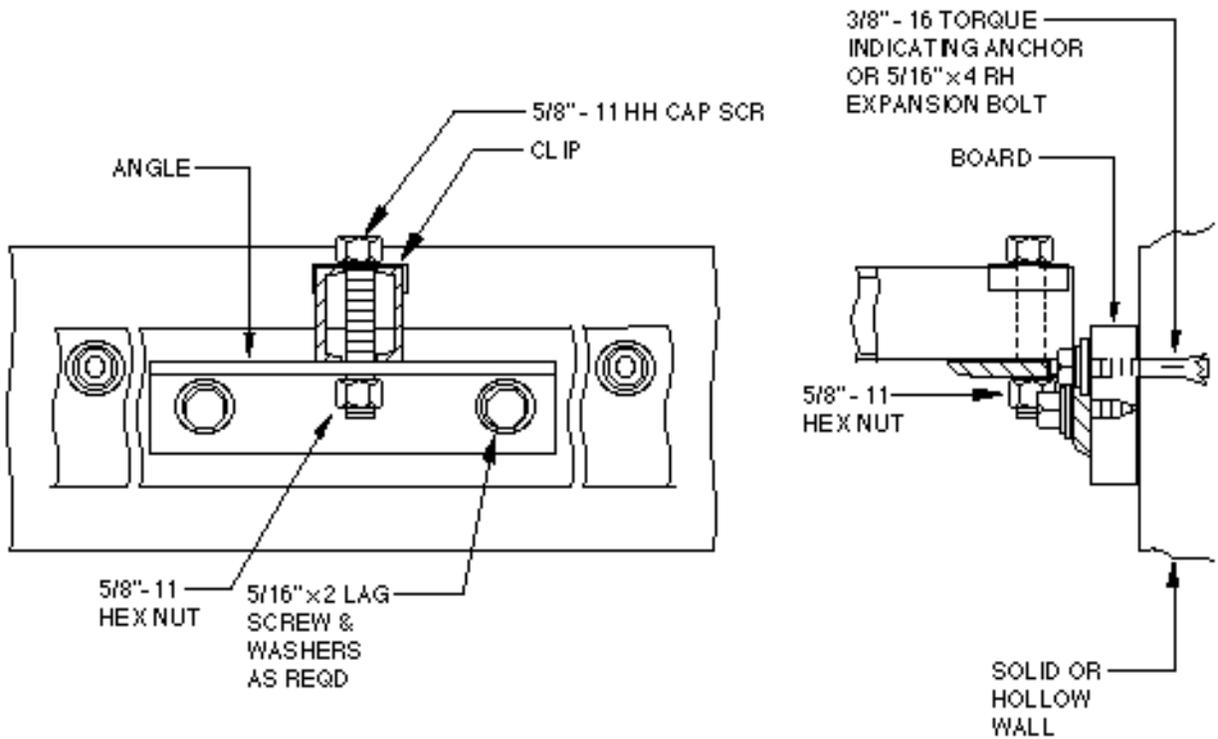


EXHIBIT 2-E2-8C  
AUXILIARY FRAMING SUPPORTED AT WALLS

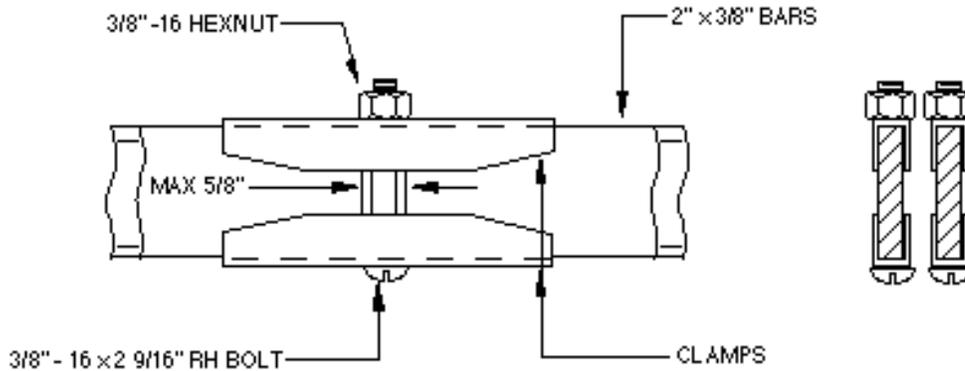


EXHIBIT 2-E2-9 (A&M)  
SPLICING AUXILIARY FRAMING-2 INCHES BY 3/8 OF AN INCH BARS TO 2 INCHES BY  
3/8 OF AN INCH BARS

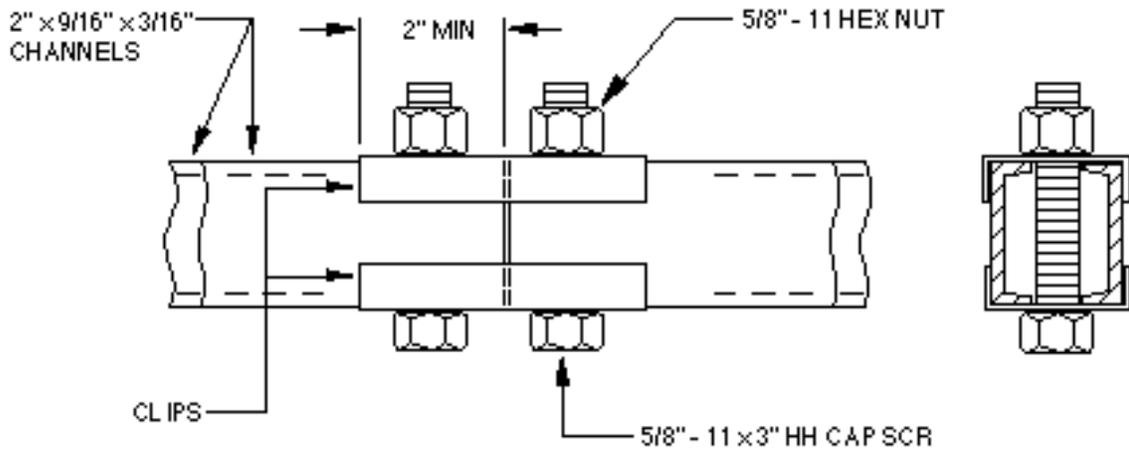


EXHIBIT 2-E2-9A (DISCONTINUED)  
SPlicing AUXILIARY FRAMING-CHANNELS TO CHANNELS

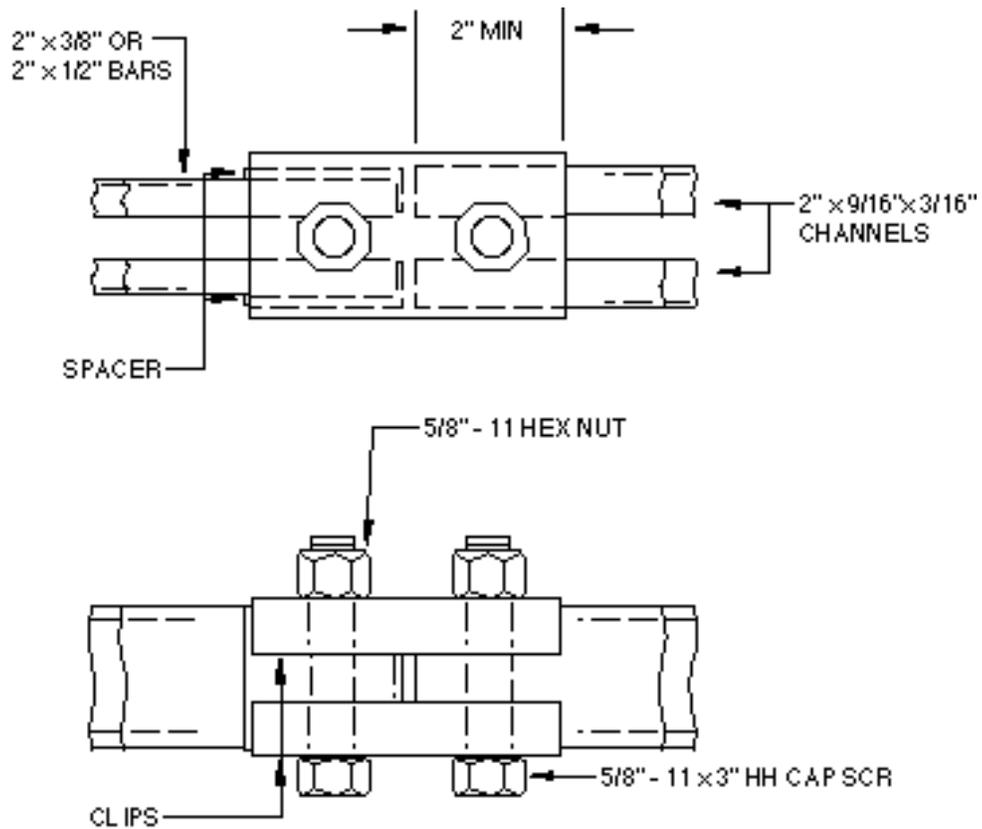


EXHIBIT 2-E2-9B (DISCONTINUED)  
SPlicing AUXILIARY FRAMING-CHANNELS TO BARS

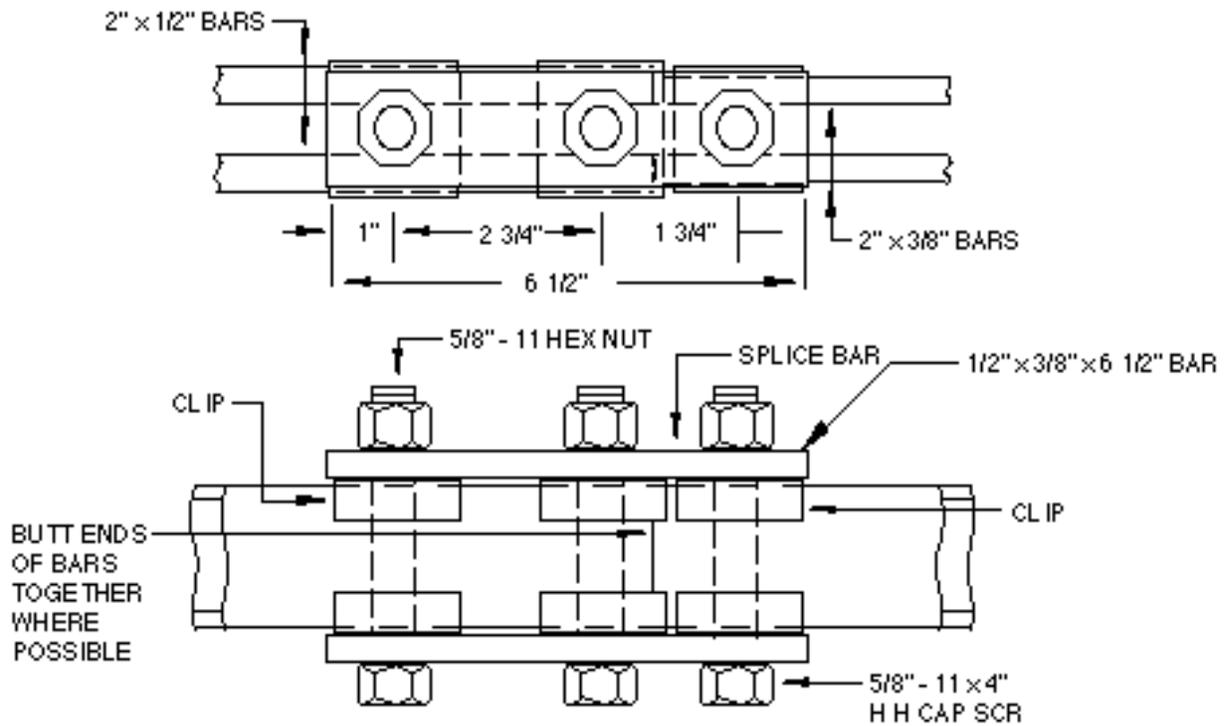
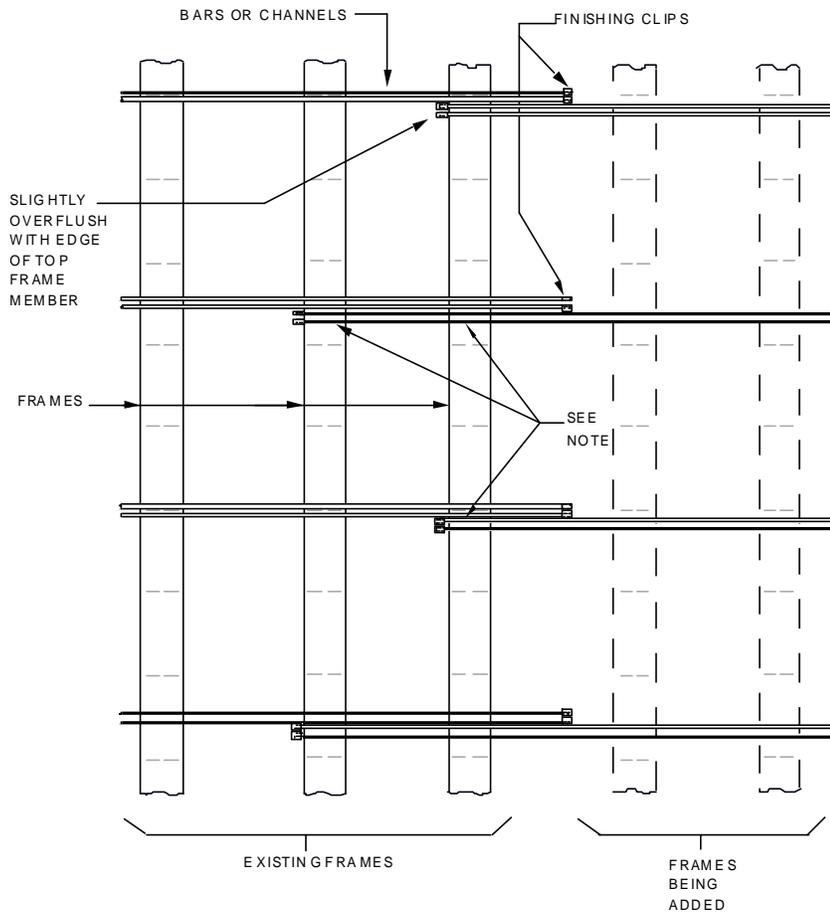


EXHIBIT 2-E2-9C  
SPLICING AUXILIARY FRAMING-2 BY 1/2 INCH BARS TO 2 BY 3/8 INCH BARS



NOTE:  
ENDS OF STAGGERED BARS OR CHANNELS MUST OVERLAP SUFFICIENTLY TO ALLOW BOTH PAIRS TO BE FASTENED TO THE SAME FRAME OR FRAMES WITH ALTERNATE PAIRS OF CHANNELS OVERLAPPING EXISTING BARS OR CHANNELS OVER TWO ROWS OF FRAMES AS SHOWN. THE EXTENDED CHANNEL MAY BE PLACED ON EITHER SIDE OF THE EXISTING FRAMING PROVIDED THE MAXIMUM SPACING OF 6'-0" IS NOT EXCEEDED. THE EXTENDED CHANNELS NEED NOT BE FASTENED TO CABLE RACK, LADDER TRACK, ETC., IN THE AISLE WHERE THEY OVERLAP THE EXISTING FRAMING.

EXHIBIT 2-E2-9D  
ARRANGEMENT FOR EXTENDING BAR OR CHANNEL FRAMING TO ELIMINATE  
NECESSITY OF CUTTING BACK EXISTING FRAMING

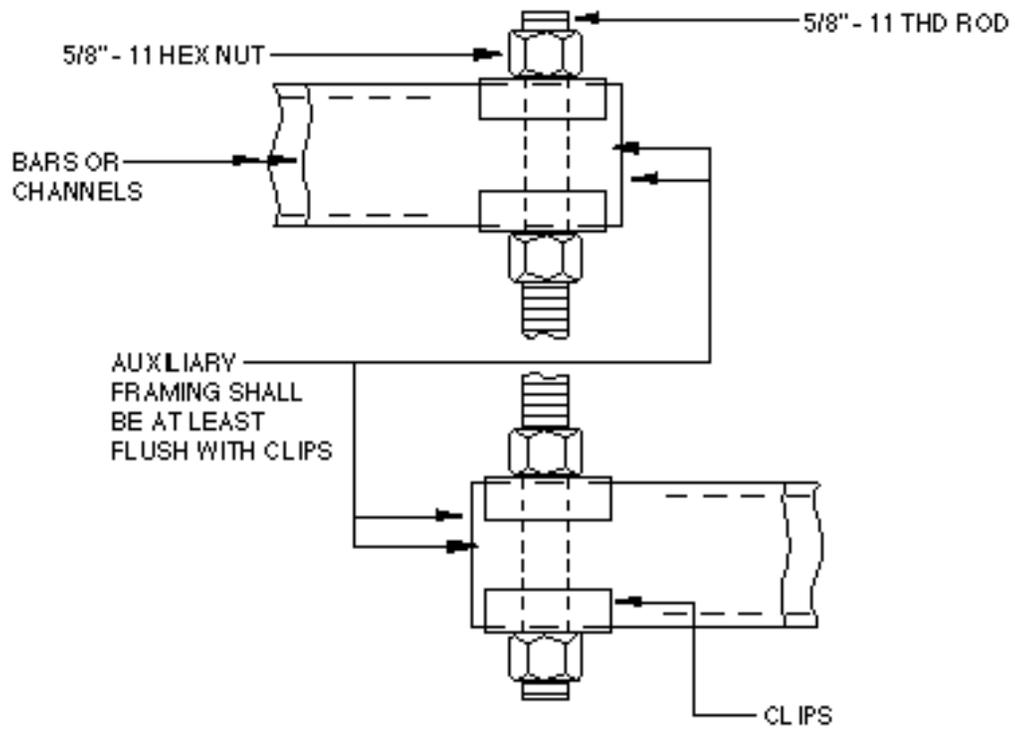


EXHIBIT 2-E2-9E  
JUNCTIONING LOW-TO HIGH-LEVEL FRAMING

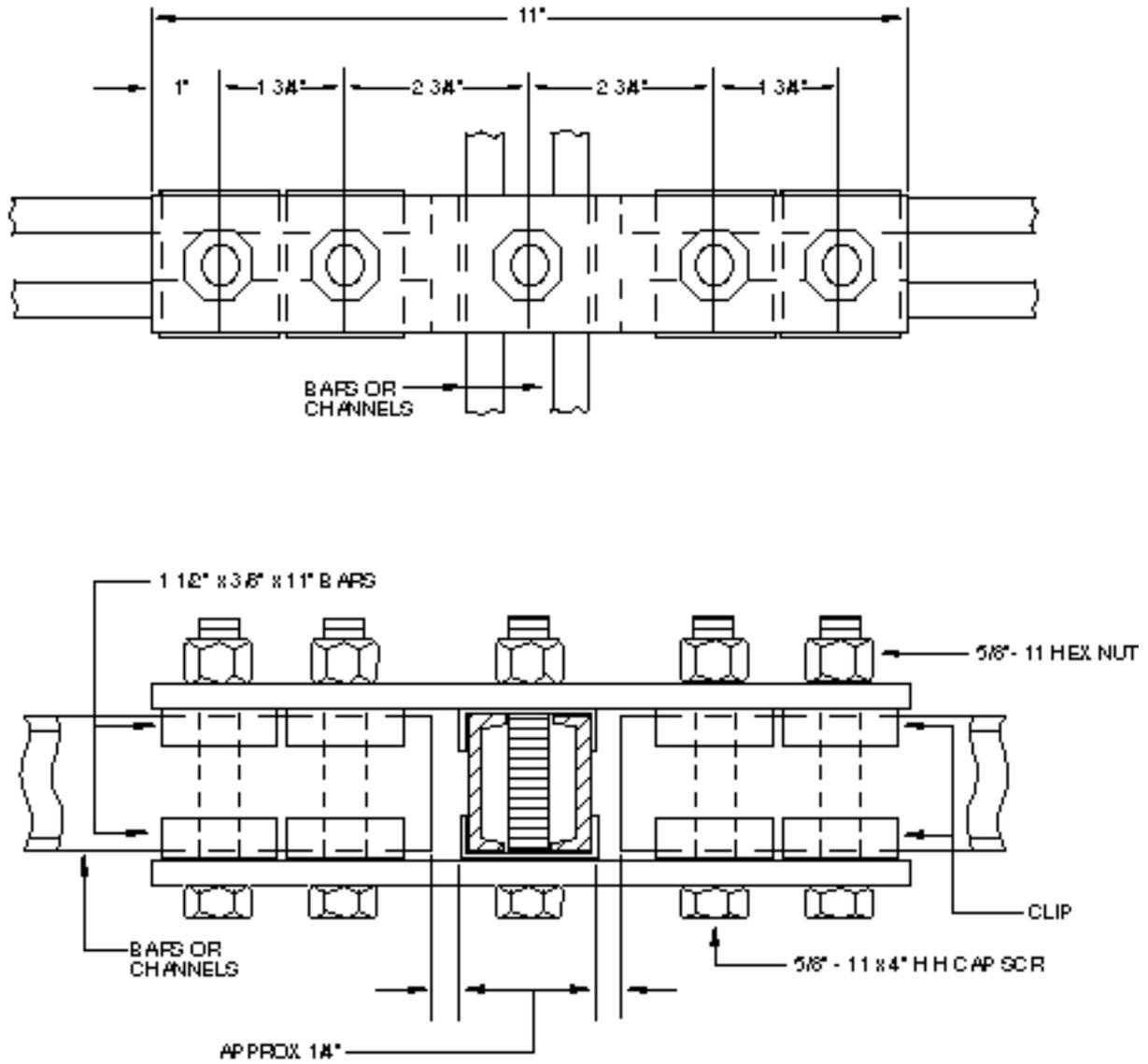


EXHIBIT 2-E2-9F  
SINGLE-LEVEL AUXILIARY FRAMING INTERSECTION OF PRIMARY AND SECONDARY  
BARS OR CHANNELS

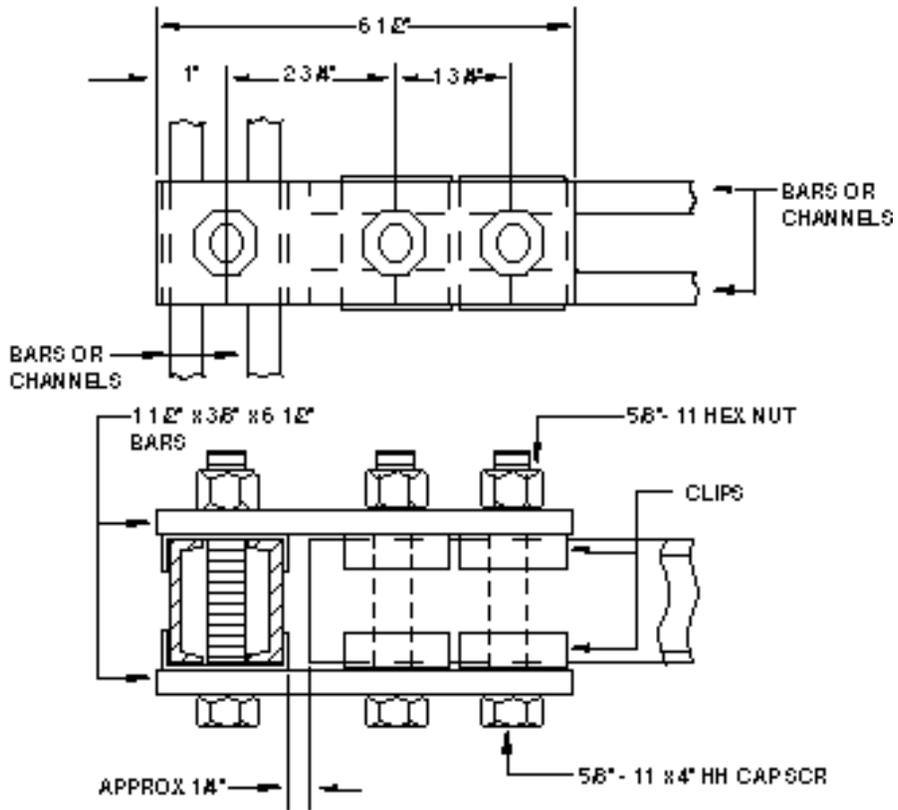


EXHIBIT 2-E2-9G  
SINGLE-LEVEL AUXILIARY FRAMING JUNCTION OF PRIMARY AND SECONDARY  
BARS OR CHANNELS

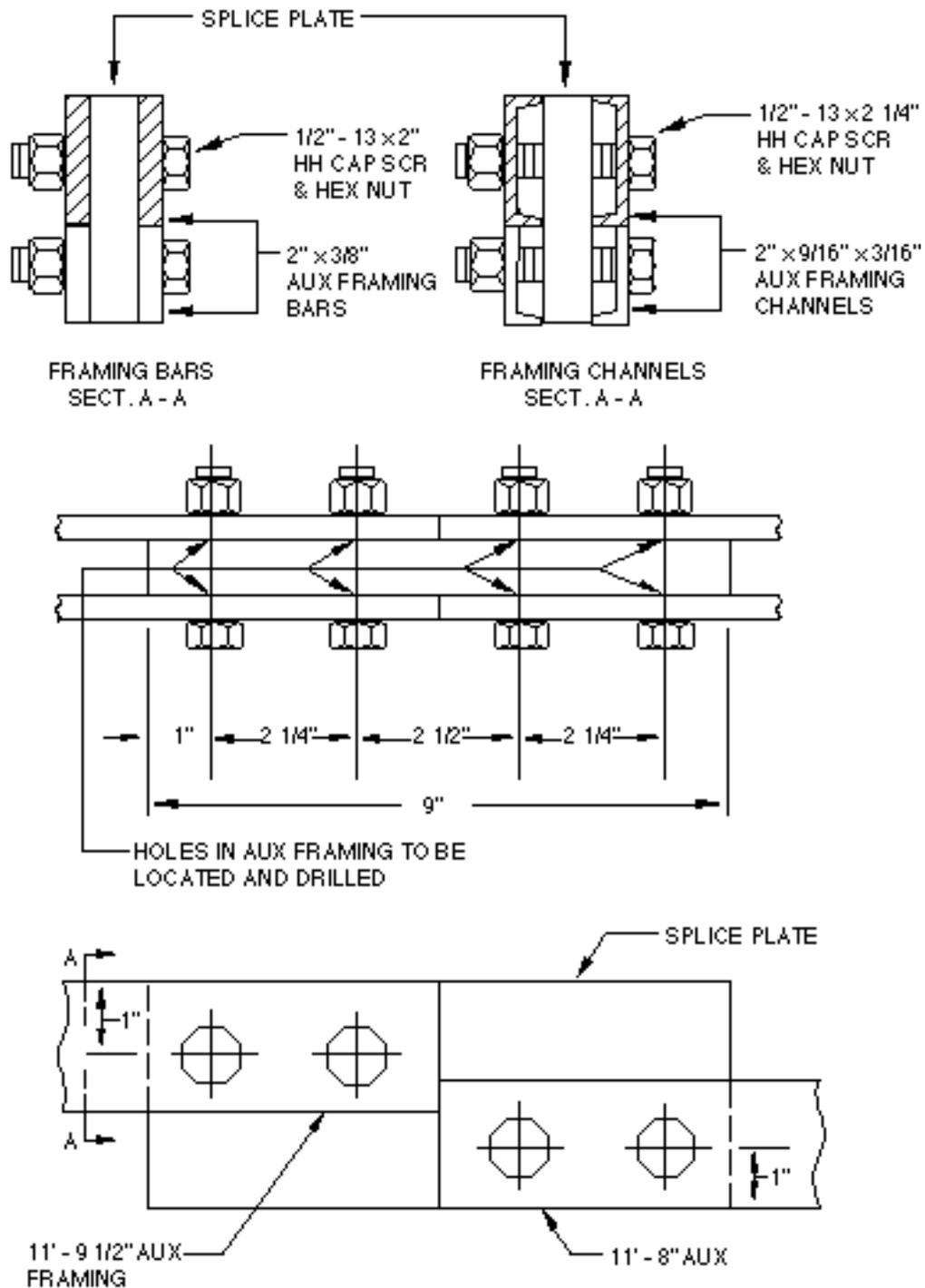


EXHIBIT 2-E2-9H  
 SPLICING AUXILIARY FRAMING 11 FOOT 8 INCH AND 11 FOOT 9 and 1/2 INCH  
 FRAMING

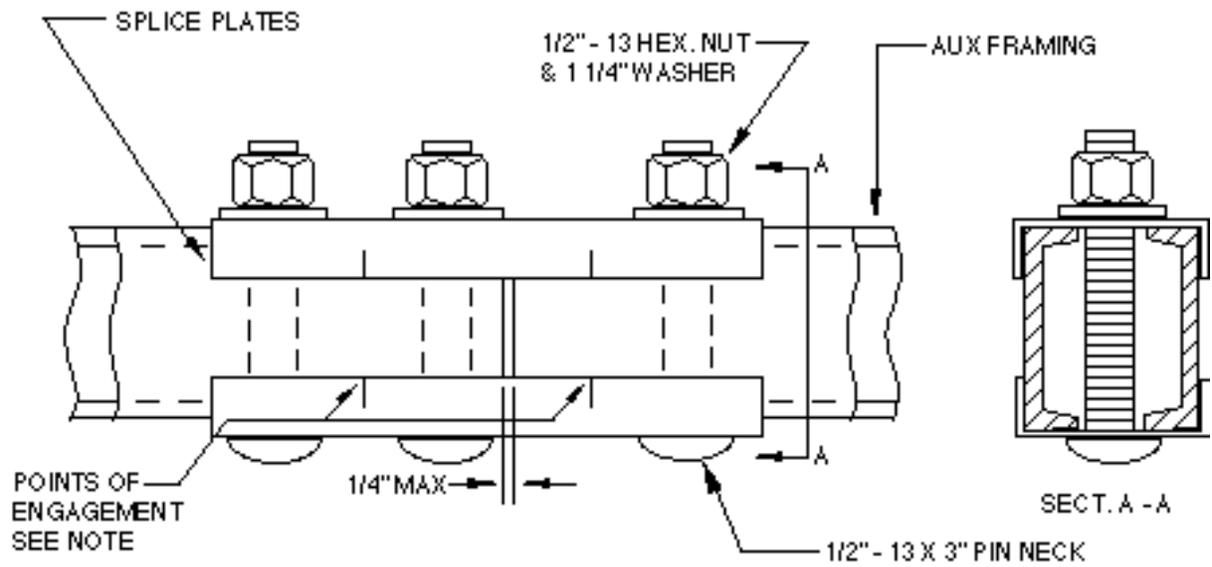
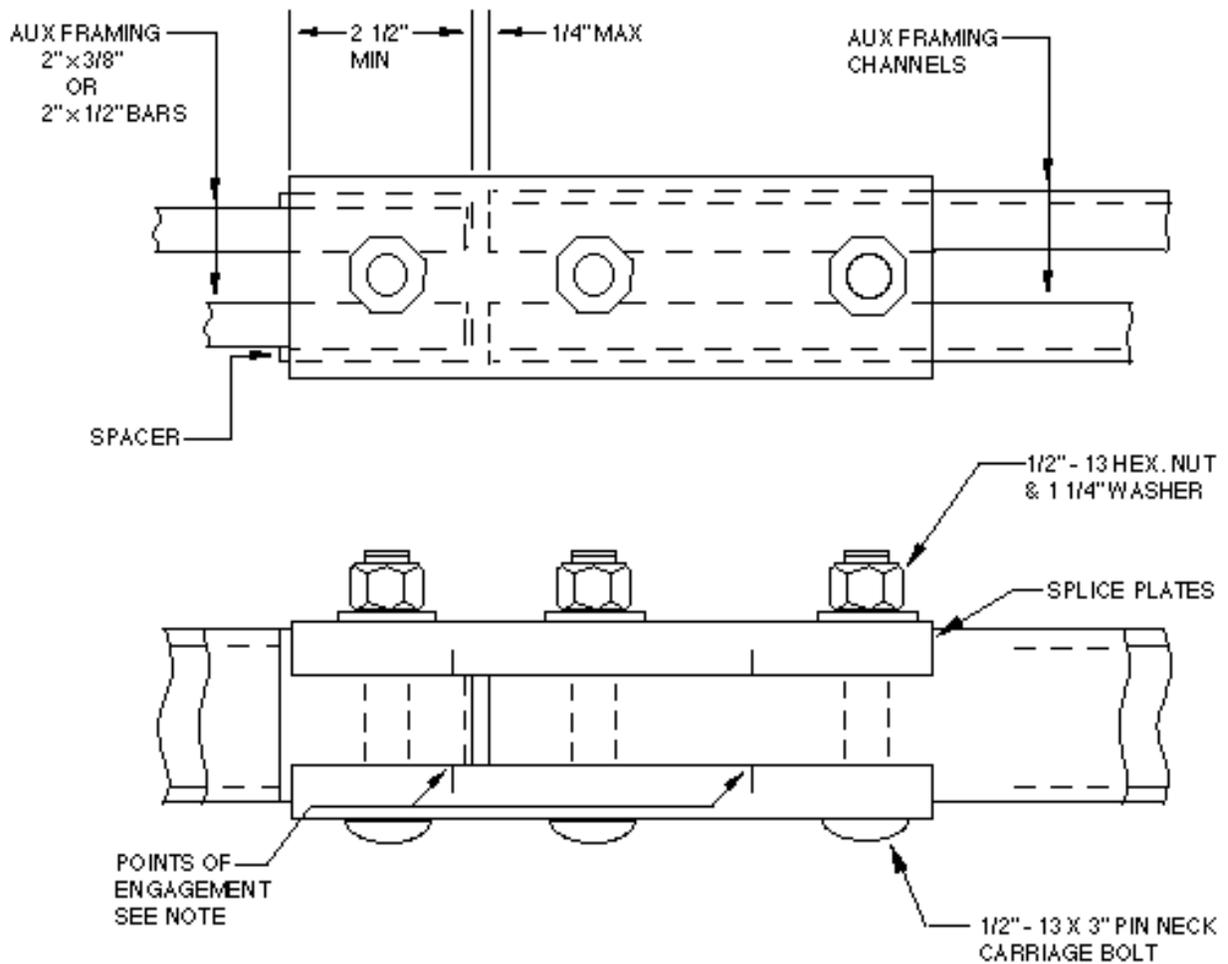


EXHIBIT 2-E2-9J  
SPlicing AUXILIARY FRAMING-CHANNELS TO CHANNELS USING 3-HOLE SPLICE PLATES



NOTE:  
THE AUXILIARY FRAMING BAR AND CHANNEL ENDS MUST BE LOCATED WITHIN THE POINTS OF ENGAGEMENT WHICH ARE MARKED ON THE SIDES OF THE SPLICE PLATE.

EXHIBIT 2-E2-9K  
SPLICING AUXILIARY FRAMING-CHANNELS TO BARS-USING 3-HOLE SPLICE PLATES

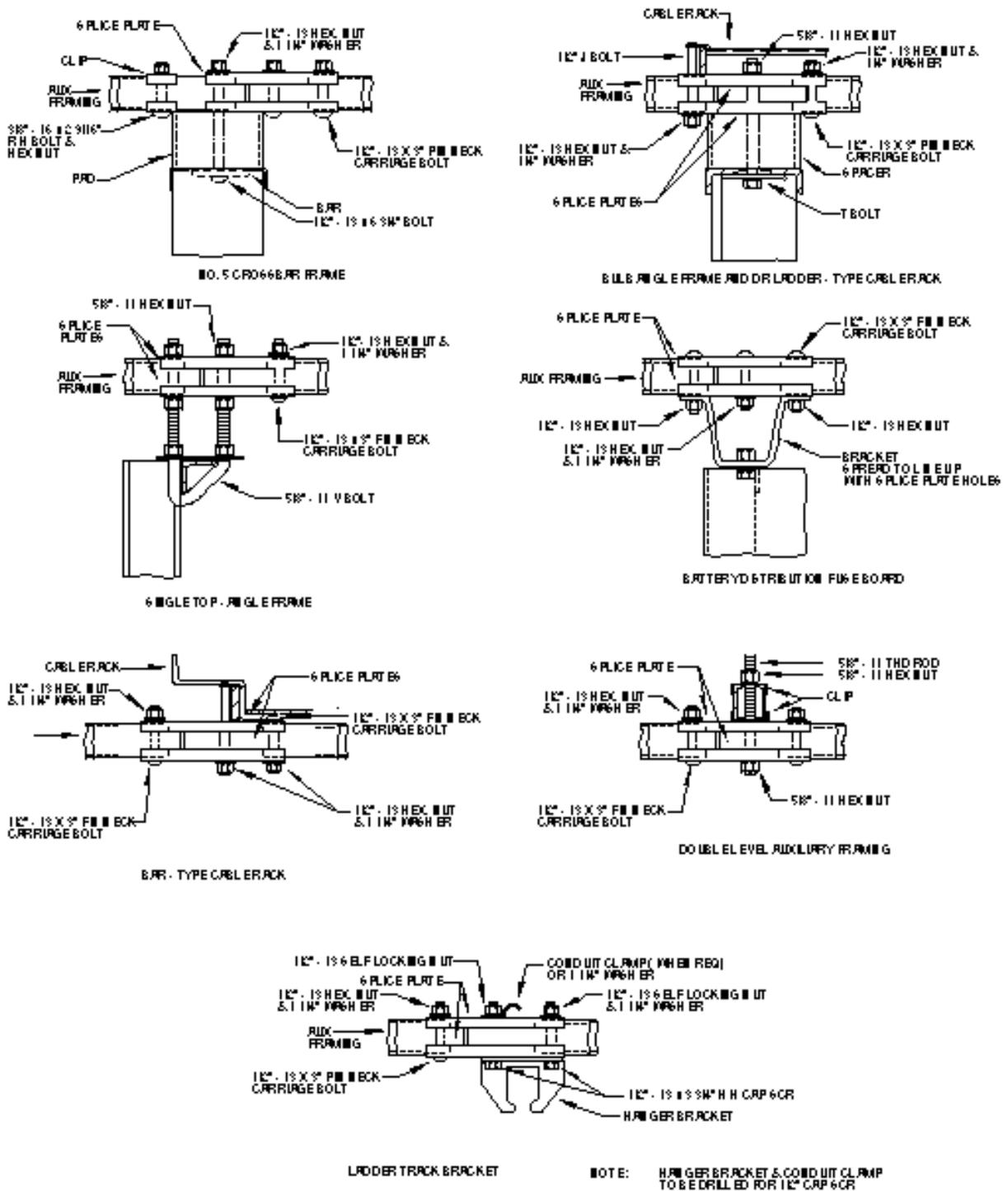
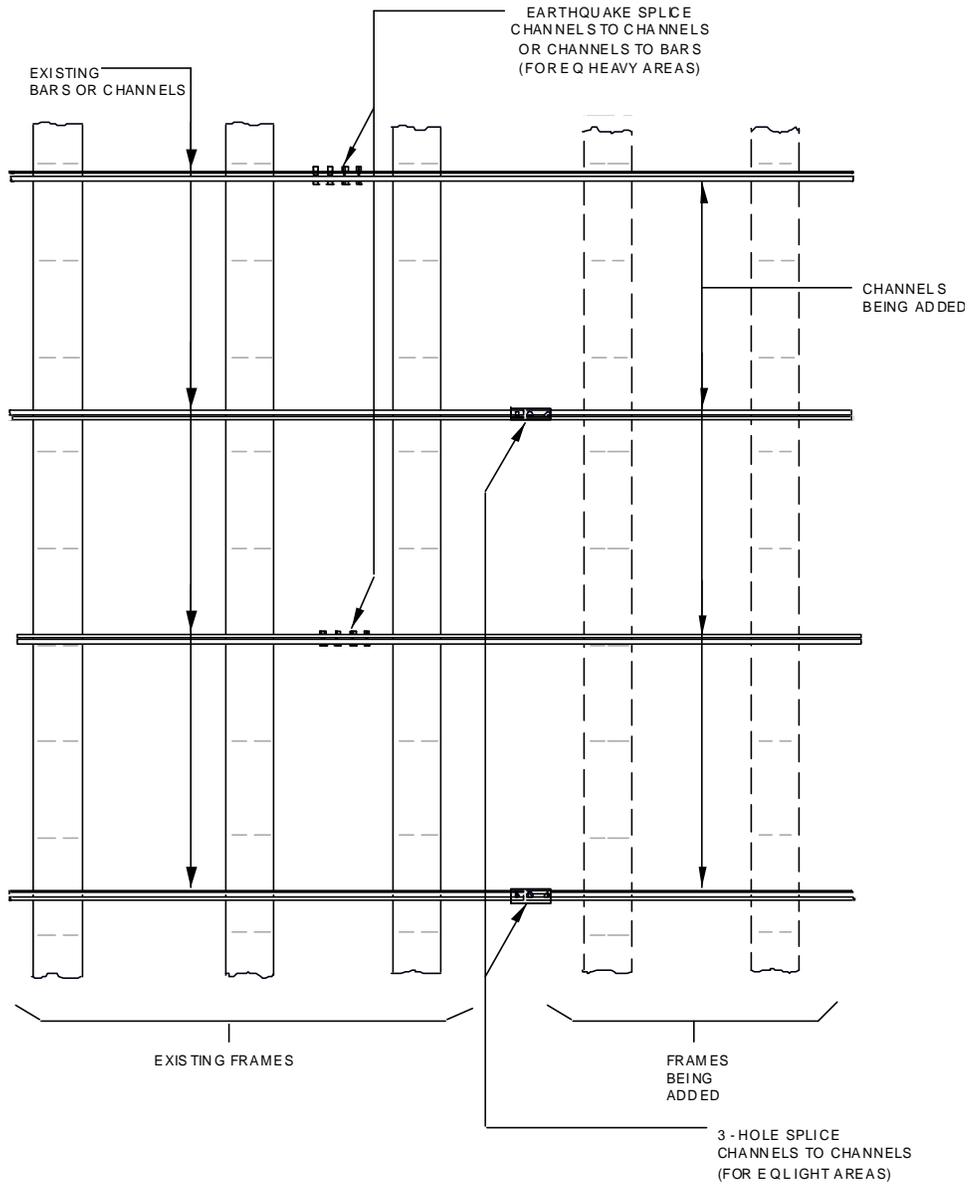


EXHIBIT 2-E2-9L  
 SPLICING AUXILIARY FRAMING-TYPICAL APPLICATIONS-USING 3-HOLE SPLICE PLATES



NOTE:  
EXISTING AUXILIARY FRAMING SHALL BE MODIFIED TO ACCOMMODATE STAGGERED SPLICING.

EXHIBIT 2-E2-9M  
ARRANGEMENT FOR EXTENDING BAR OR CHANNEL FRAMING WITH CHANNEL  
FRAMING-ELIMINATING NECESSITY OF CUTTING BACK EXISTING FRAME

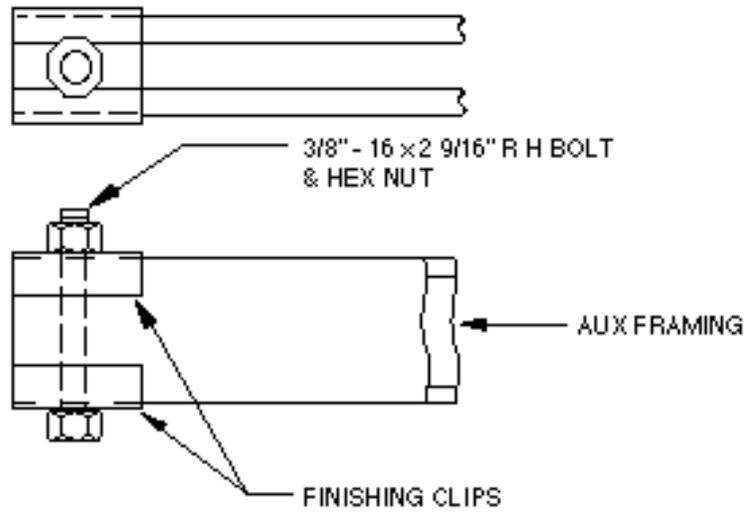


EXHIBIT 2-E2-10  
FINISHING CLIPS ON AUXILIARY FRAMING

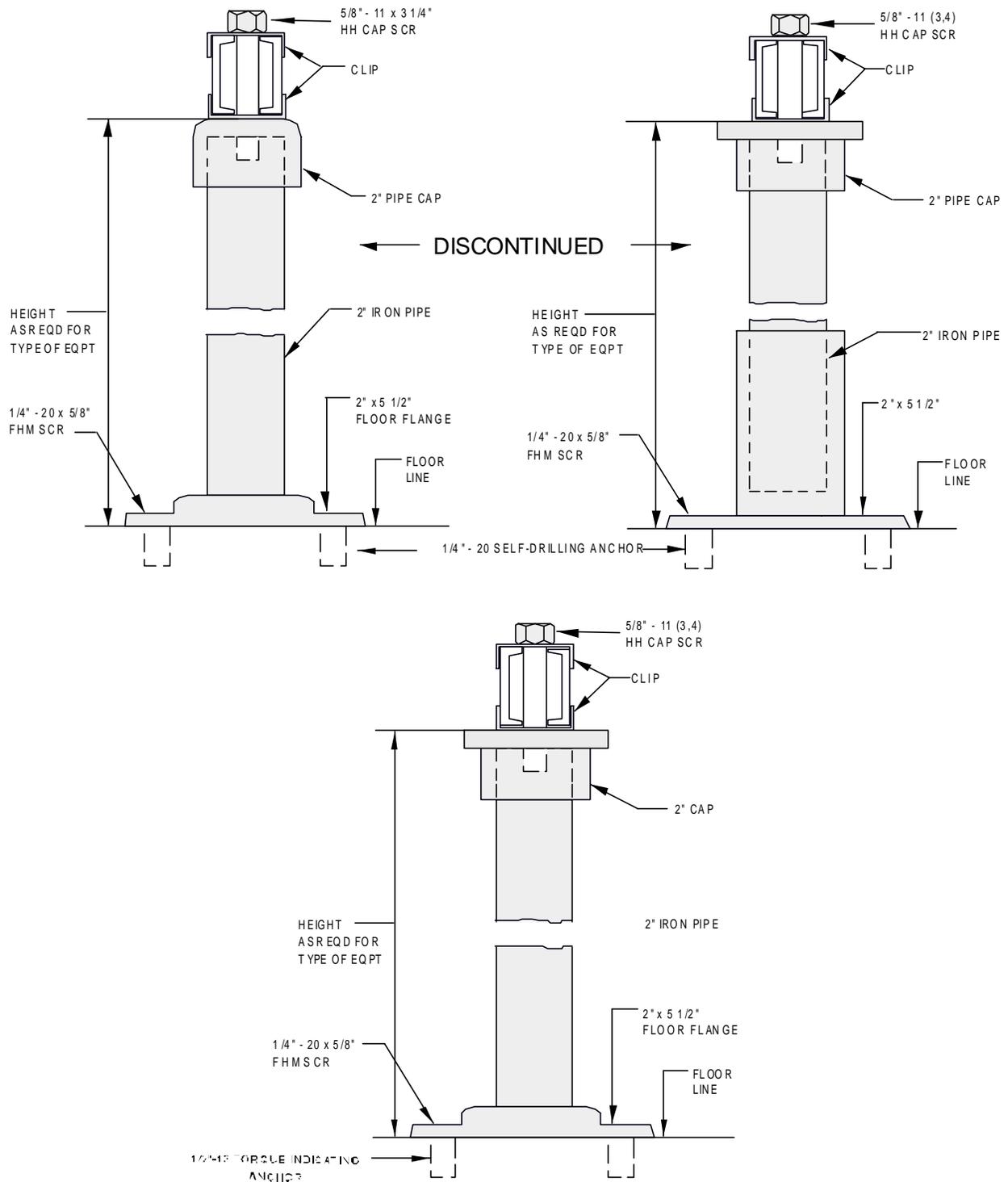


EXHIBIT 2-E2-11A  
 PIPE STAND SUPPORT OF AUXILIARY FRAMING

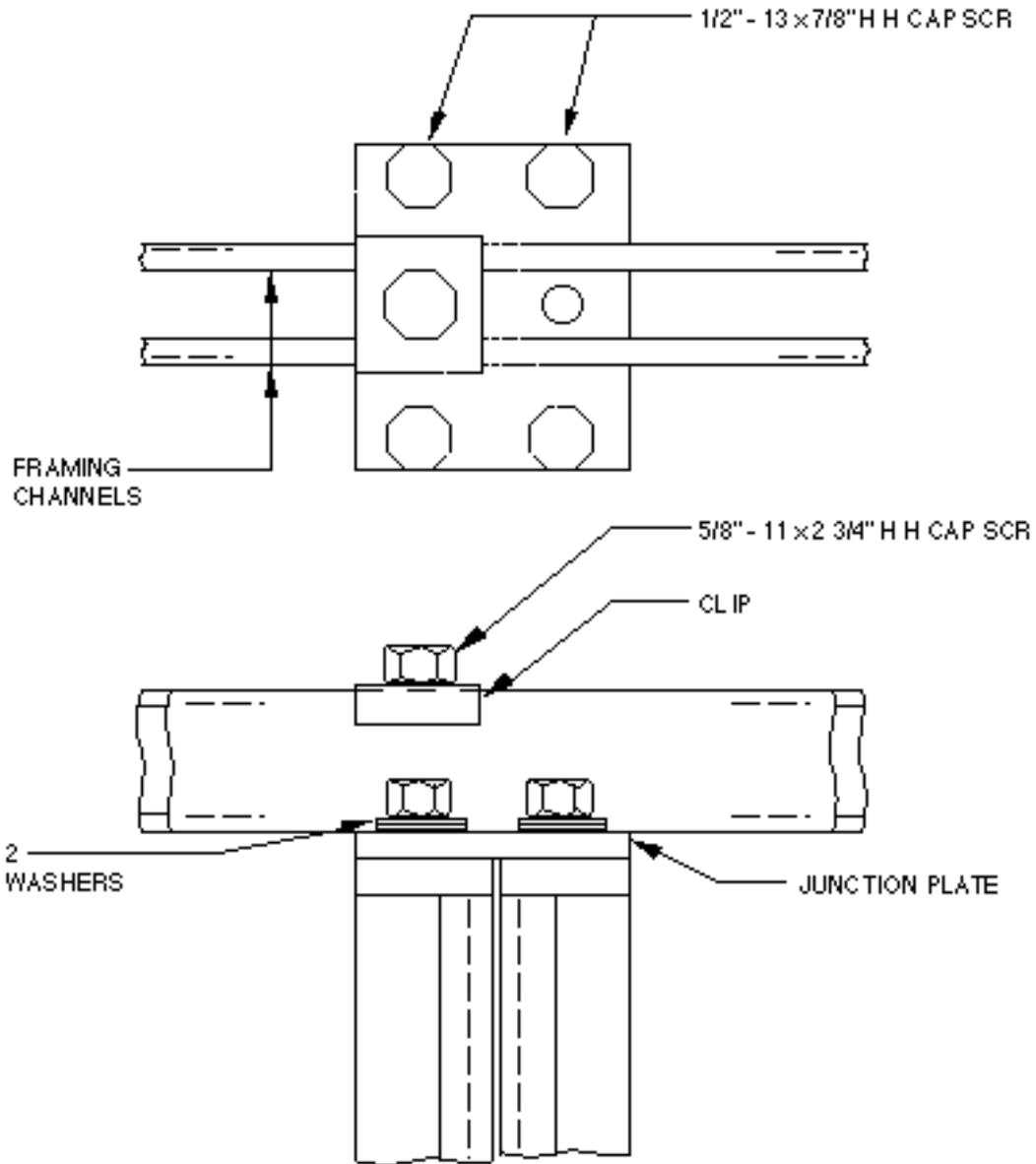


EXHIBIT 2-E2-11B (A&M)  
JUNCTIONING ADJACENT FRAME UPRIGHTS WITH CHANNEL TOP MEMBERS-BULB-  
ANGLE OR CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES-BULB-ANGLE TYPE  
SHOWN

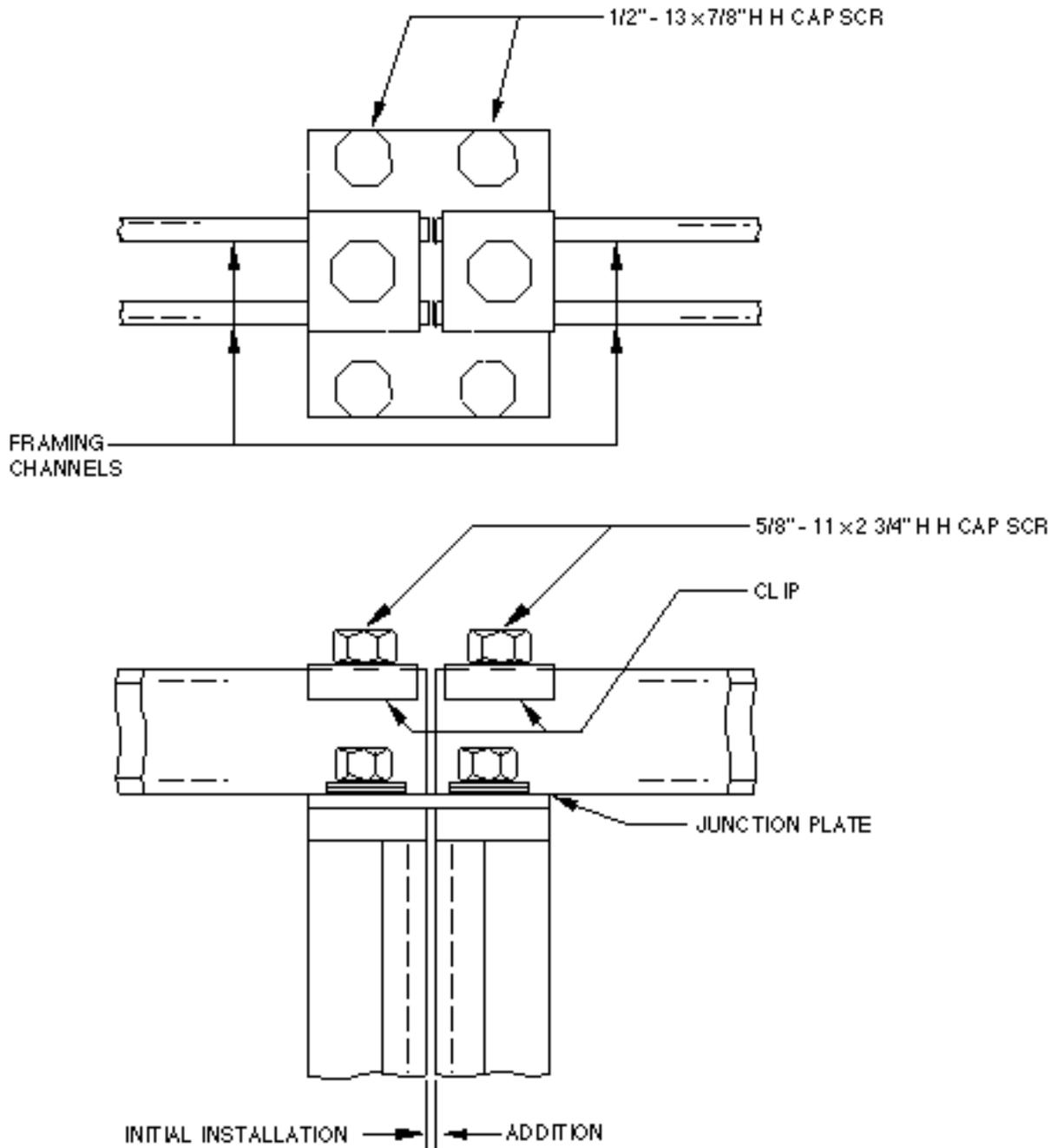


EXHIBIT 2-E2-11C (A&M)

JUNCTIONING ADJACENT FRAME UPRIGHTS WITH CHANNEL TOP MEMBER-WHERE A FRAME HAS BEEN ADDED TO AN EXISTING LINE-UP-BULB-ANGLE OR CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES-BULB-ANGLE TYPE SHOWN

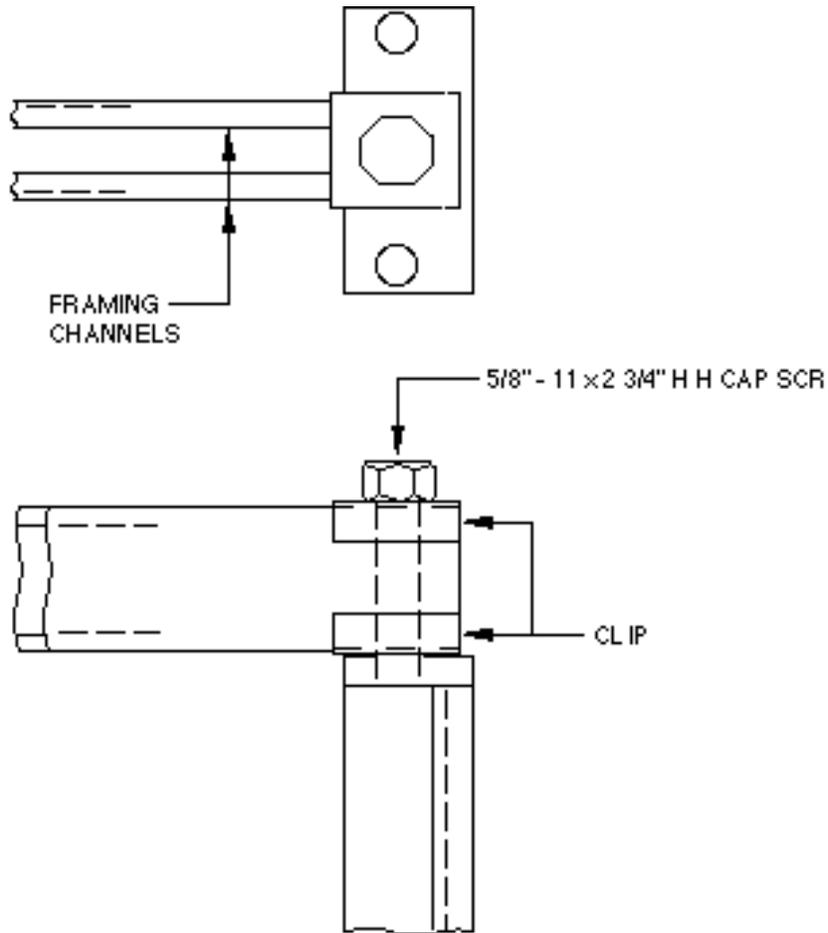


EXHIBIT 2-E2-11D (A&M)

FASTENING 2 INCH CHANNEL TOP MEMBERS AT END OF LINE-UP OR AT AN INTERMEDIATE UPRIGHT OF A FRAME-BULB-ANGLE OR CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES-BULB ANGLE UPRIGHT AT END OF LINE SHOWN

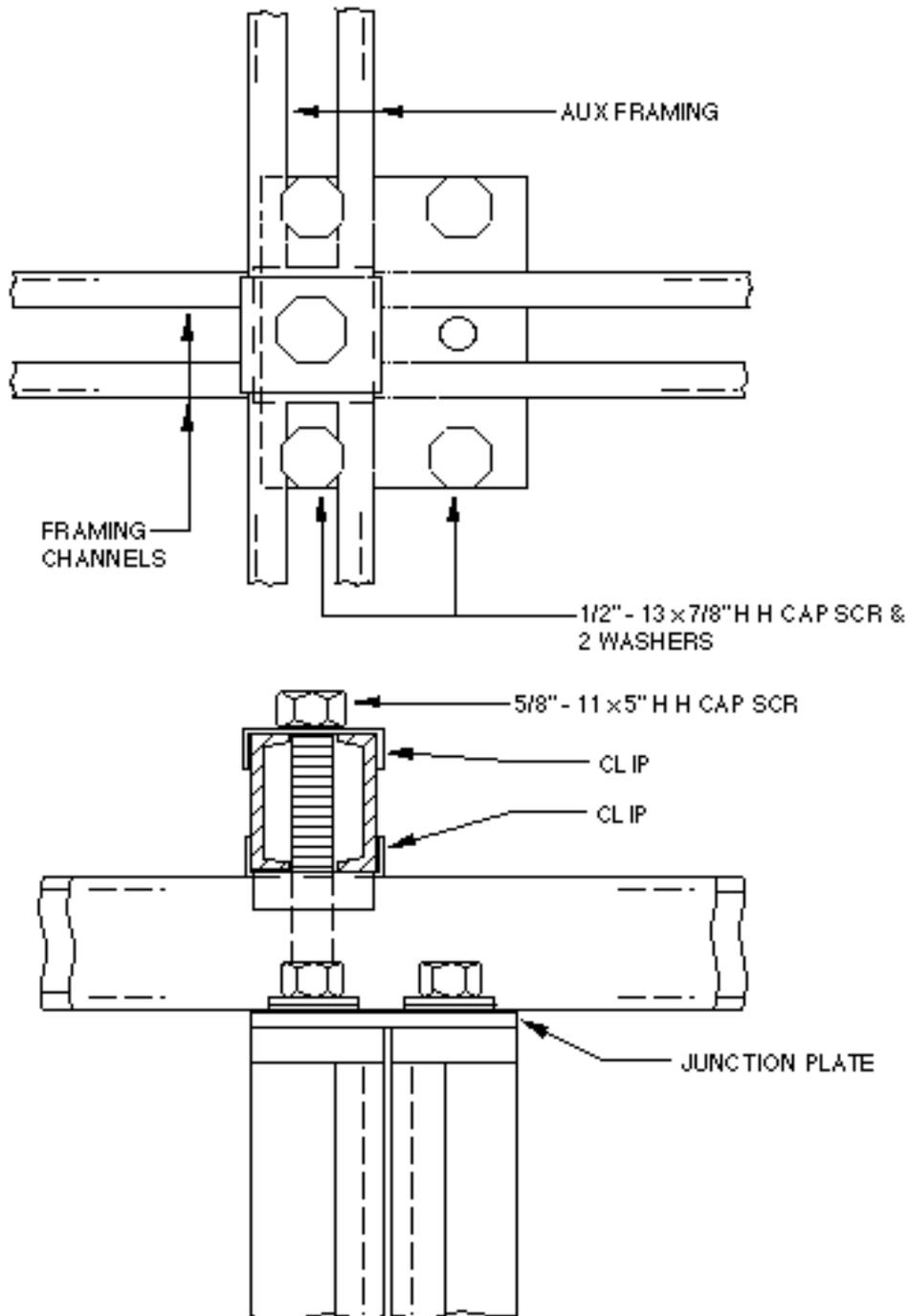


EXHIBIT 2-E2-11E (A&M)

JUNCTIONING ADJACENT FRAME UPRIGHTS HAVING 2 INCH CHANNEL TOP MEMBER WITH AUXILIARY FRAMING OVER ONE OF THE UPRIGHTS-BULB-ANGLE OR CHANNEL-TYPE STEP-BY-STEP FRAMES-BULB-ANGLE TYPE SHOWN 11 FOOT 8 INCH FRAMING

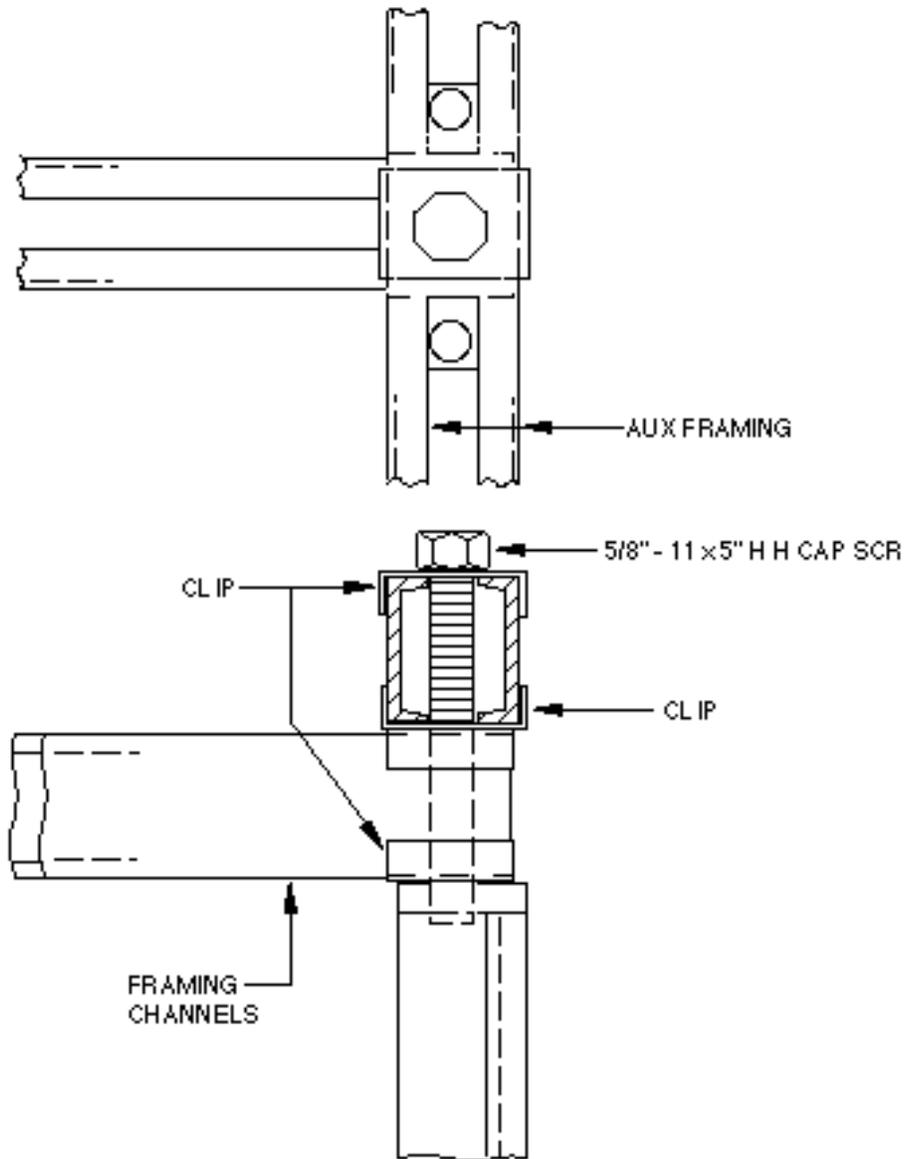


EXHIBIT 2-E2-11F (A&M)

FASTENING 2 INCH CHANNEL TOP MEMBERS TO UPRIGHT AT END OF LINE-UP WITH  
AUXILIARY FRAMING OVER THE UPRIGHT-BULB-ANGLE OR CHANNEL-TYPE STEP-  
BY-STEP SWITCH FRAMES-BULB-ANGLE TYPE SHOWN-11 FOOT 9 INCH FRAMING

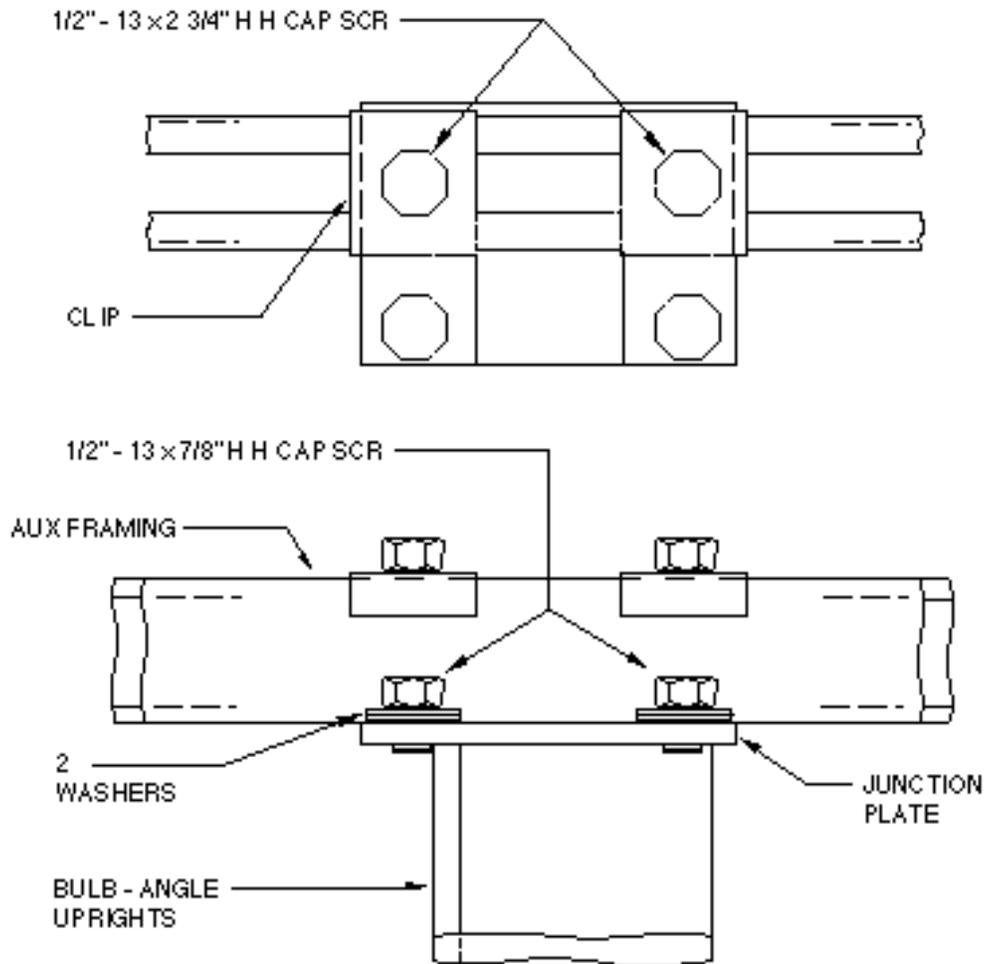


EXHIBIT 2-E2-11G (A&M)  
AUXILIARY FRAMING ATTACHED WITH JUNCTION PLATE TO TWO ADJACENT BULB-  
ANGLE UPRIGHTS IN 11 FOOT 6 INCH FRAMING AREA-STEP-BY-STEP OFFICES

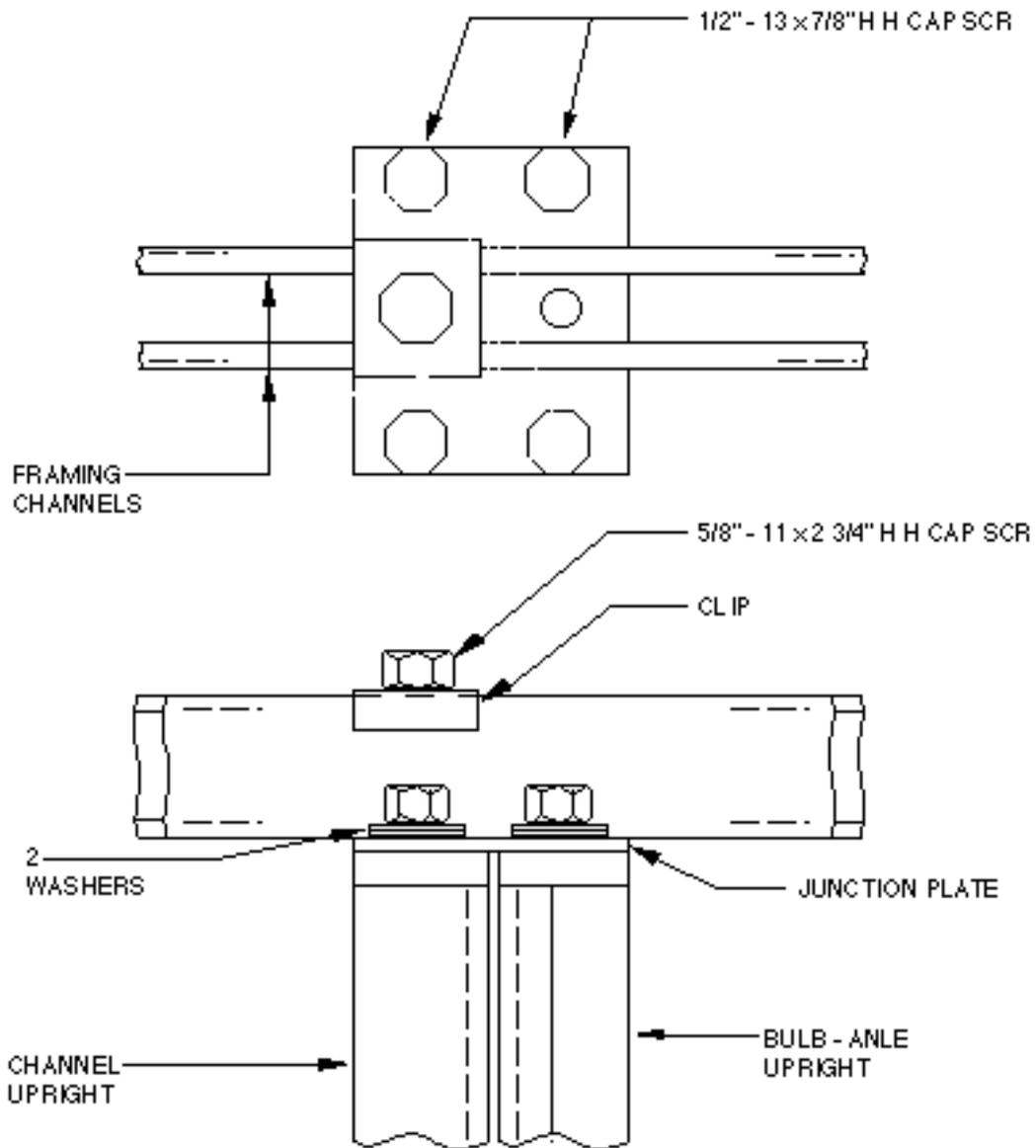


EXHIBIT 2-E2-11H (A&M)  
JUNCTIONING ADJACENT FRAME UPRIGHTS WITH CHANNEL-TYPE TOP MEMBERS  
BULB-ANGLE TO CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES

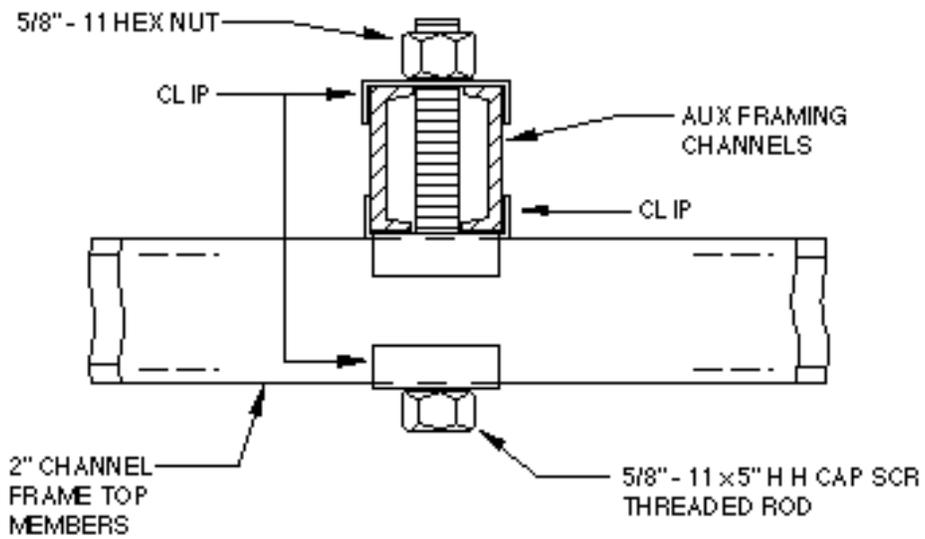


EXHIBIT 2-E2-11J  
DOUBLE-LEVEL AUXILIARY FRAMING-FASTENING CHANNEL OVER CHANNEL

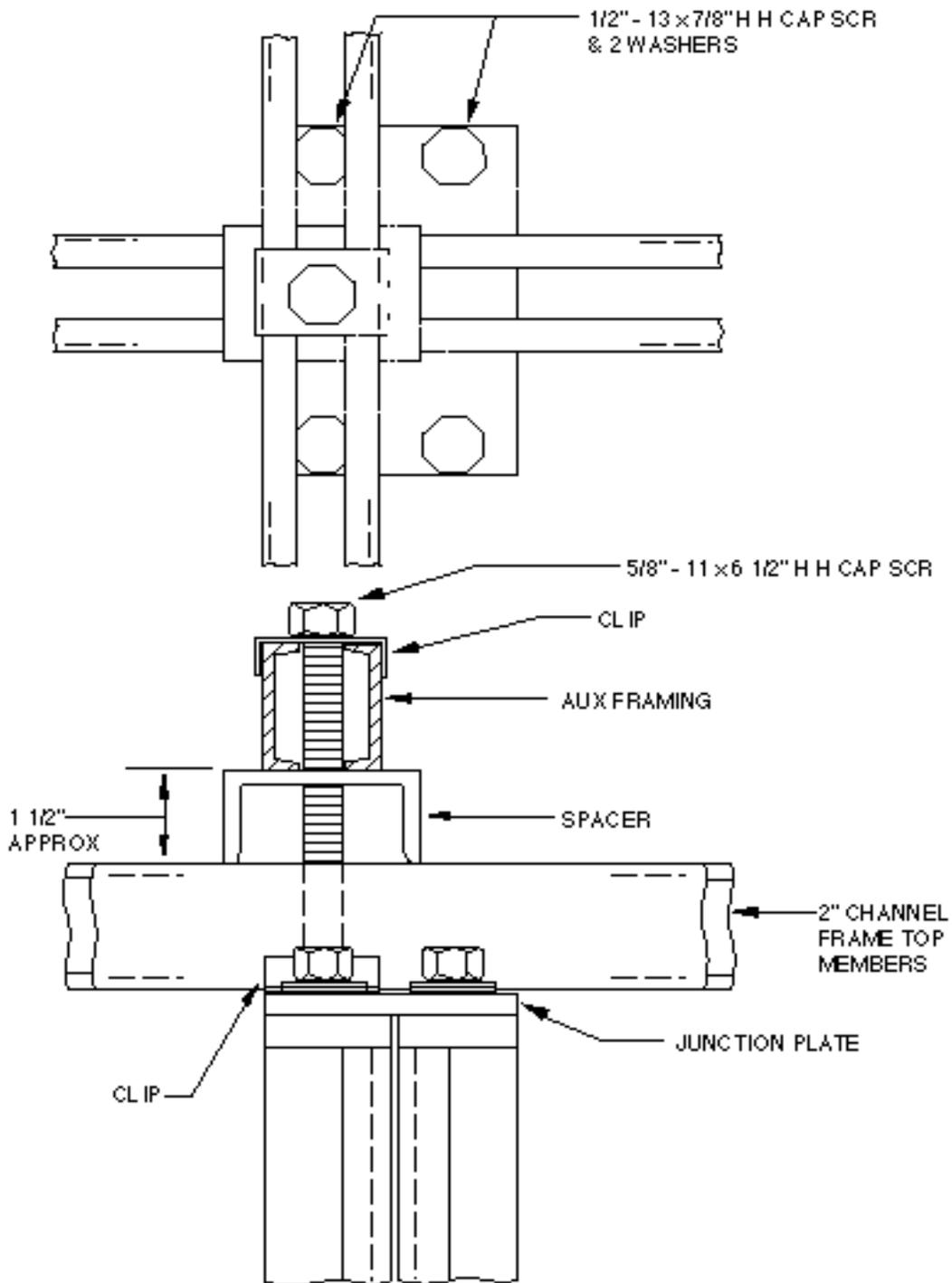


EXHIBIT 2-E2-11K (A&M)

JUNCTIONING ADJACENT FRAME UPRIGHTS HAVING 2 INCH CHANNEL TOP MEMBERS WITH AUXILIARY FRAMING OVER ONE OF THE UPRIGHTS-BULB-ANGLE OR CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES-BULB-ANGLE-TYPE SHOWN-11 FOOT 9 and 1/2 INCH FRAMING

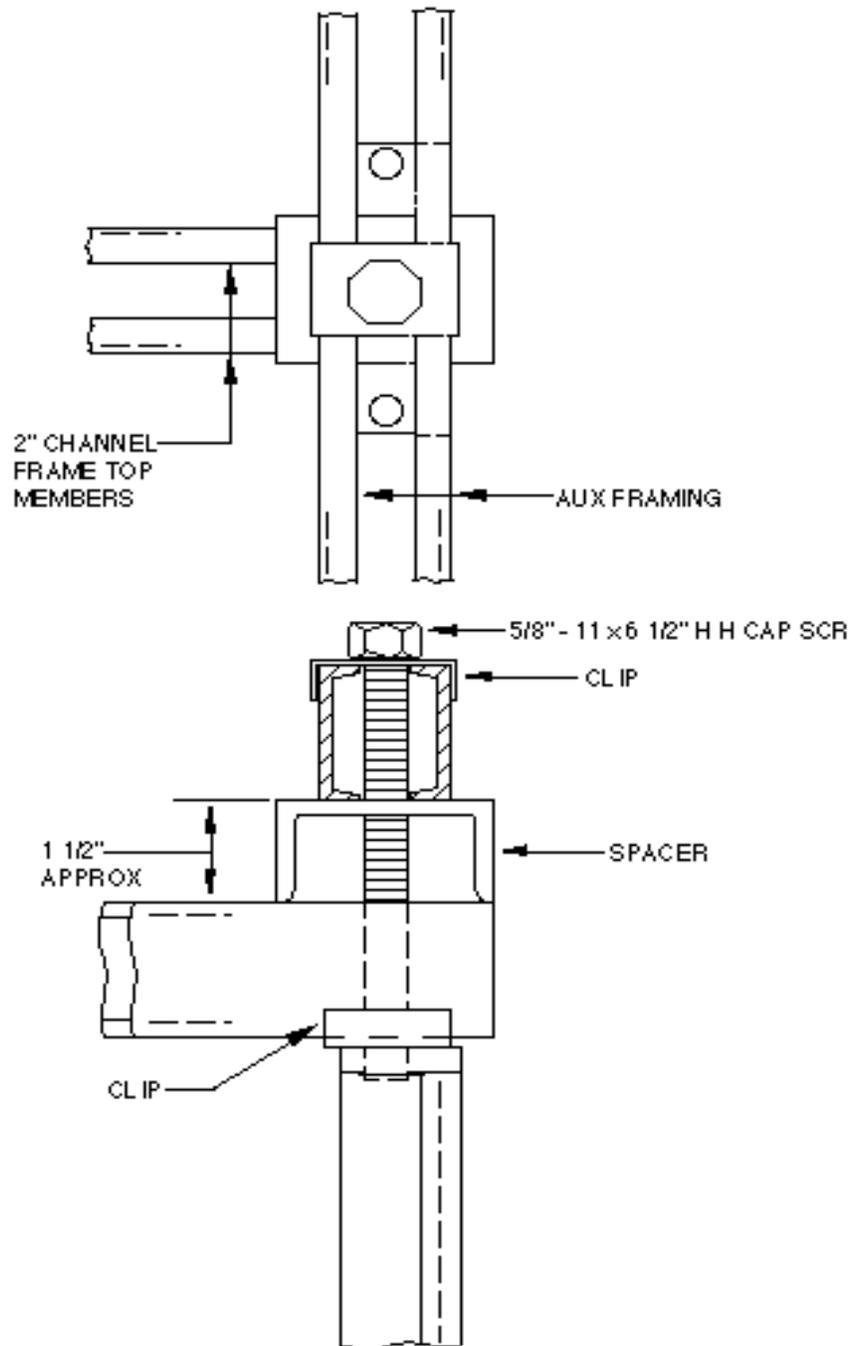


EXHIBIT 2-E2-11L (A&M)

FASTENING 2 INCH CHANNEL TOP MEMBERS TO UPRIGHT AT END OF LINE-UP WITH  
AUXILIARY FRAMING OVER THE UPRIGHT BULB-ANGLE OR CHANNEL-TYPE STEP-  
BY-STEP SWITCH FRAMES-BULB-ANGLE-TYPE SHOWN-11 FOOT 9 and 1/2 INCH  
FRAMING

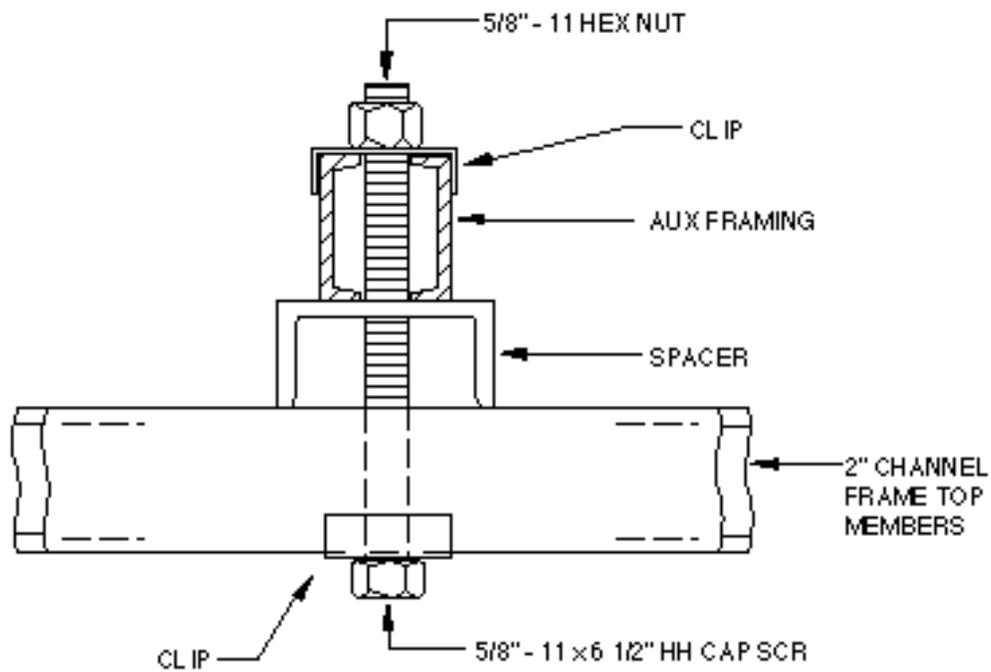


EXHIBIT 2-E2-11M (A&M)  
AUXILIARY FRAMING ATTACHED TO 2 INCH CHANNEL TOP MEMBERS OF STEP-BY-STEP SWITCH FRAMES-FASTENING BETWEEN FRAME UPRIGHTS 11 FOOT 9 and 1/2 INCH FRAMING

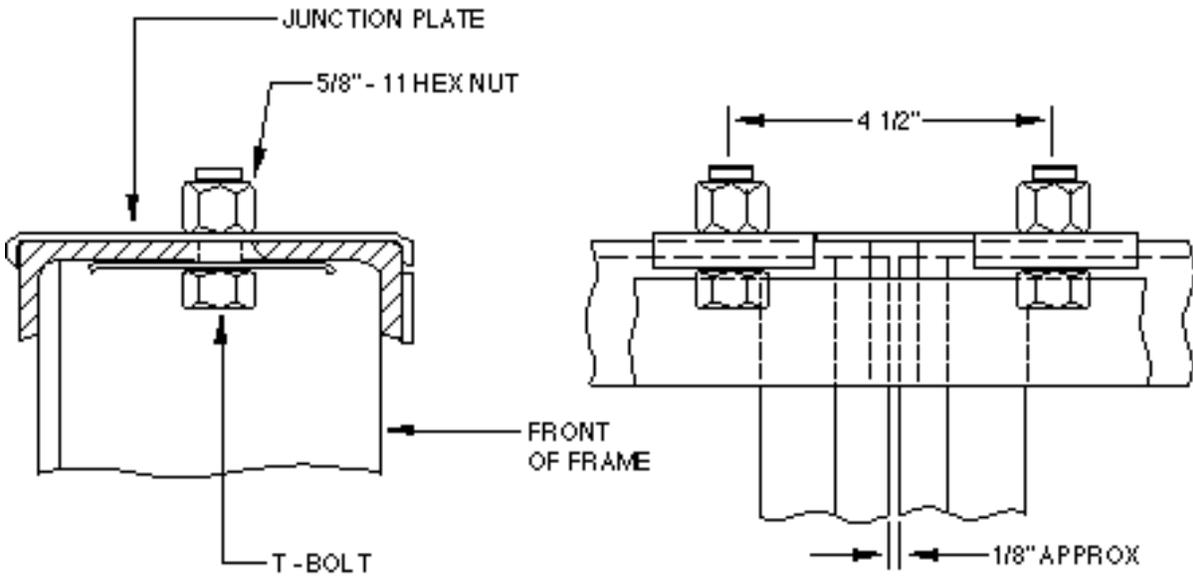


EXHIBIT 2-E2-12B (A&M)  
JUNCTIONING TOP ANGLES OF BULB-ANGLE-TYPE FRAMES

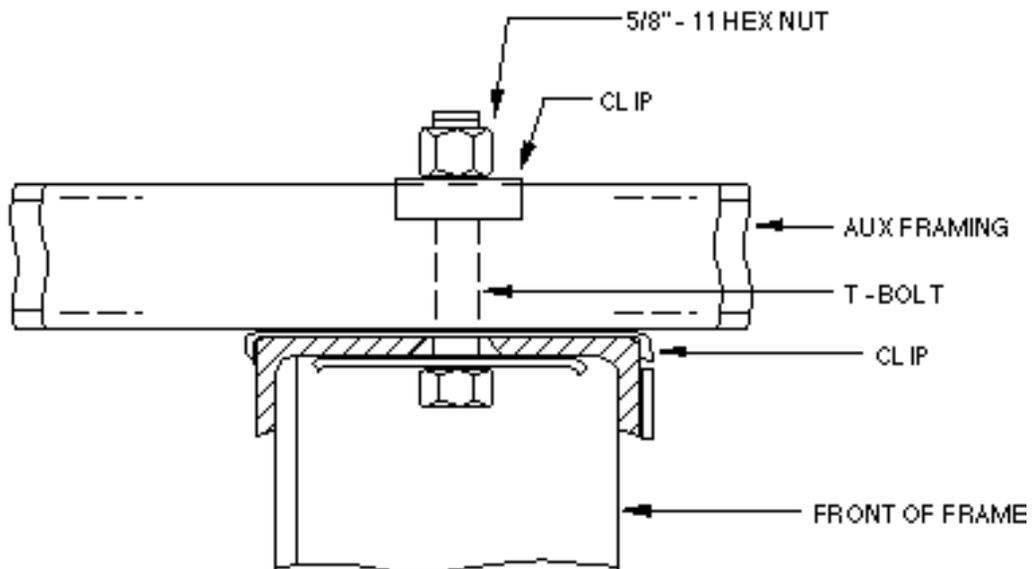
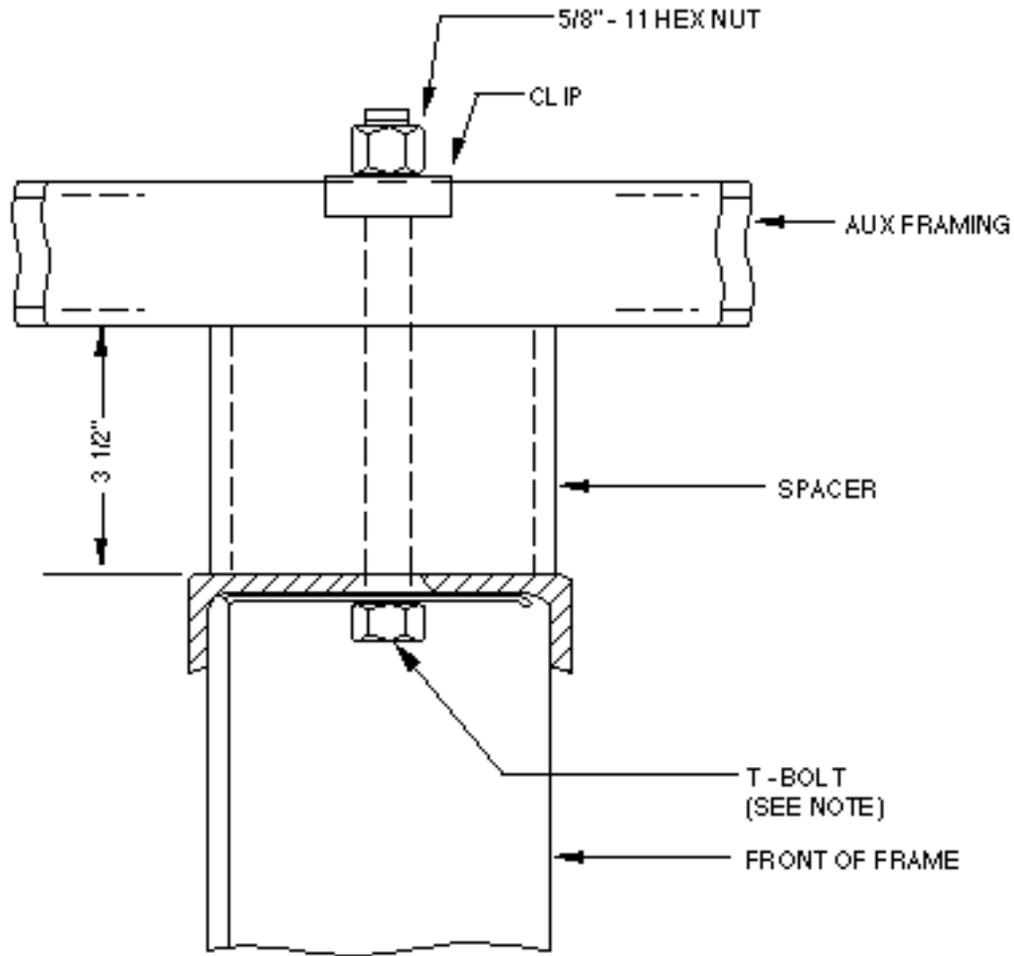
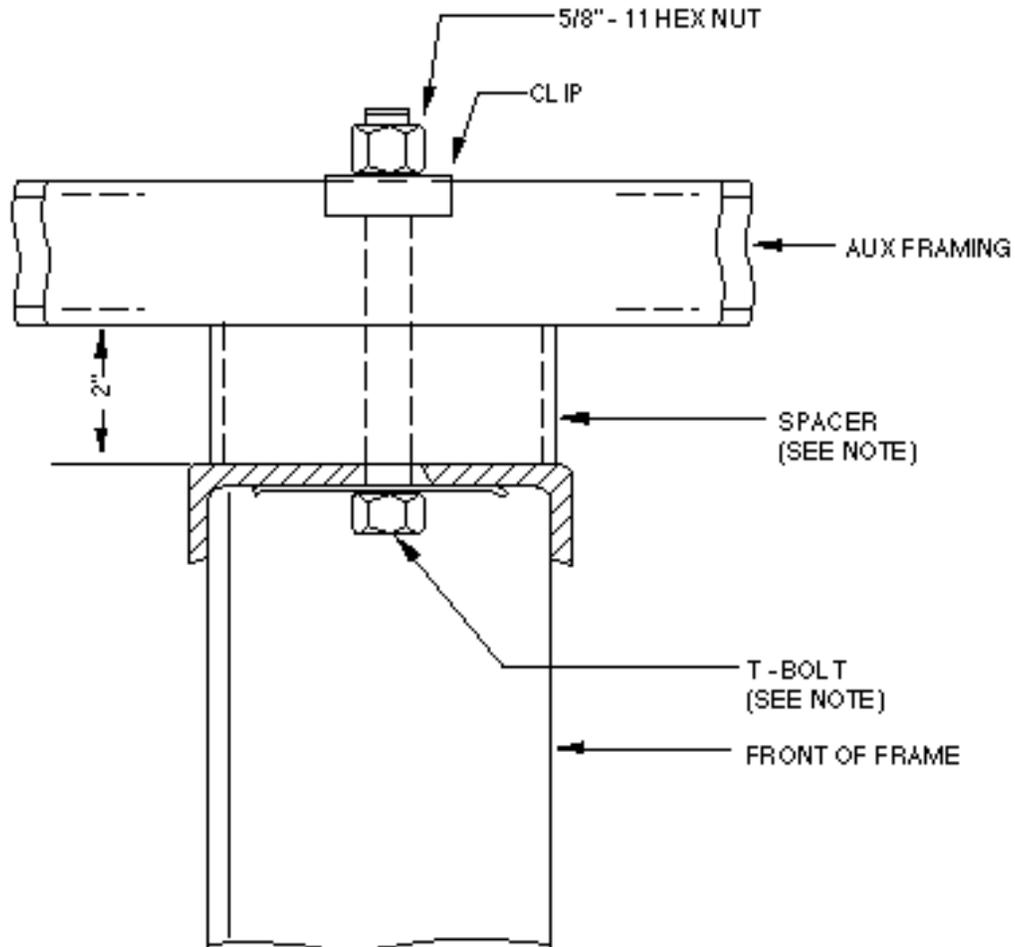


EXHIBIT 2-E2-12C (A&M)  
AUXILIARY FRAMING ATTACHED DIRECTLY TO TOP ANGLES OF BULB-ANGLE-TYPE  
FRAMES



NOTE:  
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-12F (A&M)  
AUXILIARY FRAMING ATTACHED TO TOP ANGLES OF BULB-ANGLE-TYPE FRAMES-  
11 FOOT 9 and 1/2 INCH AUXILIARY FRAMING



NOTE:  
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-12G (A&M)  
AUXILIARY FRAMING ATTACHED TO TOP ANGLES OF BULB-ANGLE-TYPE FRAMES-7  
FOOT 2 INCH AND 11 FOOT 8 INCH AUXILIARY FRAMING

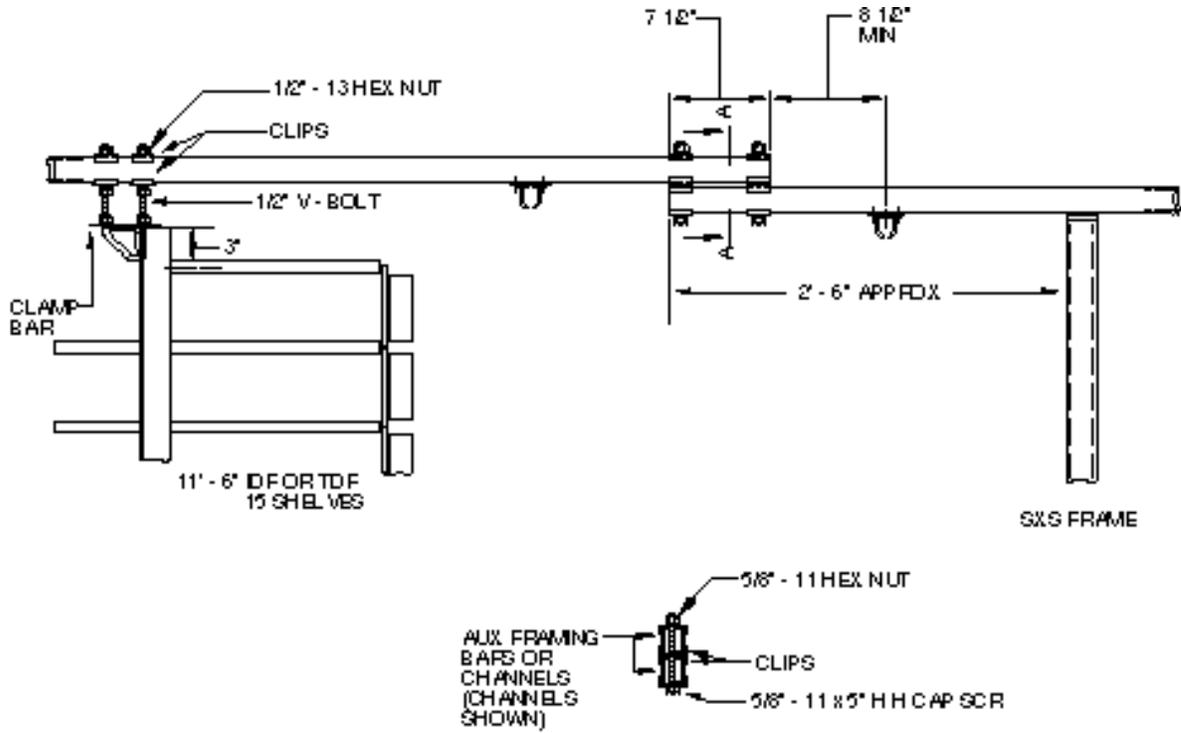


EXHIBIT 2-E2-13  
AUXILIARY FRAMING RAISED AND EXTENDED OVER STEP-BY-STEP DISTRIBUTING  
FRAMES-11 FOOT 6 INCH FRAMING-ADDITIONS ONLY

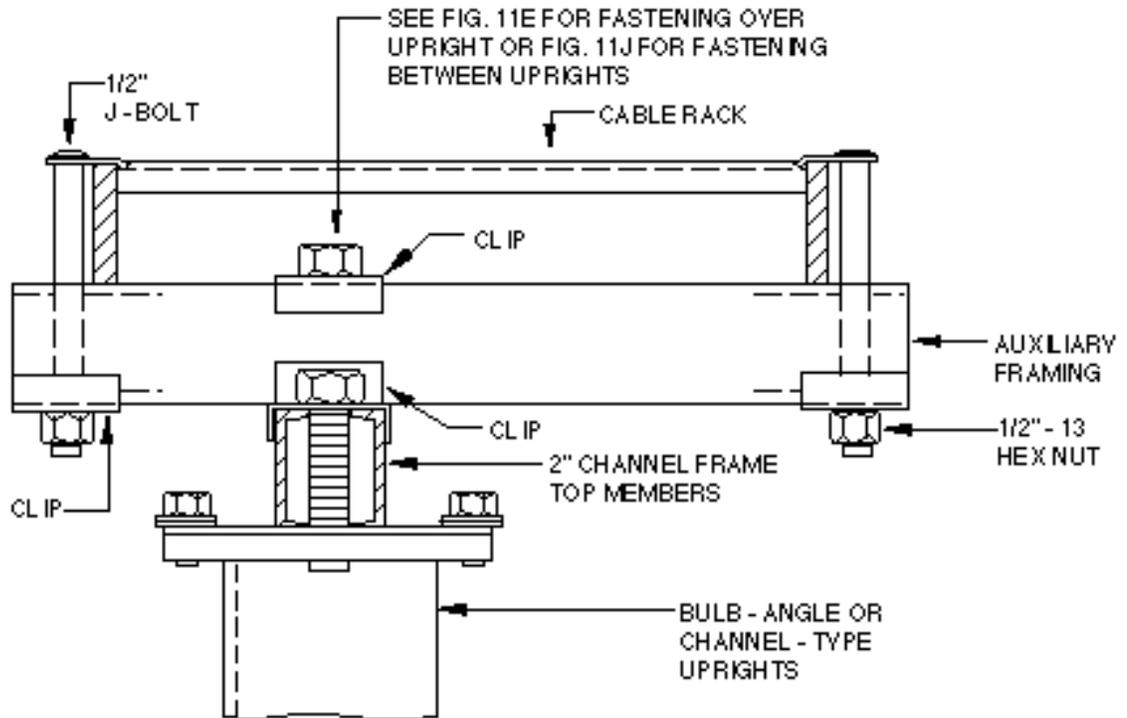


EXHIBIT 2-E2-15B (A&M)  
ISOLATED STEP-BY-STEP FRAMES SUPPORTED FROM ONE CABLE RACK 11 FOOT 8  
INCH FRAMING

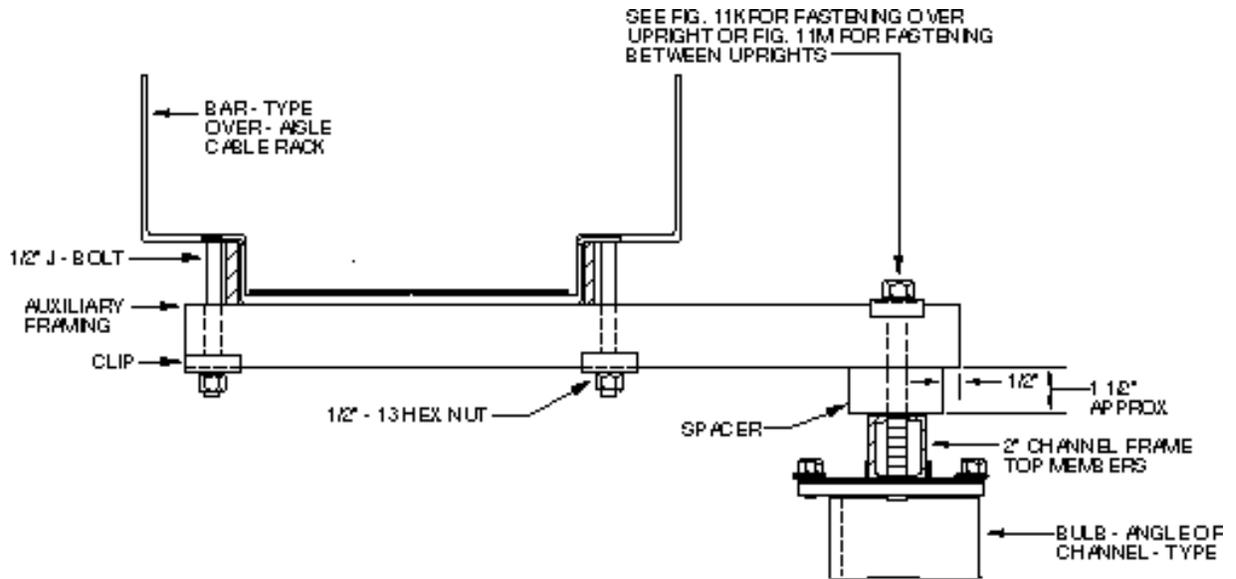
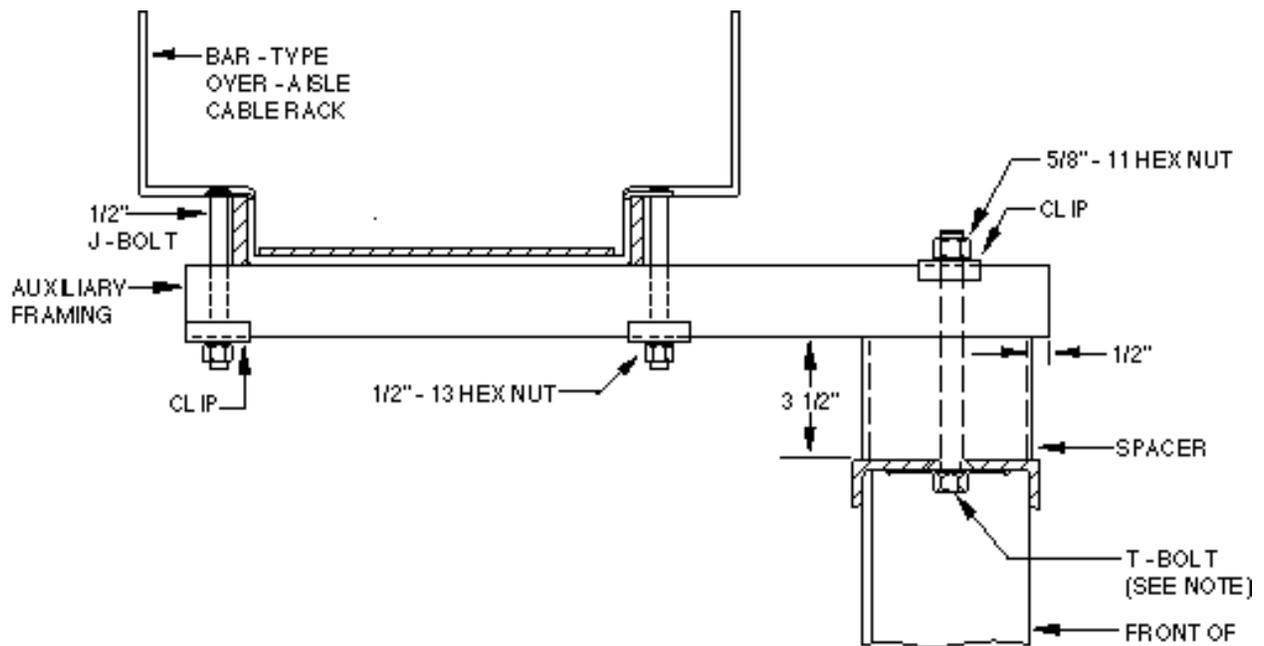
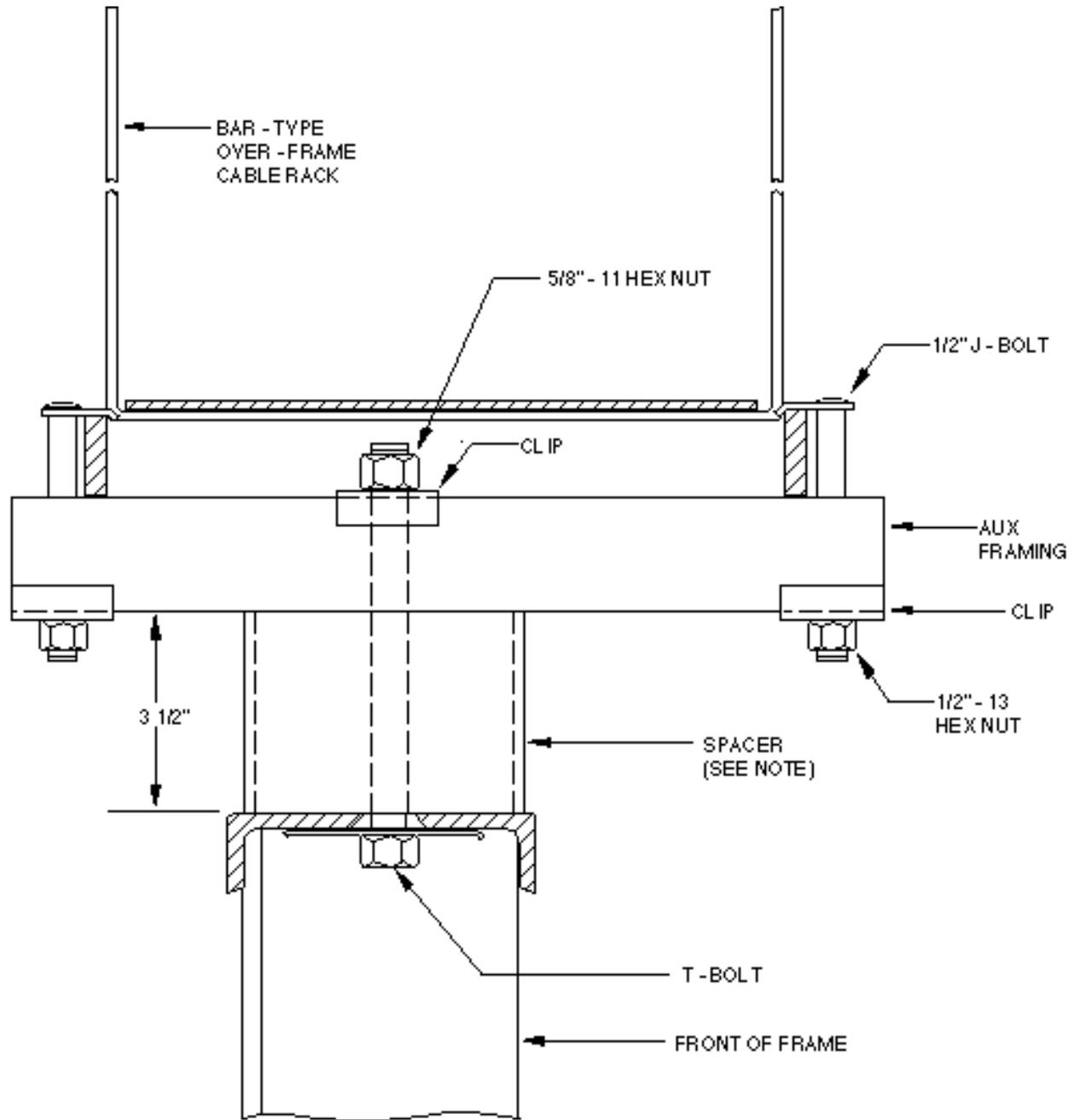


EXHIBIT 2-E2-15C (A&M)  
ISOLATED STEP-BY-STEP FRAMES SUPPORTED FROM ONE CABLE RACK 11 FOOT 9  
and 1/2 INCH FRAMING



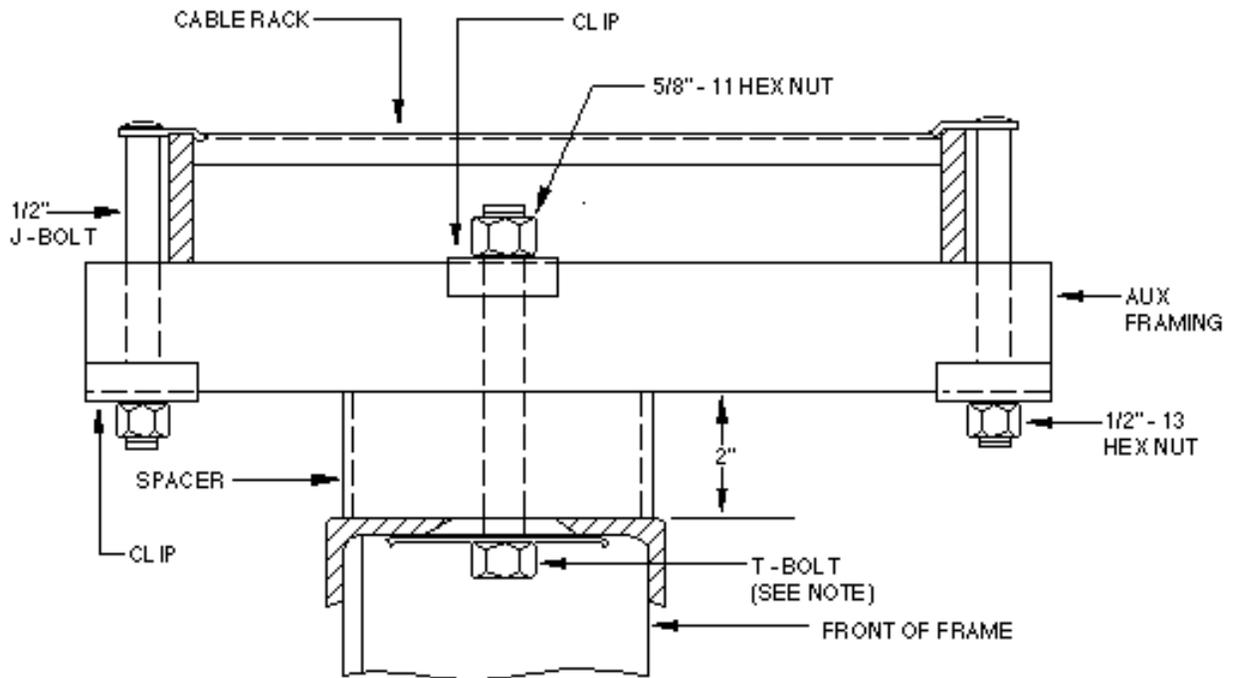
NOTE:  
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-15D (A&M)  
ISOLATED NO. 1 CROSSBAR FRAME SUPPORTED FROM BAR-TYPE OVER-AISLE  
CABLE RACK 11 FOOT 9 and 1/2 INCH FRAMING



NOTE:  
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-15E (A&M)  
ISOLATED NO. 1 CROSSBAR FRAME SUPPORTED FROM BAR-TYPE OVER-FRAME  
CABLE RACK 11 FOOT 9 and 1/2 INCH FRAMING



NOTE:  
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-15F (A&M)  
ISOLATED NO.1 CROSSBAR AND NO. 4 TOLL SWITCHING FRAMES SUPPORTED FROM  
ONE CABLE RACK-11 FOOT 8 INCH FRAMING

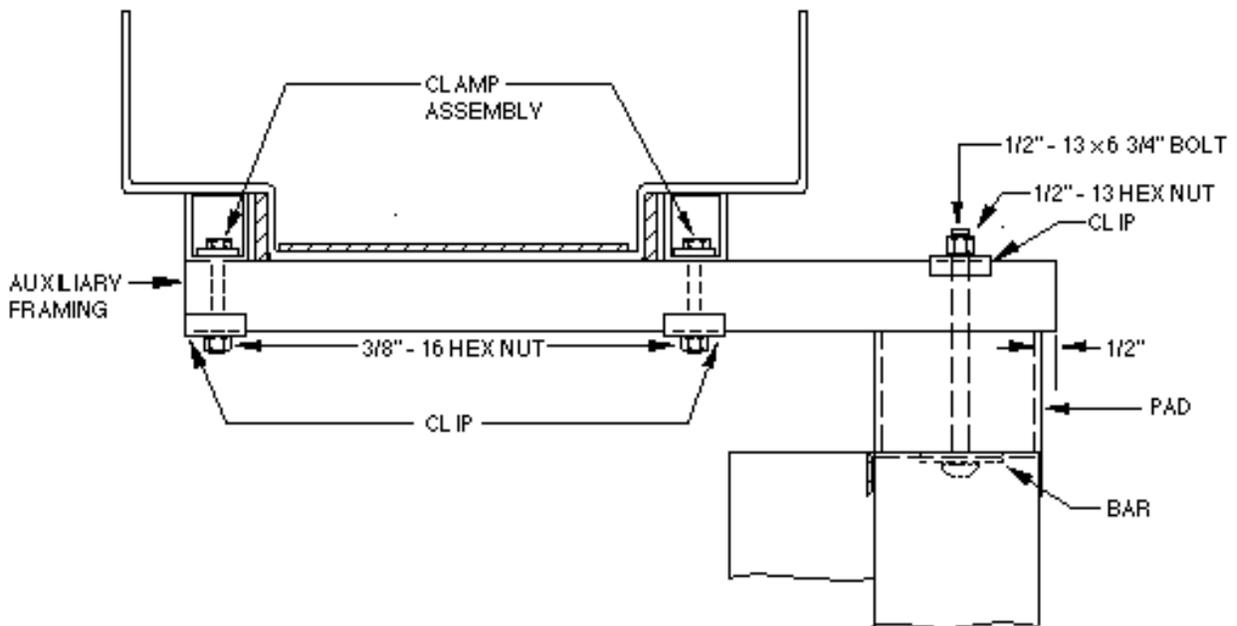


EXHIBIT 2-E2-16B (A&M)  
ISOLATED CROSSBAR FRAMES SUPPORTED FROM ONE CHANNEL-TYPE CABLE  
RACK-ADDITIONS ONLY

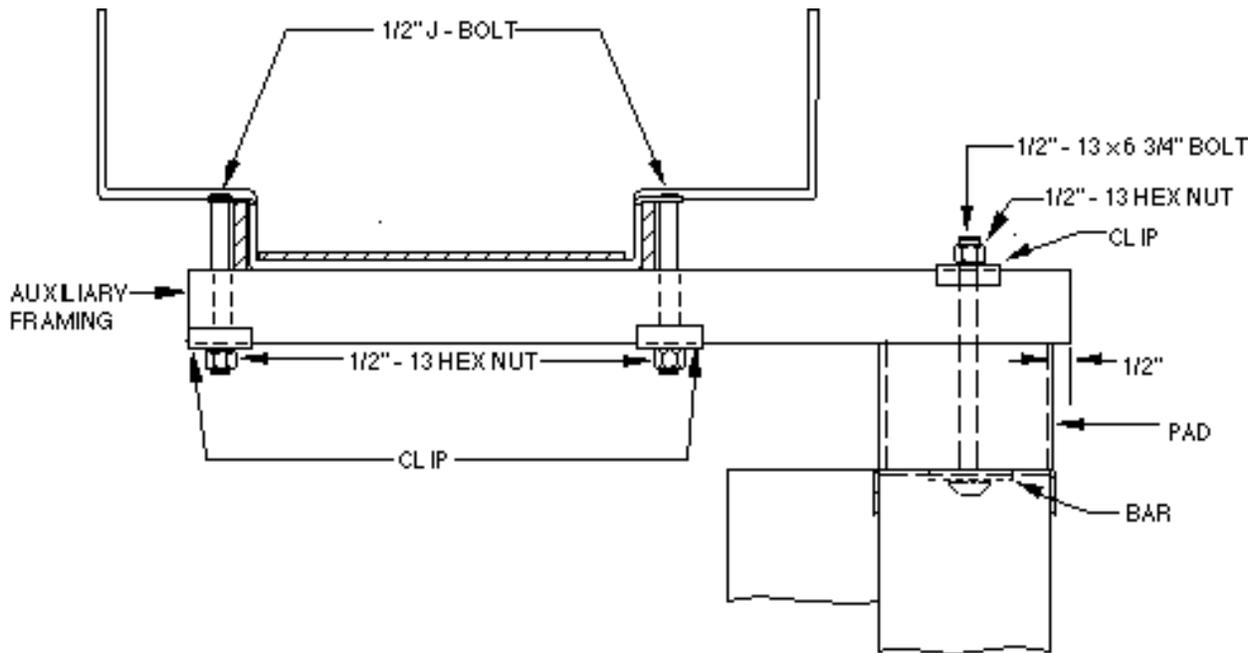


EXHIBIT 2-E2-16C (A&M)  
ISOLATED CROSSBAR FRAMES SUPPORTED FROM ONE BAR-TYPE CABLE RACK

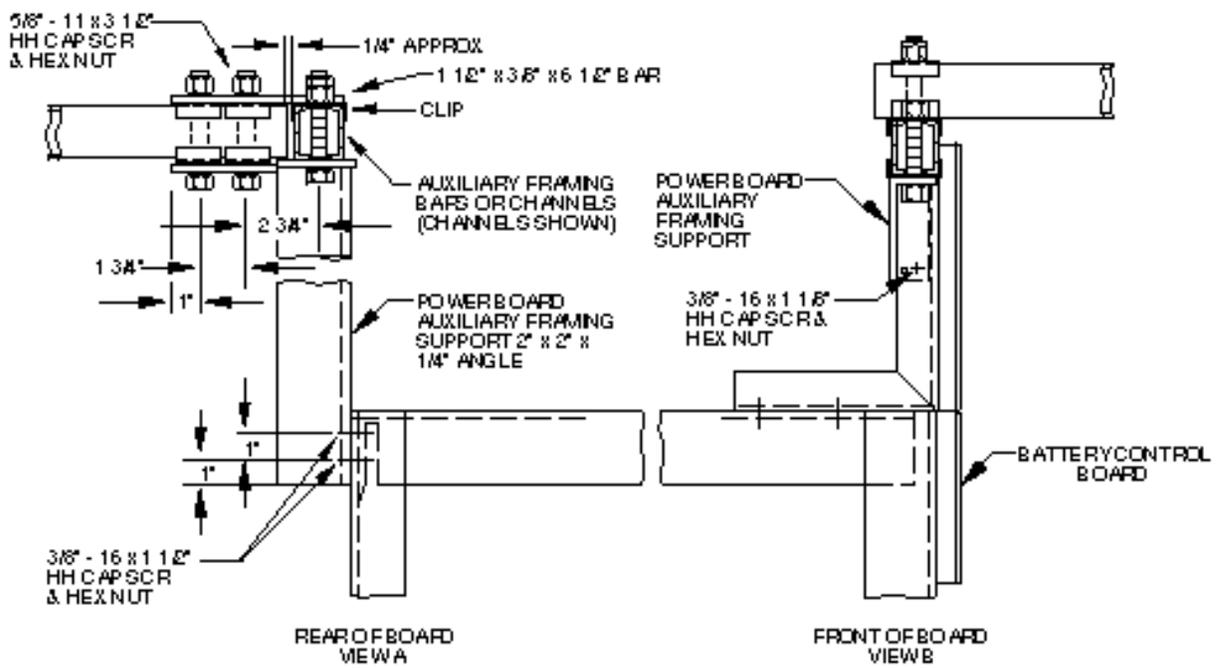


EXHIBIT 2-E2-18  
AUXILIARY FRAMING OVER BATTERY CONTROL BOARDS

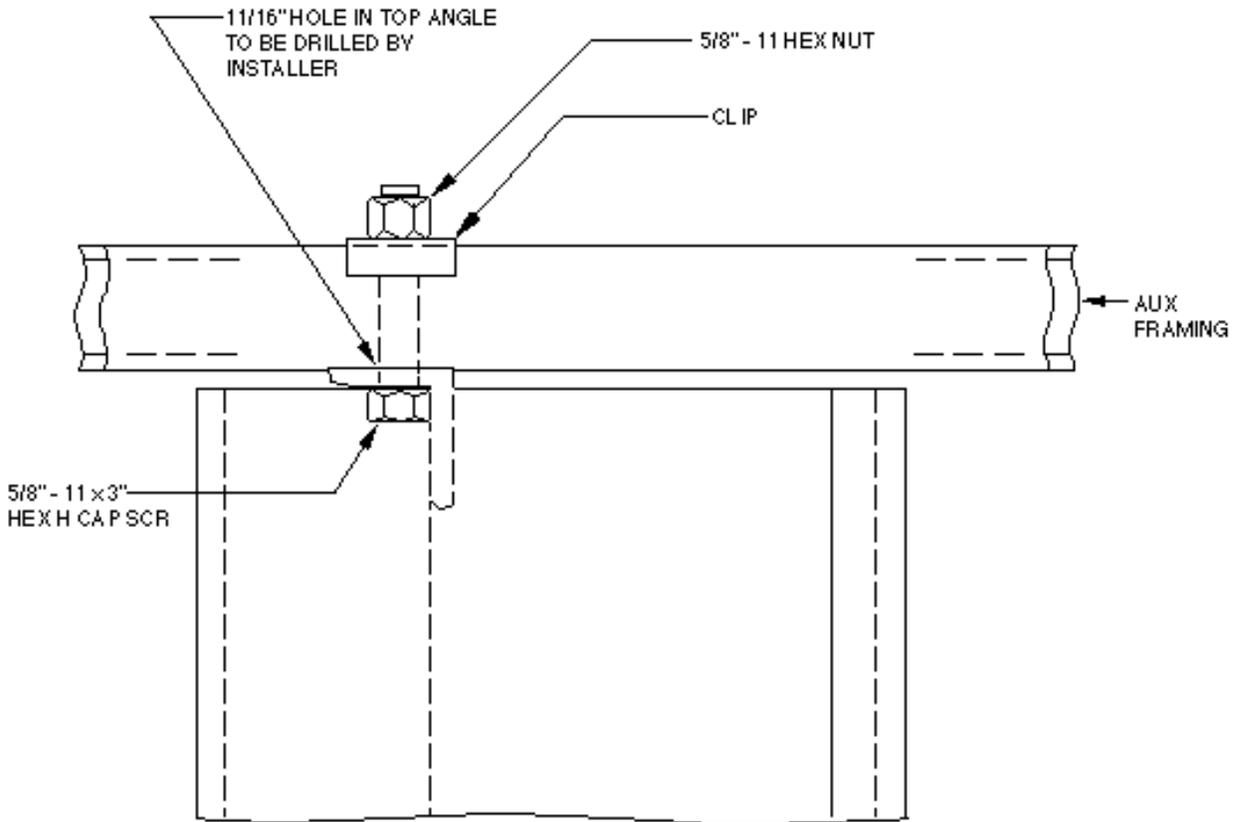


EXHIBIT 2-E2-18A  
AUXILIARY FRAMING ATTACHED DIRECTLY TO TOP-ANGLES OF BATTERY  
DISTRIBUTING FUSE BOARDS-11 FOOT 6 INCH FRAMING

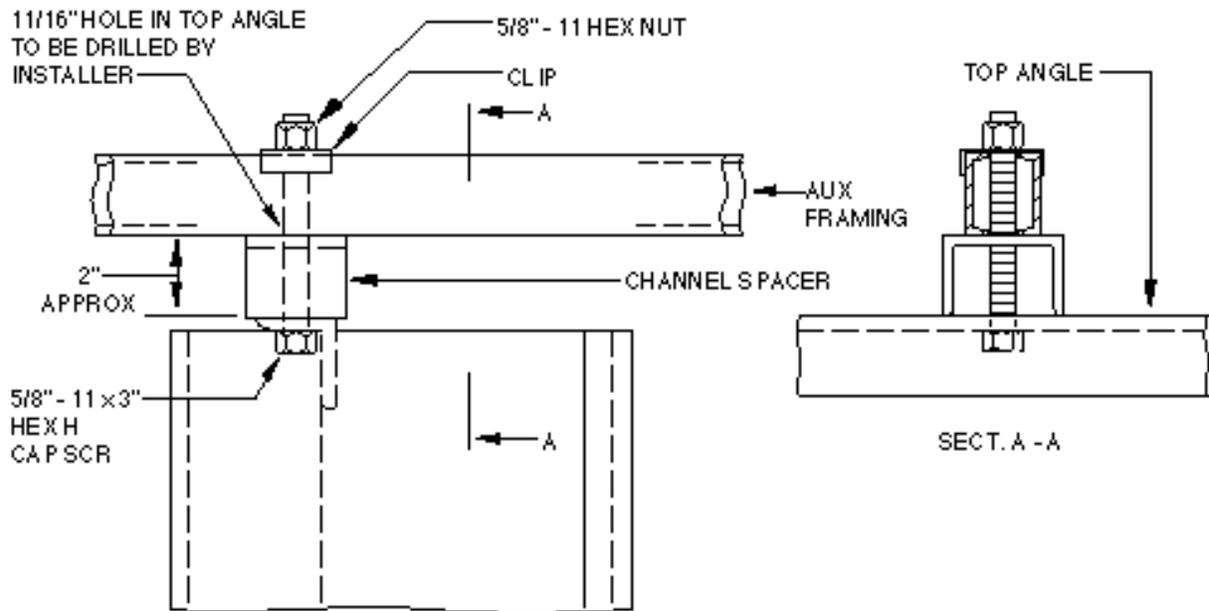


EXHIBIT 2-E2-18B  
AUXILIARY FRAMING ATTACHED TO TOP-ANGLES OF BATTERY DISTRIBUTION  
FUSE BOARDS-11 FOOT 8 INCH FRAMING

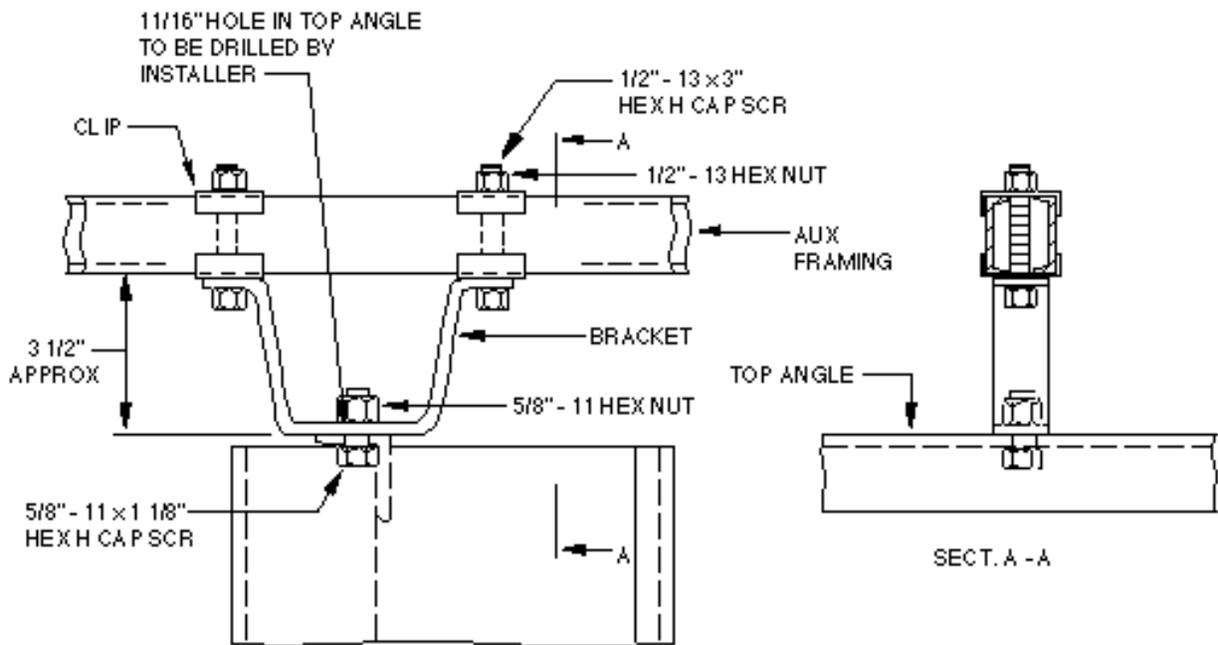


EXHIBIT 2-E2-18C  
AUXILIARY FRAMING ATTACHED TO TOP-ANGLES OF BATTERY DISTRIBUTION  
FUSE BOARDS-11 FOOT 9 and 1/2 INCH FRAMING

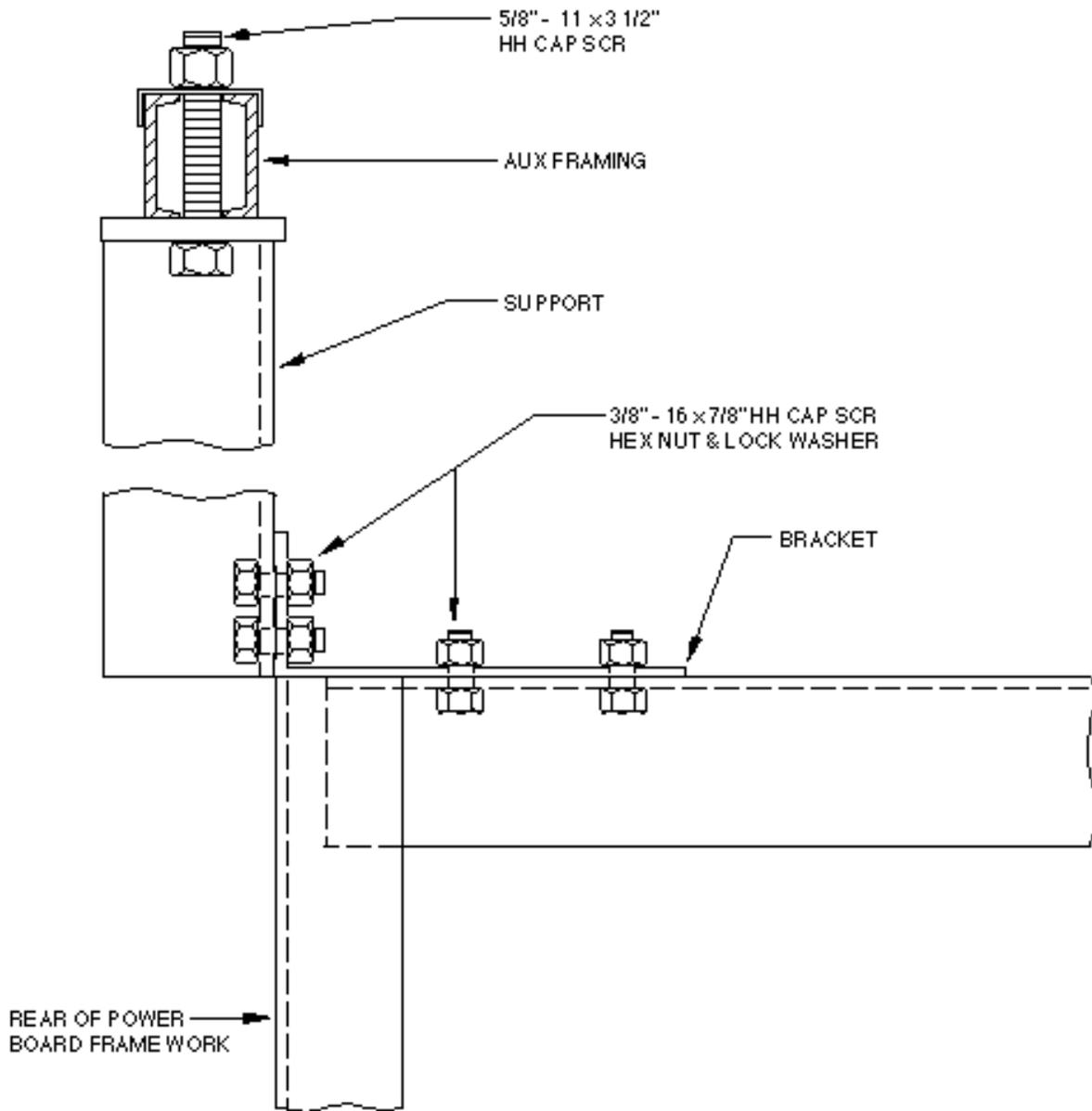


EXHIBIT 2-E2-18D  
AUXILIARY FRAMING OVER BATTERY CONTROL BOARDS EQUIPPED WITH REAR  
DOORS

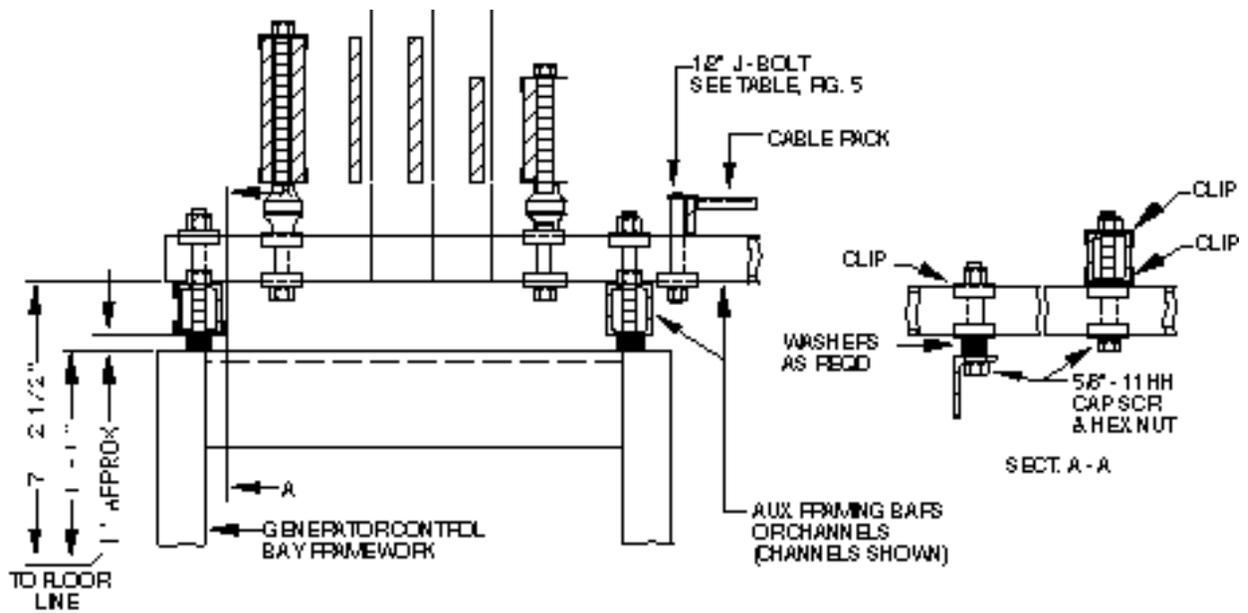


EXHIBIT 2-E2-19  
AUXILIARY FRAMING OVER GENERATOR CONTROL PANELS

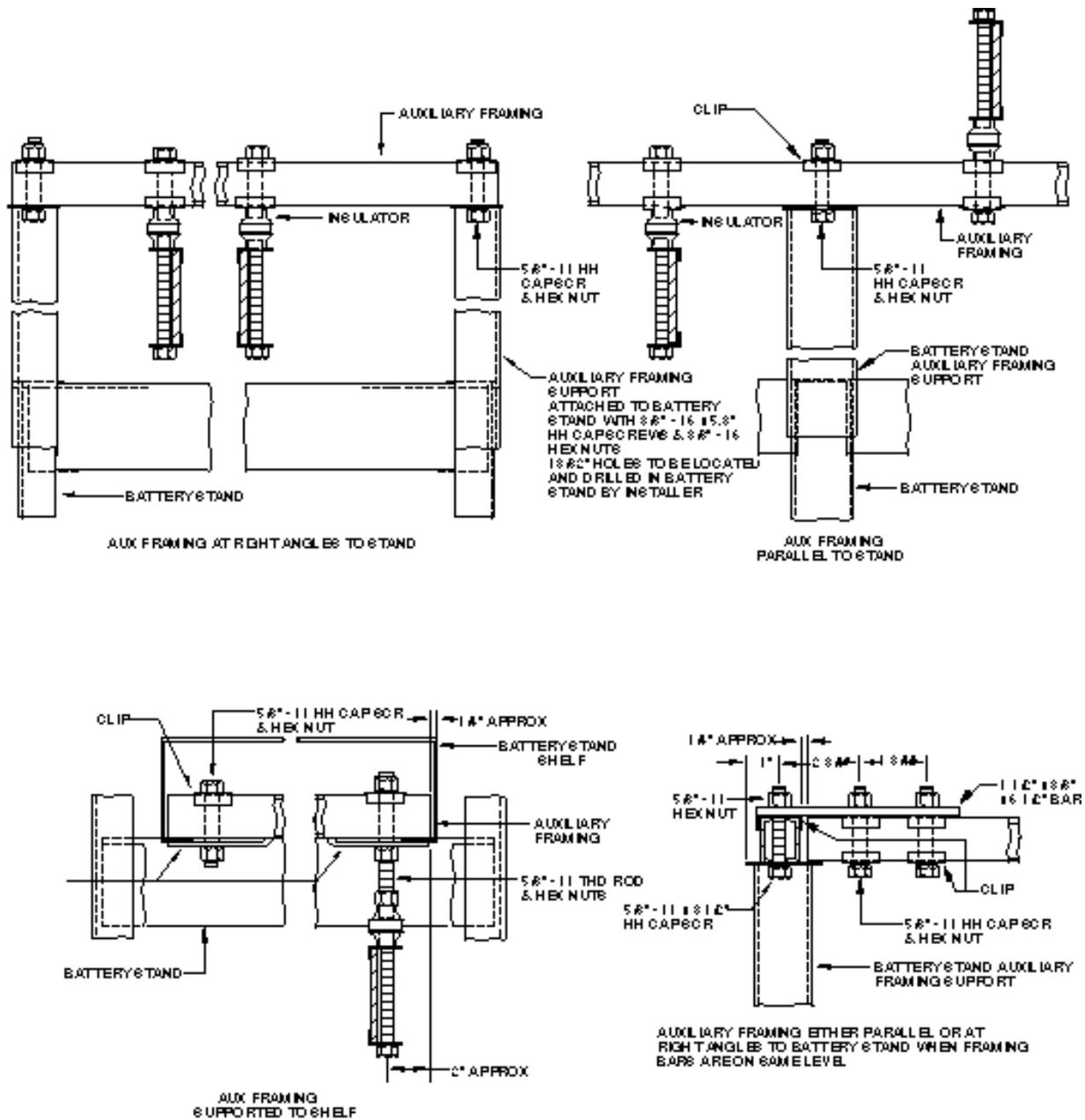


EXHIBIT 2-E2-20  
 AUXILIARY FRAMING SUPPORT OF BUS BARS AT BATTERY STANDS

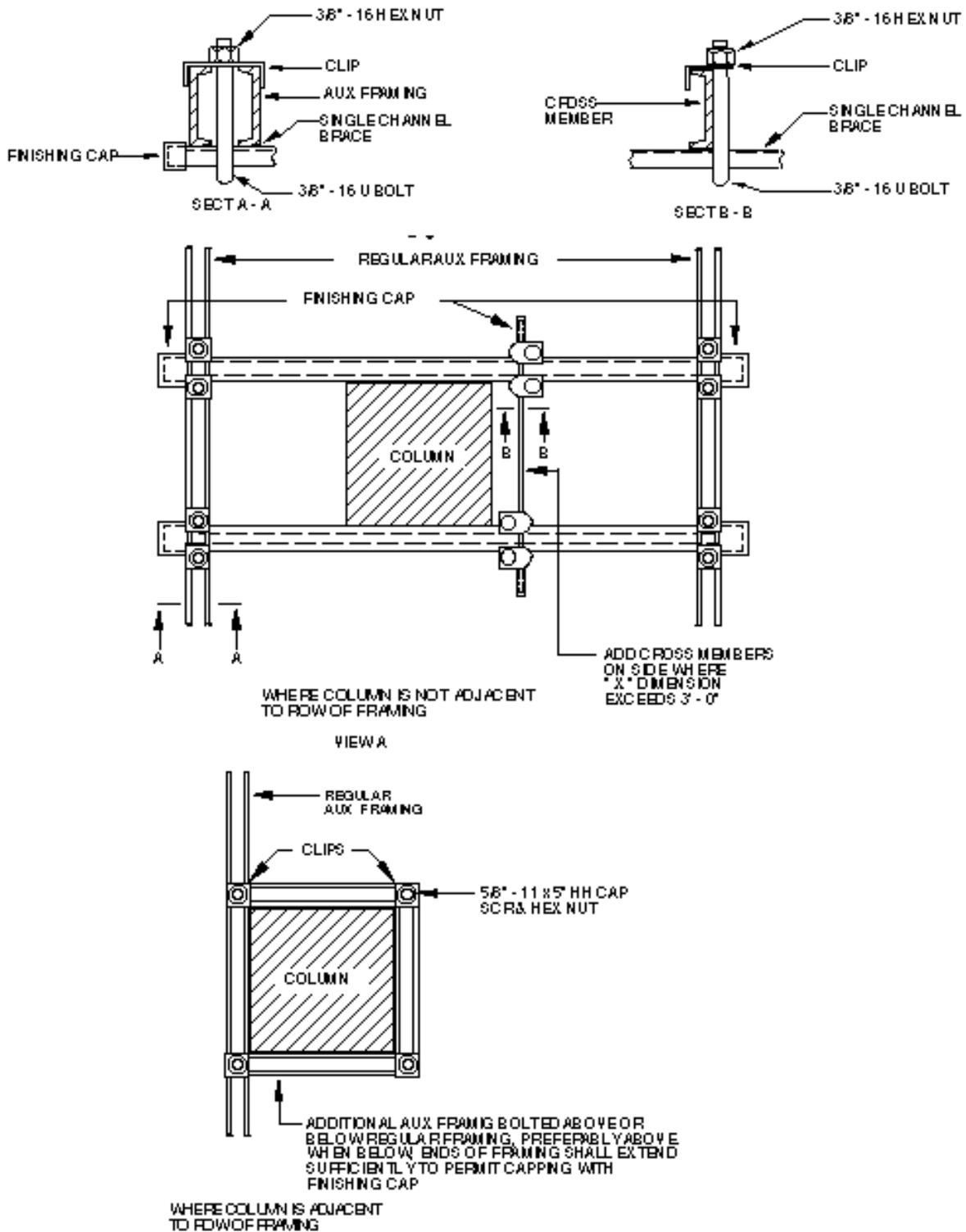


EXHIBIT 2-E2-23 (DISCONTINUED)  
 BRACING AUXILIARY FRAMING TO COLUMNS HISTORICAL ONLY

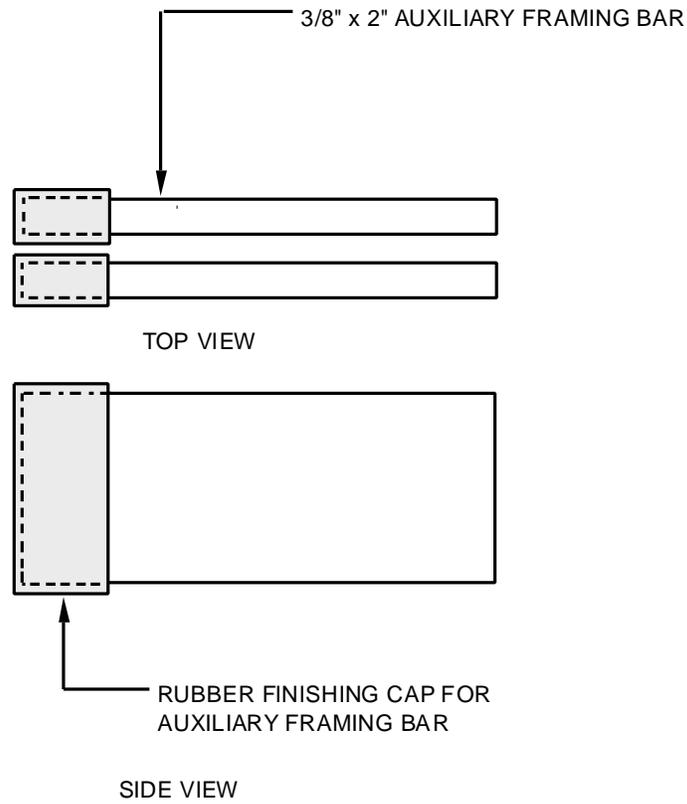


EXHIBIT 2-E2-23C  
FINISHING CAPS ON AUXILIARY FRAMING

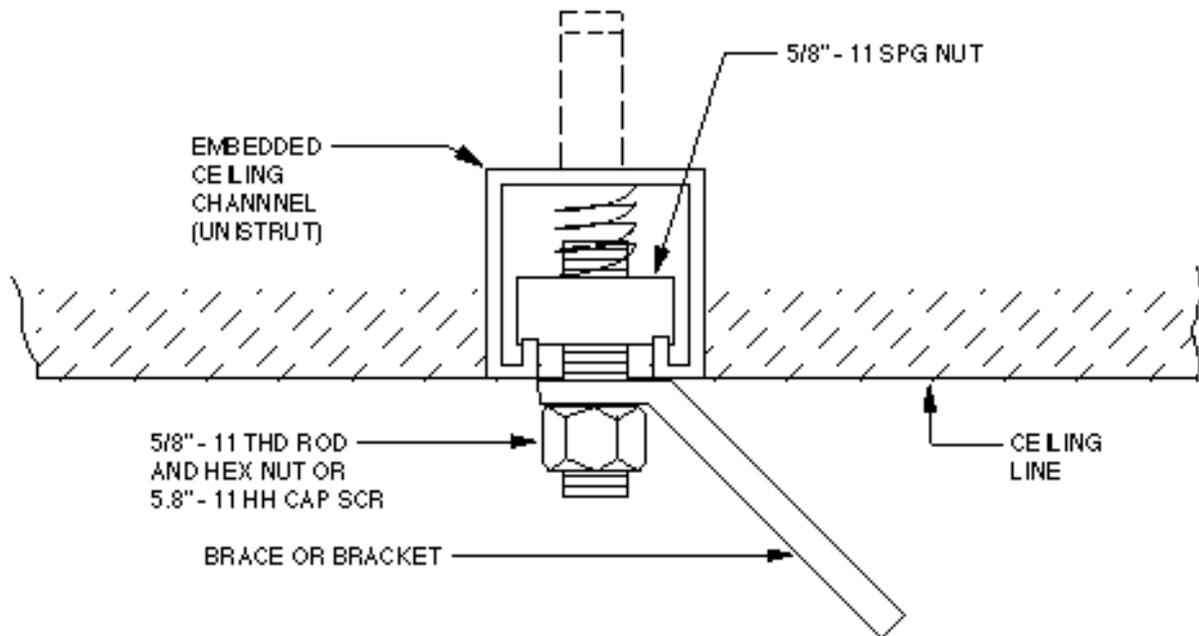


EXHIBIT 2-E2-24  
BRACING OF AUXILIARY FRAMING WITH SINGLE-ROD BRACES

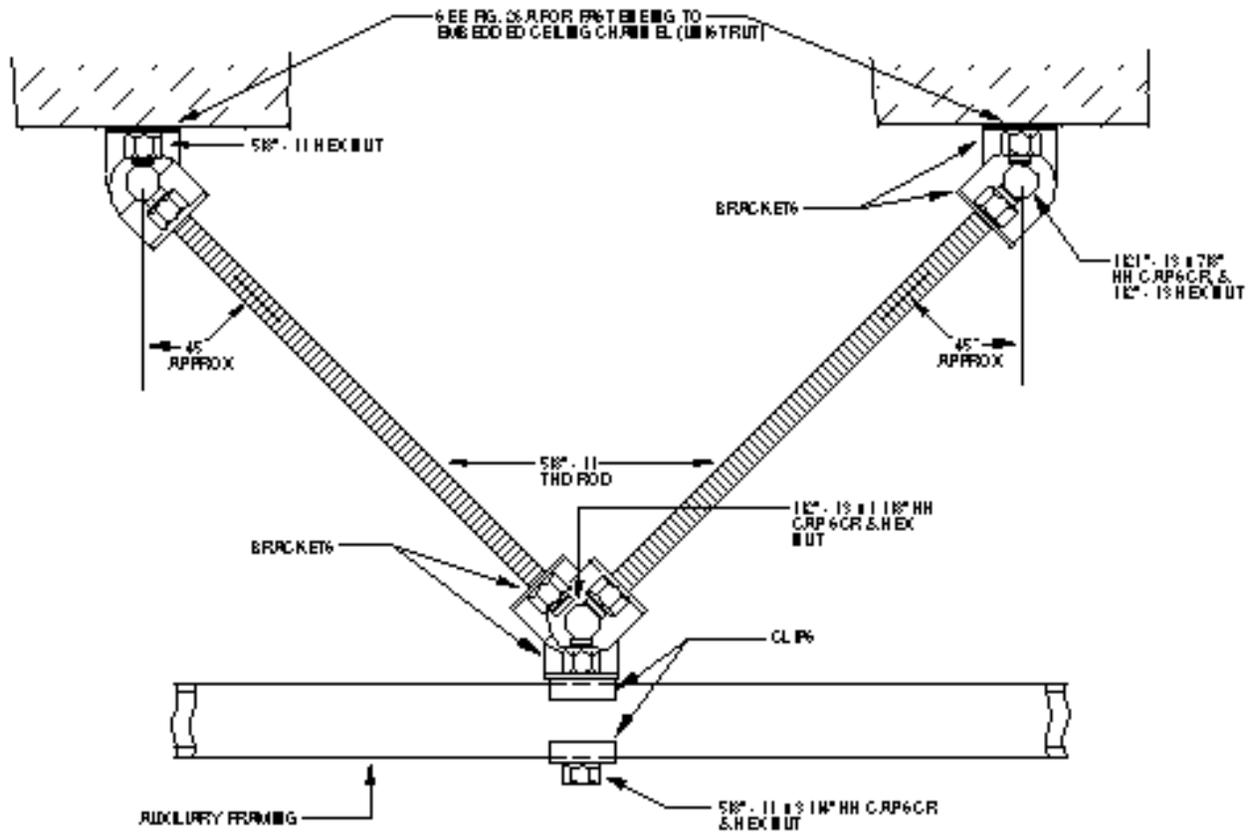


EXHIBIT 2-E2-25  
BRACING OF AUXILIARY FRAMING WITH SINGLE-ROD BRACES

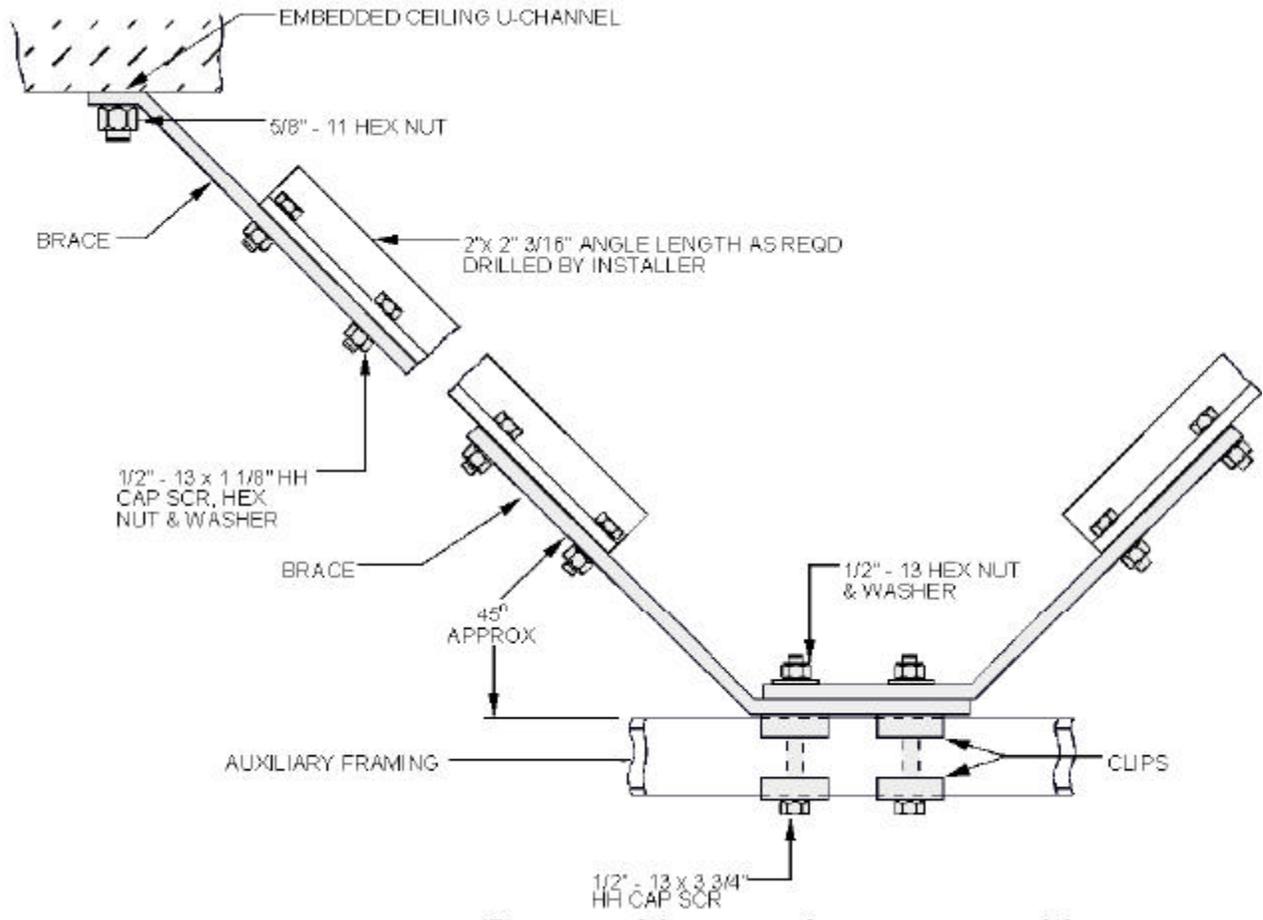


EXHIBIT 2-E2-25A  
BRACING OF AUXILIARY FRAMING WITH DOUBLE - ANGLE BRACES

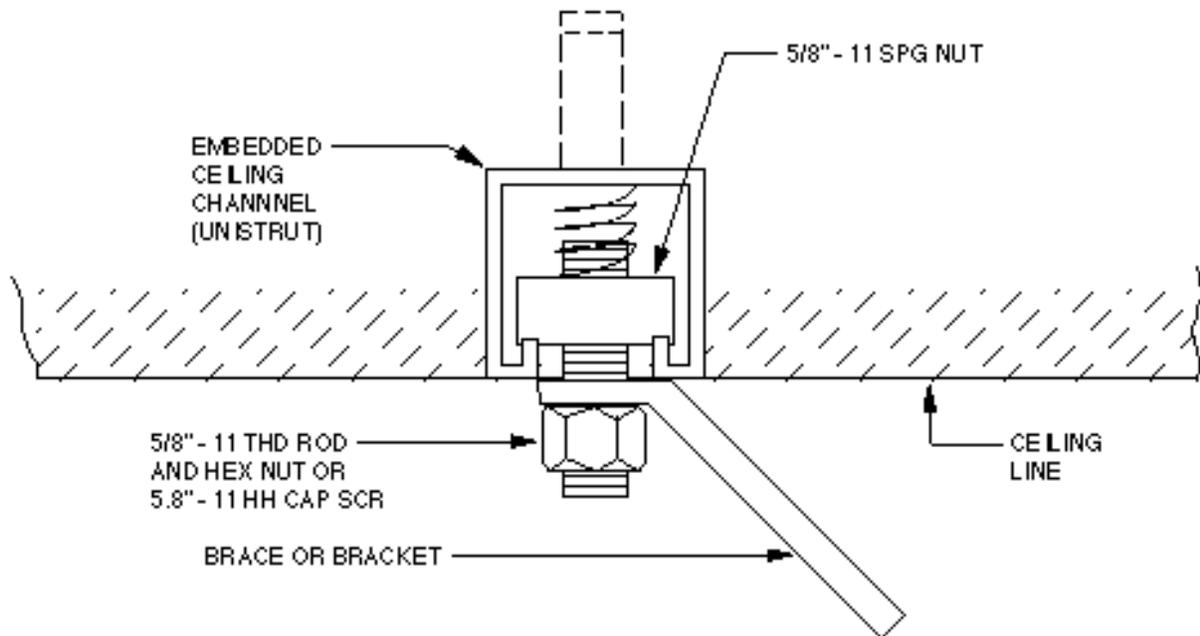


EXHIBIT 2-E2-26A  
FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL

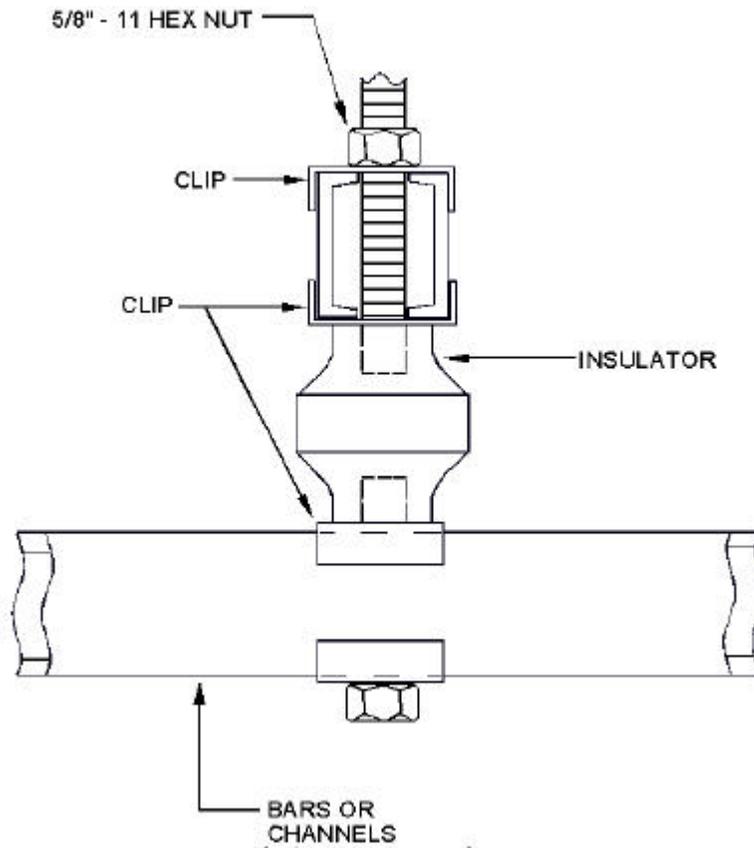


EXHIBIT 2-E2-27  
DOUBLE-LEVEL AUXILIARY FRAMING-ISOLATING TWO LEVELS OF CHANNEL

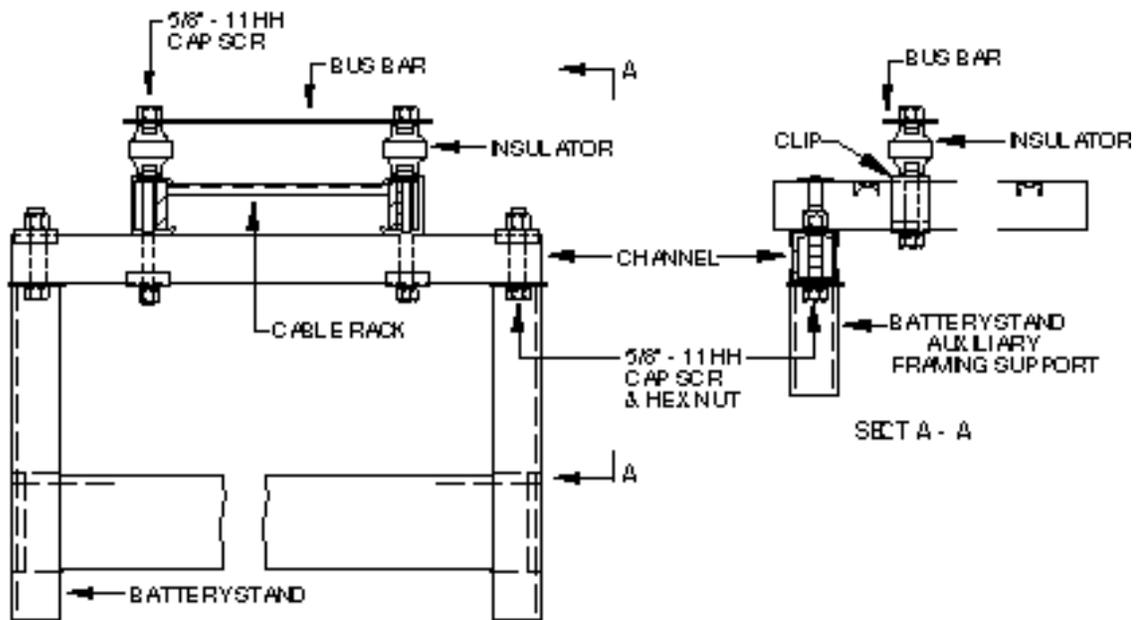


EXHIBIT 2-E2-28  
AUXILIARY FRAMING SUPPORT FOR SHORT BUS BARS ABOVE BATTERY STANDS

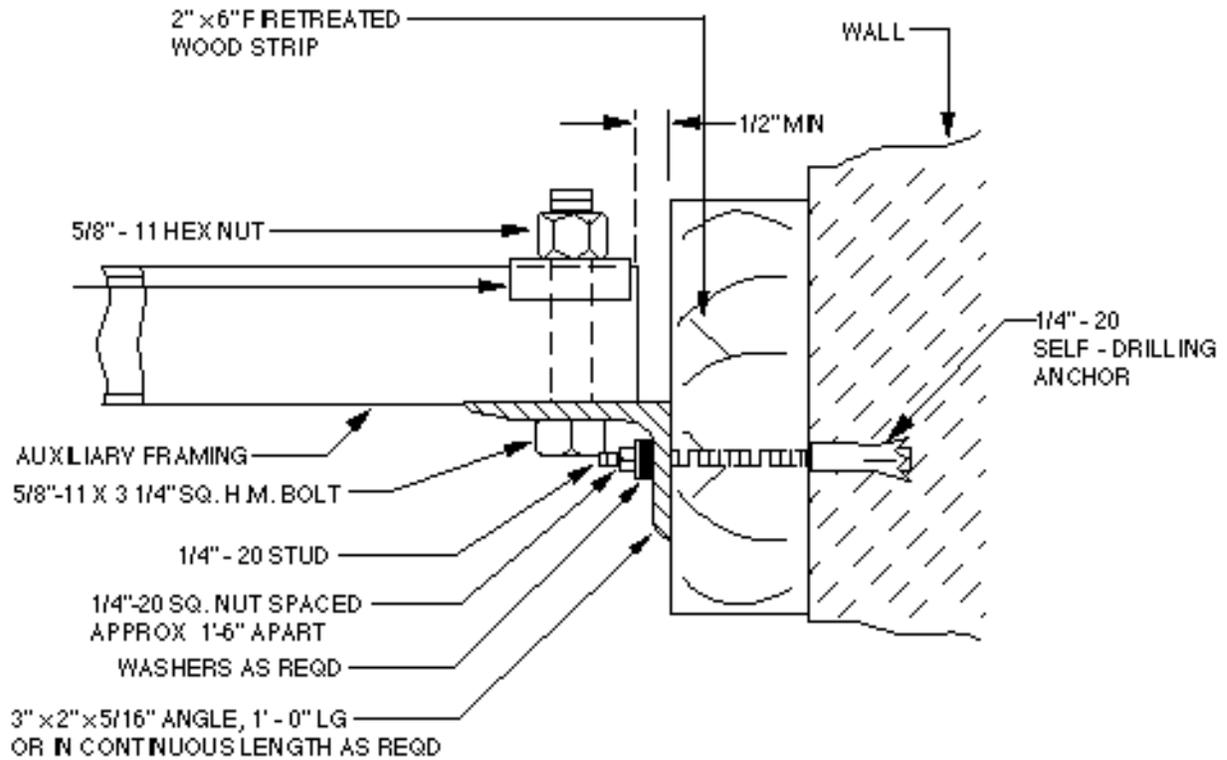


EXHIBIT 2-E2-29  
DOUBLE FRAMING ATTACHED TO WALLS WHERE ANGLE IS DRILLED

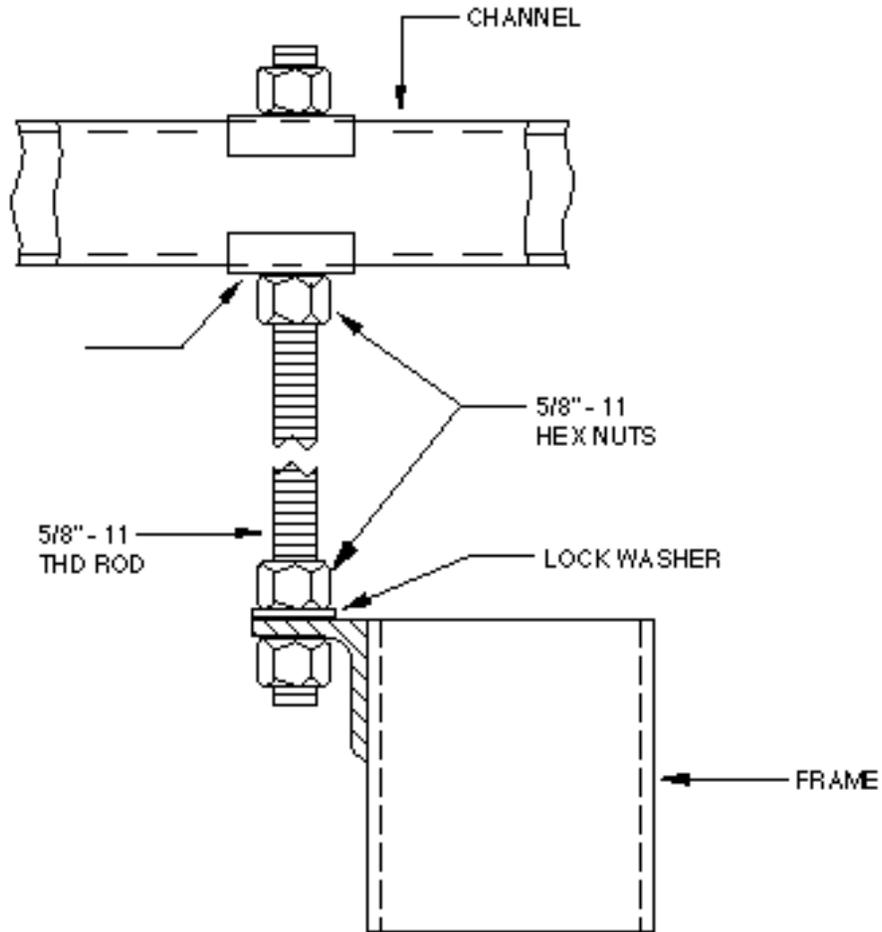


EXHIBIT 2-E2-30  
SUPPORTING FRAME WITH THREADED ROD FROM FRAMING

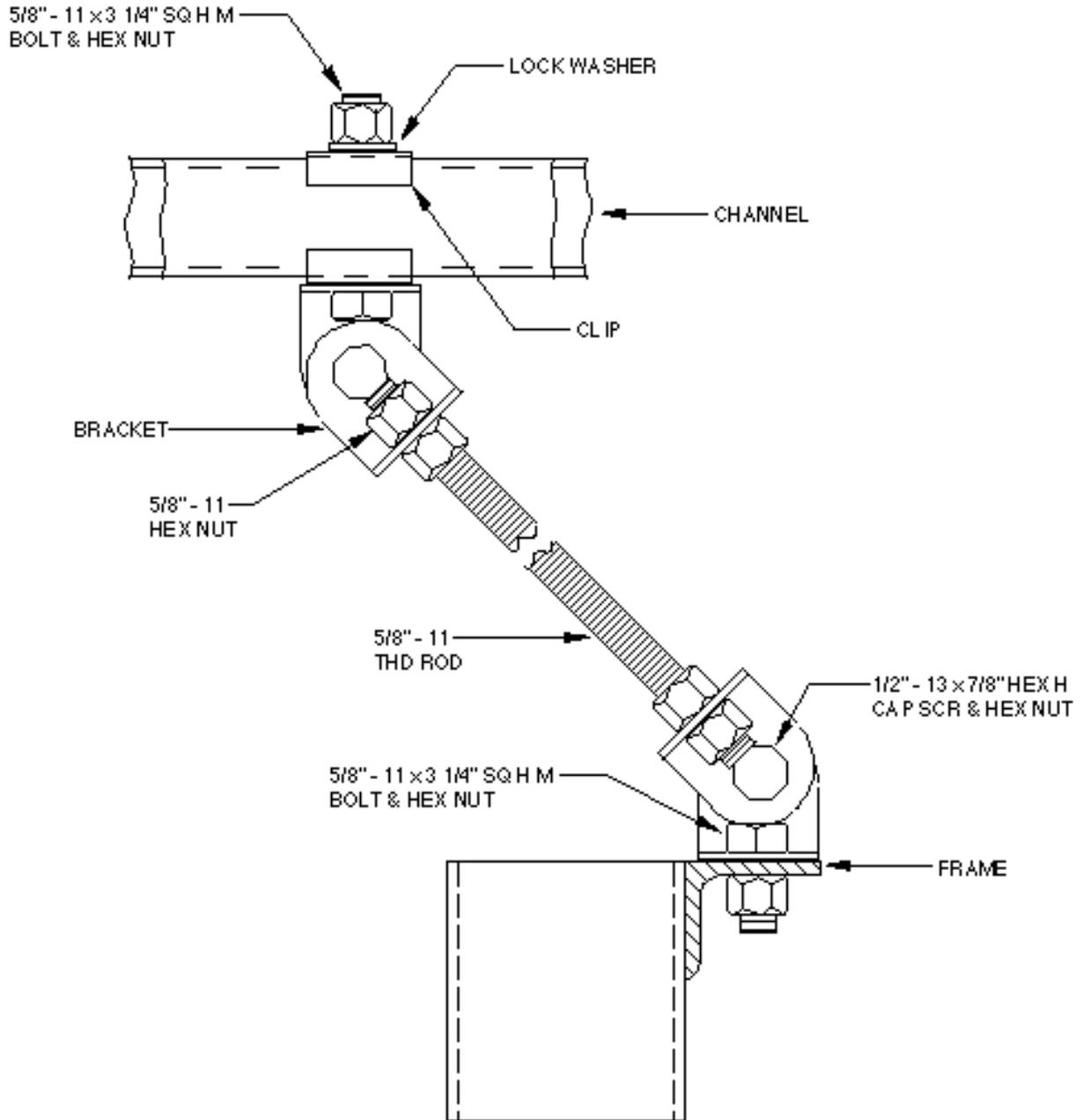
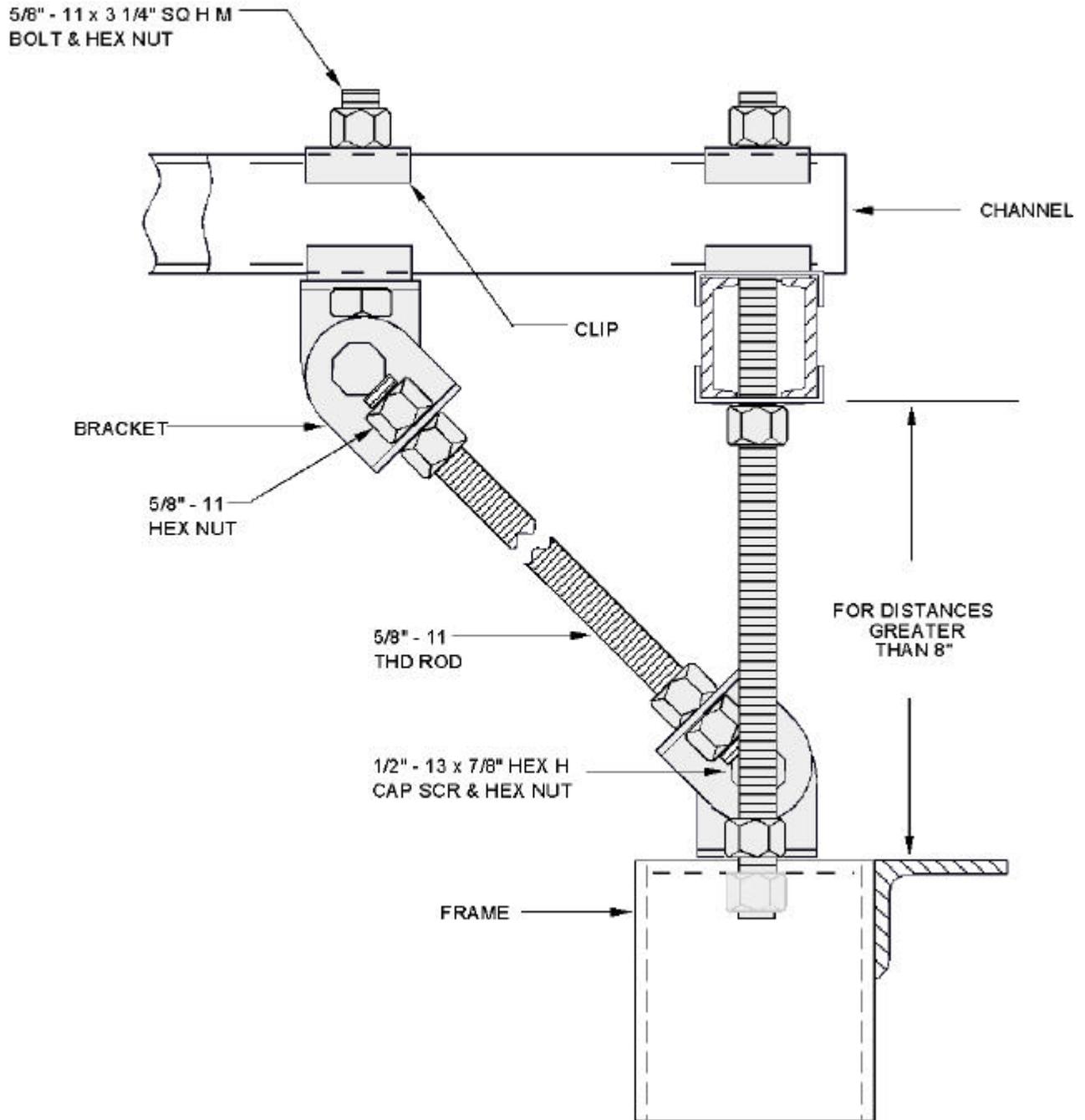


EXHIBIT 2-E2-31  
BRACING FRAMES FROM AUXILIARY FRAMING



2-E2-31A  
Bracing Low Level Environment Frames

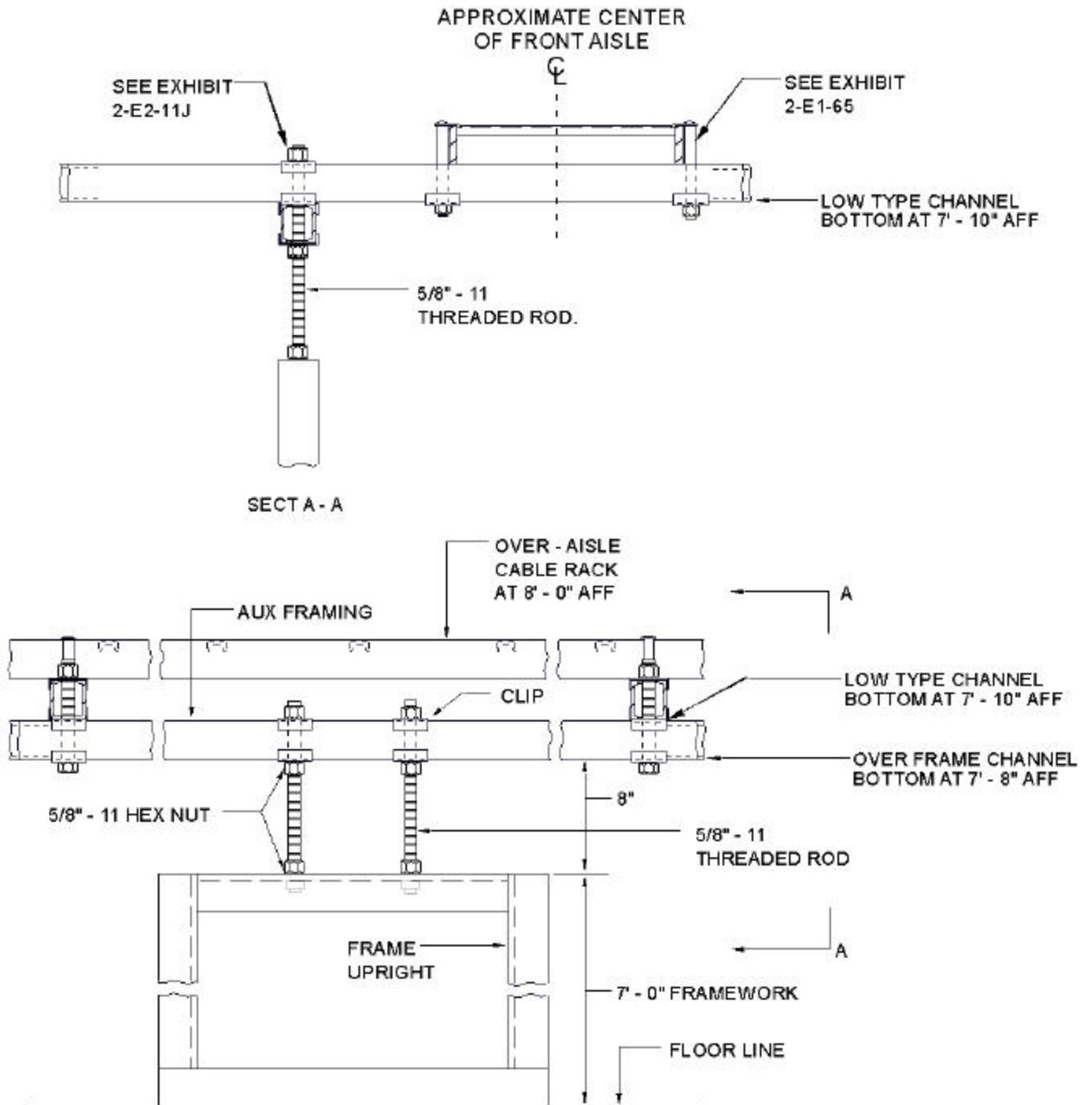


EXHIBIT 2-E2-32  
TYPICAL FRAMEWORK AND IRONWORK ARRANGEMENT FOR A 7'-0" FLOOR SUPPORTED SYSTEM

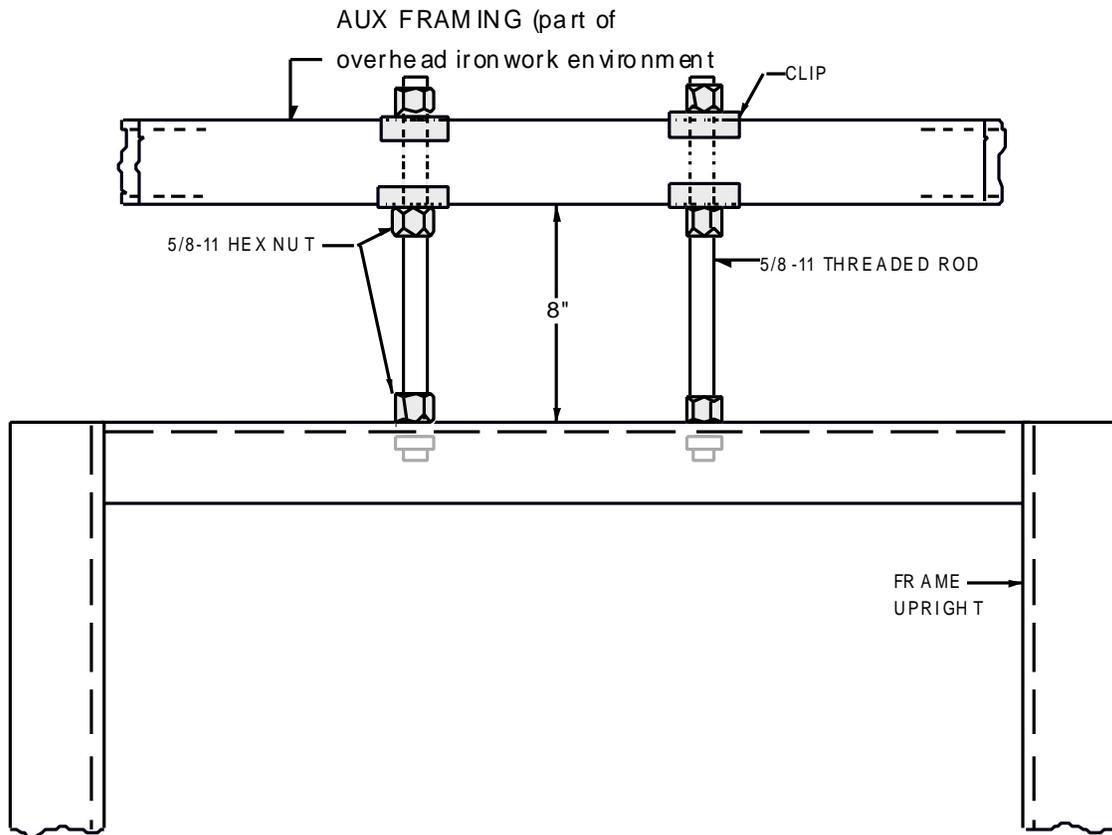


EXHIBIT 2-E2-32A  
TYPICAL ATTACHMENT OF AUXILIARY FRAMING TO UNEQUAL FLANGE CABLE  
DUCT TYPE FRAMEWORK

OFF - SETS FOR A 12" DEEP LINEUP WITH 5" FRONT AND 2" REAR GUARD RAILS:	
GUARD RAILS	"A" DIMENSION=
1" FRONT/ 6" REAR	4 INCHES
2" FRONT/ 5" REAR	3 INCHES

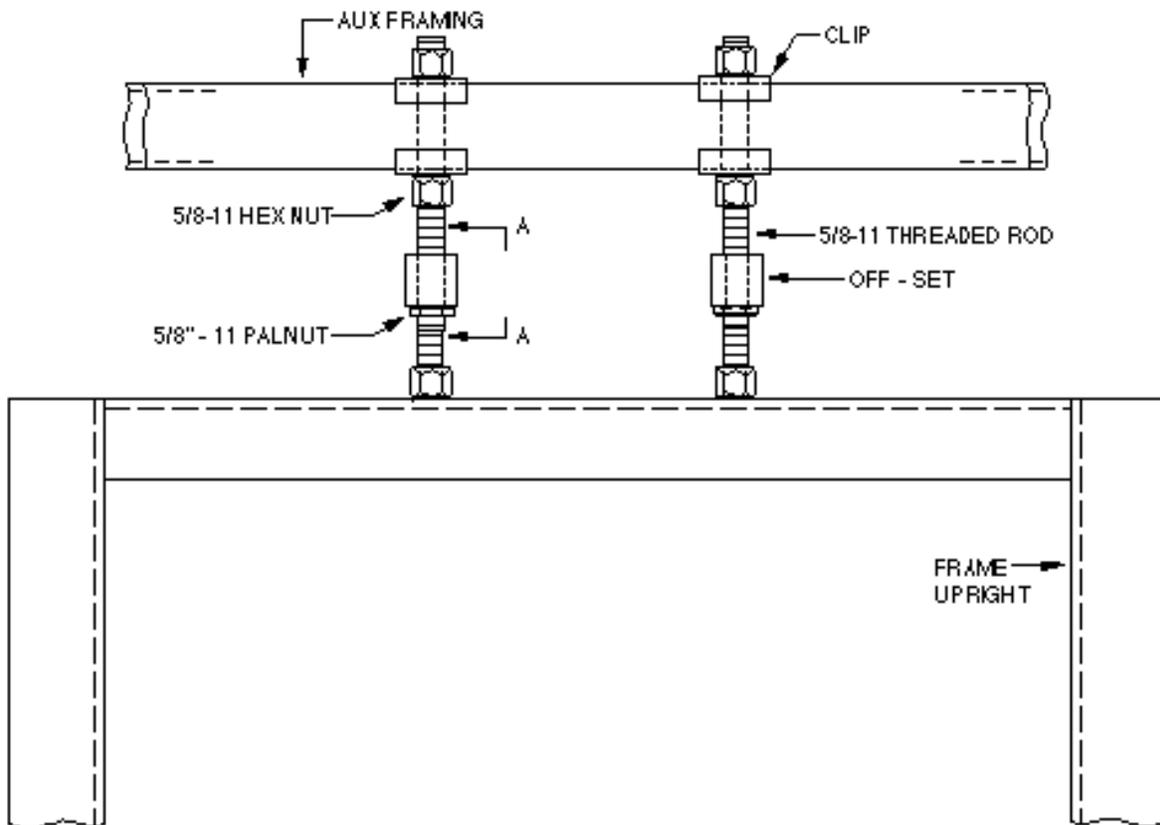
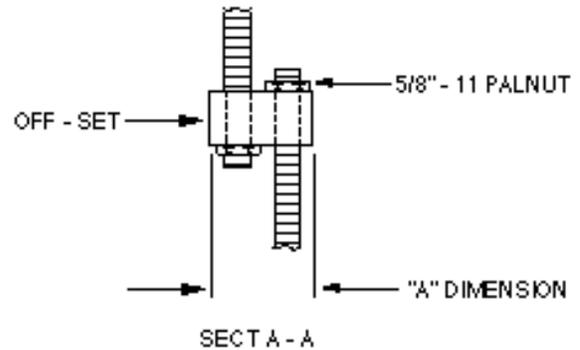


EXHIBIT 2-E2-32B  
 TYPICAL METHOD OF INSTALLING HANGER ROD OFF-SET TO MAINTAIN GUARD  
 RAIL ALIGNMENT

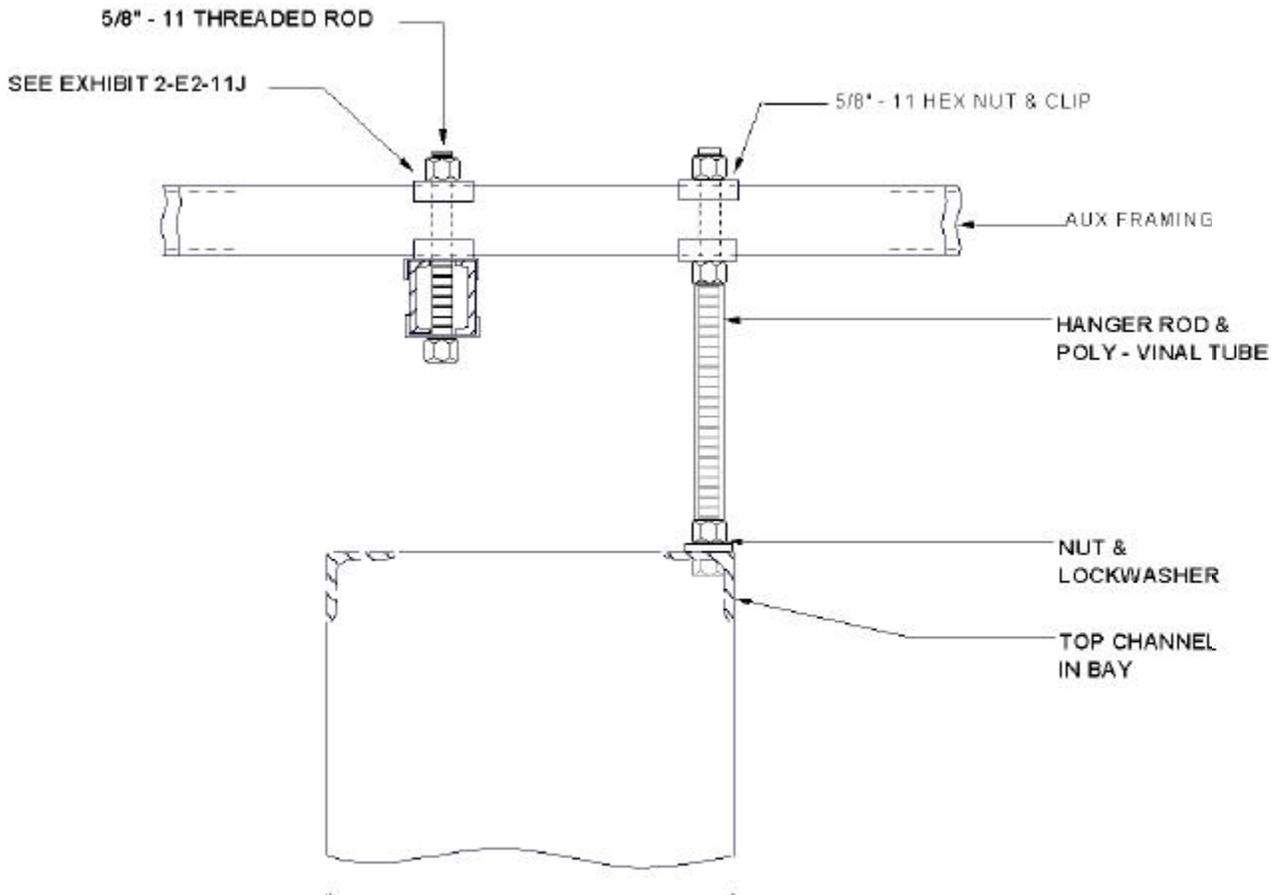


EXHIBIT 2-E2-32C  
TYPICAL METHOD OF SUPPORTING AUXILIARY FRAMING OVER A 7'-0" BDFB

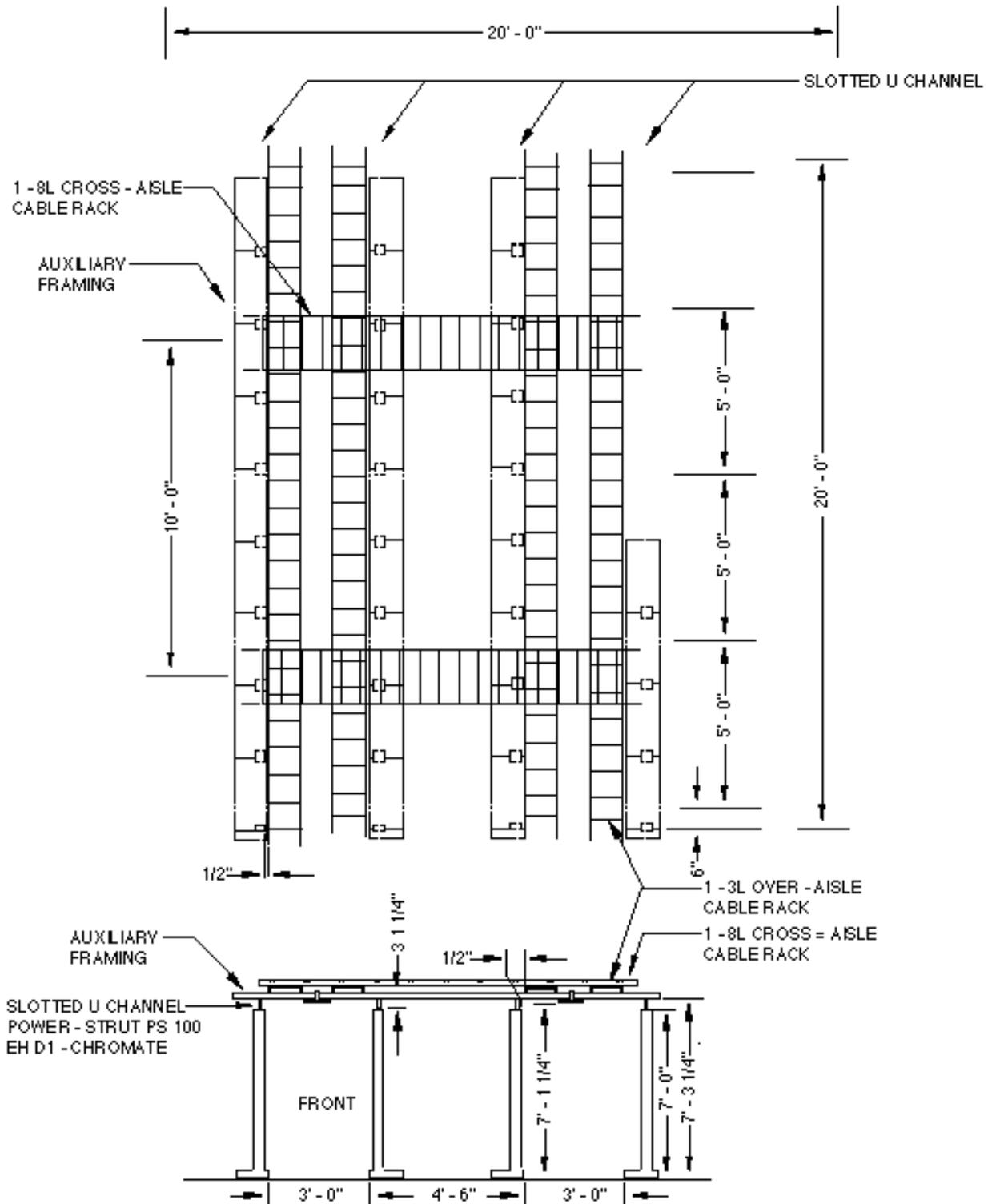


EXHIBIT 2-E2-33 (A&M)  
LOW-LEVEL CABLE RACKING (TYPICAL IRONWORK LAYOUT)

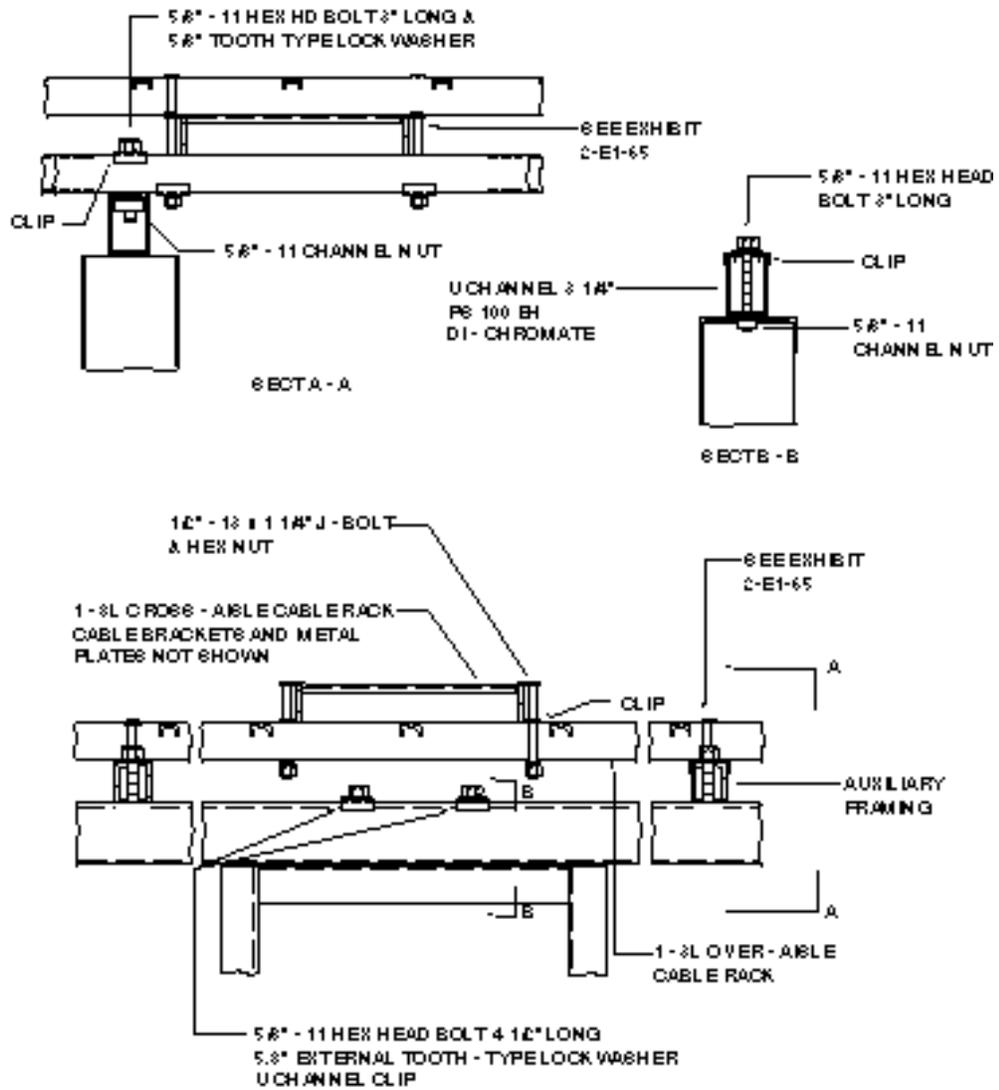


EXHIBIT 2-E2-33A (A&M)  
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## **6. Cable Rack and Auxiliary Framing-**

### **6.C Auxiliary Framing - High Type**

#### **6C.1 General**

This heading contains the general engineering requirements for ceiling suspended auxiliary framing. Refer to the chapter on low type framing for auxiliary framing over line-ups of transmission and power equipment.

- Refer to the "Auxiliary Framing - Low Type" section for auxiliary framing "Description" and "General Engineering Requirements".
- Refer to the "Earthquake and Disaster Bracing" section for auxiliary framing requirements for earthquake heavy zones.
- Refer to these requirements where multiple levels of framing are used between the ceiling and the top of framework.

Safe load limitations for embedded ceiling inserts, expansion anchors, hanger rods, and auxiliary framing are covered in the unit on Cable Rack Requirements.

Auxiliary framing shall be provided for support of equipment, cable racks, frame lighting and other apparatus in the Central Office (CO).

- Framing parts shall be directly butted. All measurements shown in Exhibits indicate maximum allowable gap tolerances.

Self-drilling anchors shall not be used to secure frames or secure ironwork to ceilings, walls or floors.

- Substitute appropriate lag bolts for attaching frames or ironwork to wooden ceilings, walls, or floors.
- Substitute torque-indicating anchors where embedded inserts or expansion anchors are shown.

Auxiliary framing arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

<p>Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.</p>
---

## **6C.2 Ceiling Heights**

The location and arrangement of high type auxiliary framing is dependent on ceiling height.

- Ceiling heights are measured in terms of minimum clearance under all obstructions such as ceiling beams.

## **6C.3 Fastening Arrangements at Ceilings**

Equipment areas are usually provided with embedded ceiling inserts, embedded ceiling channel, or other devices arranged for fastening auxiliary framing to the ceiling, as follows:

Continuous channel inserts are embedded in the concrete ceiling in parallel rows and extend over all the equipment area. Rows of channel inserts are spaced 5 feet to 6 feet apart.

- Embedded ceiling inserts, beam clamps, or embedded ceiling channel are typically located over the floor space assigned for telephone equipment as shown in Exhibit 2-E3-5.
- A commonly used beam clamp is shown in Exhibit 2-E3-1. The usual size clamp may be attached to beam flanges up to 15 inches in width. The sockets of the spindles of these clamps are tapped for 5/8"-11 thread.
- An example of the embedded ceiling inserts furnished is shown in Exhibit 2-E3-2.
- Fasten threaded hanger rods or ceiling braces as shown in Exhibit 2-E3-6B or 6C.

QWEST approved anchors may be used for hanger rods, braces, and similar occasional ceiling attachments in areas not supplied with embedded ceiling inserts or u-channel.

- The 5/8"-11 expansion anchor, as shown in Exhibit 2-E3-3, shall be used for such attachments.
- The addition of expansion anchors for attachments to ceilings is requested through Building Real Estate.

Hanger bolts, as shown in Exhibit 2-E3-4, are occasionally used to support heavy loads where other building attachments have not been provided.

## **6C.4 Hanger Rods**

Hanger rods used for the support of auxiliary framing and cable rack shall be 5/8"-11 and threaded the entire length of the rod.

- Support from embedded ceiling inserts, beam clamps, or expansion anchors as shown in Exhibits 2-E3-3 and 2-E3-6.

- A 5/8"-11 hex nut and 1-3/4 inch washer, as shown in Exhibits 2-E3-3, 4, and 6, shall be used at the ceiling on all hanger rods and bolts, regardless of the type of finish on the ceiling or the kind or support,
- Where false or suspended ceilings are encountered, an additional 1-3/4 inch washer and two 5/8"-11 nuts shall be used on each rod. The washer shall be placed below the ceiling with one nut to hold it in place against the ceiling and the other to serve as a locknut as shown in Exhibit 2-E3-6A.
- When used with beam clamps, threaded rods shall be screwed into beam clamps until firmly seated, then backed away approximately one full turn to prevent binding, after which the locknut at the ceiling shall be tightened.
- Hanger rods or threaded rods used for braces shall not be spliced. In no case, shall the hanger rods used for the support of mezzanine platforms be spliced.

### **6C.5 Engineering Requirements**

Space required for access, adding, or removing equipment, vent ducts, ironwork, conduit, etc shall be taken into consideration when determining locations of auxiliary framing and supports.

Double-level auxiliary framing, consisting of primary and secondary channel, shall be used in areas where high framing is specified.

- Primary and secondary bars or channels shall be spaced approximately 5 feet apart. In no case shall the spacing exceed 6 feet apart.
- Upper level bars or channels shall be installed directly under the ceiling attachments as shown in Exhibit 2-E3-11.
- Secondary framing shall be installed beneath and at right angles to the primary framing to add stiffening per Exhibit 2-E3-11A. Where ladder type cable rack will be used as stiffening, secondary framing may be omitted.

Auxiliary framing shall be installed in accordance with Exhibits 2-E3-28 and 2-E3-29 where additional auxiliary framing is required for the support of cable racks and conduit.

Single-level auxiliary framing utilizing Exhibits 2-E3-9 and 2-E3-10 may be used in ceiling supported environments where additional space over head is required.

Where bars or channels terminate at hanger rods, they shall be supported as shown in Exhibit 2-E3-14.

Auxiliary framing shall be provided under beams or girders, where required, per Exhibits 2-E3-22 and 2-E3-23.

Auxiliary framing shall be located as high as practicable above Distributing Frames (DF) to provide cabling clearance and headroom.

**JUNCTIONING AUXILIARY FRAMING:** Where junctioning auxiliary framing is necessary, junctions shall be made as follows:

- Channels shall be junctioned together as shown in Exhibit 2-E2-9J.
- The 2 by 3/8 inches bars or 2 by 1/2 inches bars shall be junctioned to channels as shown in Exhibit 2-E2-9K.
- (A&M) The 2 inches by 3/8-inch bars shall be junctioned to 2 inches by 1/2-inch bars when extending old high-type framing installations as shown in Exhibits 2-E3-19 and 2-E3-20. Clamp junctions as shown in Exhibit 2-E3-21 shall be used where 2 by 3/8 inches bars are junctioned together either in pairs or singularly.

### 6C.6 Bracing

The entire ceiling supported auxiliary framing structure shall be braced similar to Exhibit 2-E2-2E with ceiling braces of the threaded rod or angle type.

- The braces shall be located at approximate building column intervals or about 20 feet in both directions in a building not having columns.
- A brace shall be provided within 10 feet of the end of an auxiliary framing course. An auxiliary framing course is a succession of channels junctioned end-to-end.
- Both primary and secondary framing shall be braced.

Framing bars or channels shall be braced per the distances in the following table and where necessary to provide rigidity for framing that supports cable rack.

DISTANCE TO CEILING OR BETWEEN AUXILIARY FRAMING LEVELS	TYPE OF BRACE	EXHIBIT
1 foot 0 inches or more	Single-rod brace	2-E3-15, 16, 16A, 18
Over 2 foot 6 inches	Double-rod brace	2-E3-17, 18

- The maximum distance between levels of framing or the ceiling and the first level of framing shall not exceed 5 feet 0 inches.
- Where lower level framing bars or channels are used only for the support of cable racks, bracing shall be furnished only as required for rigidity of the cable racks.

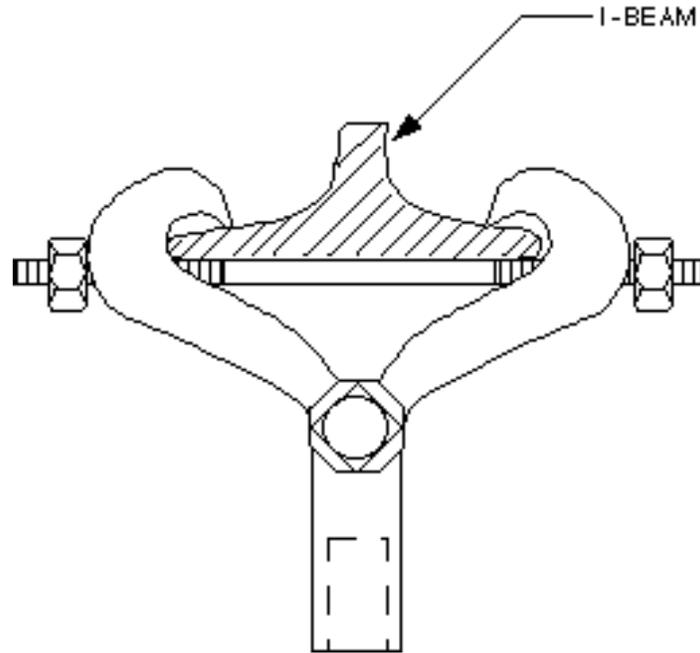


EXHIBIT 2-E3-1  
BEAM CLAMP

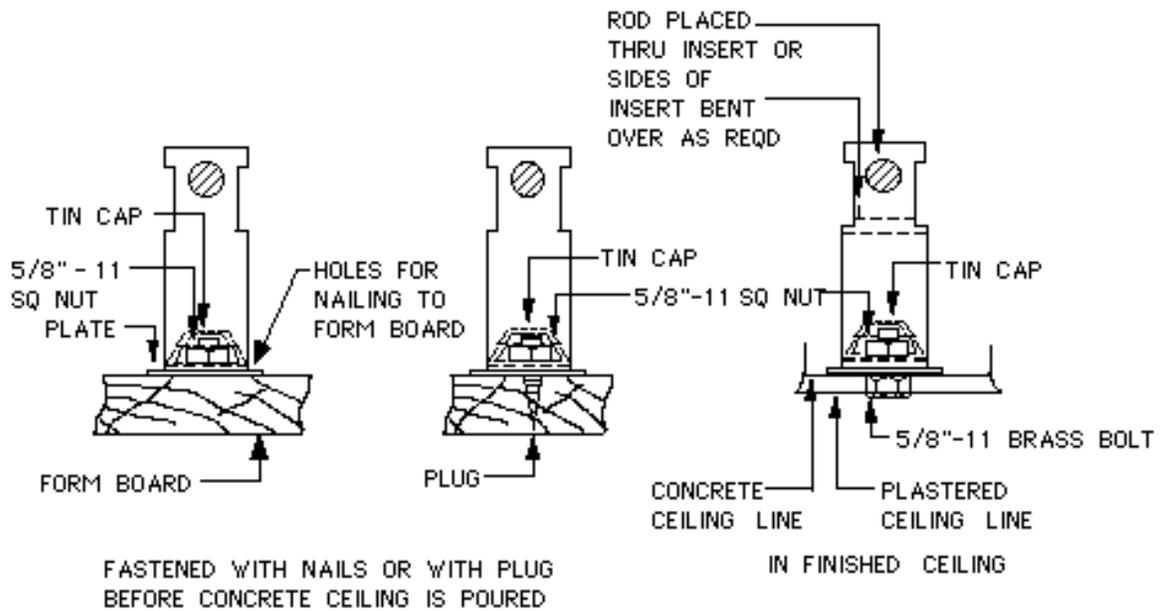


EXHIBIT 2-E3-2  
CEILING INSERT AS INSTALLED

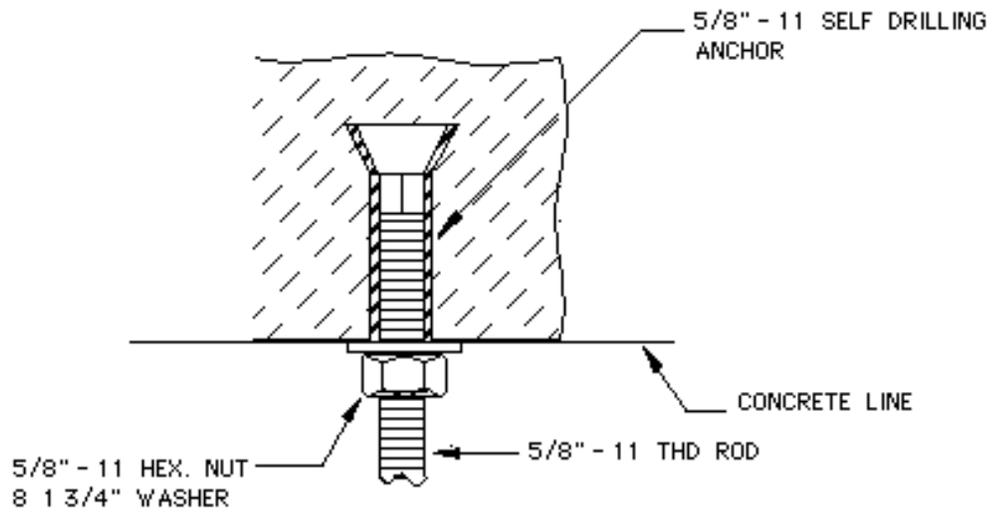


EXHIBIT 2-E3-3  
EXPANSION ANCHOR FOR HANGER ROD

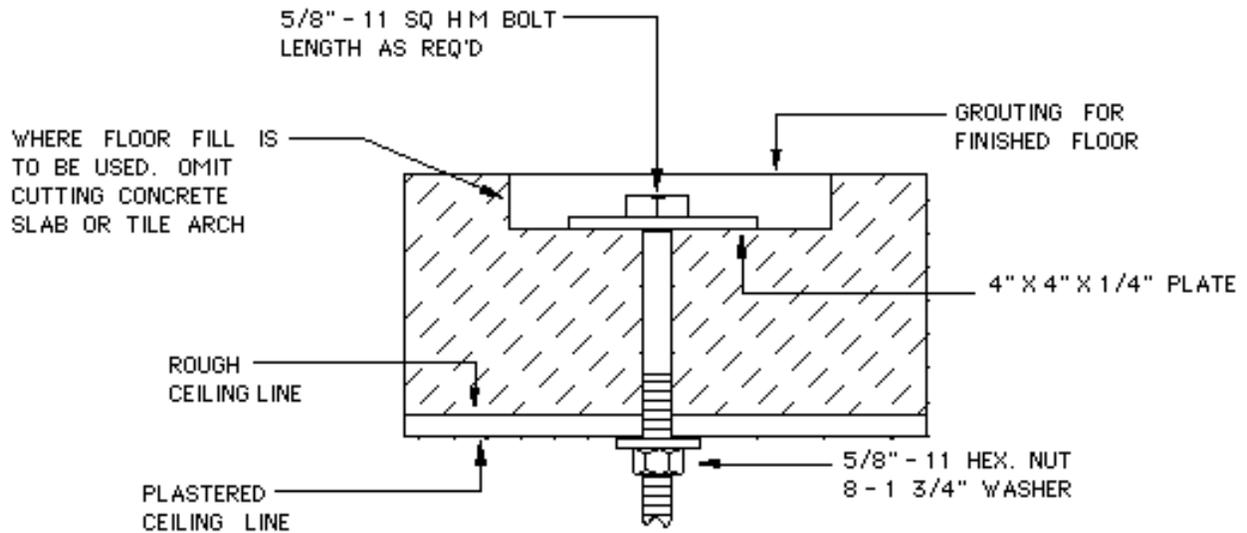


EXHIBIT 2-E3-4

HANGER BOLTS USED WHERE BEAM CLAMPS OR EMBEDDED CEILING INSERTS ARE  
NOT PROVIDED

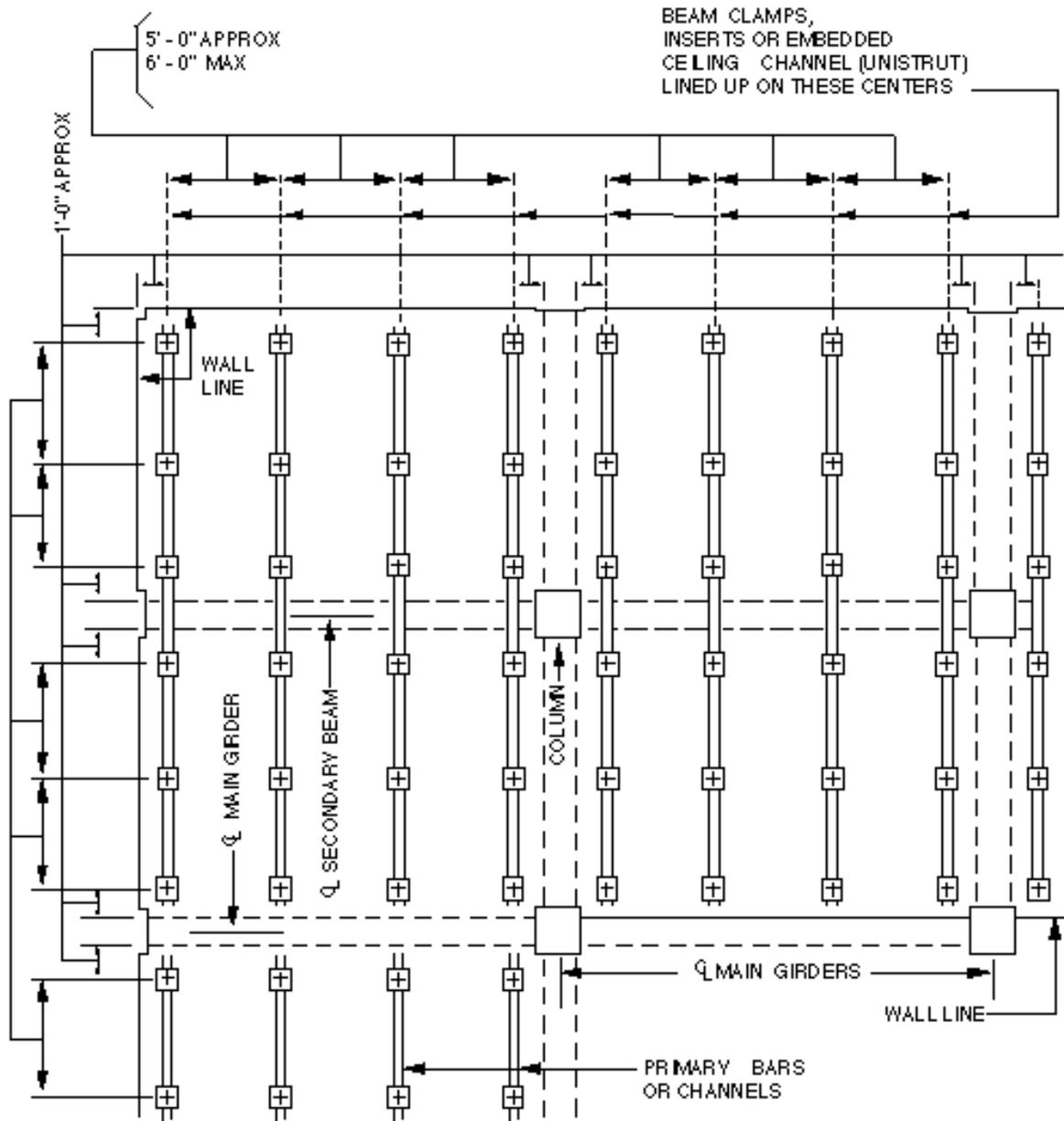


EXHIBIT 2-E3-5

TYPICAL LAYOUT OF BEAM CLAMPS OR INSERTS AND PRIMARY BARS OR CHANNELS

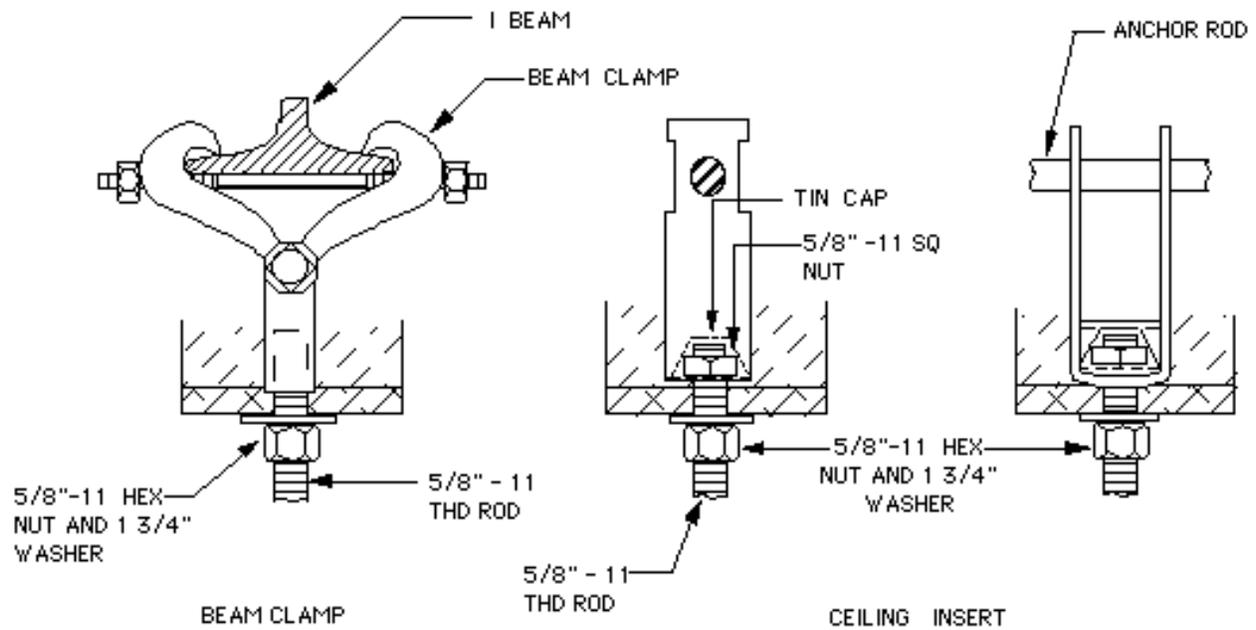


EXHIBIT 2-E3-6  
HANGER ROD ATTACHED TO BEAM CLAMP OR CEILING INSERT

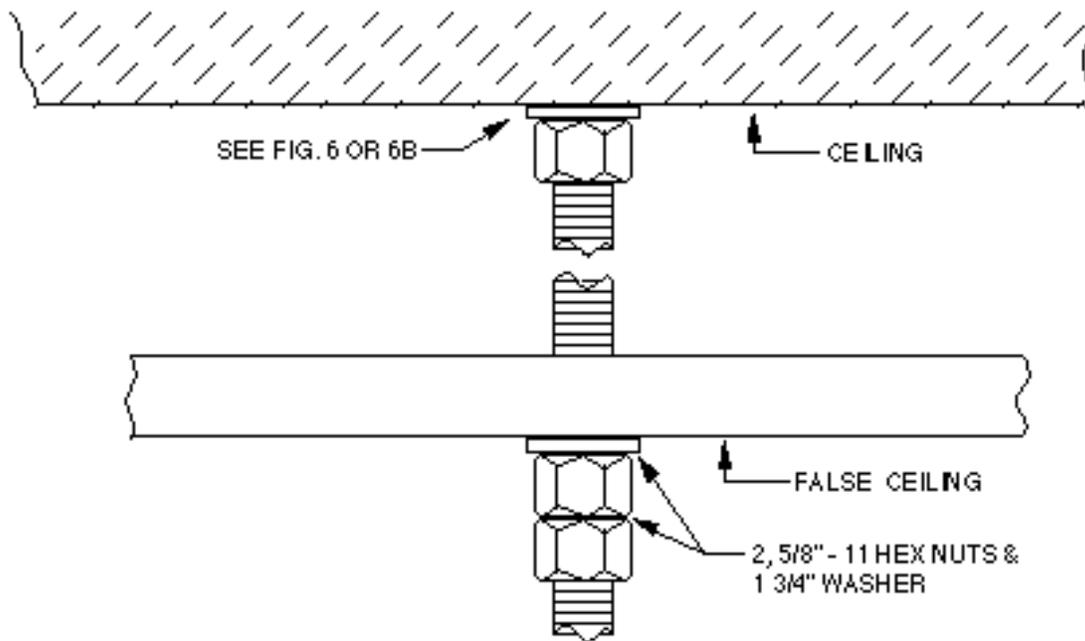
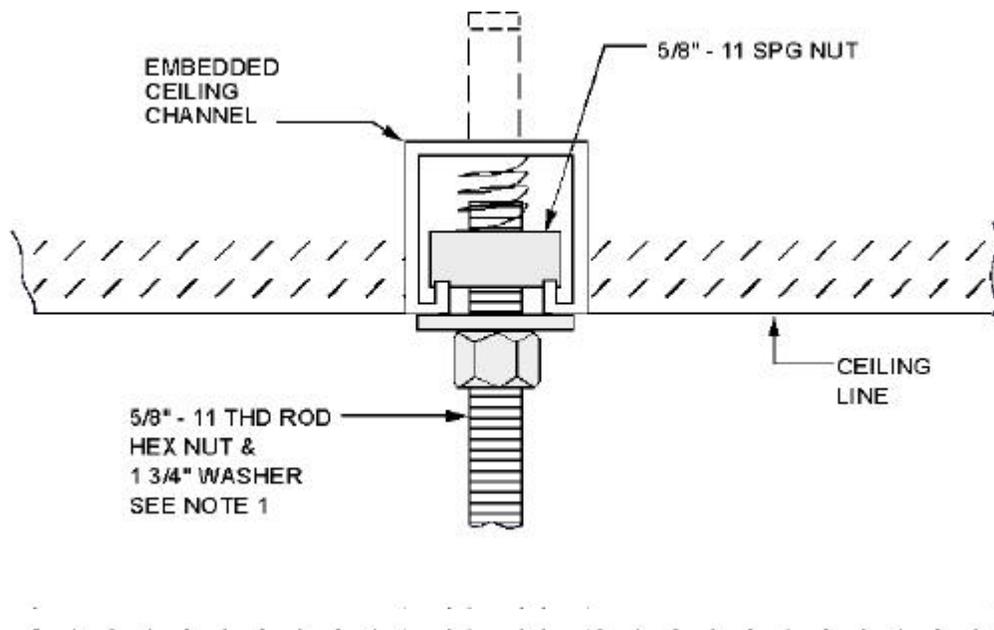


EXHIBIT 2-E3-6A  
HANGER ROD PASSING THROUGH FALSE CEILING



NOTE:  
THE THREADED ROD SHALL BE TURNED INTO THE UNISTRUT NUT SO THAT AT LEAST THREE  
THREADS PROTRUDE BEYOND THE END OF THE NUT.

EXHIBIT 2-E3-6B  
FASTENING CEILING HANGER ROD TO EMBEDDED CEILING CHANNEL

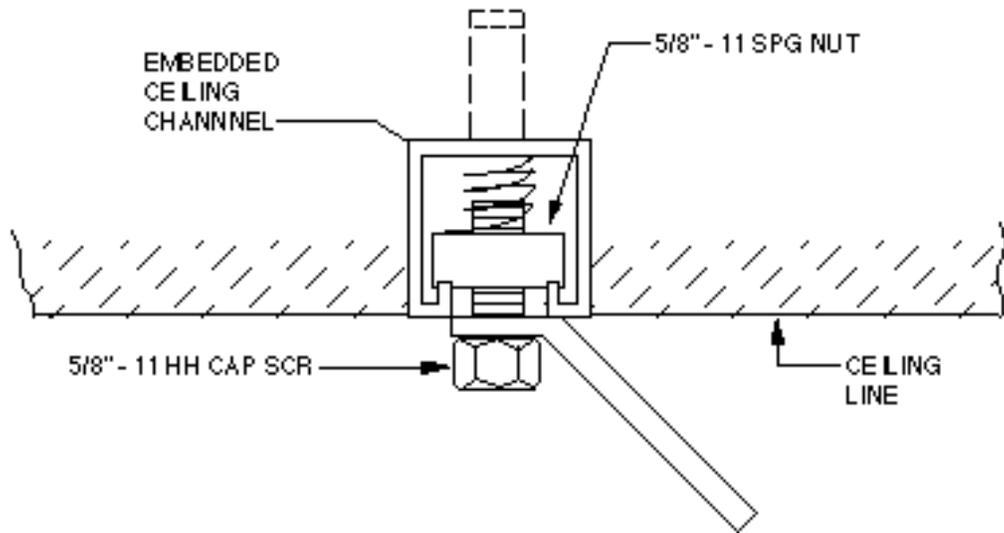


EXHIBIT 2-E3-6C

FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL

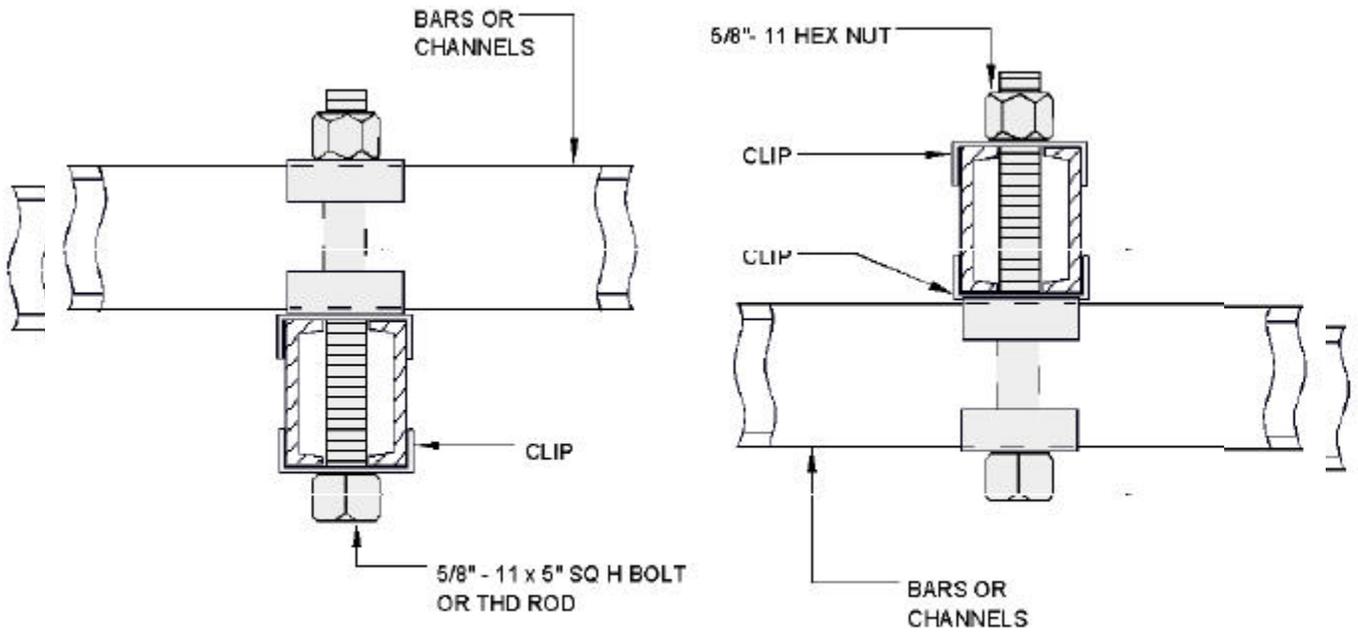
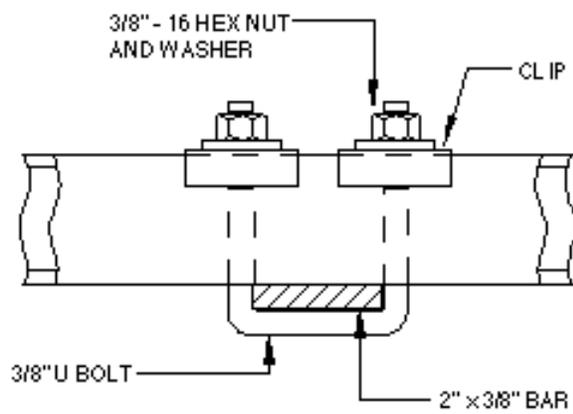
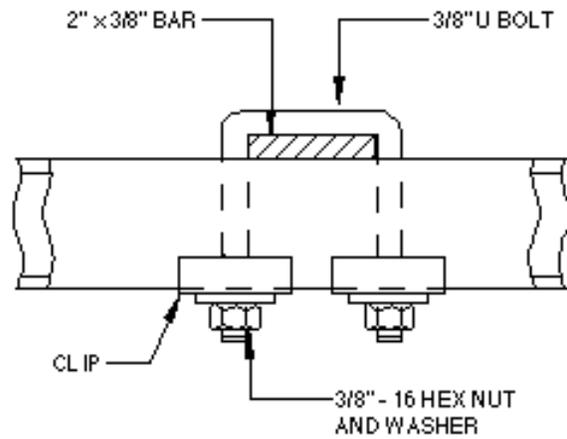


EXHIBIT 2-E3-7

DOUBLE-LEVEL AUXILIARY FRAMING-DOUBLE BARS OR CHANNELS ATTACHED TO  
DOUBLE BARS OR CHANNELS



SINGLE BAR BELOW  
DOUBLE BARS OR CHANNELS



SINGLE BAR ABOVE  
DOUBLE BARS OR CHANNELS

EXHIBIT 2-E3-8

DOUBLE-LEVEL AUXILIARY FRAMING-SINGLE BARS ATTACHED TO DOUBLE BARS OR CHANNELS

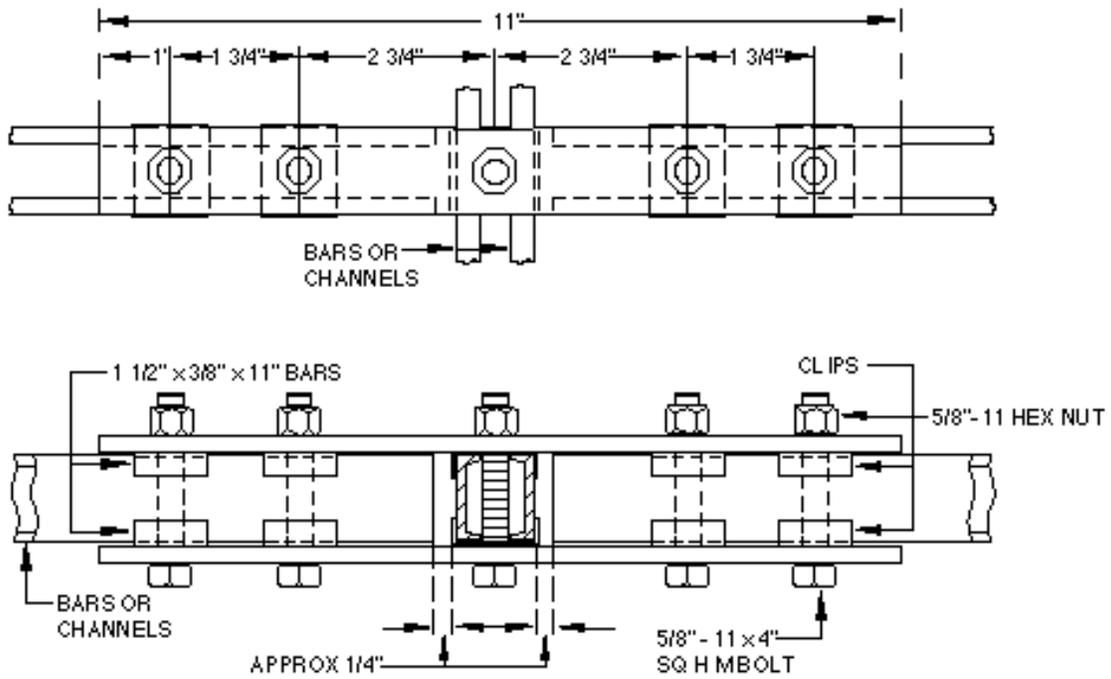


EXHIBIT 2-E3-9  
SINGLE-LEVEL AUXILIARY FRAMING INTERSECTION OF PRIMARY AND SECONDARY  
BARS OR CHANNELS

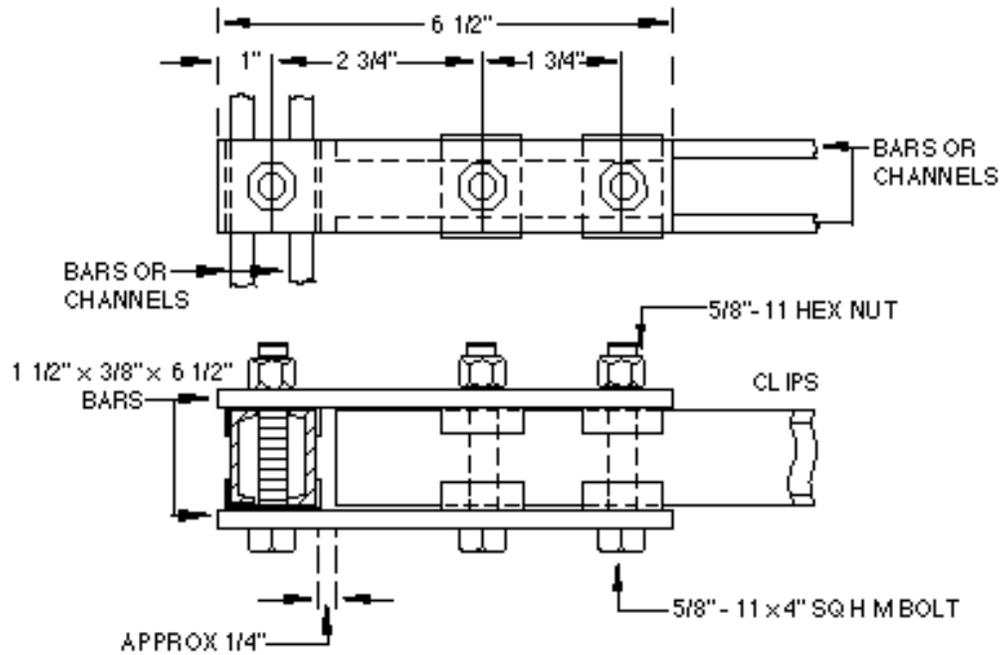


EXHIBIT 2-E3-10

SINGLE-LEVEL AUXILIARY FRAMING JUNCTION OF PRIMARY AND SECONDARY  
BARS OR CHANNELS

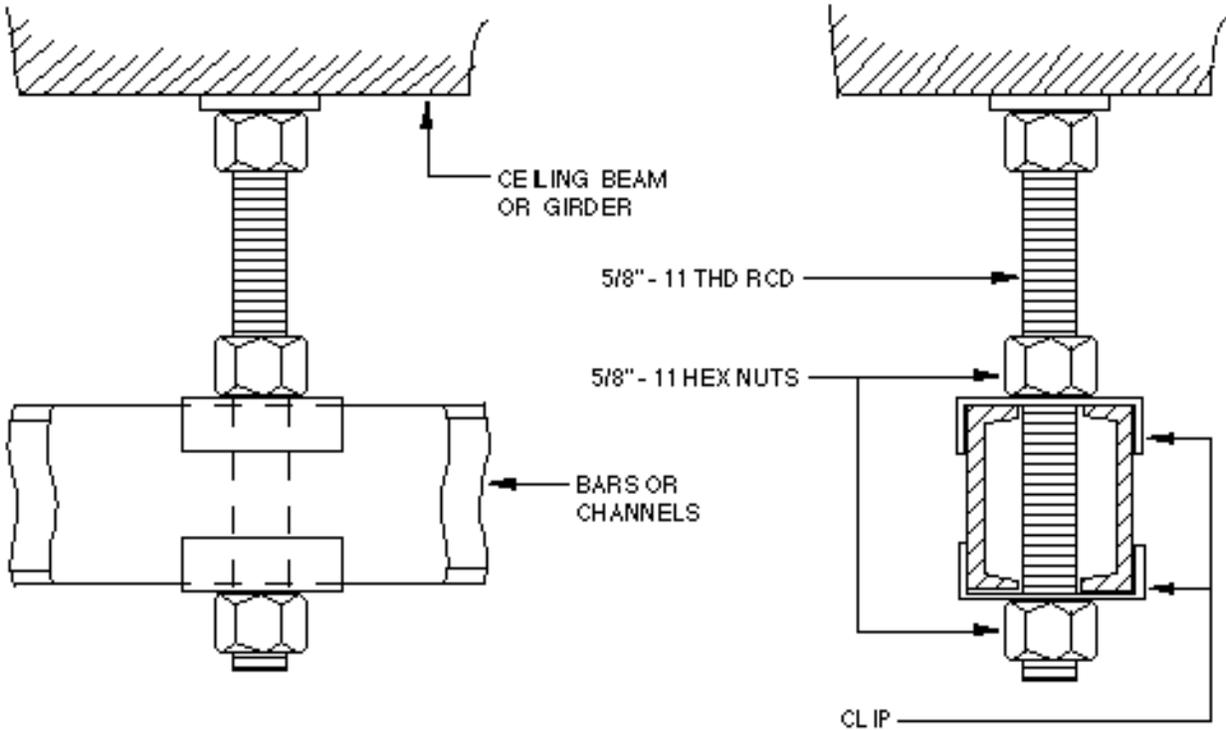


EXHIBIT 2-E3-11  
DOUBLE BARS OR CHANNELS ATTACHED TO HANGER RODS

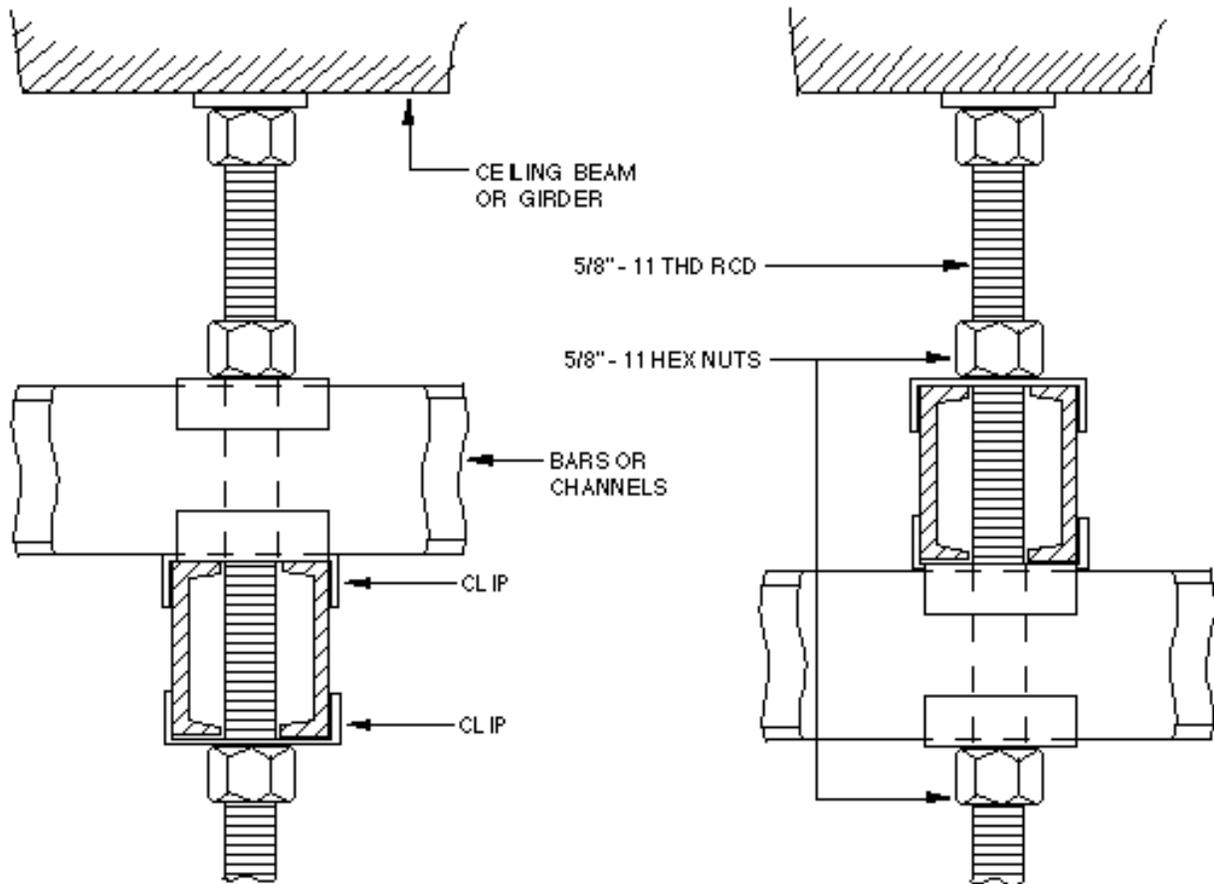


EXHIBIT 2-E3-11A  
DOUBLE BARS OR CHANNELS ATTACHED TO HANGER RODS

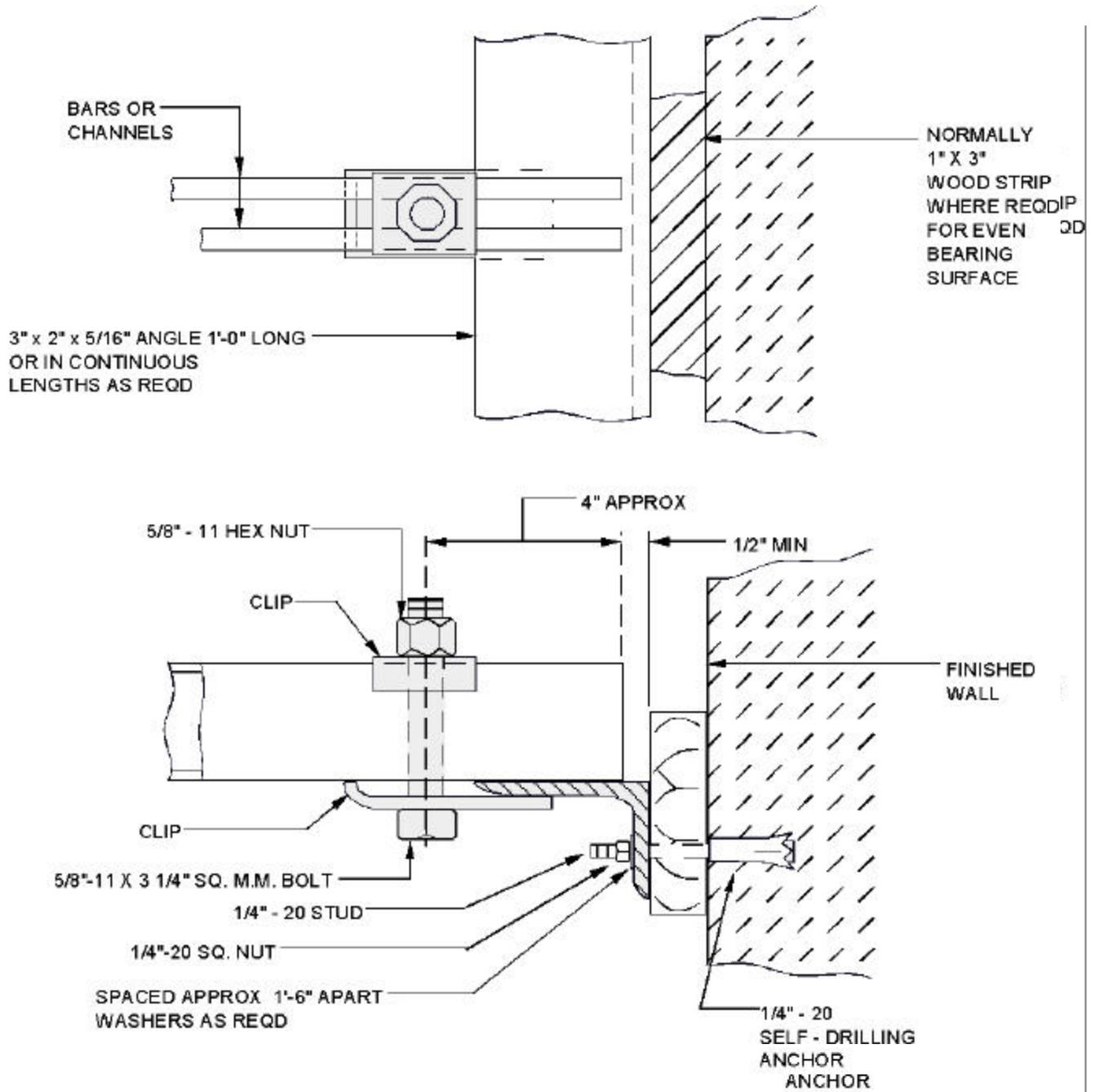


EXHIBIT 2-E3-12

DOUBLE FRAMING ATTACHED TO WALLS WHERE IMPRACTICABLE TO DRILL  
 WALL ANGLE

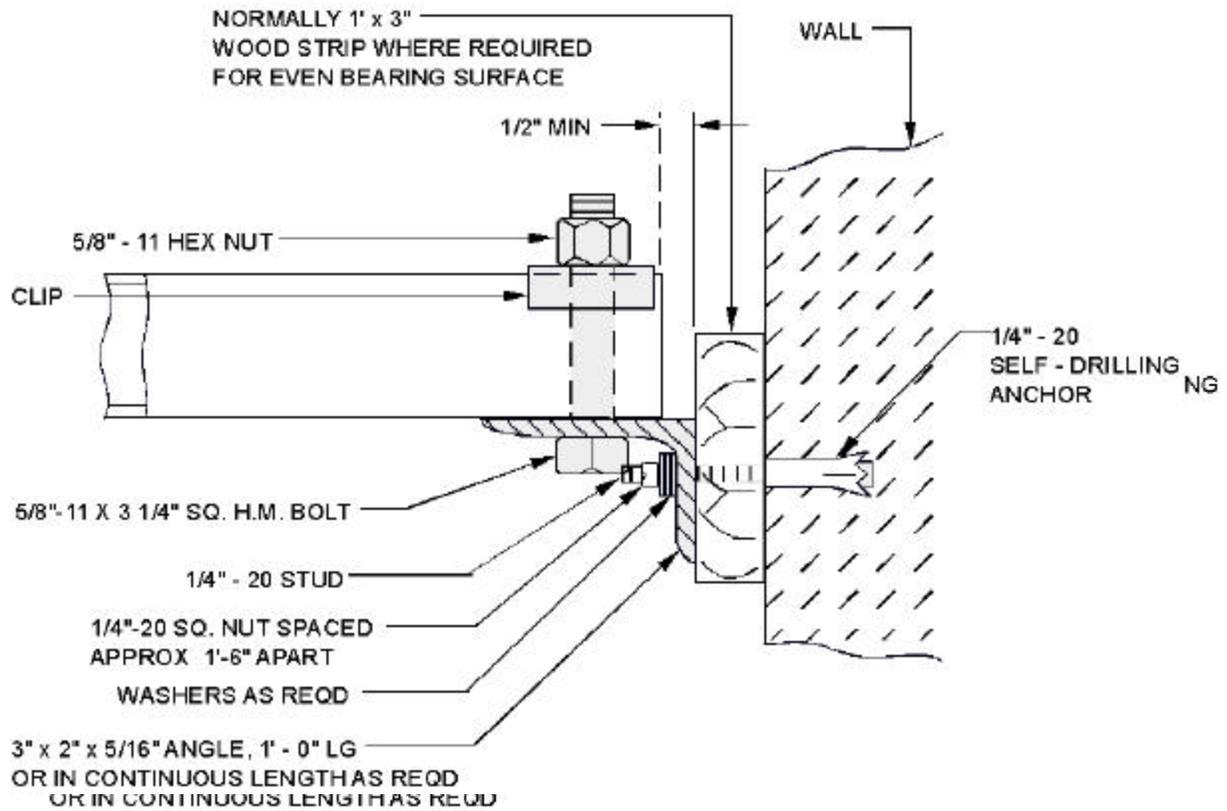


EXHIBIT 2-E3-12A

DOUBLE FRAMING ATTACHED TO WALLS WHERE ANGLE IS DRILLED

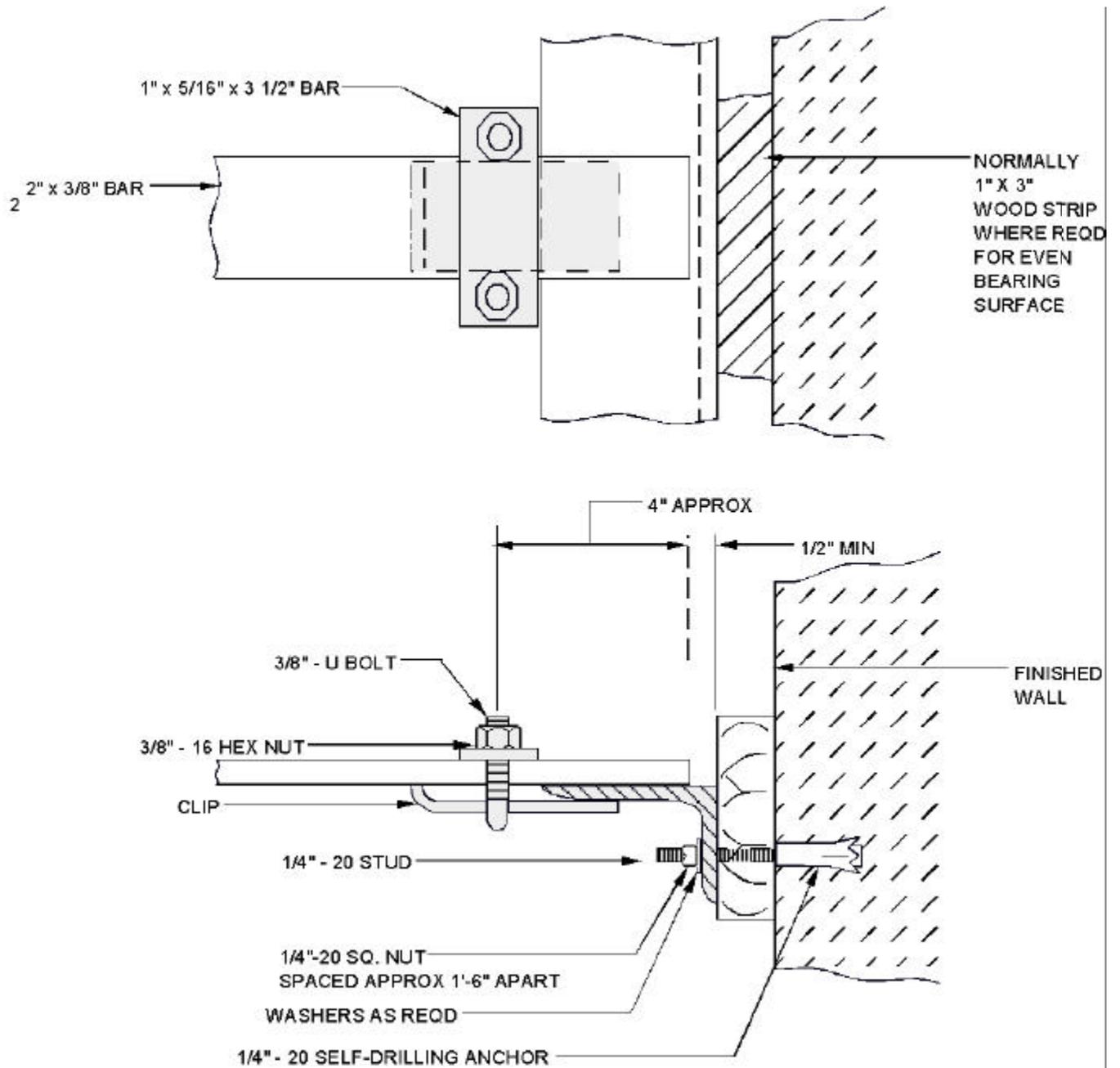


EXHIBIT 2-E3-13  
SINGLE FRAMING ATTACHED TO WALLS

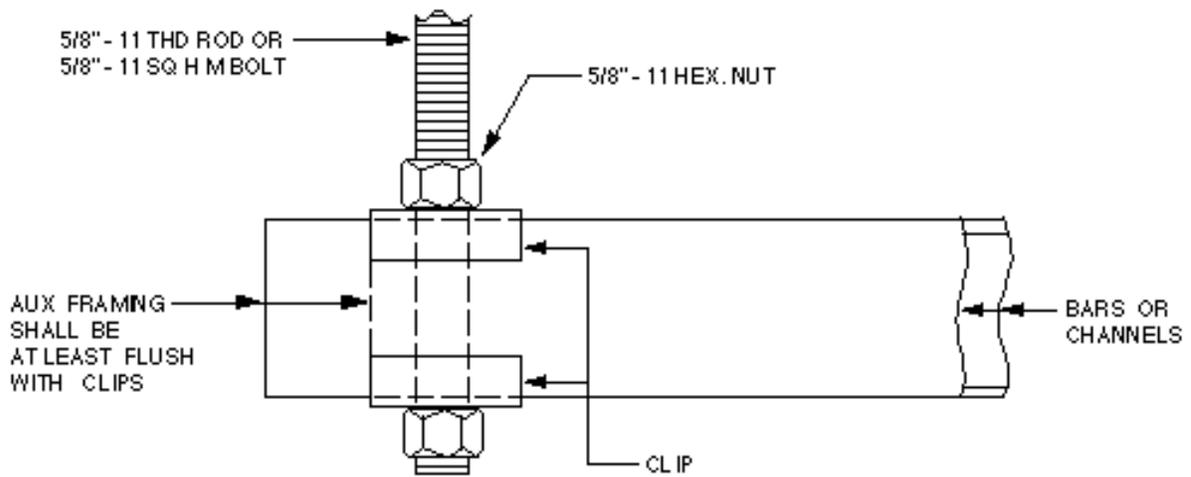


EXHIBIT 2-E3-14

HANGER RODS OR BOLTS ATTACHED AT ENDS OF DOUBLE BARS OR CHANNELS

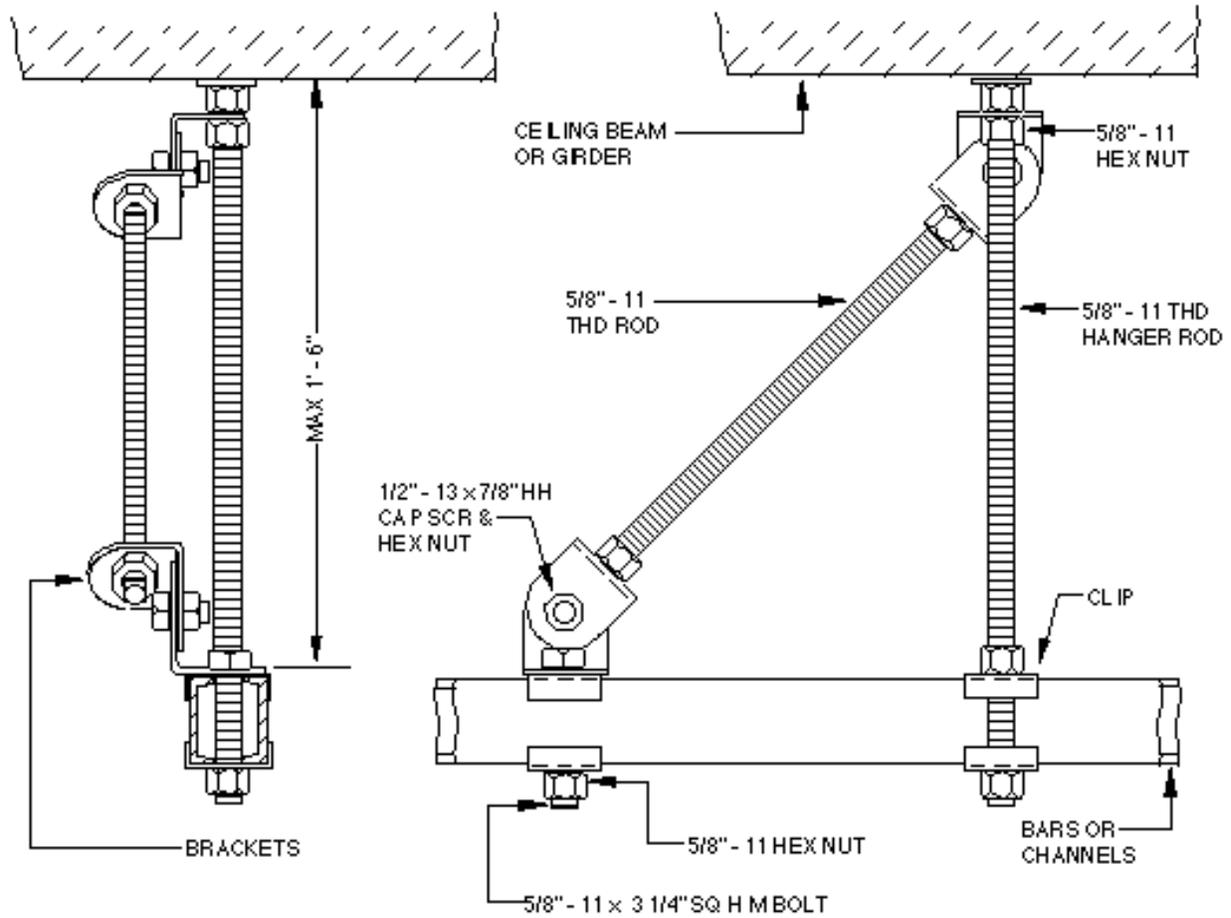


EXHIBIT 2-E3-15  
BRACING UPPER LEVEL FRAMING

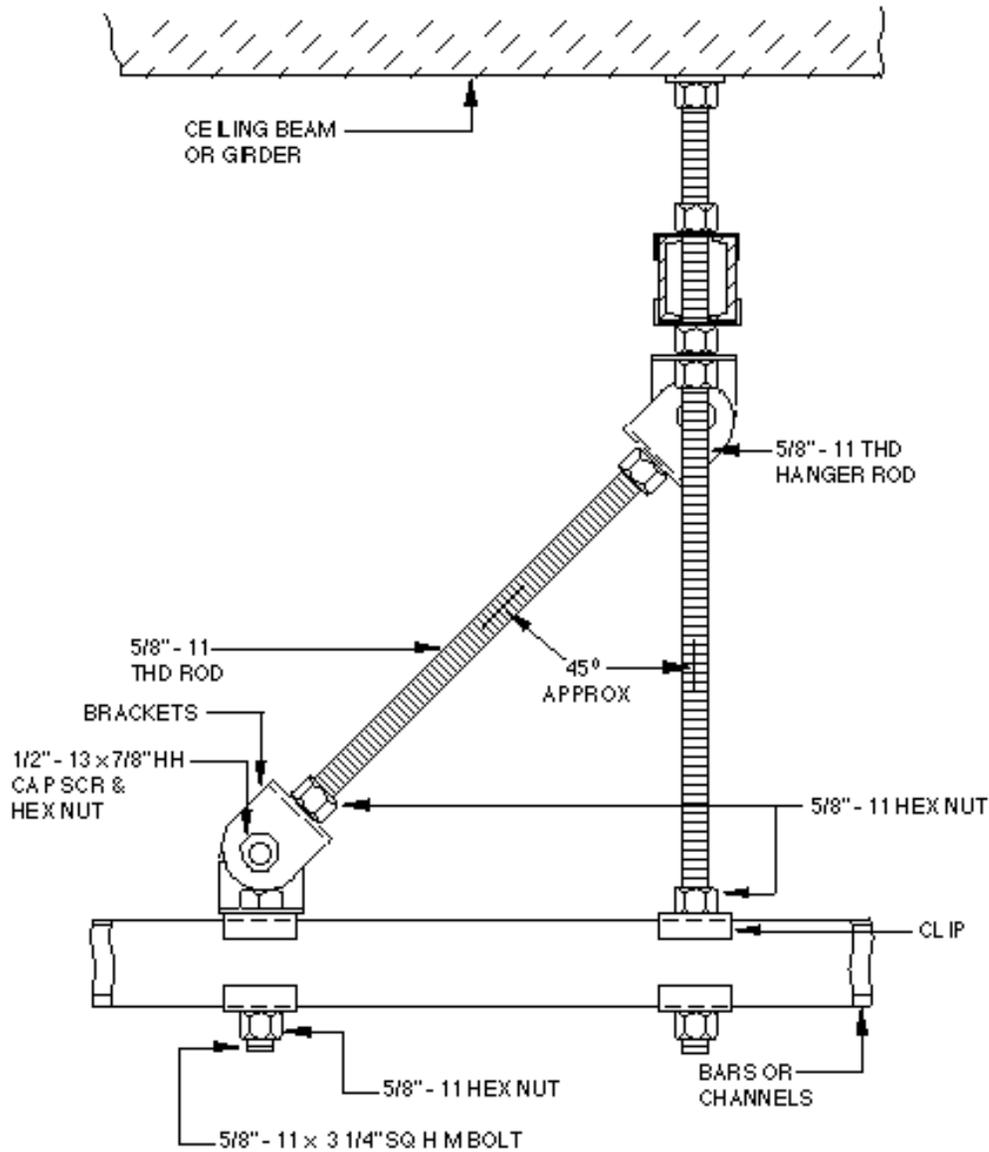


EXHIBIT 2-E3-16

BRACING LOWER LEVEL FRAMING AT RIGHT ANGLES TO HIGHER LEVEL FRAMING

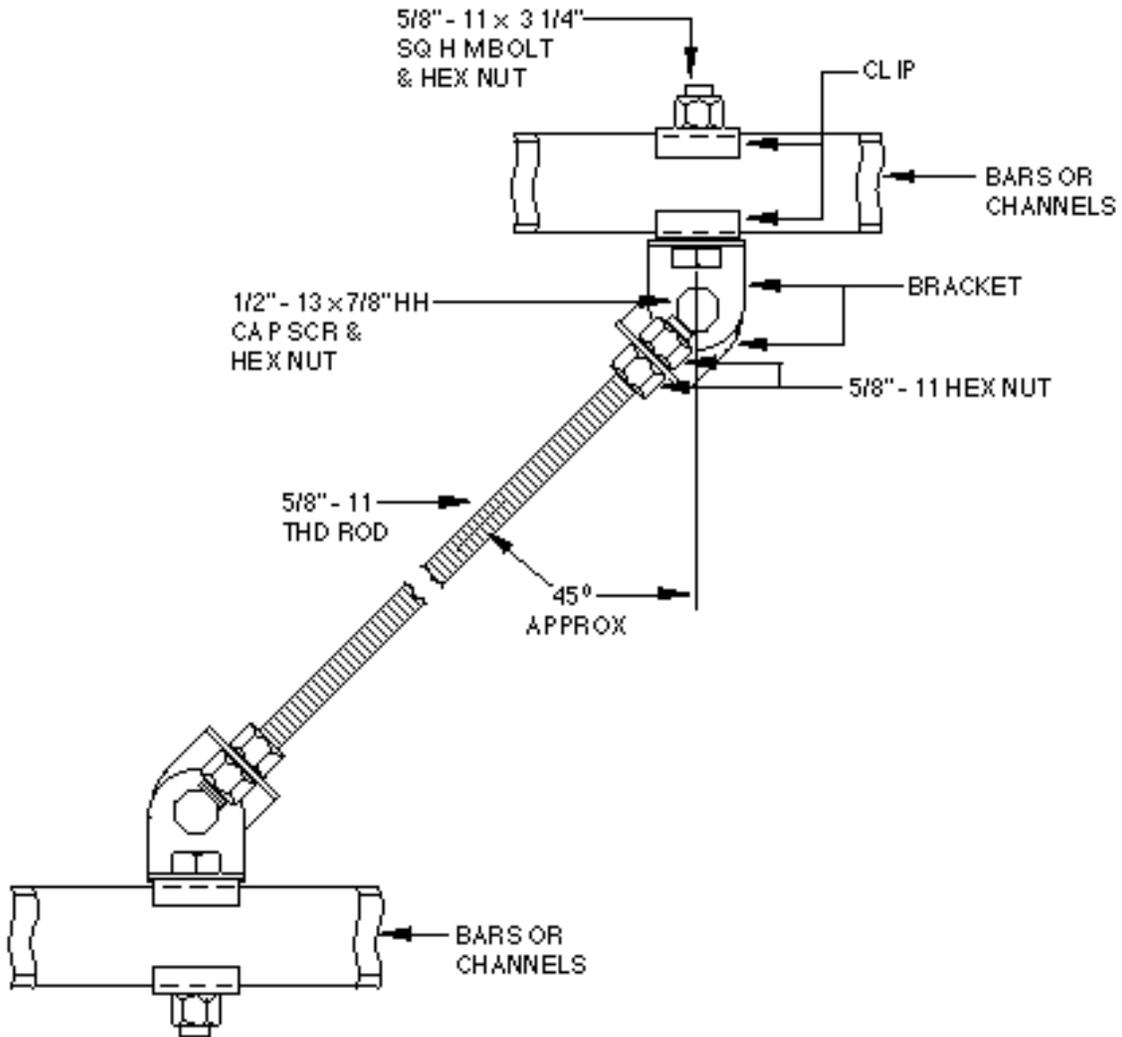


EXHIBIT 2-E3-16A

BRACING LOWER LEVEL FRAMING PARALLEL TO HIGHER LEVEL FRAMING

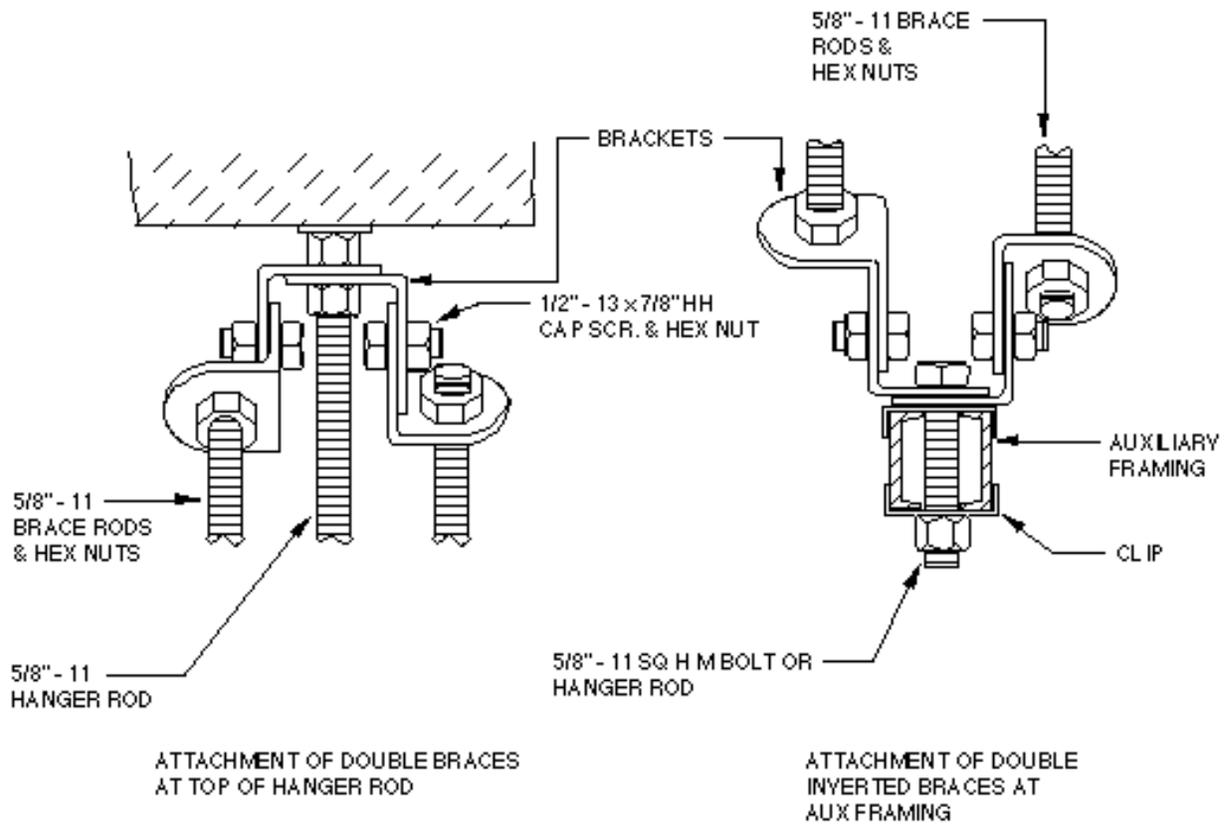


EXHIBIT 2-E3-17  
ATTACHING DOUBLE BRACING

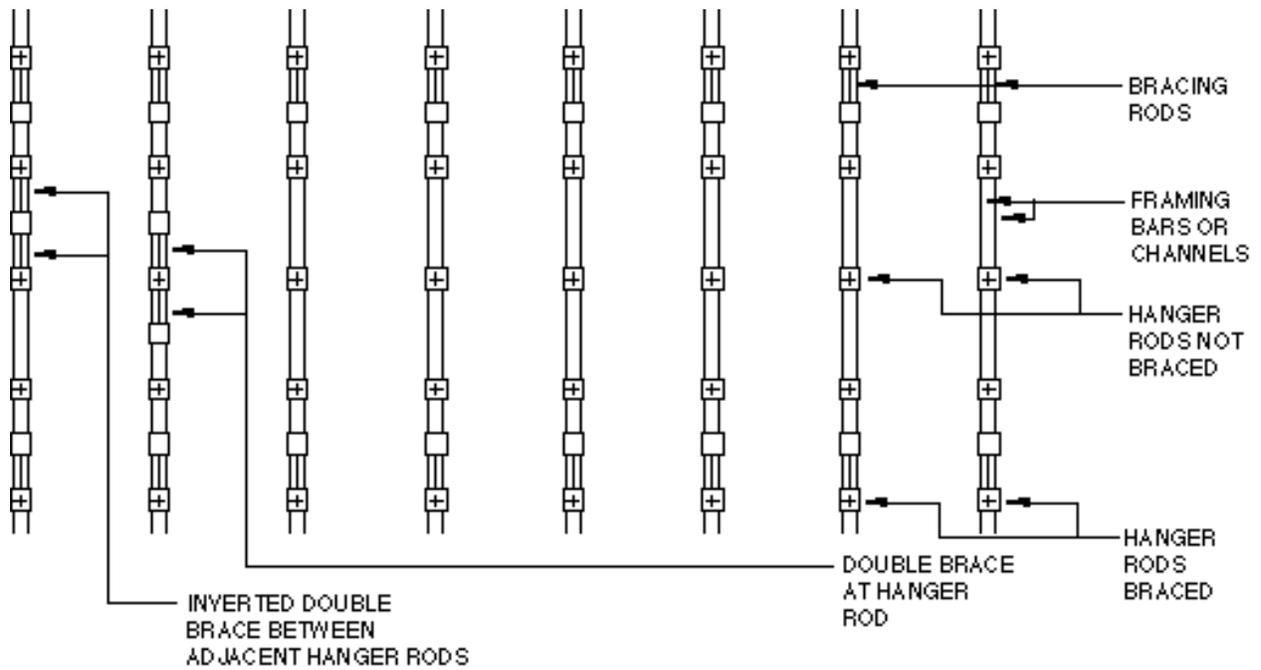


EXHIBIT 2-E3-18  
TYPICAL LAYOUT OF BRACING DETAILS

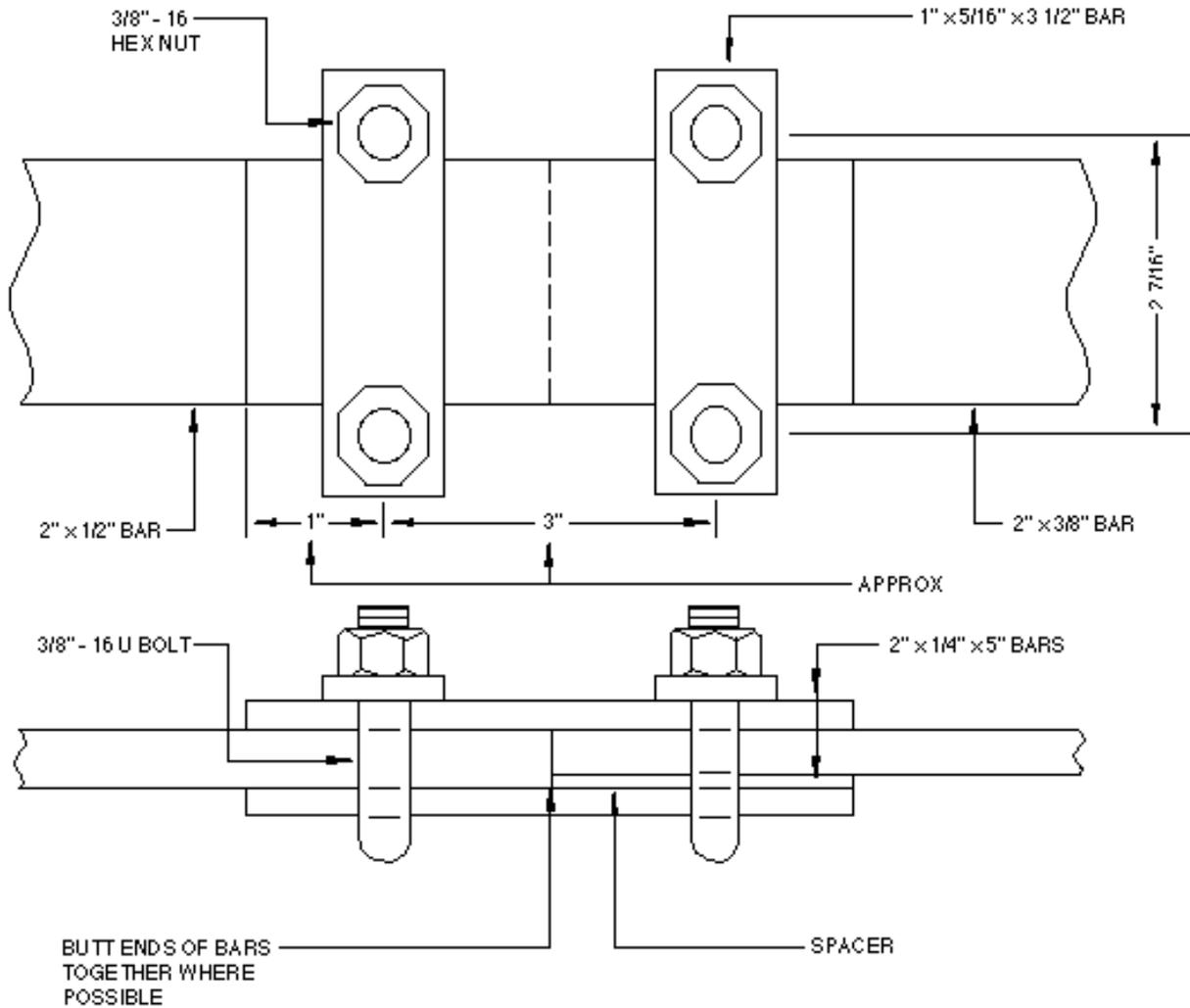


EXHIBIT 2-E3-19

SPLICING SINGLE 2 INCHES BY 3/8 OF AN INCH BARS TO 2 INCHES BY 1/2 OF AN  
INCH BARS

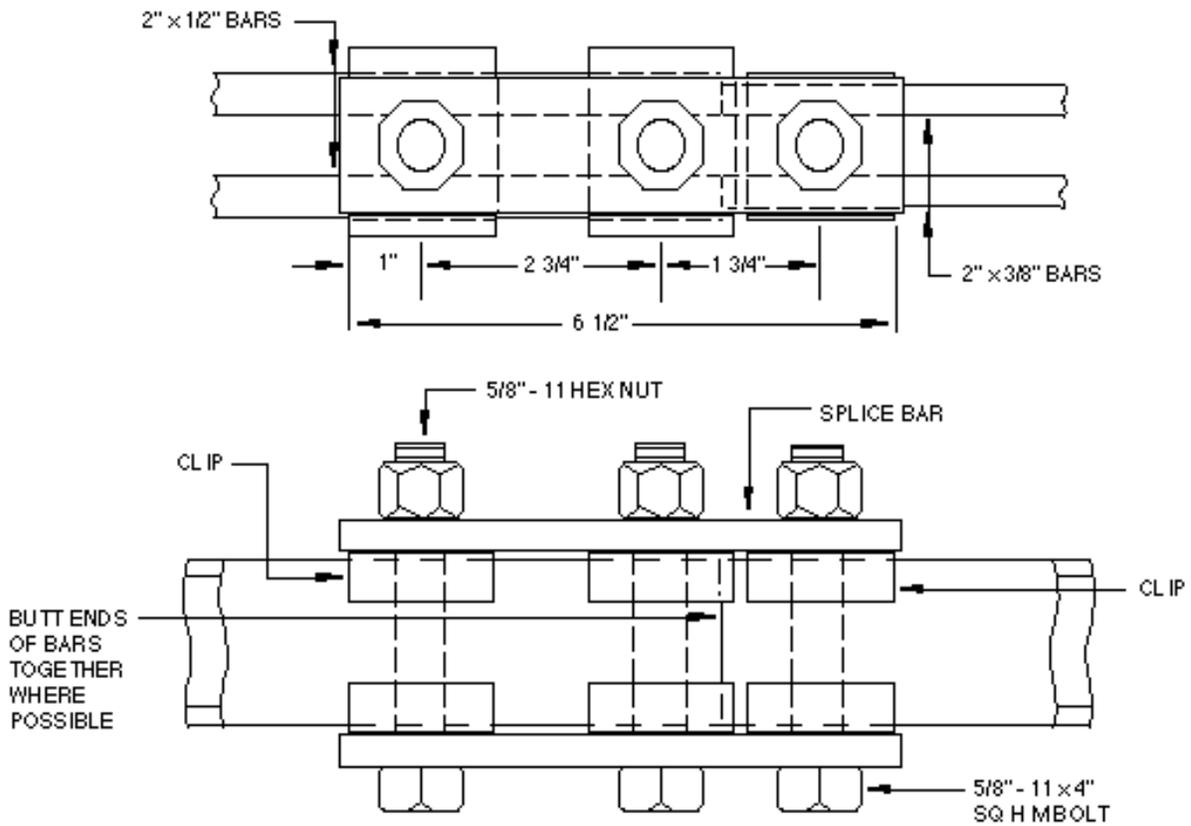


EXHIBIT 2-E3-20

SPLICING PAIRS OF 2 INCHES BY 3/8 OF AN INCH BARS TO 2 INCHES BY 1/2 OF AN INCH BARS

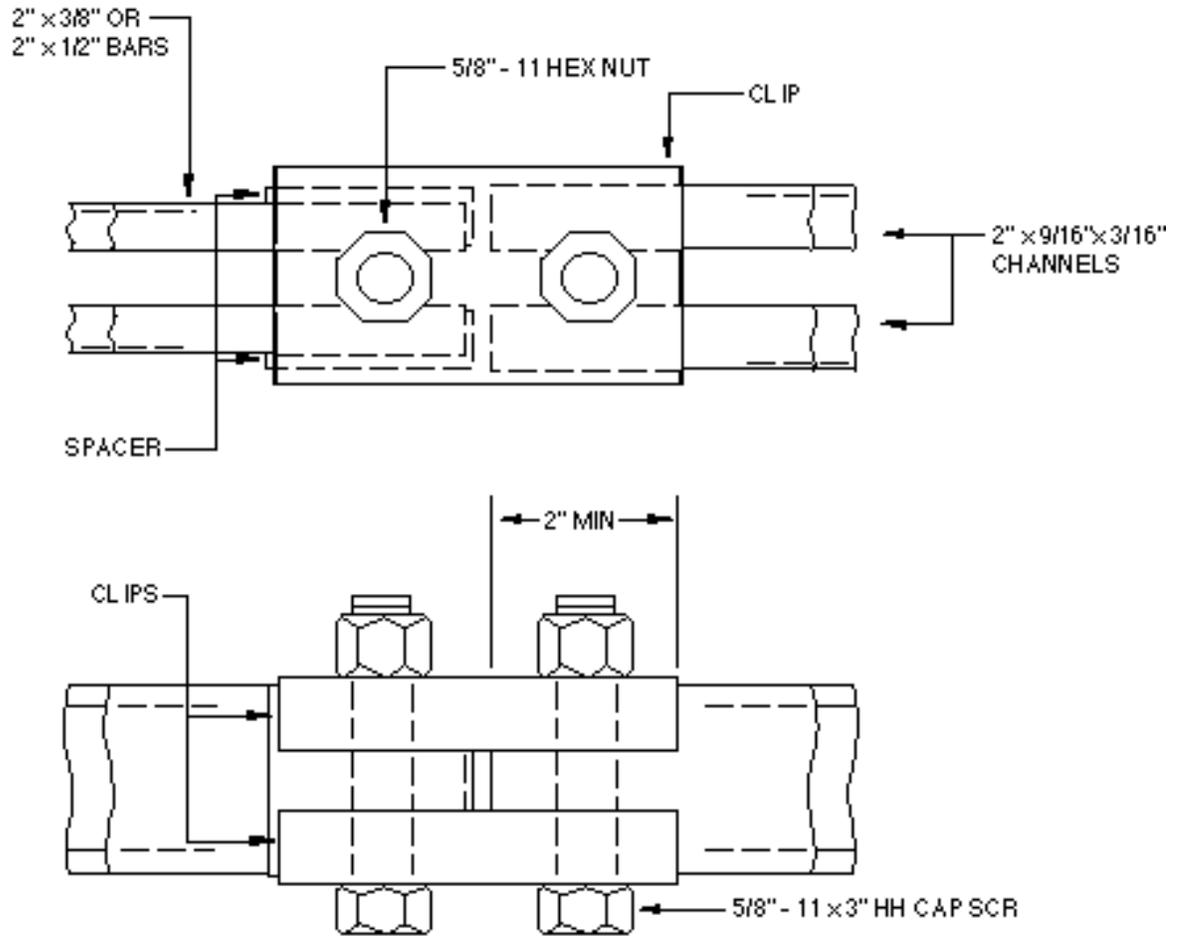


EXHIBIT 2-E3-20A (A&M)  
SPLICING PAIRS OF 2 INCHES BY 3/8 OF AN INCH OR 2 INCHES BY 1/2 OF AN INCH  
BARS TO CHANNELS

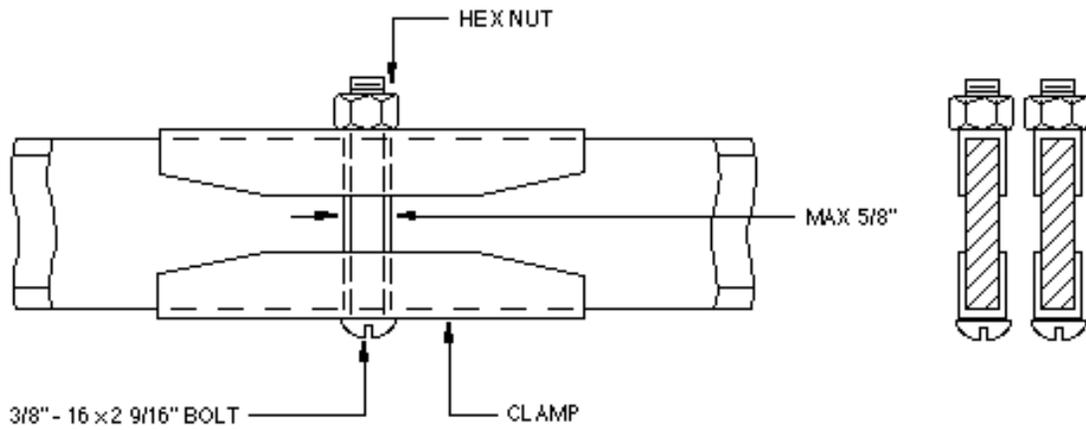


EXHIBIT 2-E3-21  
SPLICING PAIRS OF 2 INCHES BY 3/8 OF AN INCH BARS

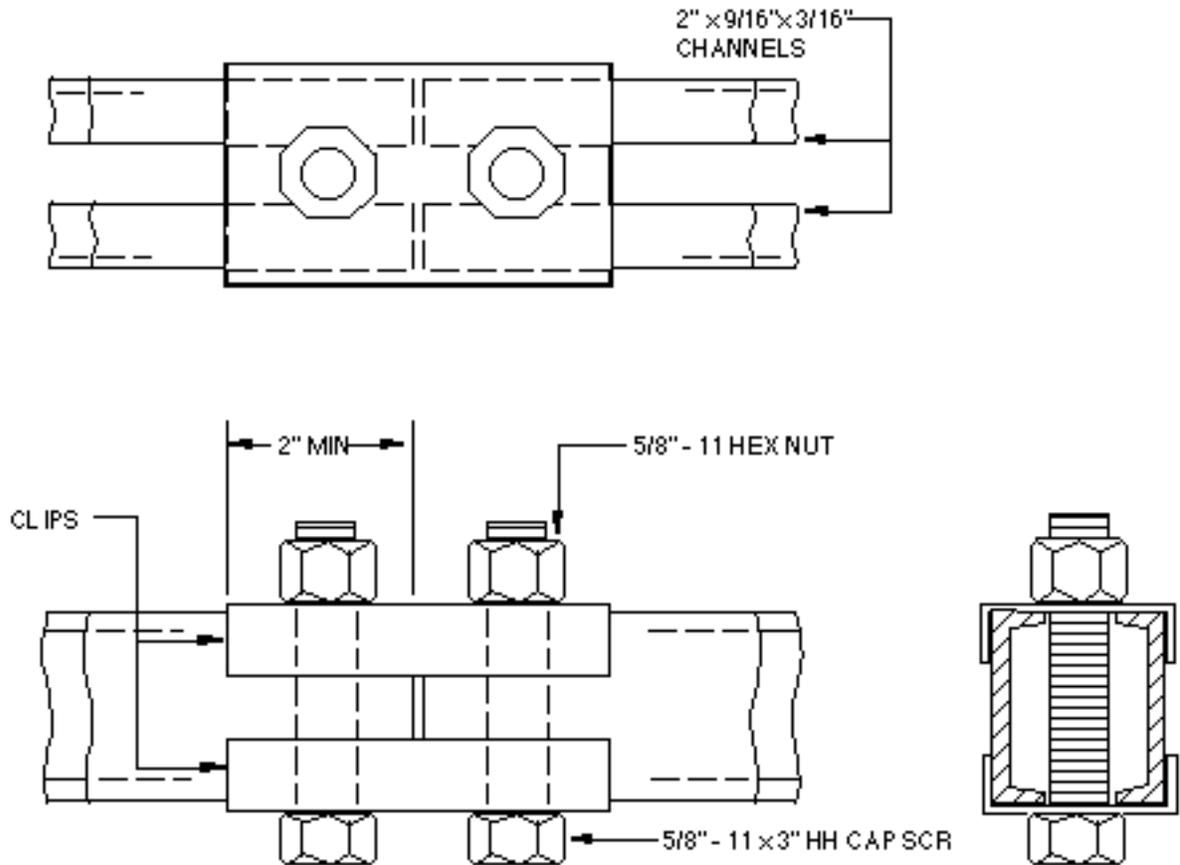


EXHIBIT 2-E3-21A (A&M)  
SPLICING PAIRS OF 2 INCHES BY 9/16 OF AN INCH CHANNELS

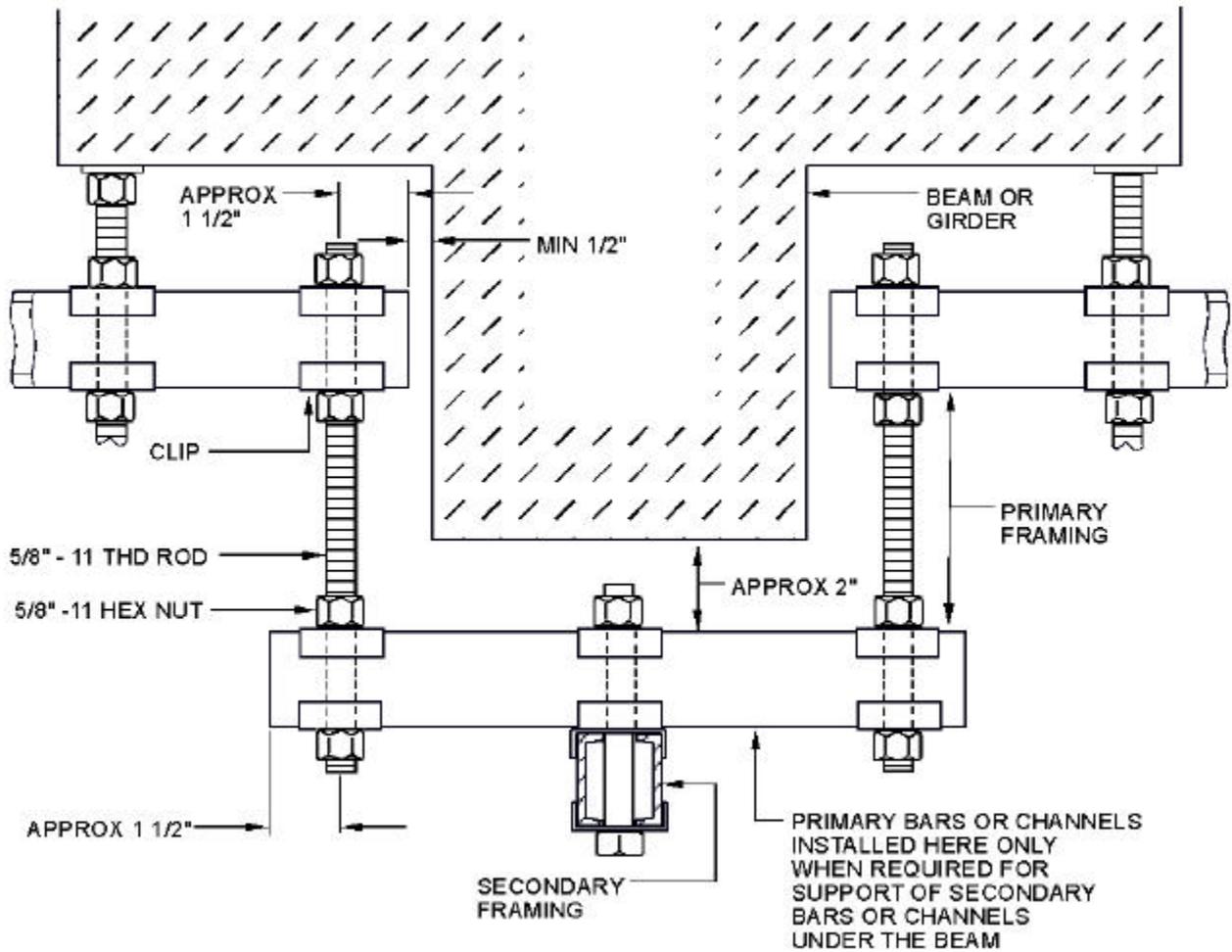


EXHIBIT 2-E3-22

DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS AT  
RIGHT ANGLES TO BEAMS OR GIRDERS

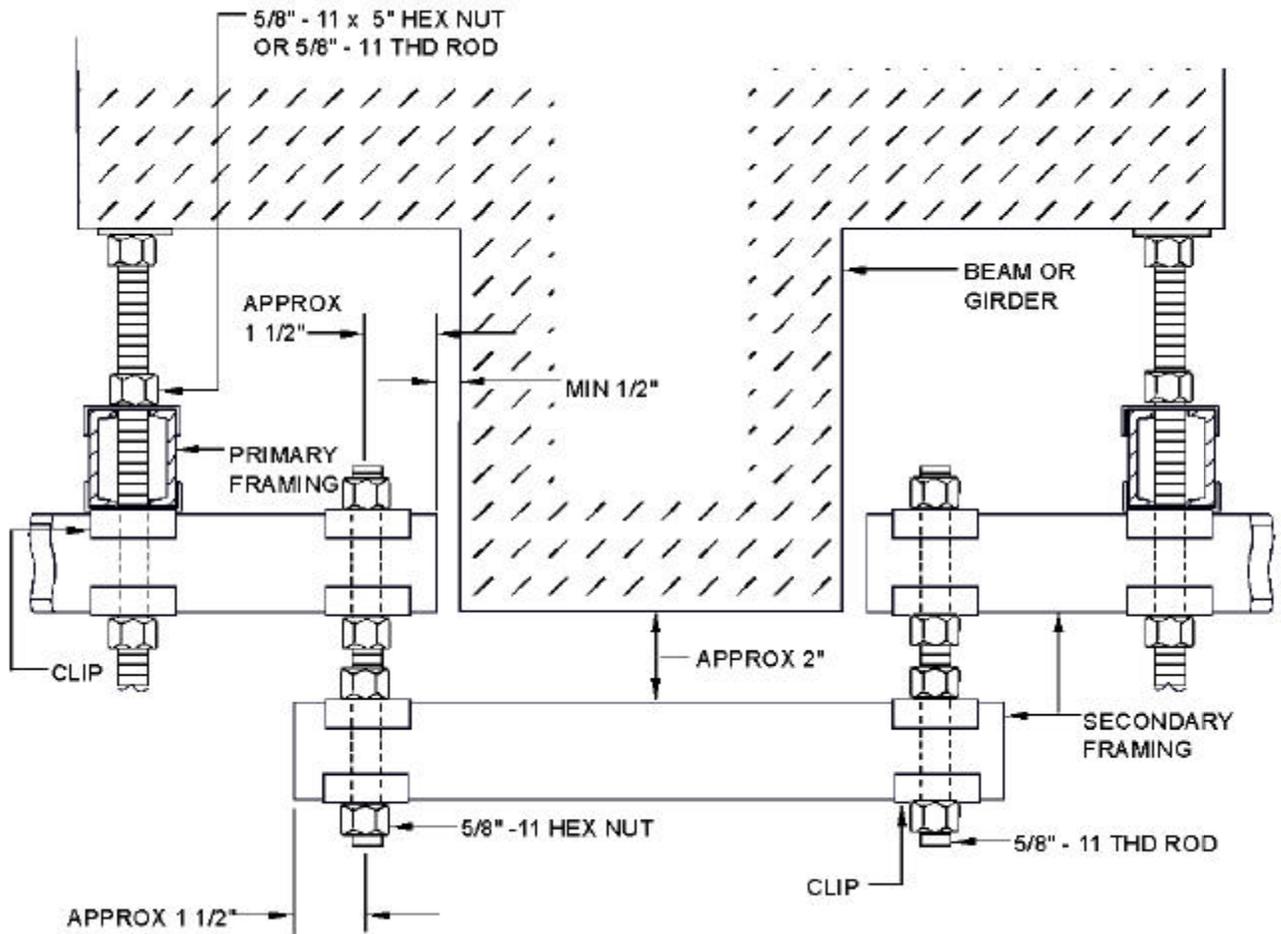


EXHIBIT 2-E3-23

DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS  
PARALLEL TO BEAMS OR GIRDERS

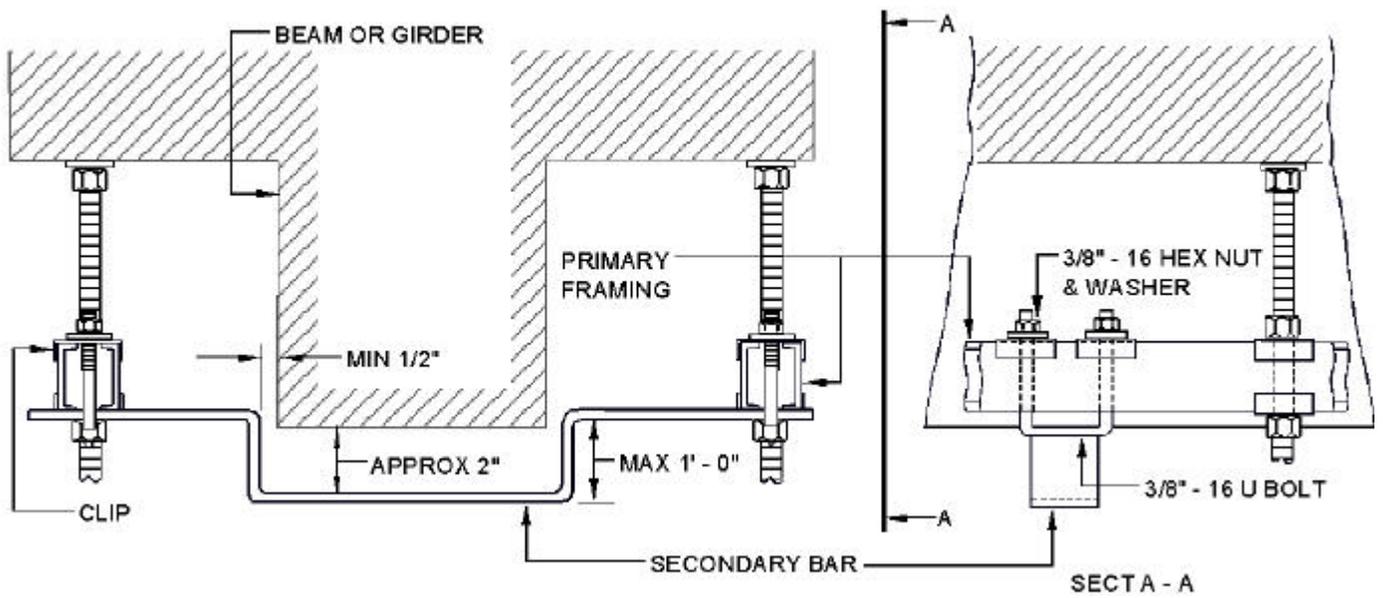


EXHIBIT 2-E3-24

SINGLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY

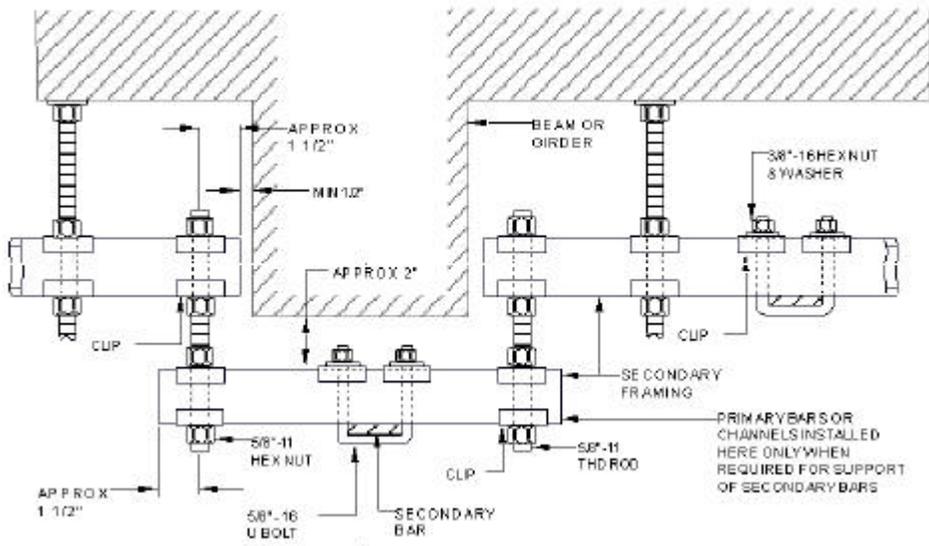


EXHIBIT 2-E3-25

SINGLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS AT  
RIGHT ANGLES TO BEAMS OR GIRDERS

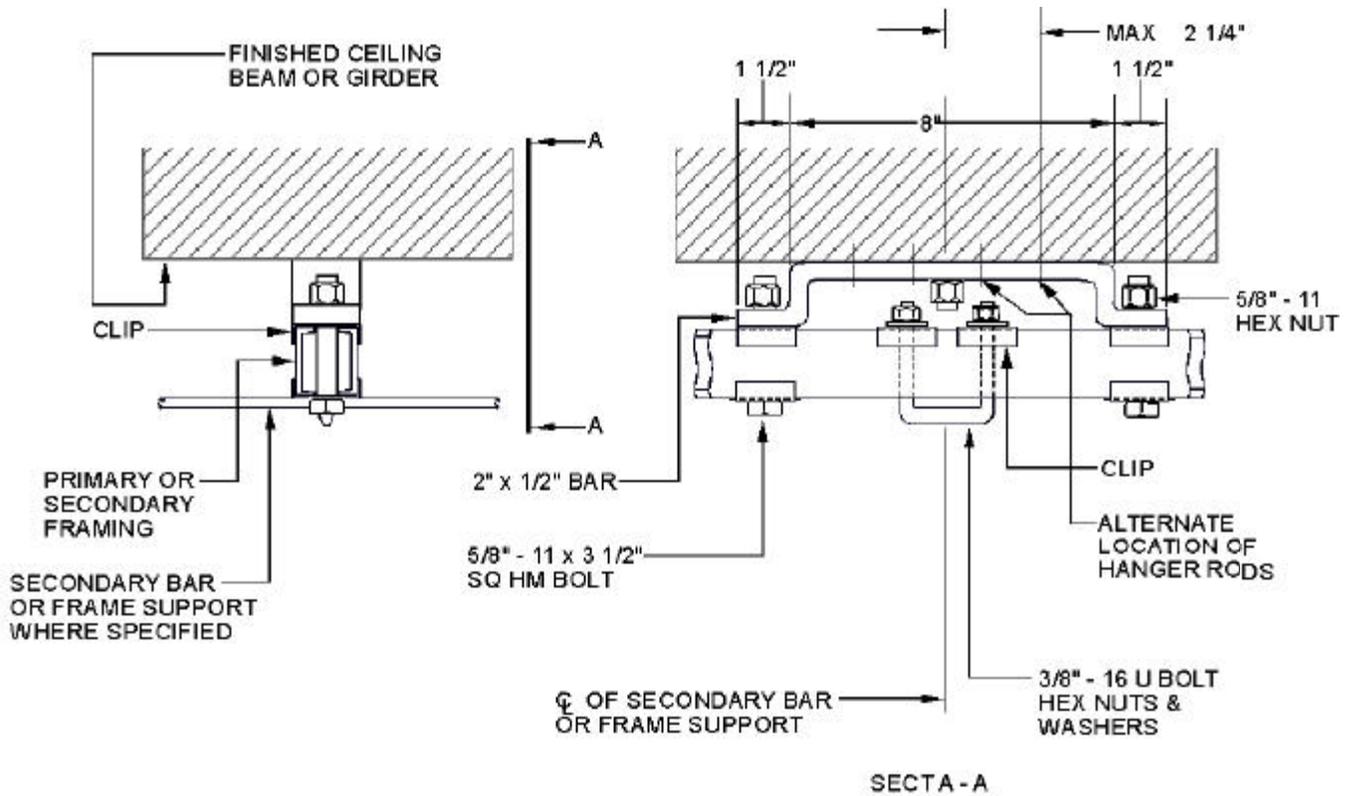


EXHIBIT 2-E3-26  
SUPPORTING FRAMING WHERE HANGER RODS INTERFERE WITH OTHER ATTACHMENTS

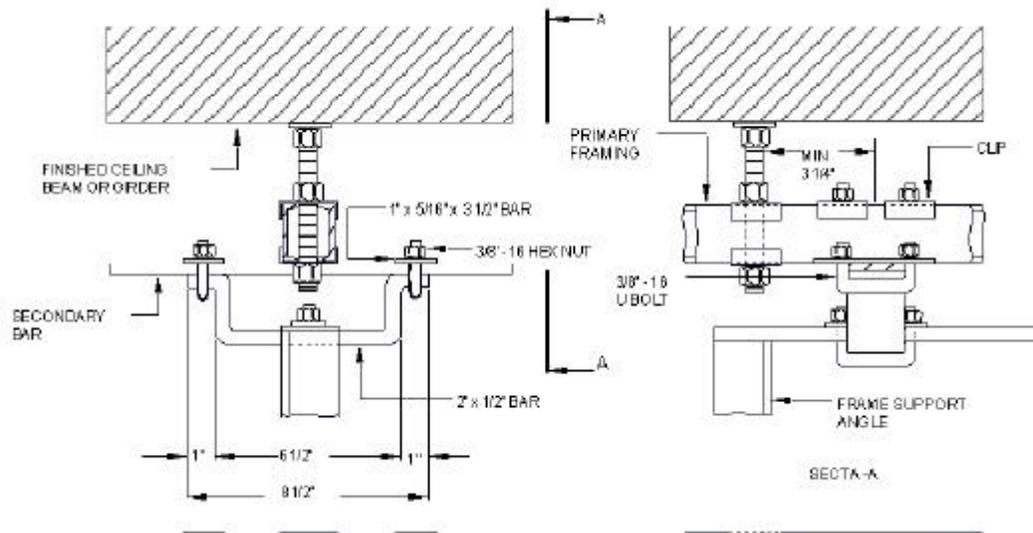


EXHIBIT 2-E3-27

FRAMING BARS OR CHANNELS ATTACHED AT FRAME SUPPORTS-MAIN HANGER  
ROD AT POINT OF SUPPORT

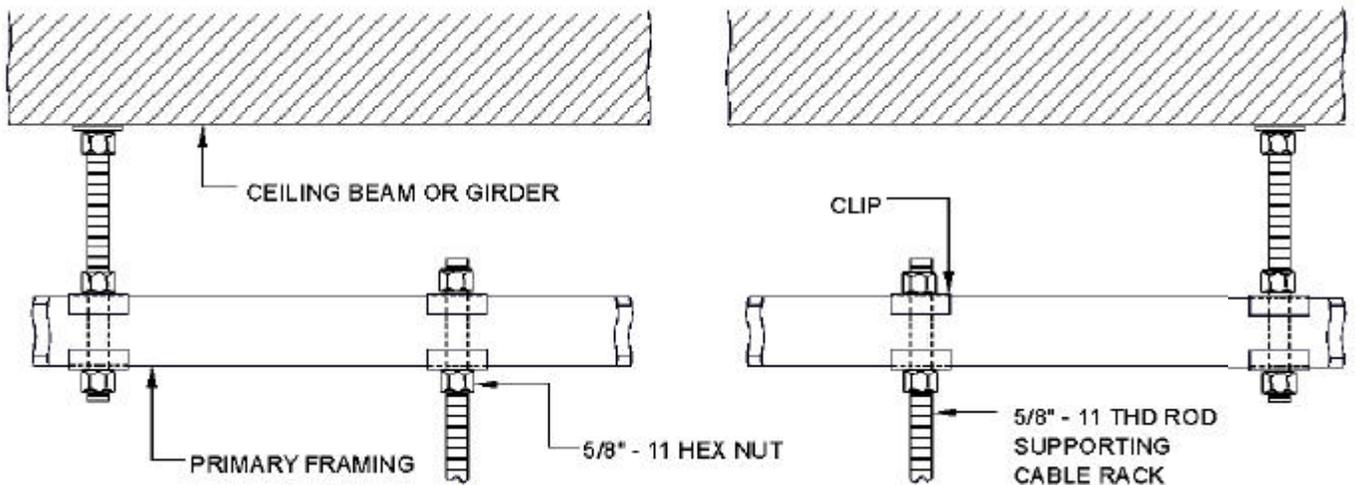


EXHIBIT 2-E3-28

CABLE RACK OR CONDUIT HANGER RODS ATTACHED TO FRAMING-CABLE RACK  
OR CONDUIT RUN AT RIGHT ANGLES TO PRIMARY BARS OR CHANNELS

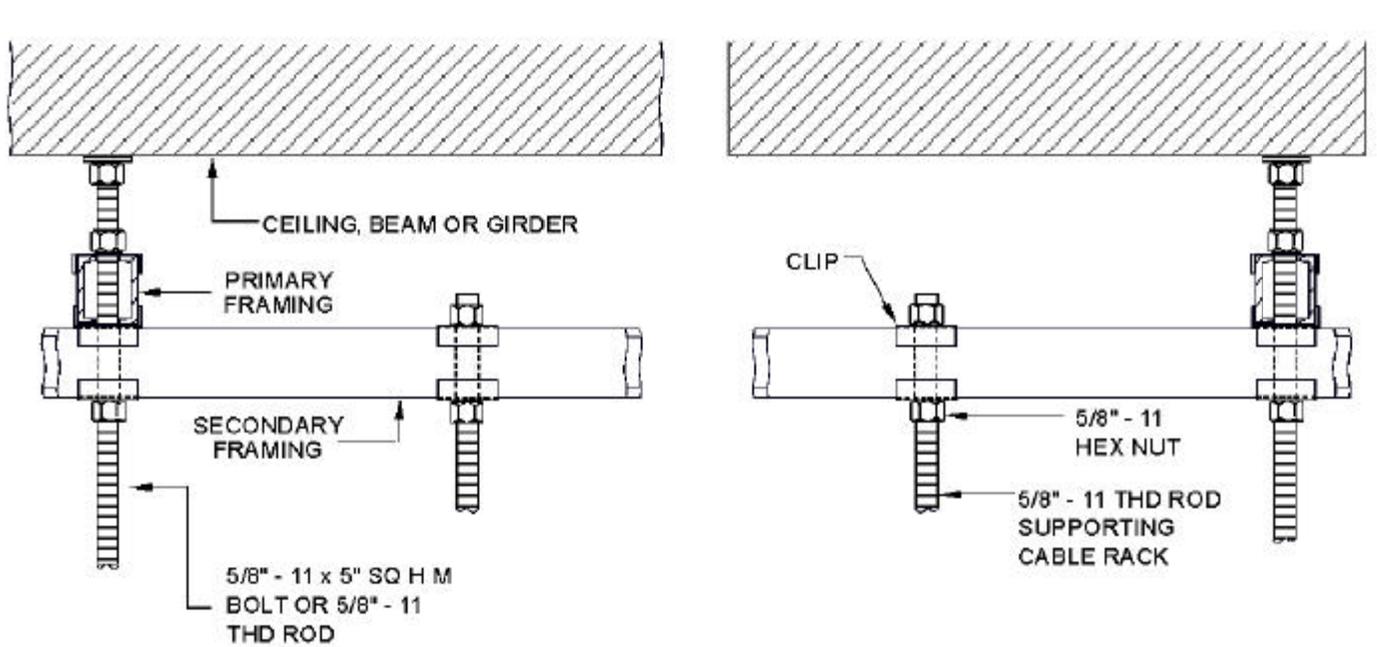


EXHIBIT 2-E3-29

CABLE RACK OR CONDUIT HANGER RODS ATTACHED TO FRAMING-CABLE RACK  
OR CONDUIT RUN PARALLEL TO PRIMARY BARS OR CHANNELS

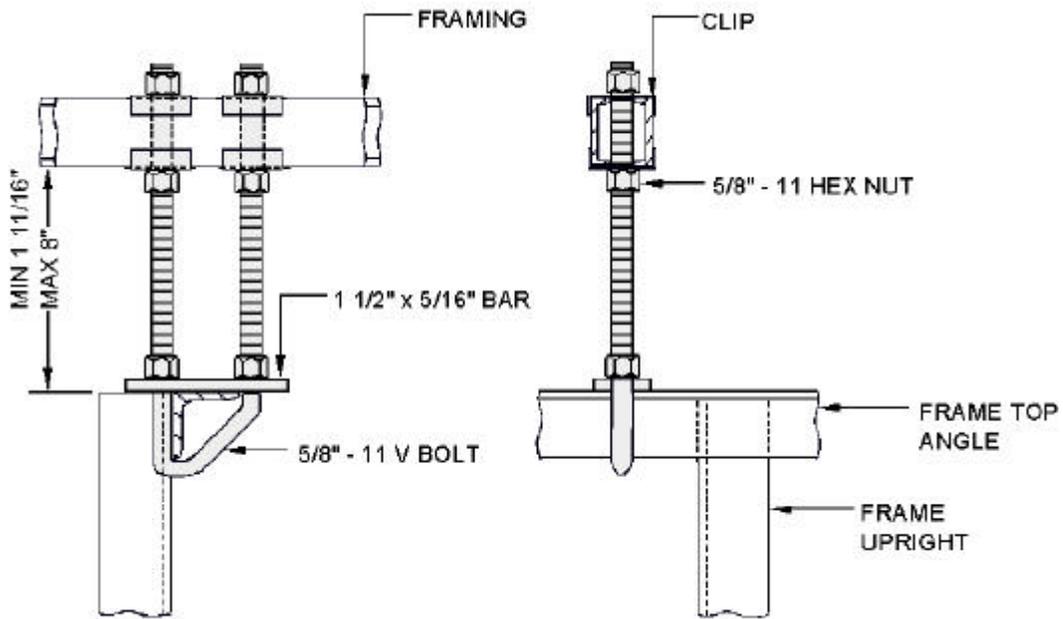


EXHIBIT 2-E3-30  
V BOLT FRAME SUPPORT ASSEMBLY

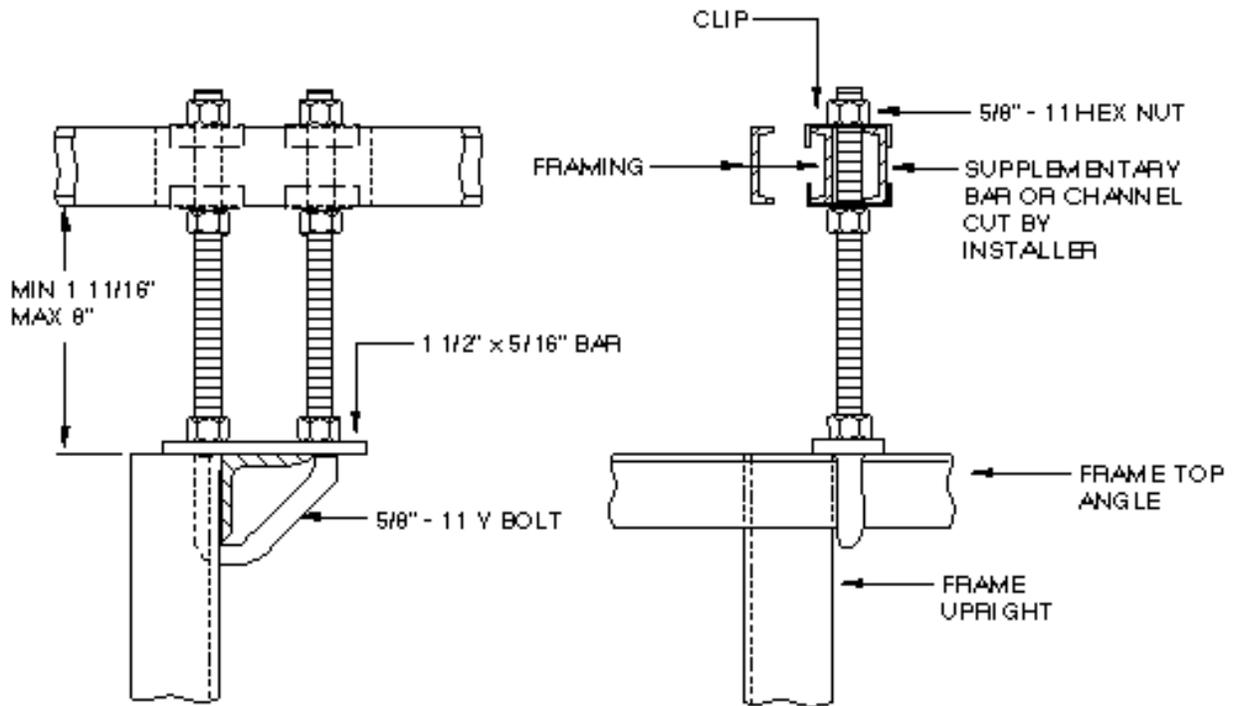


EXHIBIT 2-E3-31

V BOLT FRAME SUPPORT OFFSET TO CLEAR FRAME UPRIGHT

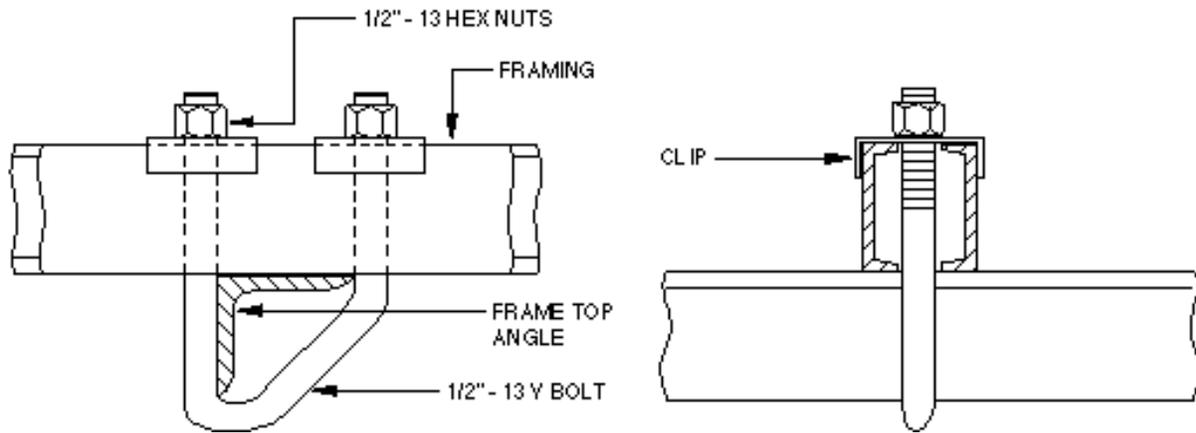


EXHIBIT 2-E3-32

V BOLT FRAME SUPPORT-TOP FRAME ANGLE ATTACHED DIRECTLY TO FRAMING

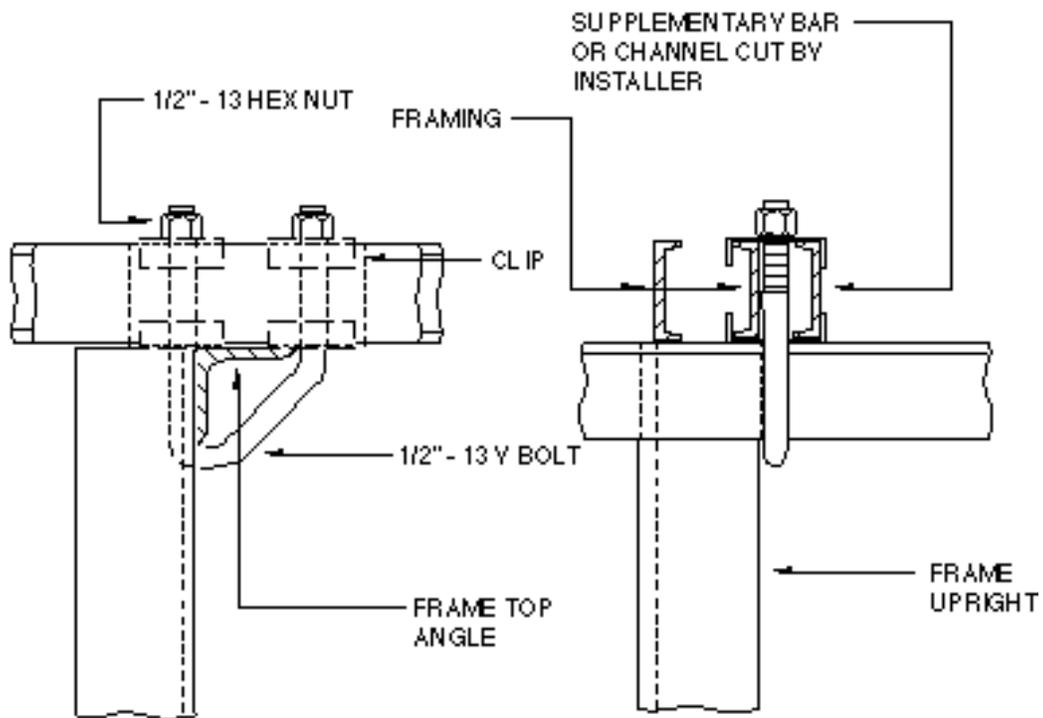


EXHIBIT 2-E3-33

V BOLT FRAME SUPPORT-V BOLT OFFSET TO CLEAR UPRIGHT

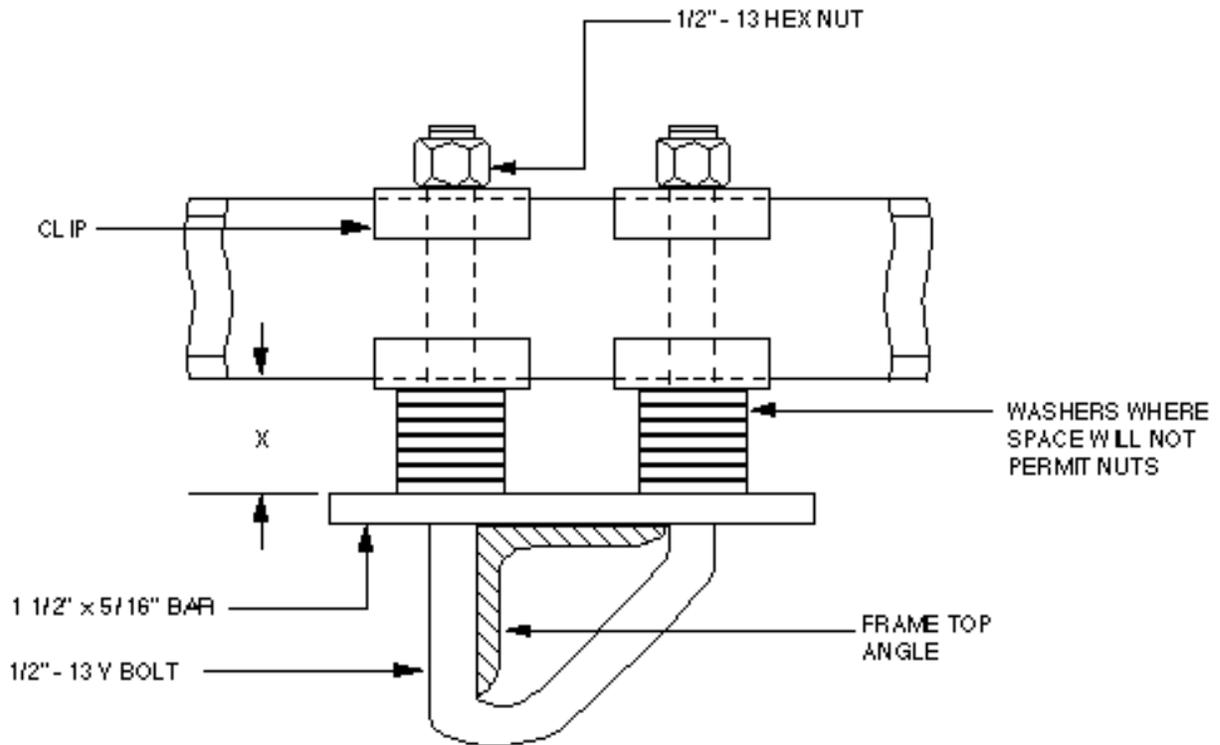


EXHIBIT 2-E3-34

V BOLT FRAME SUPPORT ASSEMBLY WHERE DIMENSION X IS LESS THAN 1 11/16 INCHES

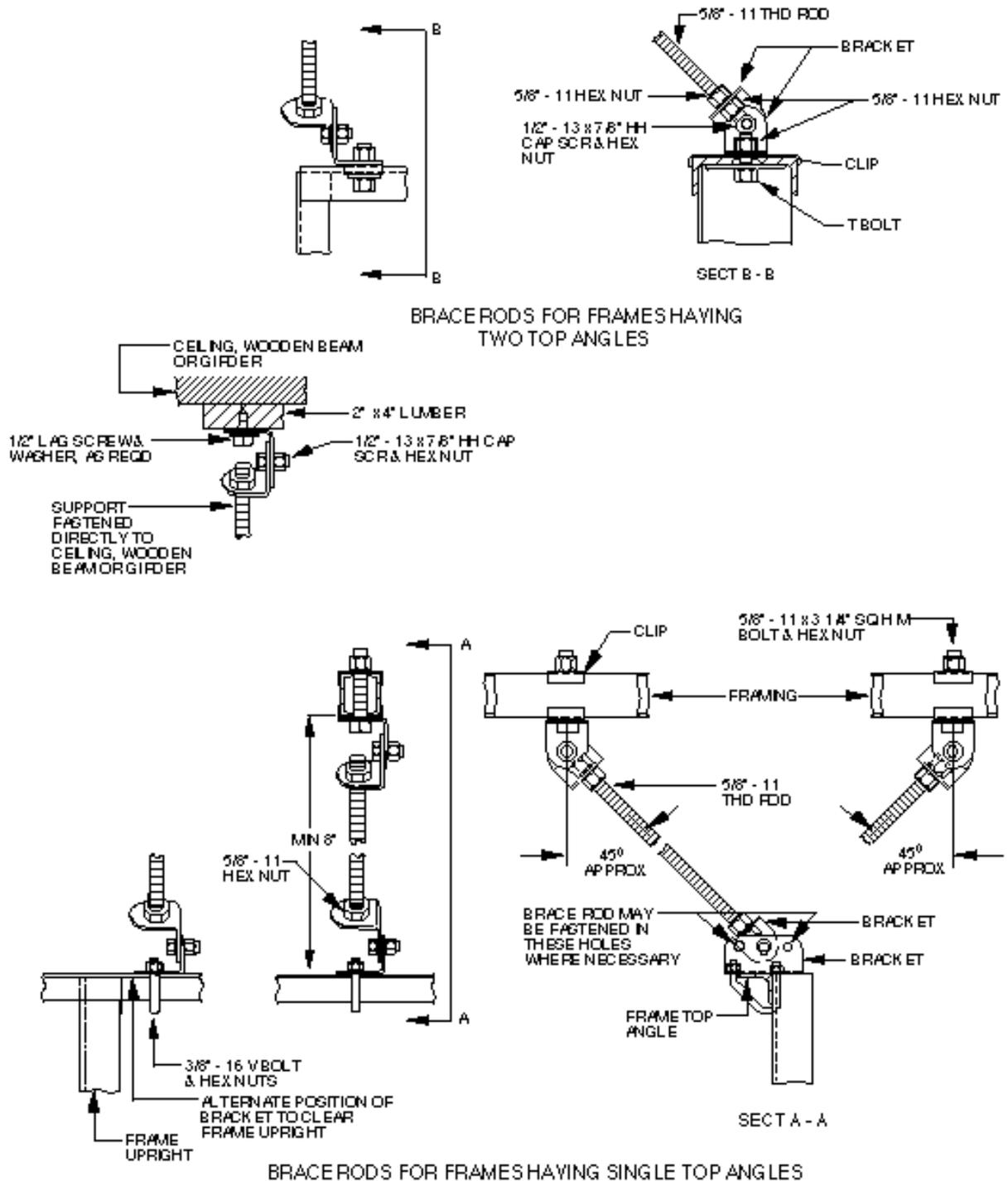
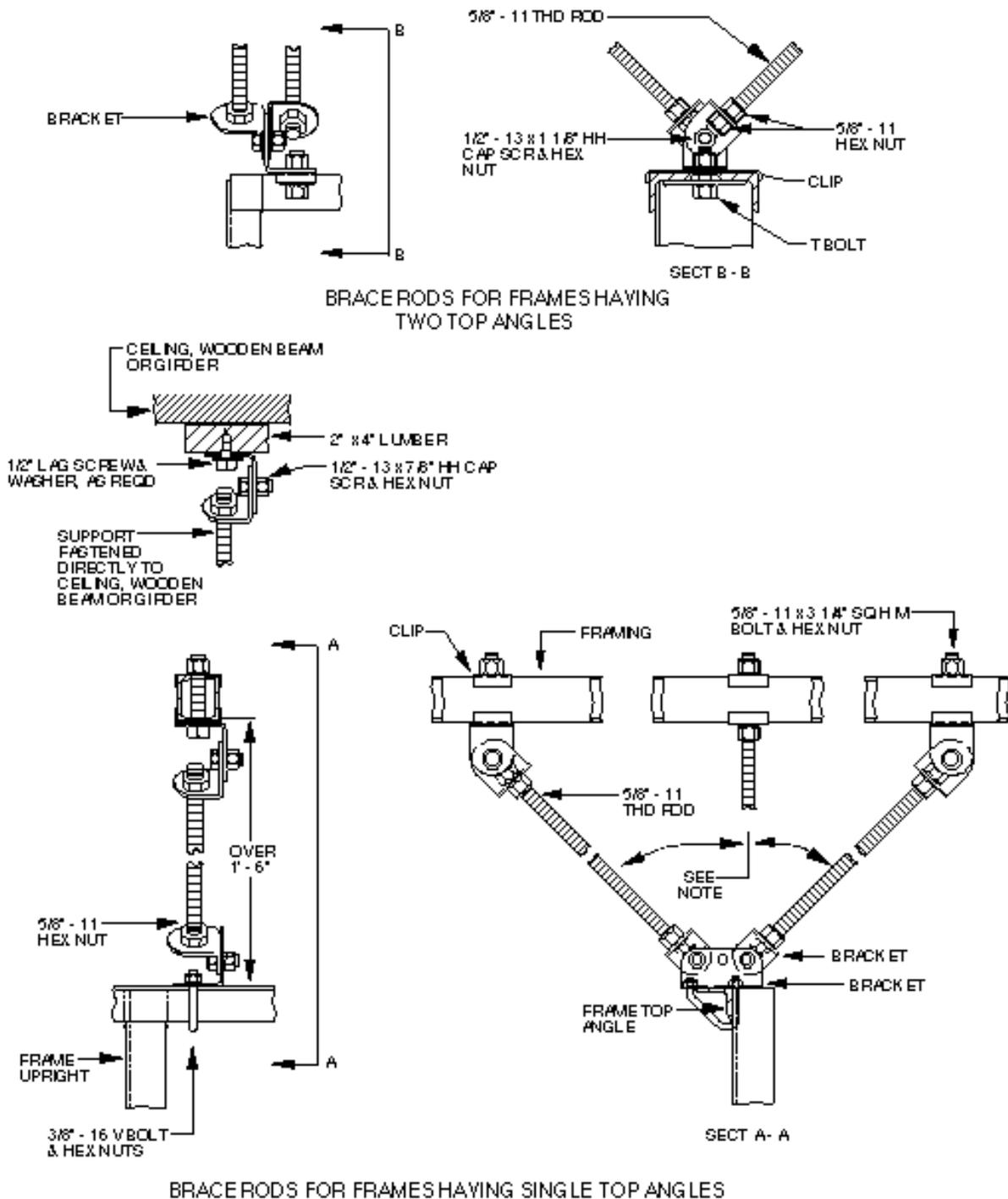


EXHIBIT 2-E3-35  
 SINGLE BRACE FRAME SUPPORT



NOTE:  
 EITHER ROD MAY BE PLACED IN A VERTICAL POSITION WHERE NECESSARY TO CLEAR CABLE RACK OR OTHER EQUIPMENT.

EXHIBIT 2-E3-36  
 DOUBLE BRACE FRAME SUPPORT USING THREADED ROD BRACES

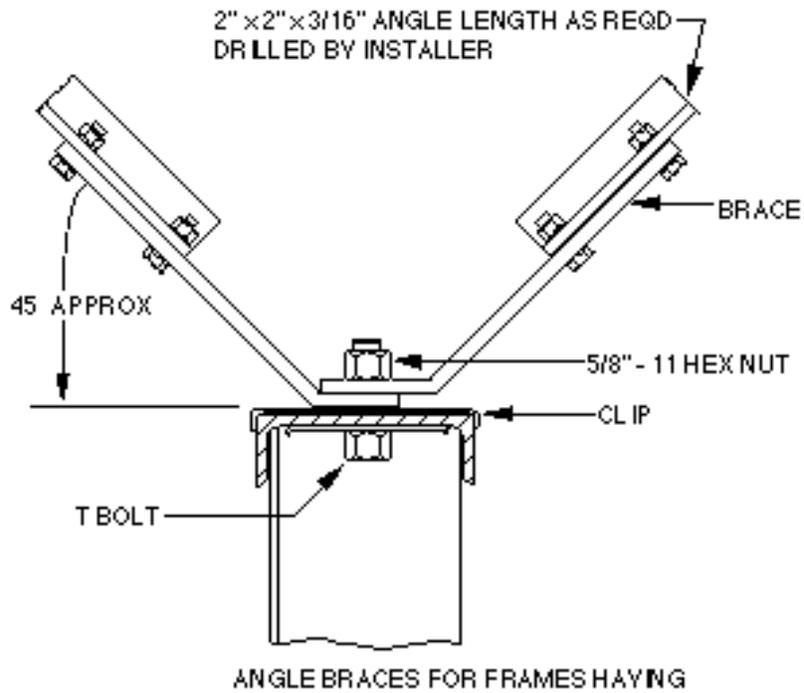
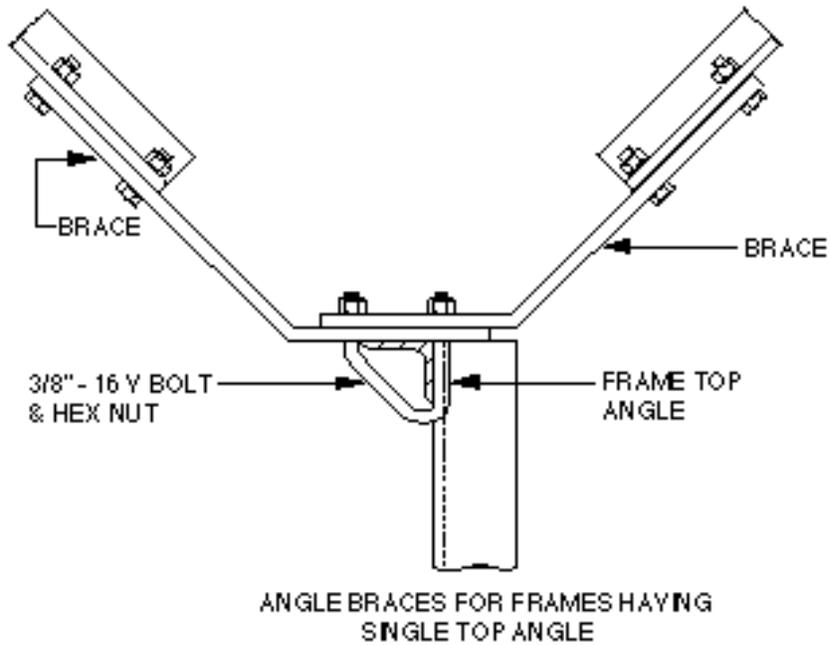
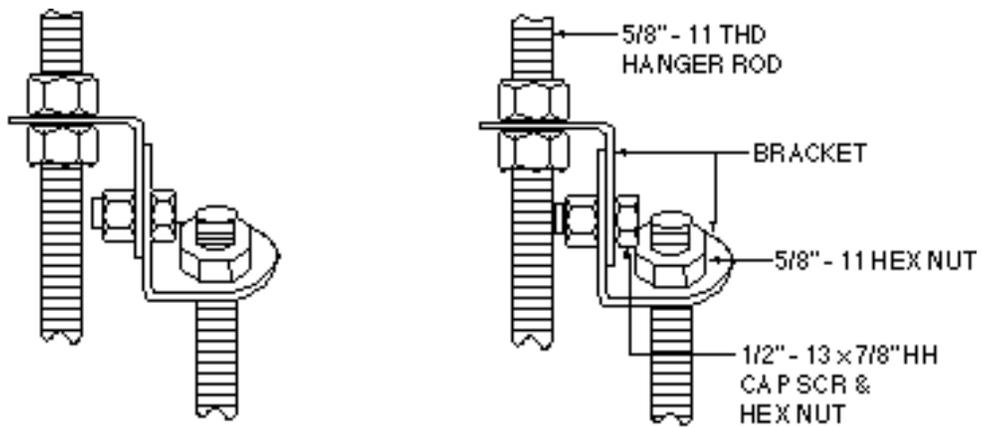


EXHIBIT 2-E3-36A  
DOUBLE BRACE FRAME SUPPORT USING ANGLE-TYPE BRACES



NOTE:  
EITHER ASSEMBLY MAY BE USED.

EXHIBIT 2-E3-37  
BRACE AT HANGER ROD

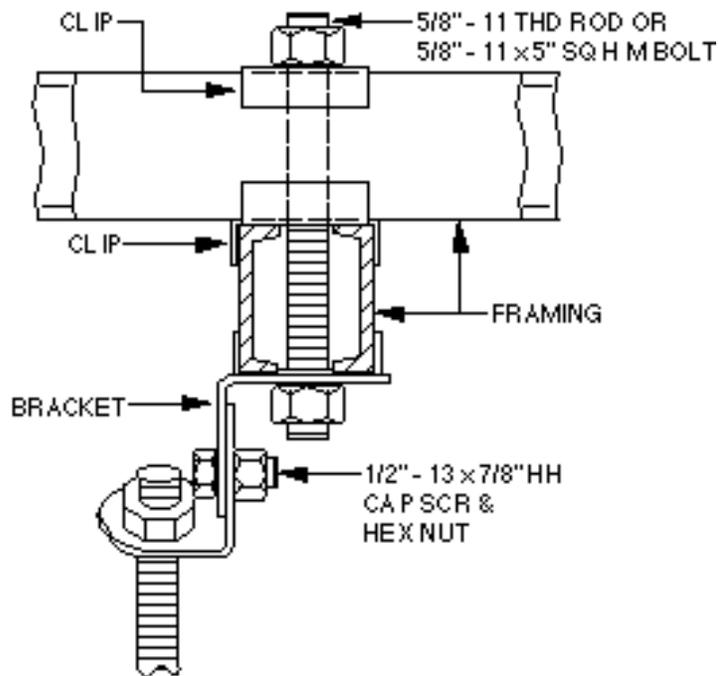


EXHIBIT 2-E3-38

BRACE ATTACHED AT JUNCTION OF FRAMING BARS OR CHANNELS

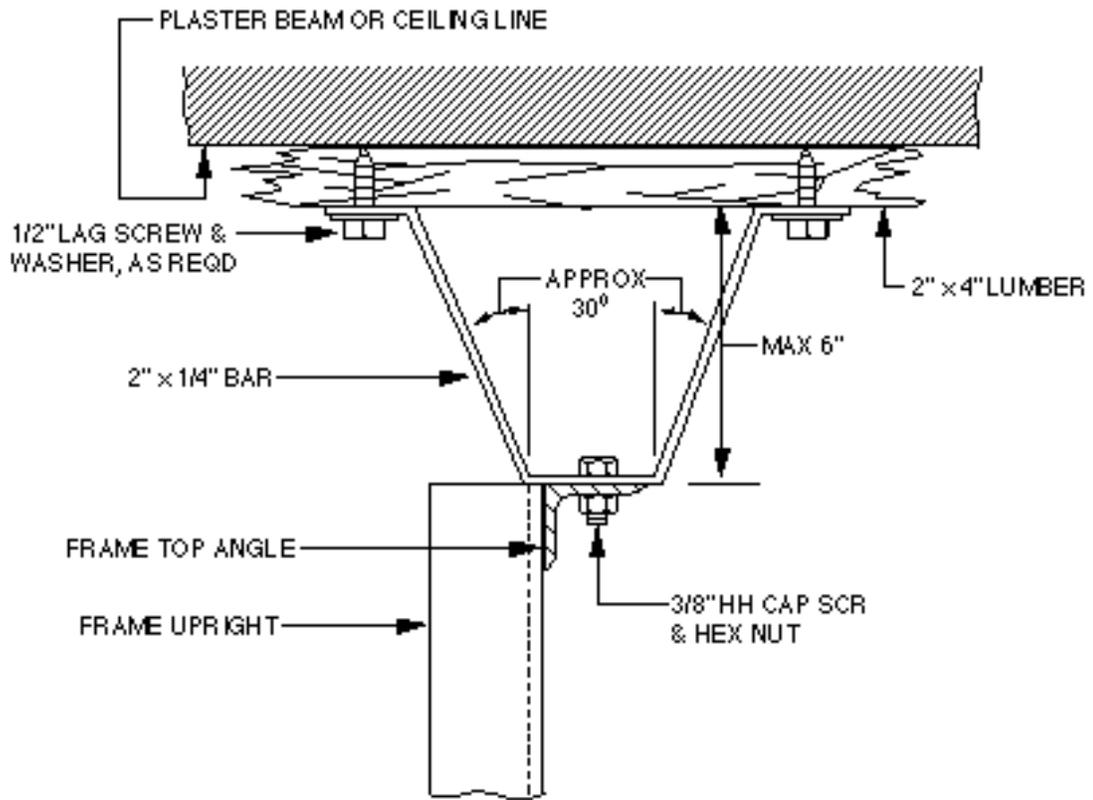


EXHIBIT 2-E3-44

V BAR FRAME SUPPORT FOR FRAMES WITH SINGLE TOP ANGLES

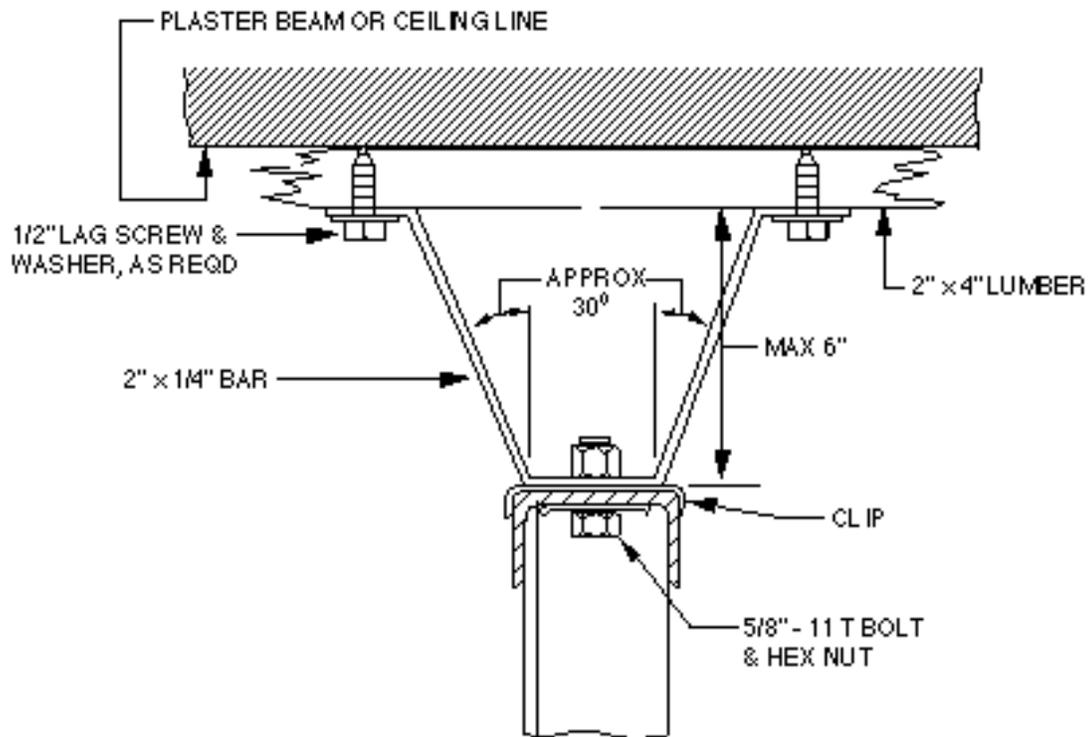


EXHIBIT 2-E3-44A

V BAR FRAME SUPPORT FOR BULB ANGLE TYPE FRAMES

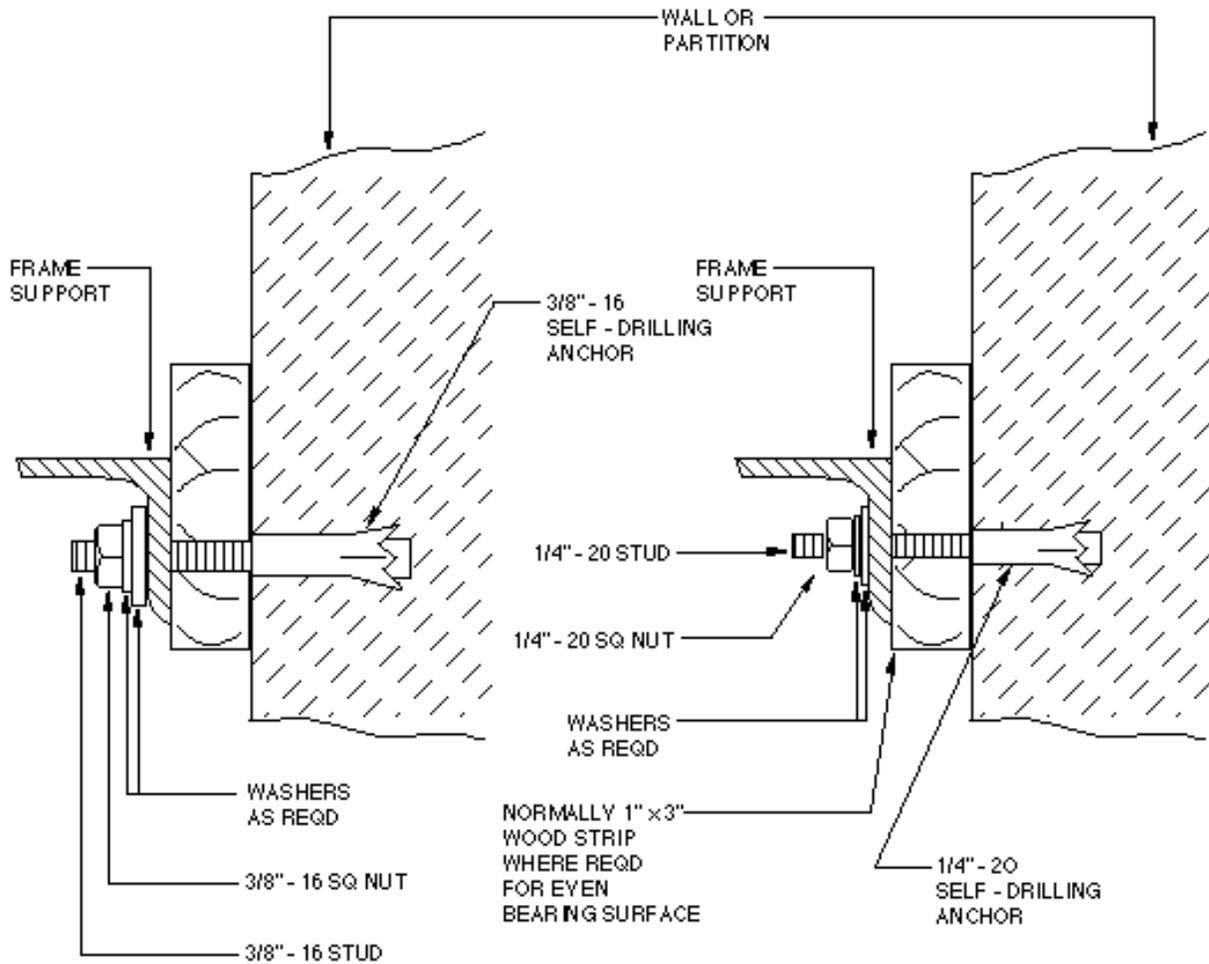


EXHIBIT 2-E3-45  
FRAME SUPPORT ATTACHED TO CEMENT WALL OR PARTITION

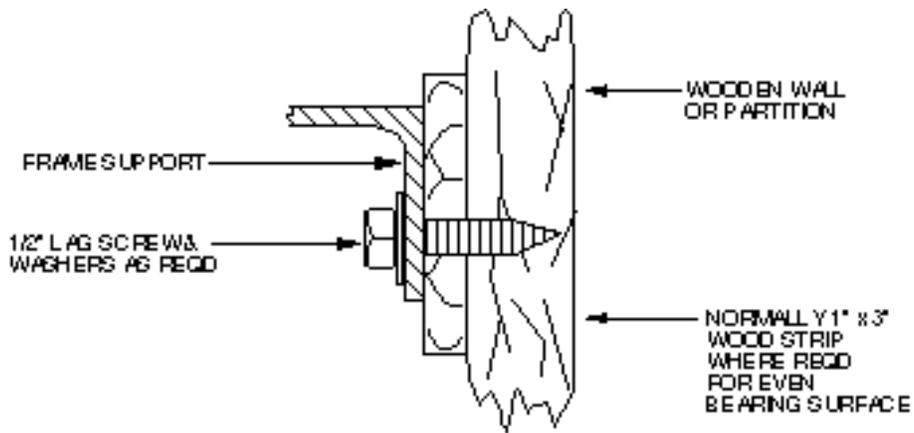


EXHIBIT 2-E3-46

CABLE RACK OR CONDUIT HANGER RODS ATTACHED TO FRAMING-CABLE RACK  
OR CONDUIT RUN PARALLEL TO PRIMARY BARS OR CHANNELS

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## **6. Cable Rack And Auxiliary Framing-**

### **6.D Rolling Ladders**

#### **6.16 General**

This unit covers the engineering requirements for rolling ladders and associated equipment such as ladder brakes and ladder track.

#### **6.17 Rolling Ladders - Track Type**

Rolling ladders, 14 inches in width of the straight-type as shown in Exhibits 2-E4-1 and 2-E4-2 or of the platform type as shown in Exhibit 2-E4-3 are to be furnished where aisle widths will permit. Ladders 12 inches wide may be furnished when aisle widths will not permit the use of 14 inch ladders. Ladders ten inches wide are considered special and are to be used only at the direction of the QWEST Equipment Engineer.

The number of steps for straight-type ladders of a particular vertical height may be determined from Exhibits 2-E4-1 and 2-E4-2. Straight-type ladders are furnished with 15 or fewer steps.

The number of steps for platform - type ladders of a particular vertical height may be determined from Exhibit 2-E4-3. Platform - type ladders are furnished with eight or fewer steps below the platform.

Ladders are assembled with the handrails on the right-hand side as shown in the illustrations. Where the floor plan arrangement is such that a ladder serves equipment on the right side only, the handrail shall be mounted on the left side of the ladder. Where a ladder serves both a Distributing Frame (DF) and other equipment frames, the handrail shall be located on the side away from the DF. The installer shall be directed to drill the left side of the ladder for handrail brackets, where required. It is not necessary to fill the bracket holes remaining in the right side rail after the handrail has been relocated.

Rolling ladders are to be equipped with fenders only where the frame guardrails are located above the shoulder of the ladder wheel brackets as is the case at DFs. In such cases, the fender shall be attached to the side rail of the ladder and located to engage with the frame guardrail as shown in Exhibit 2-E4-4. The guard plates on the vertical legs of platform-type ladders shall be relocated to engage with the guardrails in such cases. Ladders used in crossbar offices and in offices with cable duct frames having removable guardrails, shall be equipped with two wheelguards. Rolling ladders shall also be equipped with two wheelguards in line-ups where frames with guardrails extending to the floor are installed. Ladders used at Distributing Frames (DFs) shall be equipped with one wheelguard located on the side of the ladder adjacent to the DF.

The ladder shall be suspended from the upper support or hanger step by threaded rods. The effective length of the rods shall be such that the steps of the ladder are level.

Rolling ladders and ladder track at DFs shall be located as shown in Exhibit 2-E4-4 and in accordance with the following:

- Where a ladder serves a DF on one side and relay racks or other frames on the other side, the ladder shall be located with respect to the DF.
- When a ladder serves a narrow-type DF of approximately the same width as and in line with relay racks or frames, the ladder shall be located as shown in Exhibit 2-E4-5.
- Where a single line of ladders is located between DFs or between a protector frame and a DF, the ladders shall be located in the center of the aisle.
- When the distance from the center line of the ladder to the guardrail exceeds that recommended in Exhibits 2-E4-4, 2-E4-5 and 2-E4-6 the question of safety shall be reviewed with the QWEST Equipment Engineer.

At relay racks and Fuse Bays (FBs), ladders and ladder track shall be located as shown in Exhibit 2-E4-5. Where a ladder is to serve a double line of frames, only one line of which is installed initially, the ladder shall be located in the center of the aisle between the present and future line of frames.

For frames, racks or other equipment not specifically covered herein, the ladder locations shall agree, if possible, with the locations shown on the illustrations for the equipment they most closely resemble.

The minimum clearance for a single or double line of ladders is shown in Exhibit 2-E4-6.

The direction of slant of rolling ladders shall be such that the ladders are in the most suitable position for use by the maintenance force. Some of the factors with reference to the slant of rolling ladders are as follows:

- Ladders shall slant in a direction such that the foot is nearest the main cross-aisle or central maintenance point.
- Ladders in a single line of frames shall slant such that the foot of the ladder is toward the right when facing the frames.
- Ladders at DFs, where the approach is equally convenient from either direction, shall be slanted so that the right side of the person standing on and facing the ladder will be nearest to the frame.
- Ladders between lines of frames, equally convenient for approach, in either direction, may slant in either direction, preferably in the same direction as other adjacent ladders in the same section of the building.
- Where a ladder, slanted in accordance with the above, could not run a sufficient distance beyond the end of a row of frames to provide access to equipment in the upper portions of the end frame due to track interference, the direction of slant of the ladder shall be reversed.

- The slant of platform-type ladders shall be in the direction which permits access to the equipment at the upper portion of the end frames.
- At frame line-ups where the guardrails have an offset to a wider guardrail at one end, the ladder shall be slanted so as the ladder will not strike apparatus due to the wheel being opposite the narrow rail. Where a reversal of the slant of the ladder is not practical, the wider guardrail shall be extended to prevent interference.

### **6.18 Rolling Ladder Track**

Ladder track shall be installed, wherever practical in sections 8 feet and 10 feet in length. The number of sections required for various overall lengths is given in Exhibit 2-E4-7.

- Where the ultimate length of a line-up of track is being installed initially, or when the existing line-up is being extended to the ultimate and the overall length is such that one of the track sections is less than 5 feet, the shorter section shall be placed at some intermediate location in the track instead of at the end.
- Where the ultimate length of a line-up of track is not installed, but the track will be extended at some later date, the shorter length of track shall be located at the growing end of the track.
- The ladder track shall be extended at the position of future frames to obtain access to distributing power terminal strips, fuse cabinets, aisle pilots, etc., located at the ultimate end of a line-up.

The length of the ladder track shall provide an overhang at the ends of the line-up for access to all of the equipment on the frames. It shall also be long enough to permit proper support from the auxiliary framing or other details provided. A clearance of not less than 1 foot 3 inches between one end of the track and the wall toward which the ladder slopes shall be provided for the removal of the ladder trolley or brake from the track.

Ladder tracks shall ordinarily run continuously across aisles so as to permit concentration of ladders when necessary.

The end of the track toward which the ladder is inclined shall, where practical, extend sufficiently to permit placing a ladder stop 4 feet 2 inches beyond the end frame upright. The other end of the track shall extend a minimum of 3 feet beyond a ladder stop to permit entrance of maintenance equipment into the frame aisle. Ordinarily, the location of the stop in line with the end upright as shown in Exhibit 2-E4-27 will meet this requirement.

- When the ladder stop in the end of the rolling ladder track toward which the ladder slopes is located 4 feet 2 inches from the frame upright as mentioned above, the foot of the ladder blocks egress from the aisle. Where space permits, the ladder track may be extended such that the foot of the ladder will clear the end of the aisle to permit entrance and the number and spacing of track supports requirements are met.
- Where the ladder track is installed close to and beyond a column so that the rolling ladder cannot pass the column, a platform-type-rolling ladder is used and the stops located so that the ladder can approach the column without touching it.
- Where the ladder track serves equipment in close proximity to partitions or walls, so that platform-type ladders have to be used to reach all of the equipment, the minimum distance from the end of the last frame to the center of the ladder stop shall be 12 inches.
- For Partial equipment frame line-ups where the ultimate requirements for ladder track are finished initially, the stops shall be installed at the ends of the track to permit ladders to serve the ultimate line-up.

The track shall be assembled and aligned to ensure the proper operation of the ladder trolley and brake.

Sections of track shall be spliced as shown in Exhibit 2-E4-8.

Track support brackets shall be fitted closely to the tracks so as to hold the track as securely as practical against lengthwise movement. To prevent creeping of the track in the supports, the track shall be bolted to both end support brackets in each continuous line as shown in Exhibit 2-E4-9. When a line of track is extended, an additional bolt shall be added in the track support at the end of the new section. The intermediate bolt and support may be left in place.

- Where an end support is bolted to the track by means of the ladder stop bolt as shown in Exhibit 2-E4-26, the 1/4 of an inch bolt per Exhibit 2-E4-9 may be omitted from this end.
- Where there is interference between the 1/4 of an inch creeper bolts and the hanger rod in the end ladder track supports, the creeper bolts may be located in the next to the end track support. Should similar interference also be encountered in the next to the end supports, the creeper bolt shall be located in the end support bracket as shown in View E of Exhibit 2-E4-9; the installer shall be instructed to redrill the track support bracket. The latter arrangement also applies should interference from the bolt prevent placing a creeper bolt in the regular location in the track support below the end brace shown in Exhibit 2-E4-24.
- Where the ladder track is supported from high-type auxiliary framing, and end braces are required, additional creeper bolts shall be installed in the track supports of the angle braces associated with both end braces.

- Where hanger brackets are used, clearances in excess of 1/32 of an inch may be encountered between the sides of the ladder track and the inside of the bracket. Shims 1/32 of an inch thick are available to ensure a tight fit of the track in the bracket in such cases. They shall be installed as shown in Exhibit 2-E4-9, View C.
- When hanger brackets shown in Exhibit 2-E4-9, View B are removed while making changes or extension to the existing track; they shall be discarded and replaced by any of the brackets shown in Exhibit 2-E4-9, View A, C or D.
- When installing hanger brackets shown in Exhibit 2-E4-9, View D, the horizontal portion of the bracket may be turned in either direction.
- When it is necessary to install creeper bolts at supports per Exhibits 2-E4-18 and 2-E4-19, the creeper bolts shall be long enough to go through the 2 inches by 1/2 inch bar.

Where low-type auxiliary framing is used, ladder track shall be attached directly to the underside of the auxiliary framing.

Ladder track shall be located as high as cable racks will permit where frames are supported by high-type auxiliary framing. At DFs supported by high-type auxiliary framing, it is desirable that the ladder track be located to take advantage of available headroom.

Ladder track shall be installed as level as possible. However, where ladder tracks run continuously between areas having auxiliary framing at different levels, such as between areas having high framing and areas having low framing or between two heights of low-type framing, the difference in level may be taken care of by a slight slope of the track. For differences in level of 1-1/2 inches to 2 inches, the sloping portion shall not be less than 20 feet and shall be installed as shown in Exhibit 2-E4-11A. The ladder used at this slope shall be adjusted so that the steps are level at the midpoint of the slope. Differences of 1/2 of an inch or less may be taken care of by sloping the track between adjacent supports of the different levels.

Continuous runs of ladder track shall be supported at approximately 5 foot intervals and in no case shall the spacing between adjacent supports exceed 6 feet 5/8 of an inch.

- Provide a least two supports for each length of track supported from high-type auxiliary framing.
- Provide at least one support for each length of track supported from low-type auxiliary framing or cable rack except that end pieces shall have not less than two supports.

- Track shall not extend cantilever-fashion more than 3 feet beyond a support if the trolley traverses the entire length of the extension. If the travel of the trolley in the extension is limited by a stop bolt, the total extension beyond the last support shall not exceed 4 feet. In this case, the distance from the last support to the stop bolt may be up to 3 feet and the track may extend beyond the stop bolt. Exhibit 2-E4-27 illustrates conditions that may be encountered.

Tracks shall be supported from auxiliary framing or the ceiling in steel frame and concrete buildings as shown in Exhibits 2-E4-10 through 2-E4-13. Where proper support cannot be obtained with auxiliary framing, additional framing shall be installed.

When support from cable rack is required, tracks shall be fastened as shown in Exhibits 2-E4-14 through 2-E4-18. The supporting details shall be fastened not more than one foot from the cable rack support. Tracks shall not be attached to cable rack that is supported by offset bent hanger rods.

When tracks are to be supported from cable racks that utilize hanger rods, 5/8-11 hexagon nuts shall be placed above the cable rack hanger clips as outlined in the cable rack requirements unit of this document.

Where tracks are to be under cable racks that are supported by low-type auxiliary framing, the track shall be attached to the cable rack bars as shown in Exhibit 2-E4-11 or 2-E4-12. If track supports are required at points between the cable rack supports, pairs of bars or channels shall be attached to the cable rack as shown in Exhibit 2-E4-15, and the track supported from these bars are channels as indicated by the appropriate Exhibits.

Tracks shall be supported from lattice work in accordance with Exhibit 2-E4-19.

In wood joist constructed buildings, timbers shall be installed from which the track can be supported as shown in Exhibits 2-E4-20, 2-E4-21, 2-E4-22, or 2-E4-23. The track supports may be fastened to or suspended by threaded rods from the timbers. Track supports shall be located approximately 3 feet apart, but not to exceed 4 feet apart.

End braces in accordance with Exhibit 2-E4-24 or 2-E4-25 are required at each end of track where the distance between the top of the support and the bottom of the auxiliary framing or other support is ten inches or more. The preferred location for the end brace is shown in Exhibit 2-E4-25.

Side braces in accordance with Exhibit 2-E4-25 are required for ladder track where the distance between the top of the track supports and the bottom of the auxiliary framing or other support is ten inches or more. Where this distance is ten inches but less than 1 foot 3 inches, provide a side brace at each end support and at each alternate intermediate support. Where this distance is 1 foot 3 inches or more, provide a side brace at every support.

Where ceiling inserts are not available adjacent to walls, drill new inserts. In extreme circumstances, ladder tracks may be supported from the wall in accordance with Exhibit 2-E4-28.

A ladder stop shall be installed at each end of the track as shown in Exhibit 2-E4-27. Ladder stops shall be equipped with cotter pins. Where rubber plugs per Exhibit 2-E4-29 are installed, the plug may be used as a stop.

Where a ladder track extends close to a wall, column, or equipment, the ladder stop shall be so placed that it will prevent the ladder from striking the wall, column, or equipment.

Ladder track plugs are to be furnished for the ends of track that are exposed. The plugs shall be installed as shown in Exhibit 2-E4-29.

- Ladder track plugs shall be provided where two lines of track are noncontinuous in the same aisle and the ends of the track overlap.
- Ladder track plugs shall be provided at both ends of a track run. In those cases where a stop would normally be provided, the plug shall serve as the stop.

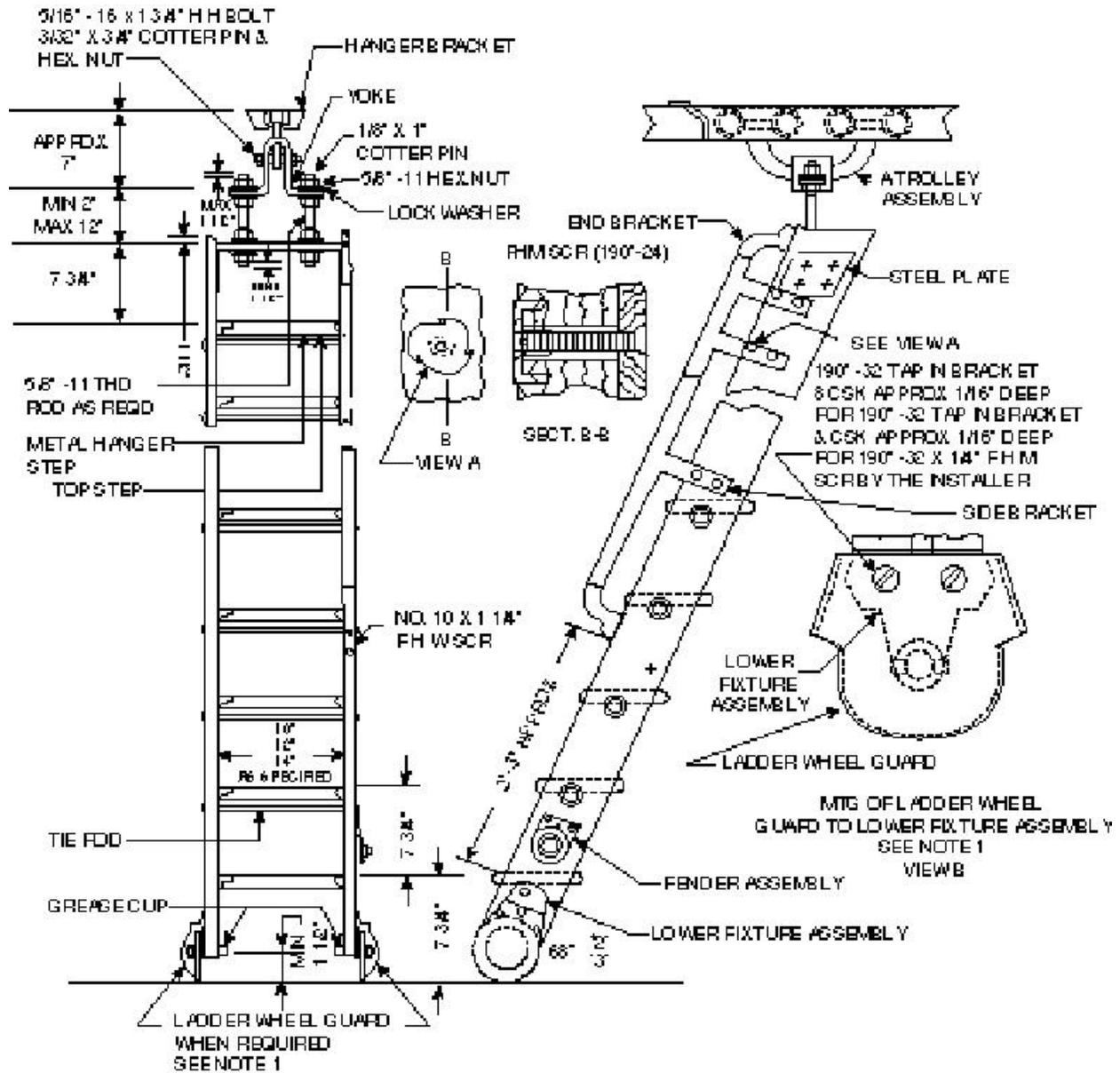


Exhibit 2-E4-1  
 Straight-Type Rolling Ladder Assembly Without Brake

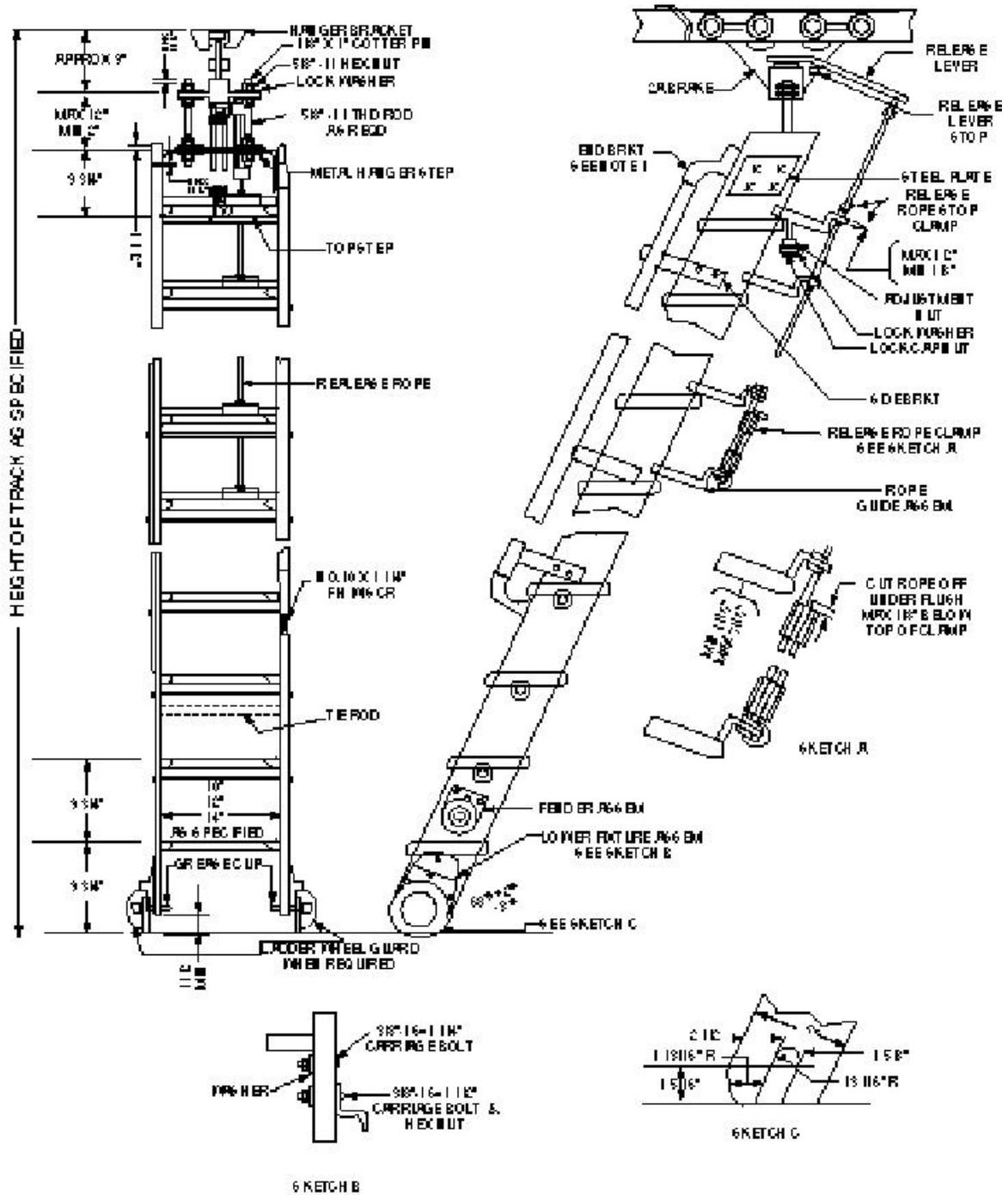
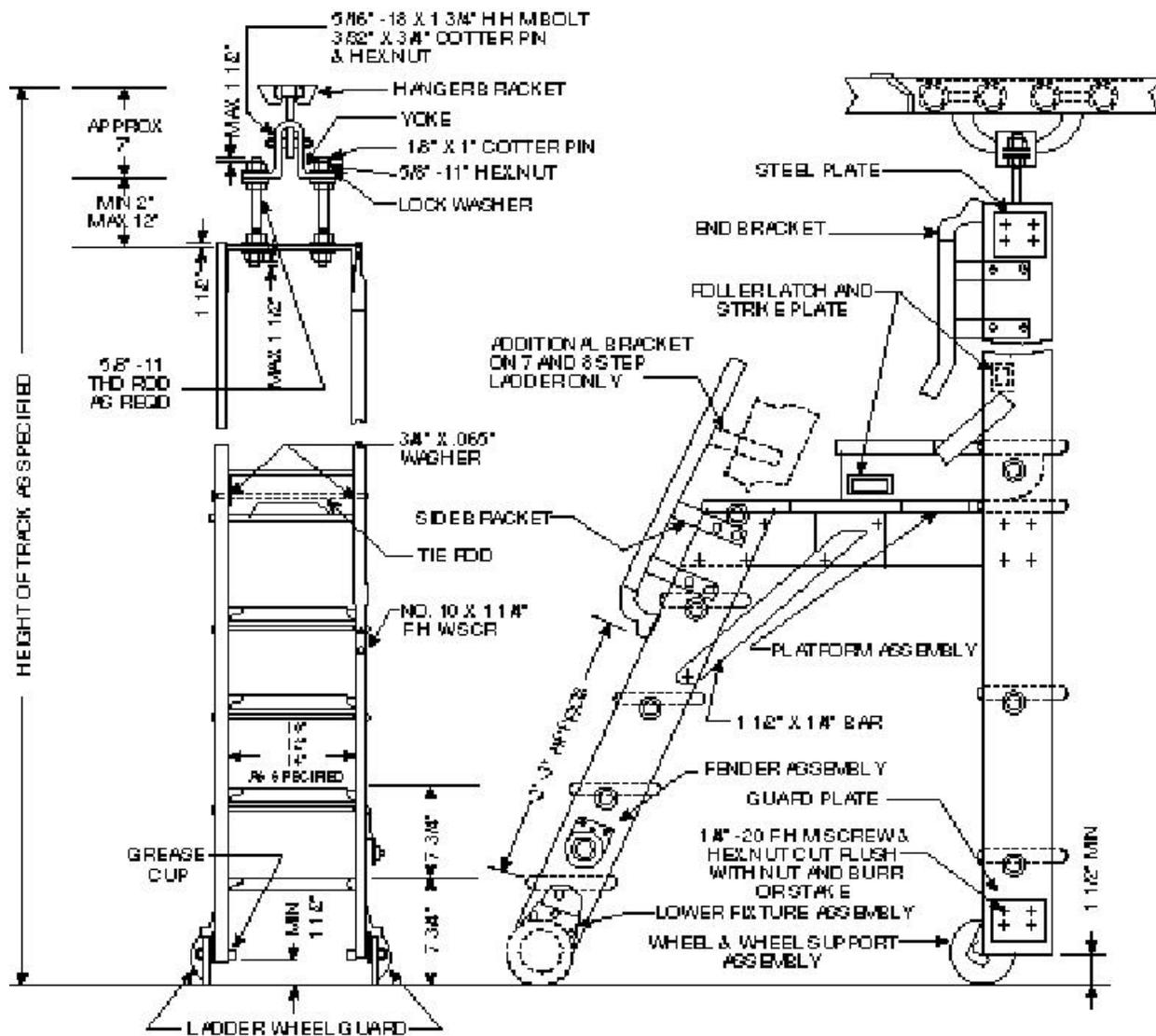
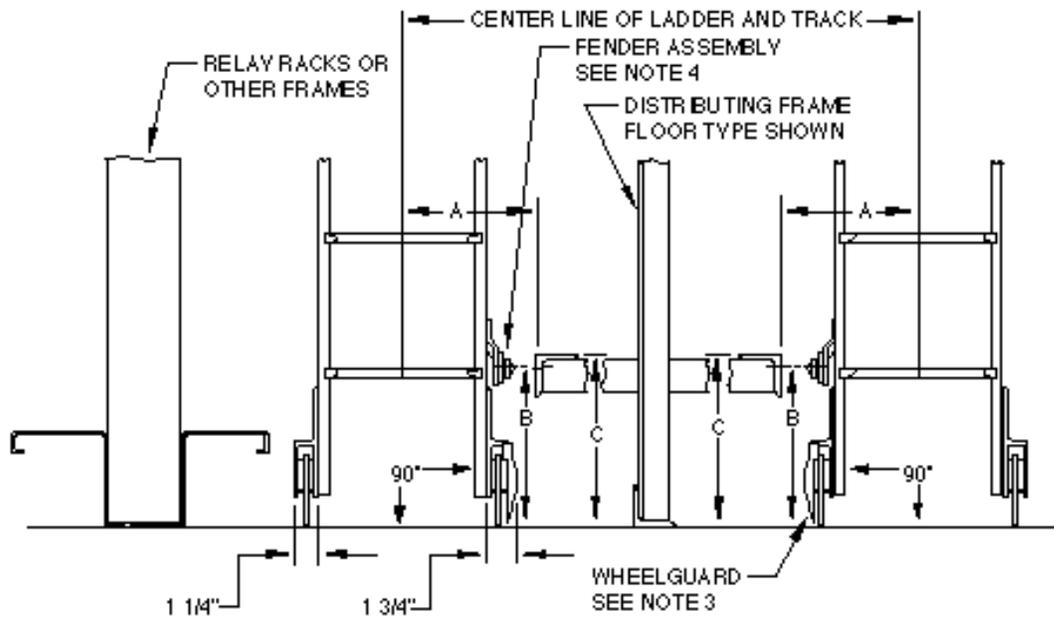


Exhibit 2-E4-2  
 Straight -Type Rolling Ladder Assembly With Brake



NUMBER OF STEPS FOR LADDERS OF THE SAME HEIGHT	
STRAIGHT LADDER	EQUIVALENT PLATFORM LADDER
11	4
12	5
13	6
14	7
15	8

Exhibit 2-E4-3  
 Platform-Type Rolling Ladder Assembly



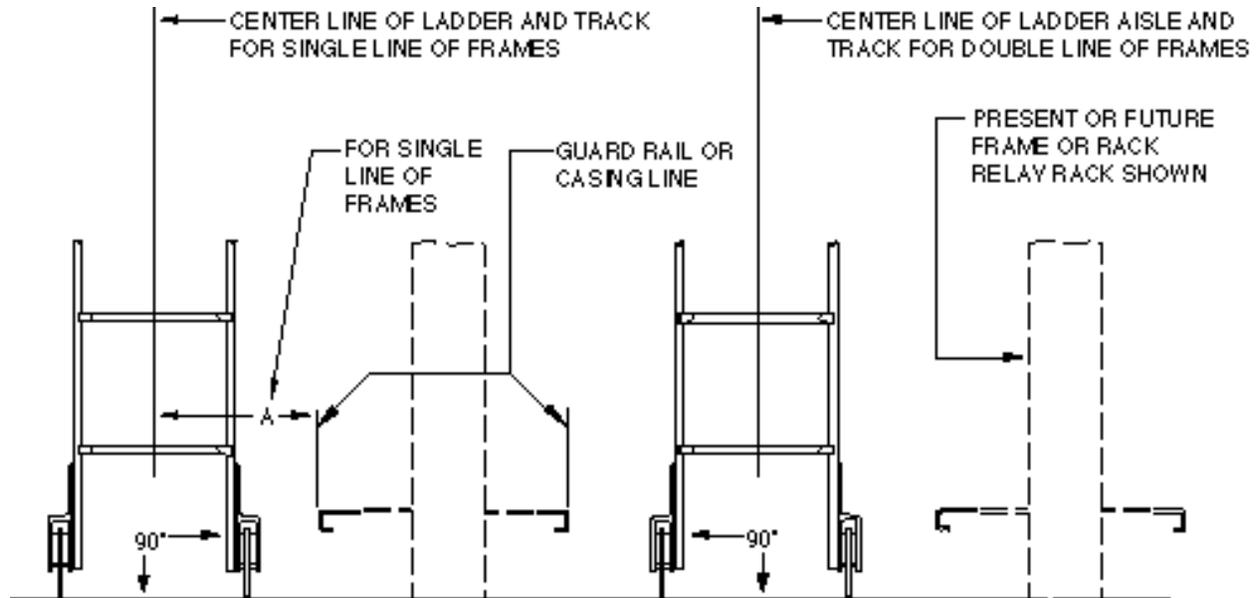
FRAME	B	C
FLOOR TYPE DISTRIBUTING OR GROUPING FRAMES WITH ANGLE IRON GUARD RAILS	10 1/4"	11"
WALL TYPE DISTRIBUTING FRAME	1'-1 1/8"	1'-1 7/8"
DISTRIBUTING OR GROUPING FRAMES WITH SHEET METAL BASE	SEE NOTE 1	

LADDER	A	
	USUAL	MIN
10"	8"	7 1/4"
12"	9"	8 1/4"
14"	10"	9 1/4"

NOTES:

1. CERTAIN DISTRIBUTING AND GROUPING FRAMES IN CROSSBAR OFFICES HAVE A SHEET METAL BASE WITH GUARD RAIL 6" FROM THE FLOOR SIMILAR TO THAT USED ON ALL CROSSBAR SWITCH FRAMES. LADDER FENDERS ARE THEREFORE NOT NECESSARY AT THESE FRAMES
2. DIMENSION "A" FOR THE CROSSBAR LDF SHALL BE 12" BECAUSE OF 6 POINT BUNCHING BLOCKS LOCATED IN THE UPPER PORTION OF THE FRAME. A 14" LADDER WILL ALWAYS BE USED AT THE LDF. DIMENSION "A" FOR ALL OF THE VARIOUS GROUPING FRAMES IN NO. 1 CROSSBAR AND NO. 4 TOLL SWITCHING OFFICES SHALL BE AS SHOWN WHERE THE FRAMES ARE ISOLATED. WHERE THEY ARE ARRANGED WITH REGULAR CROSSBAR FRAMES SO THAT ONE LADDER WILL SERVE TWO LINES OF FRAMES, THE LADDER TRACK SHALL BE LOCATED IN THE CENTER OF THE AISLE AS SHOWN IN FIG. 5.
3. IN ORDER TO PREVENT JUMPER WIRE FROM BECOMING ENTANGLED WITH LOWER FIXTURE ASSEMBLIES A WHEELGUARD SHALL BE FURNISHED ON THE FRAME SIDE OF ALL LADDERS AT DISTRIBUTING FRAMES IN ALL OFFICES.
4. THE FENDER ASSEMBLY SHALL BE LOCATED ON THE SIDE RAIL ADJACENT TO THE GUARD RAIL WITH THE CASTER

Exhibit 2-E4-4  
Location And Clearance For Ladders At Distributing Frames

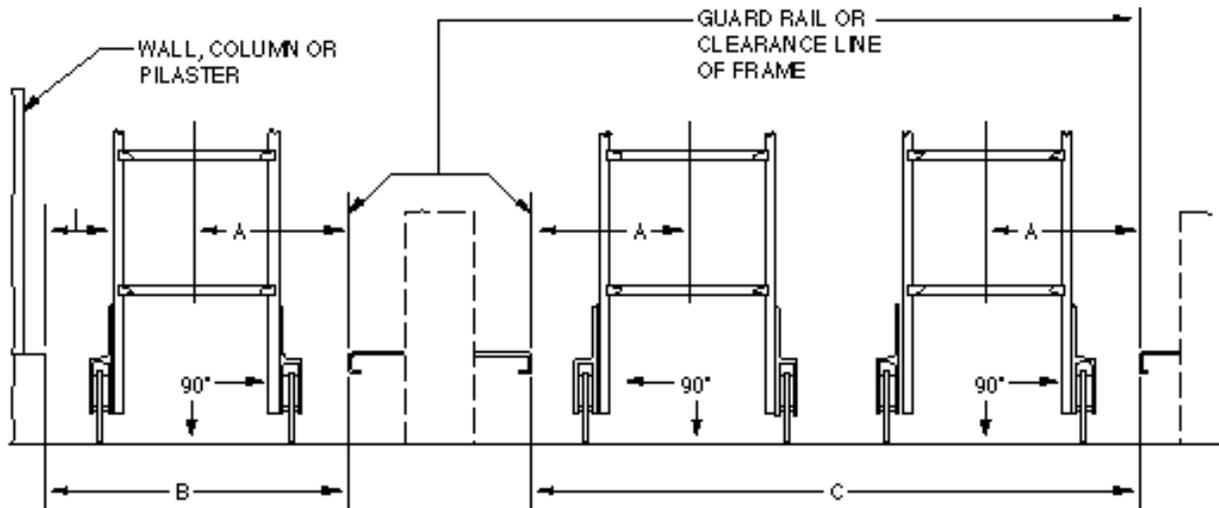


NOTES:

1. DIMENSION "A" FOR FUSE BOARDS HAVING A 12" GUARD RAIL SHALL BE 8 1/2", 9 1/2" OR 10 1/2" FOR 10", 12" & 14" LADDERS RESPECTIVELY.
2. WHEREVER IN CROSSBAR OFFICES (ALL TYPES) A 14" LADDER SERVES A SINGLE LINE OF FRAMES AND SPACE WILL PERMIT, THE TRACK SHALL BE LOCATED 13" FROM

LADDER	A	
	USUAL	MIN
10"	8"	7 1/4"
12"	9"	8 1/4"
14"	10"	9 1/4"

Exhibit 2-E4-5  
 Location And Clearance For Ladders At Relay Racks, Fuse Bays, Crossbar, And Step-By-Step  
 Frames



NOTES:

1. WHERE THE "B" DIMENSION IS GREATER THAN THAT SHOWN, THE LADDER SHALL BE CENTERED BETWEEN THE GUARD RAIL AND THE  $\phi$  OF THE COLUMN, DEVIATING FROM THIS LOCATION ONLY TO THE EXTENT REQUIRED TO MAINTAIN THE NECESSARY 2 1/4" CLEARANCE BETWEEN THE LADDER SIDE RAIL AND THE BASE OF THE COLUMN. WHERE PRINT DISPLAY BOARDS ARE LOCATED ON THE  $\phi$  OF THE COLUMN ROWS THIS 2 1/4" MINIMUM SHALL BE INCREASED TO 3" TO ALLOW A 5" CLEARANCE BETWEEN THE LADDER SIDE RAIL AND THE DISPLAY BOARD LIGHTING FIXTURE.

LADDER	A	B	C
10"	7 1/4"	1'-2 1/2"	2'-5 3/4"
12"	8 1/4"	1'-4 1/2"	2'-9 3/4"
14"	9 1/4"	1'-6 1/2"	3'-1 3/4"

Exhibit 2-E4-6  
 Minimum Clearances For Single And Double Lines Of Ladders

LENGTH OF TRACK	NUMBER OF SECTIONS OF TRACK REQUIRED		LENGTH OF TRACK	NUMBER OF SECTIONS OF TRACK REQUIRED	
	10' SECT	8' SECT		10' SECT	8' SECT
8		1	66	5	2
10	1		68	6	1
12		2	70	7	
14		2	72	4	4
16		2	74	5	3
18	1	1	76	6	2
20	2		78	7	1
22		3	80	8	
24		3	82	5	4
26	1	2	84	6	3
28	2	1	86	7	2
30	2		88	8	1
32		4	90	9	
34	1	3	92	6	4
36	2	2	94	7	3
38	3	1	96	8	2
40	4		98	9	1
42	1	4	100	10	
44	2	3	102	7	4
46	3	2	104	8	3
48	4	1	106	9	2
50	5		108	10	1
52	2	4	110	11	
54	3	3	112	8	4
56	4	2	114	9	3
58	5	1	116	10	2
60	6		118	11	1
62	3	4	120	12	
64	4	3			

NOTE:

FOR TOTAL LENGTHS GREATER THAN 120' THE NUMBER OF LENGTHS OF TRACK MAY BE DETERMINED BY ADDING THE NUMBER REQUIRED FROM THE LENGTH IN EXCESS OF 120' TO THE NUMBER REQUIRED FOR 120' AS LISTED IN ABOVE TABLE.

Exhibit 2-E4-7  
 Number Of Section Of Track Required For Various Lengths Of Track

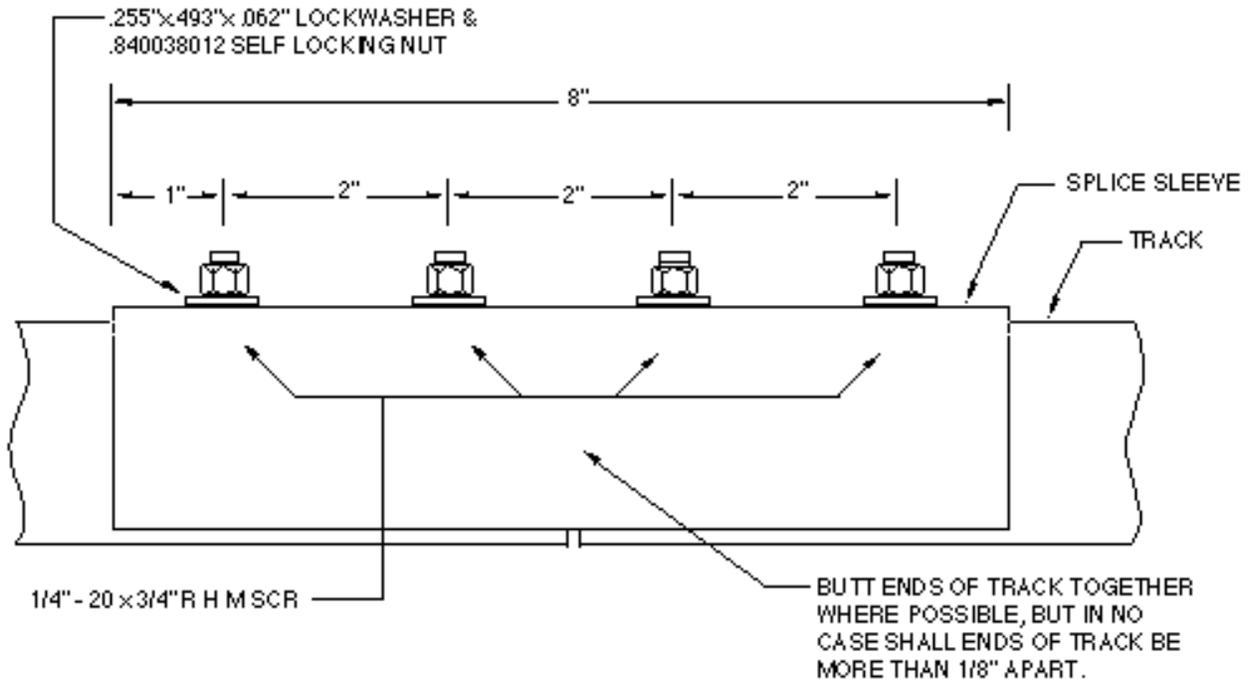
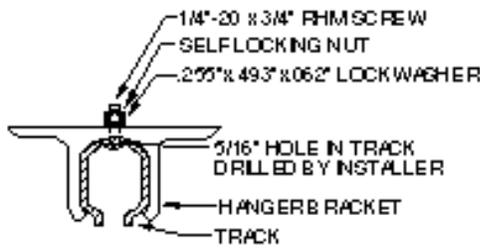
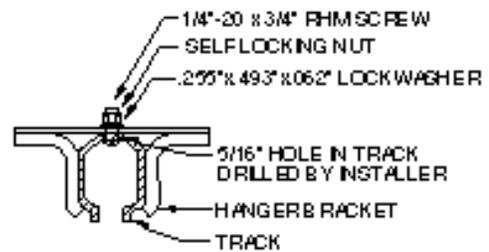


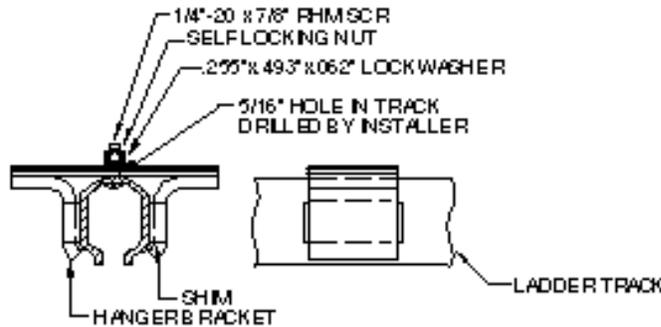
Exhibit 2-E4-8  
Splicing Sleeves For Ladder Track



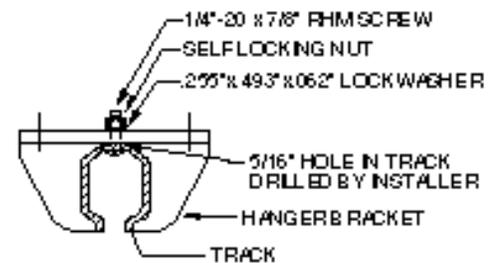
**VIEW A - CAST BRACKET**



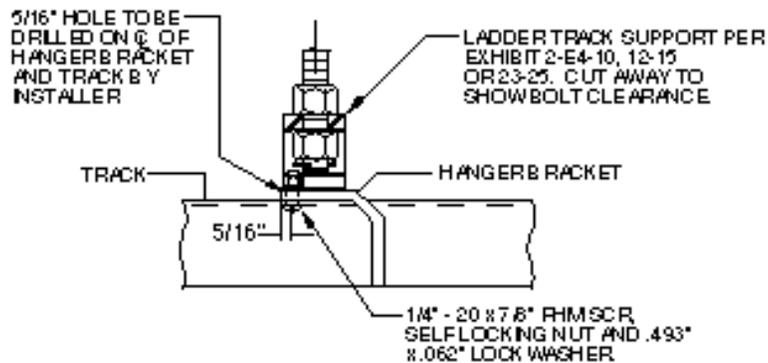
**VIEW B - WELDED STEEL BRACKET**



**VIEW C - REINFORCED WELDED STEEL BRACKET**



**VIEW D - SHEET METAL BRACKET (angle type)**



**VIEW E - RELOCATION OF CREEPER BOLT WHERE INTERFERENCE FROM END OF THREADED ROD PREVENTS ITS BEING INSTALLED IN REGULAR HOLE PROVIDED IN BRACKET (SHEET STEEL BRACKET SHOWN)**

Exhibit 2-E4-9  
 Track Support Brackets

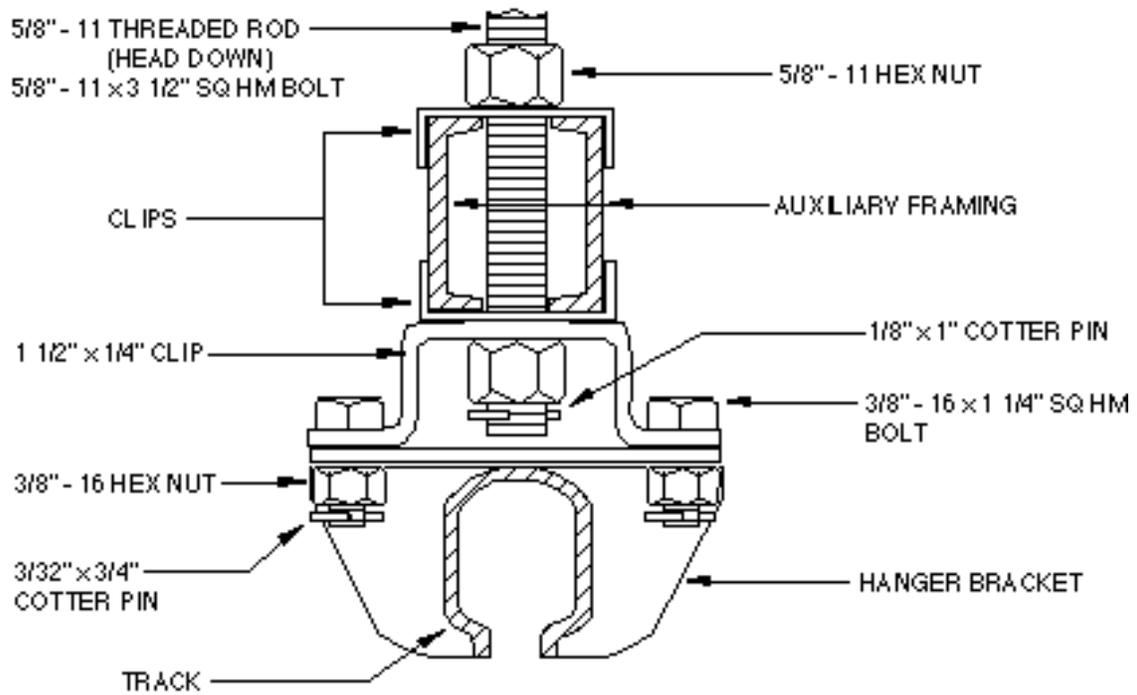


Exhibit 2-E4-10  
Track Supported Parallel To/Or At Right Angles To Auxiliary  
Framing, Parallel Shown

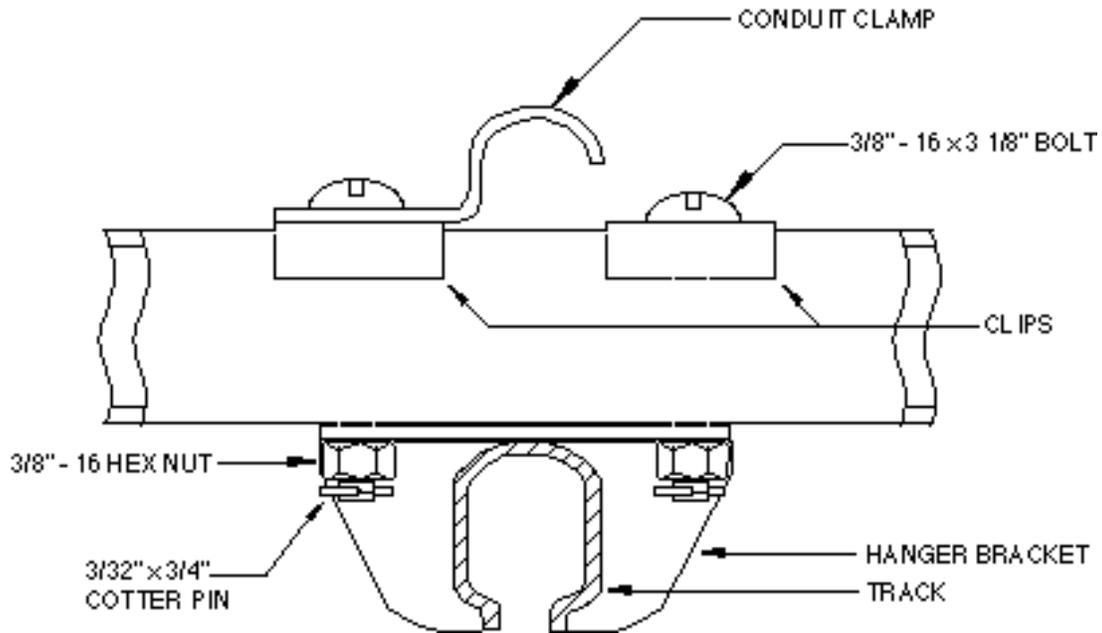


Exhibit 2-E4-11  
Track Supported Directly From And At Right Angles To Auxiliary Framing

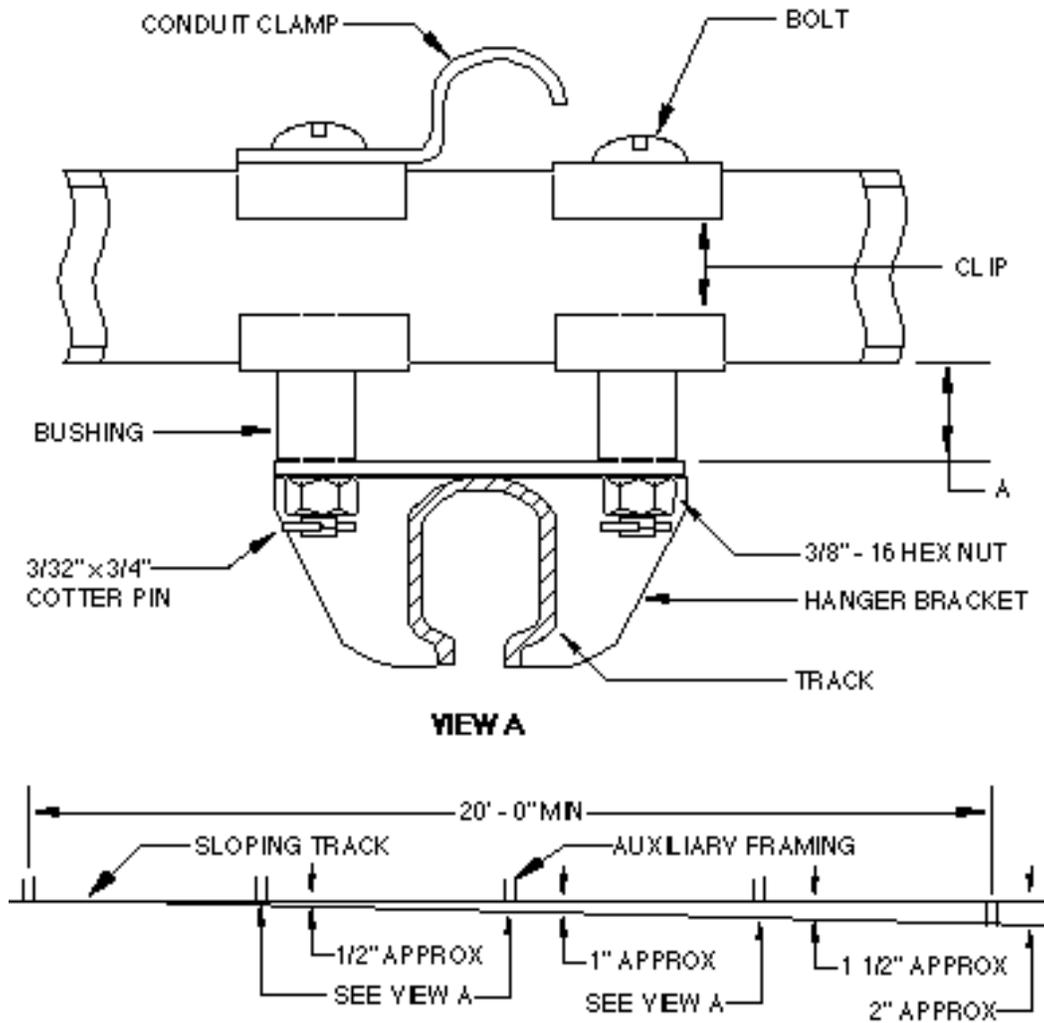


Exhibit 2-E4-11A  
Track Supported From And At Right Angles To Auxiliary Framing- Sloping Track - 2 Inches  
Difference In Auxiliary Framing Level

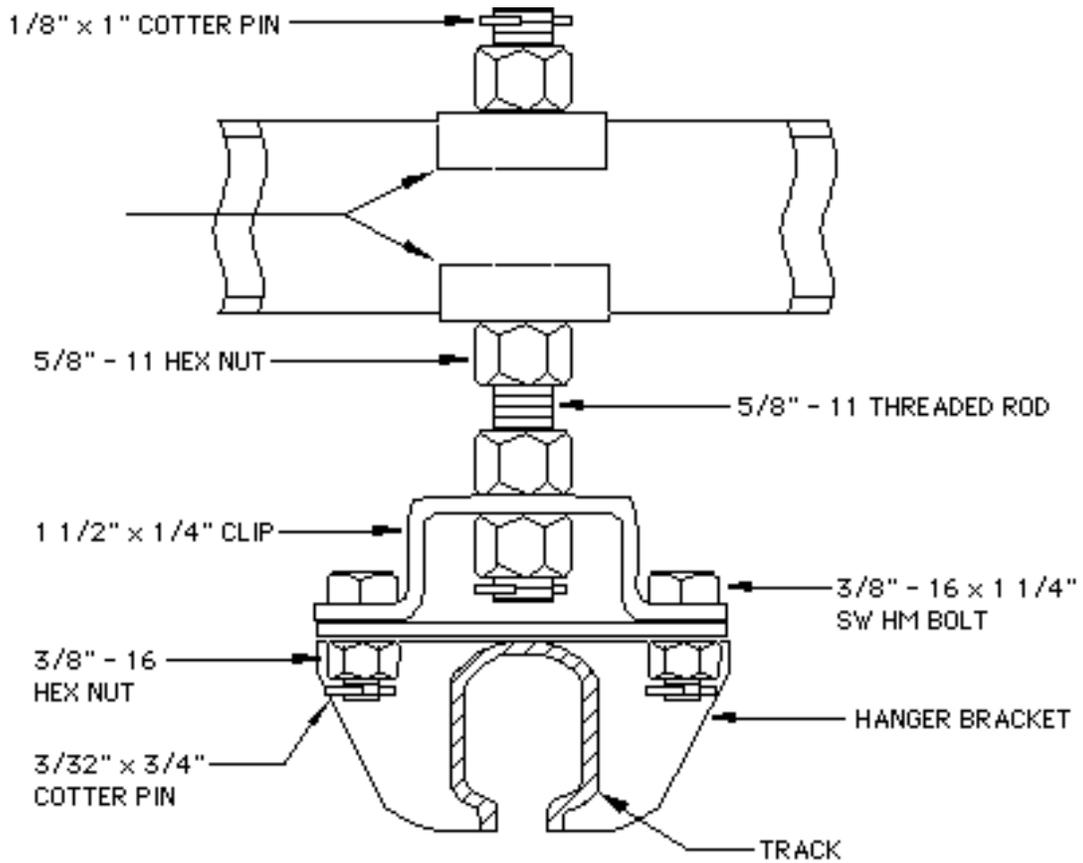


Exhibit 2-E4-12  
Track Supported From Auxiliary Framing With Extension Rod

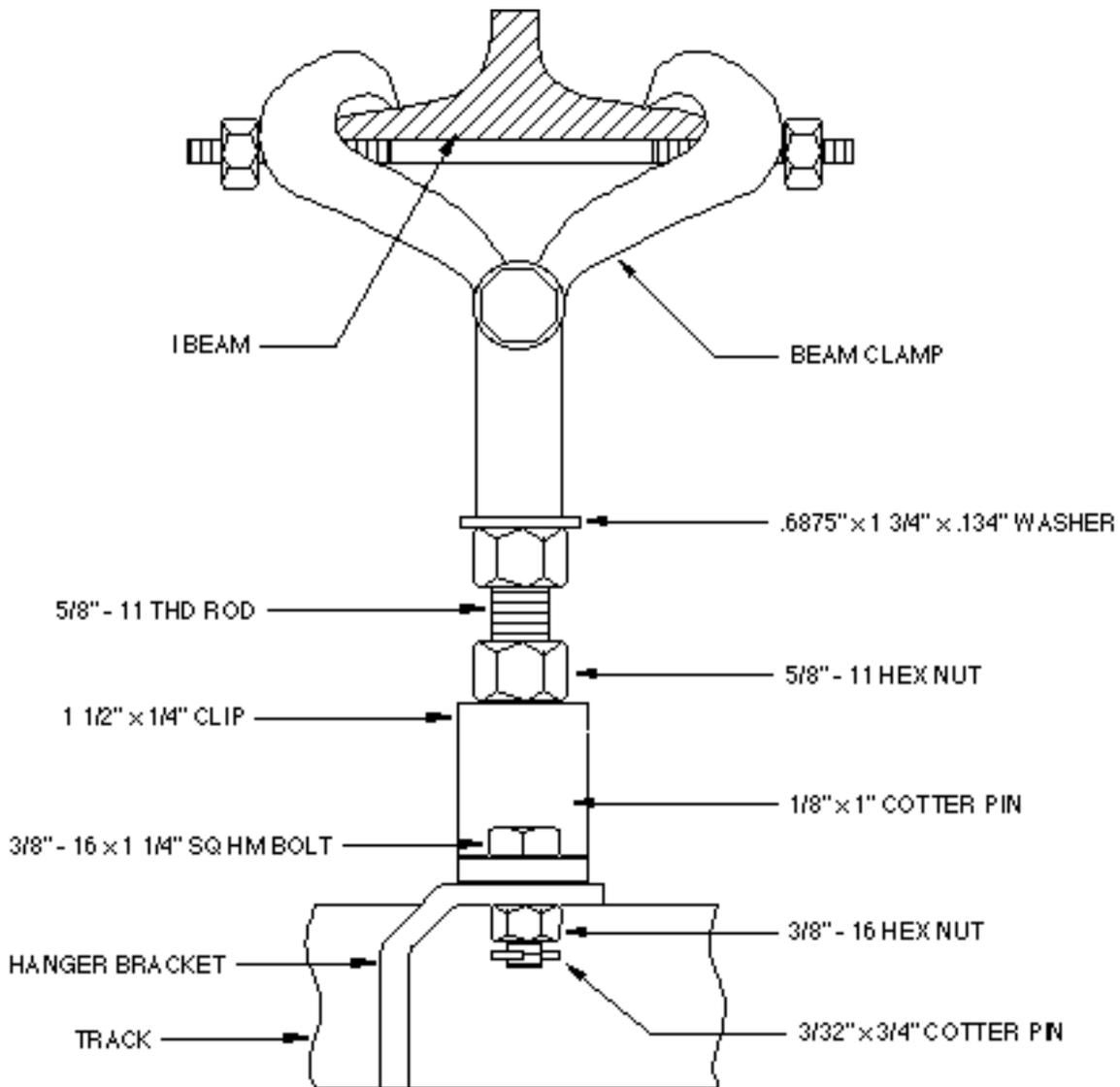


Exhibit 2-E4-13  
Track Supported Directly From Ceiling

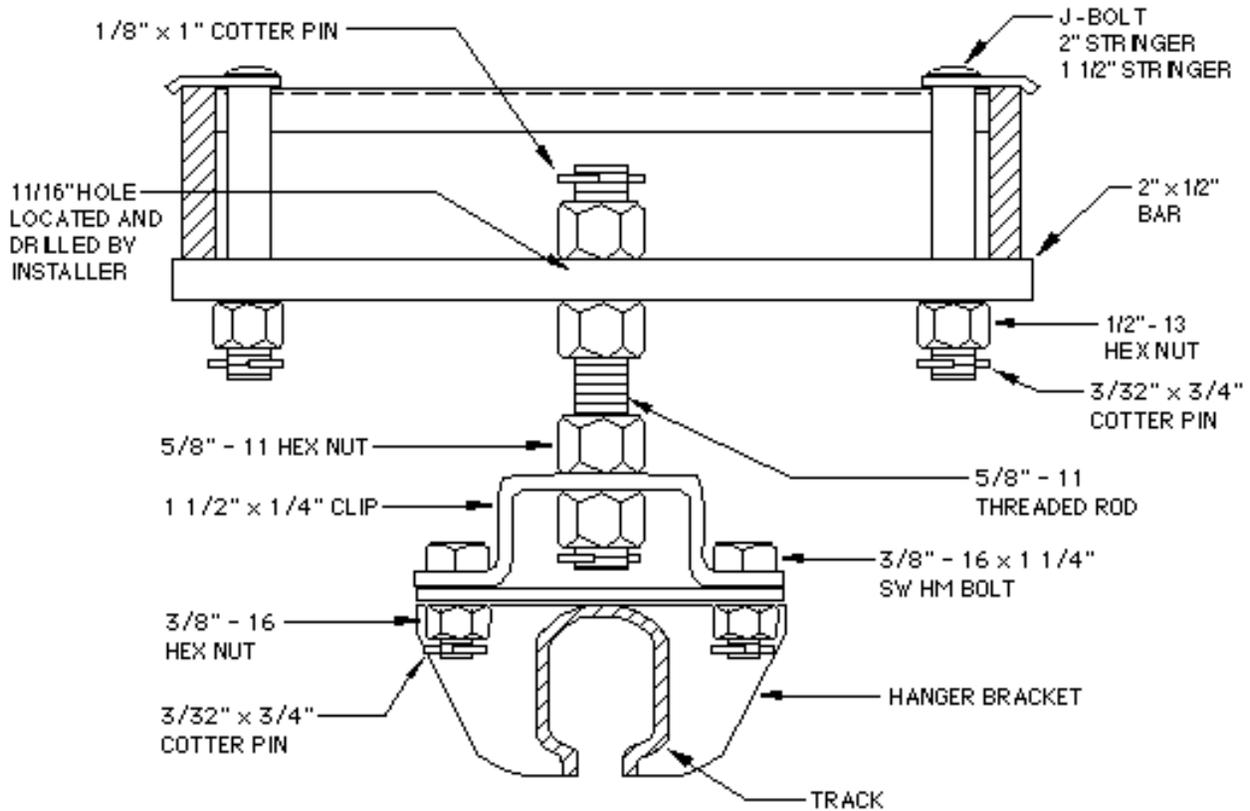


Exhibit 2-E4-14  
Track Supported With Extension Rods From Cable Rack 2 Feet 1 Inch  
Or Less Wide - Track And Parallel With Cable Rack



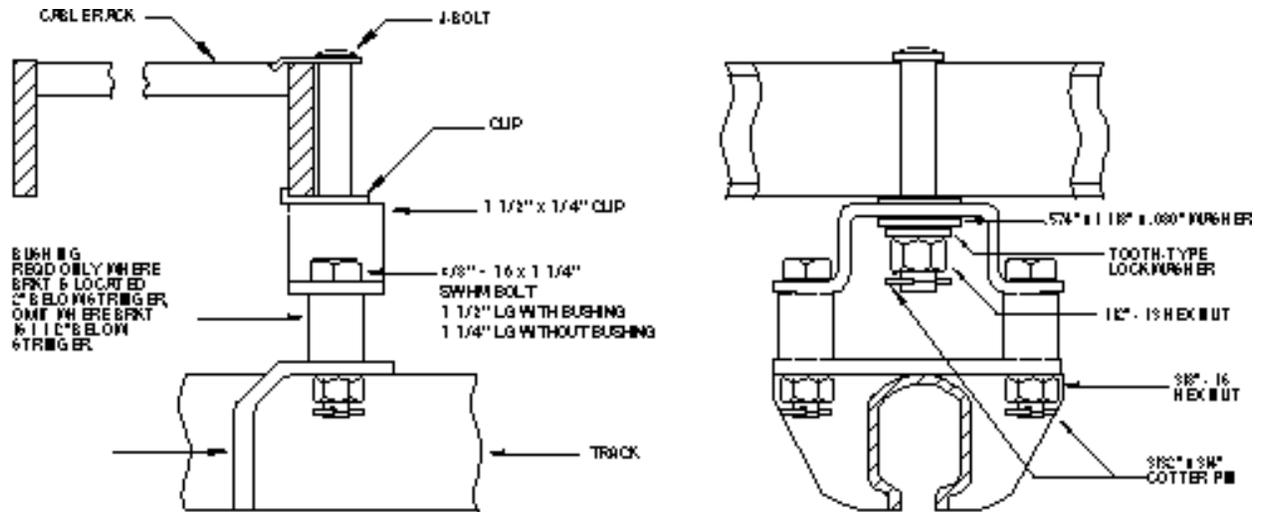


Exhibit 2-E4-16  
 Track Supported Below And At Right Angles To Cable Rack

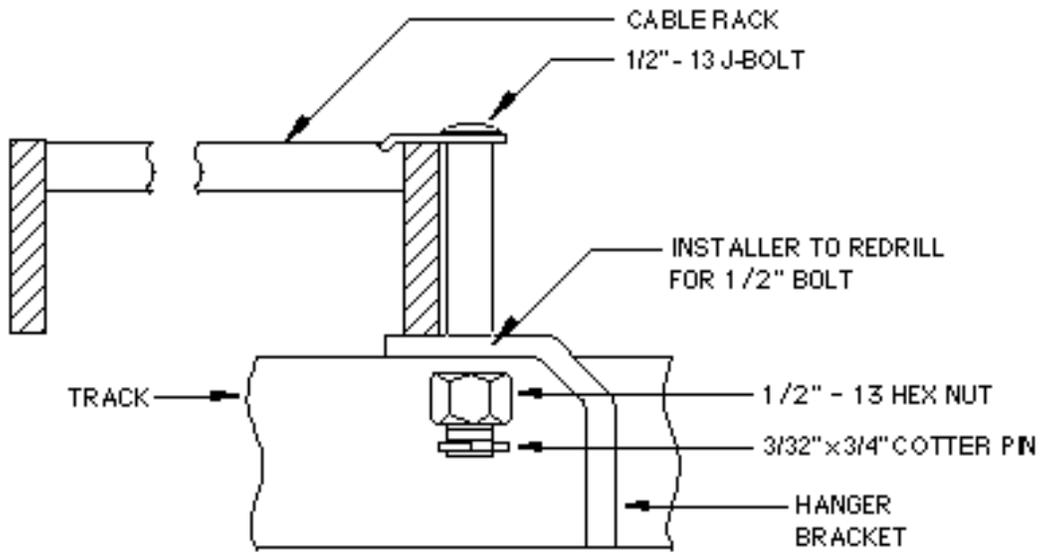


Exhibit 2-E4-17  
Track Supported Directly From And At Right Angles To Cable Rack

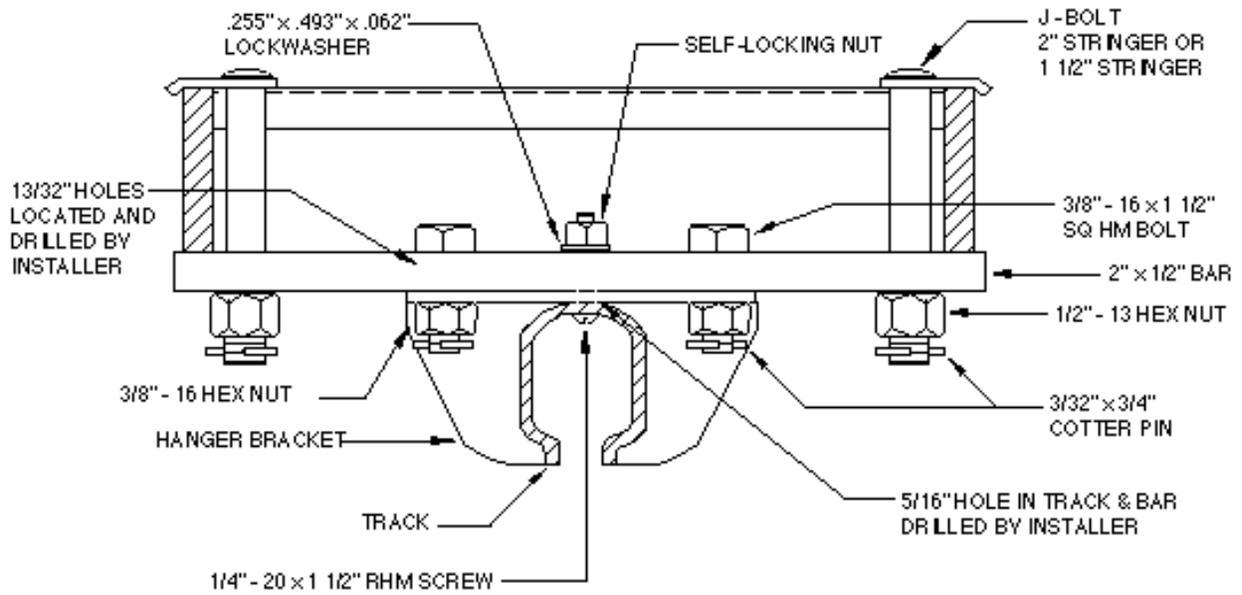


Exhibit 2-E4-18  
Track Supported With Single Bar Directly From Cable Rack  
2 Feet 1 Inch Or Less Wide

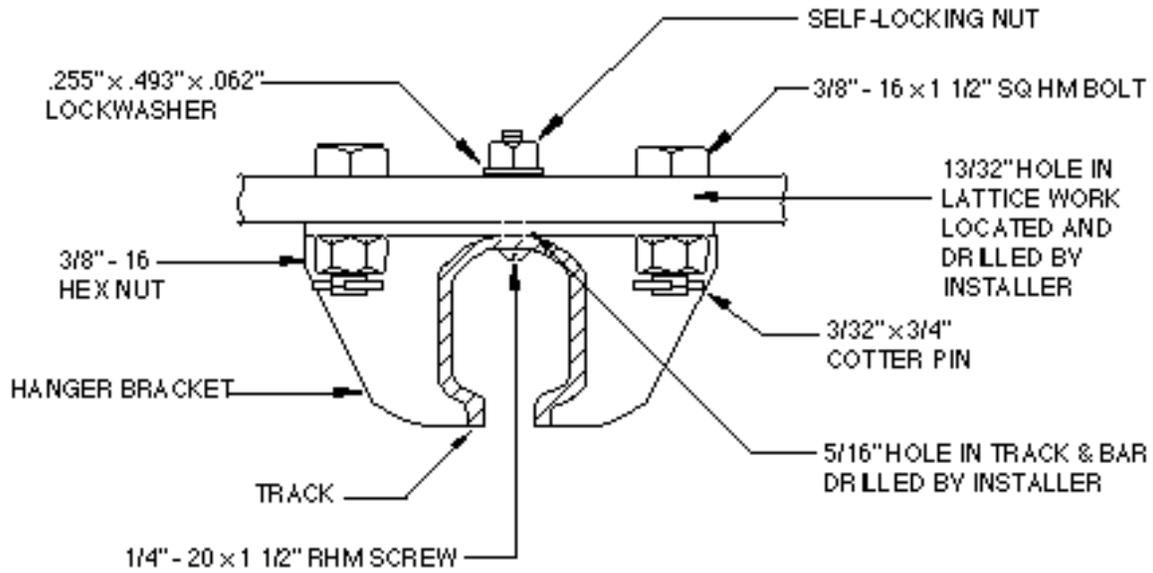


Exhibit 2-E4-19  
Track Supported From Lattice Work

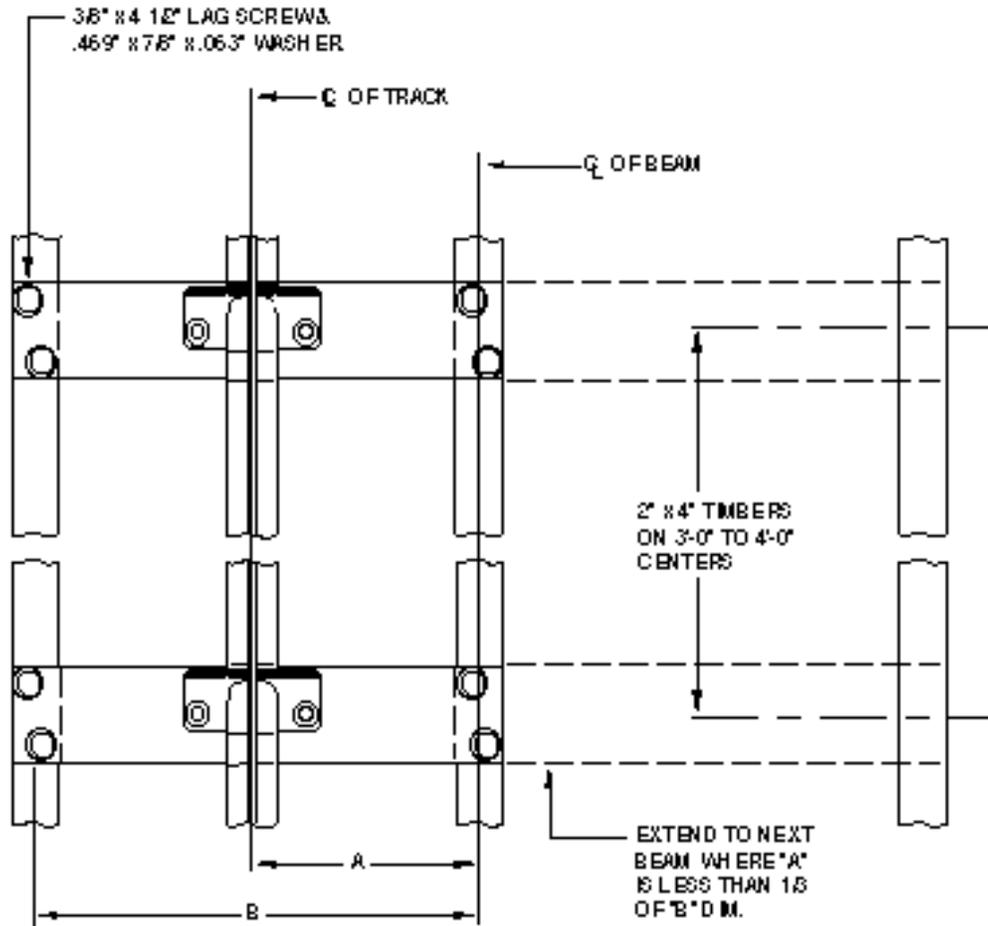


Exhibit 2-E4-20  
Track Supported Parallel To Wood Joists

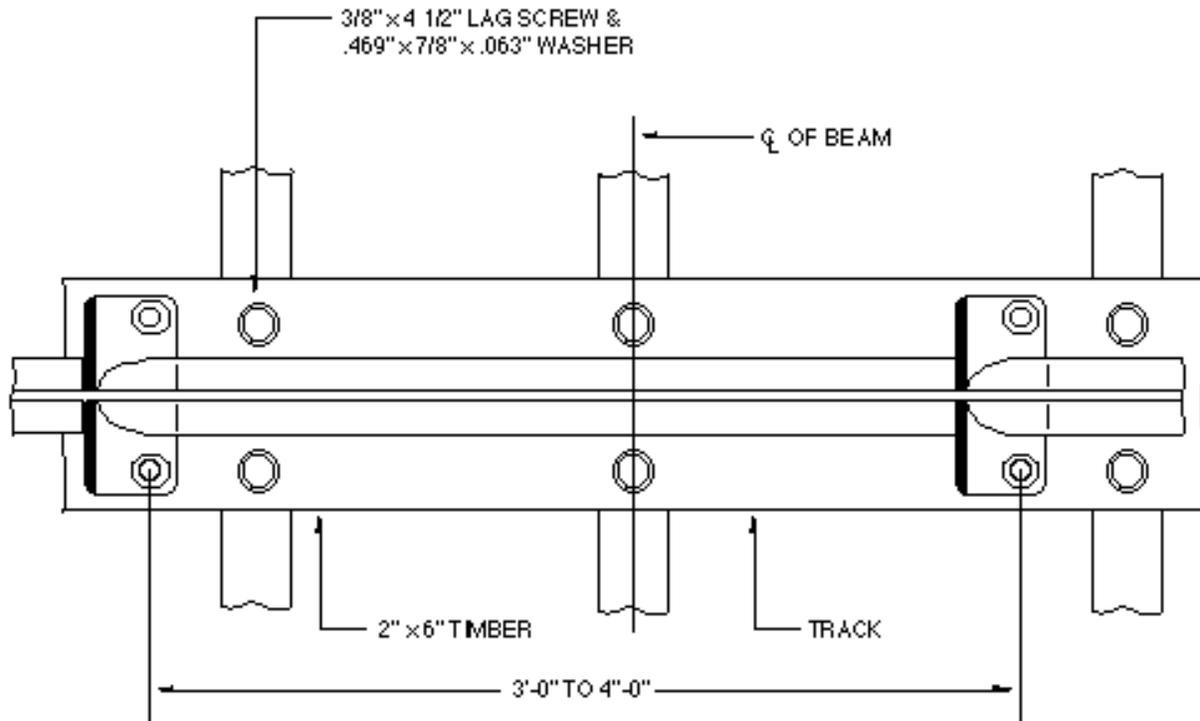


Exhibit 2-E4-21  
Track Supported At Right Angles To Wood Joists

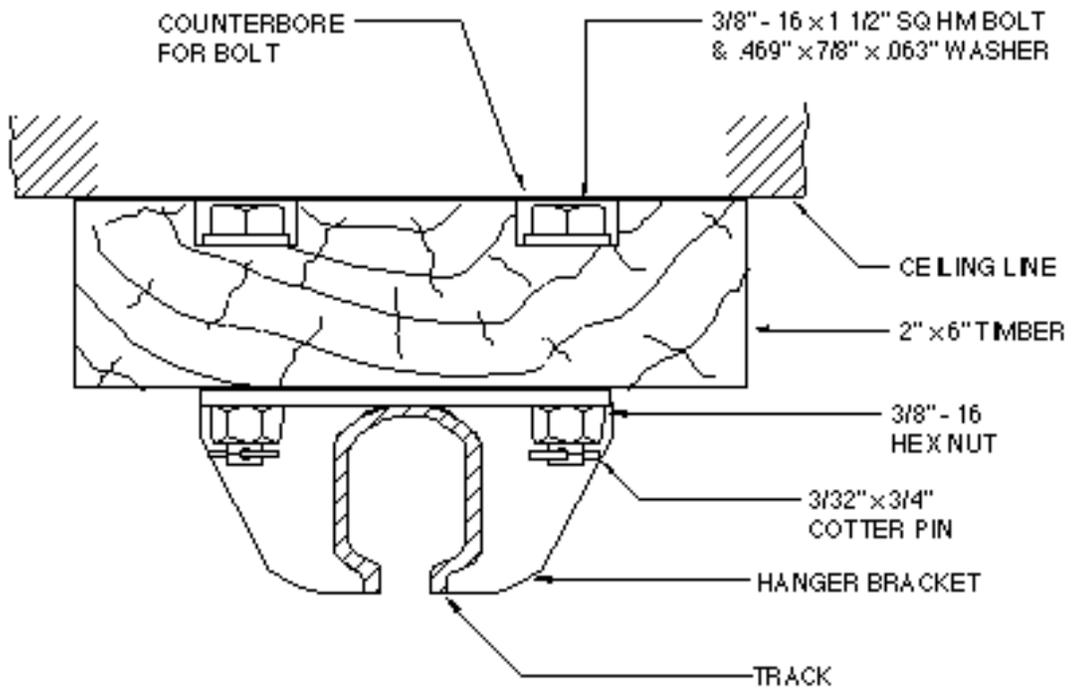


Exhibit 2-E4-22  
Track Supported Directly From Timbers

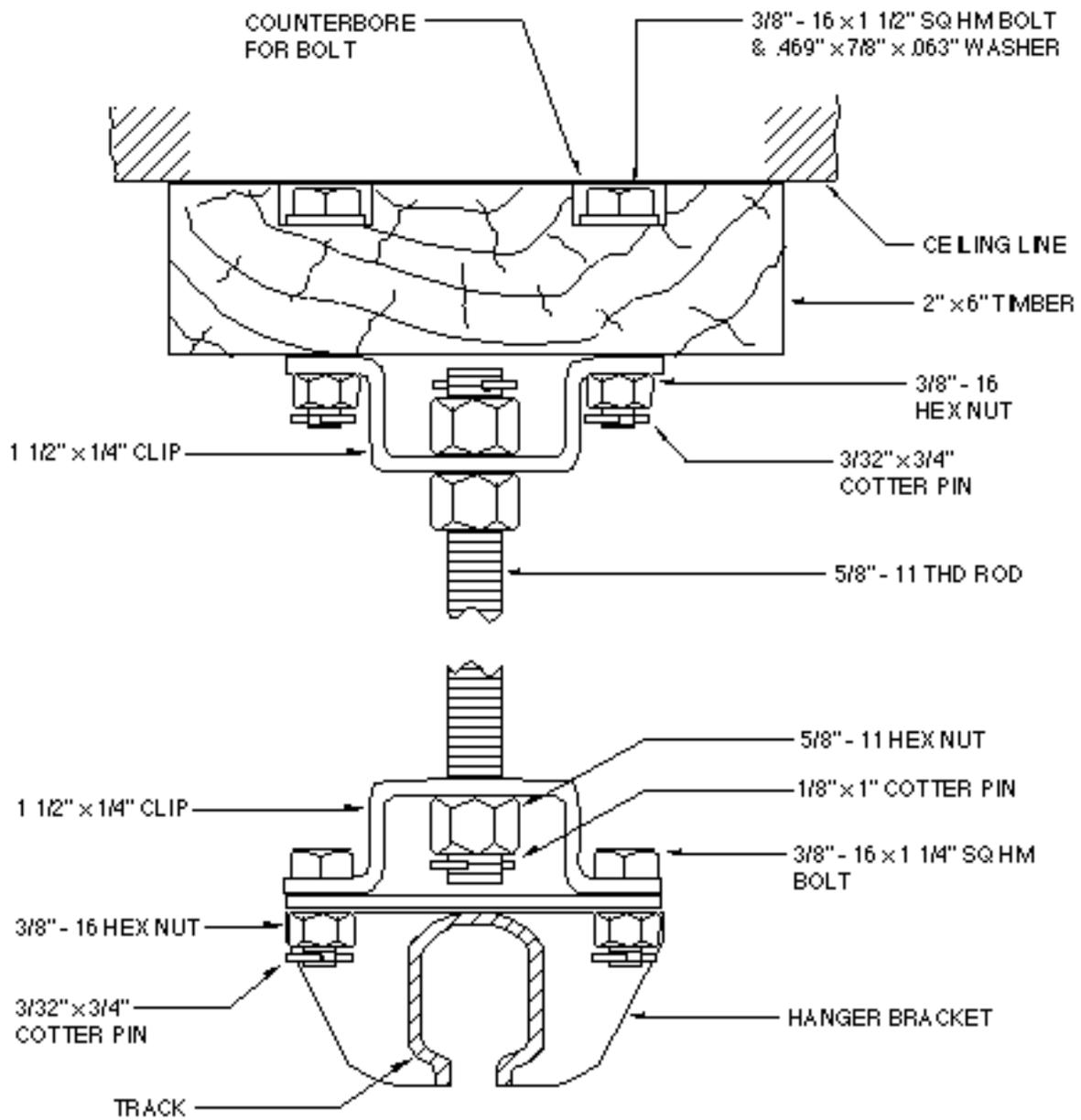


Exhibit 2-E4-23  
Track Supported From Timbers With Extension Rod

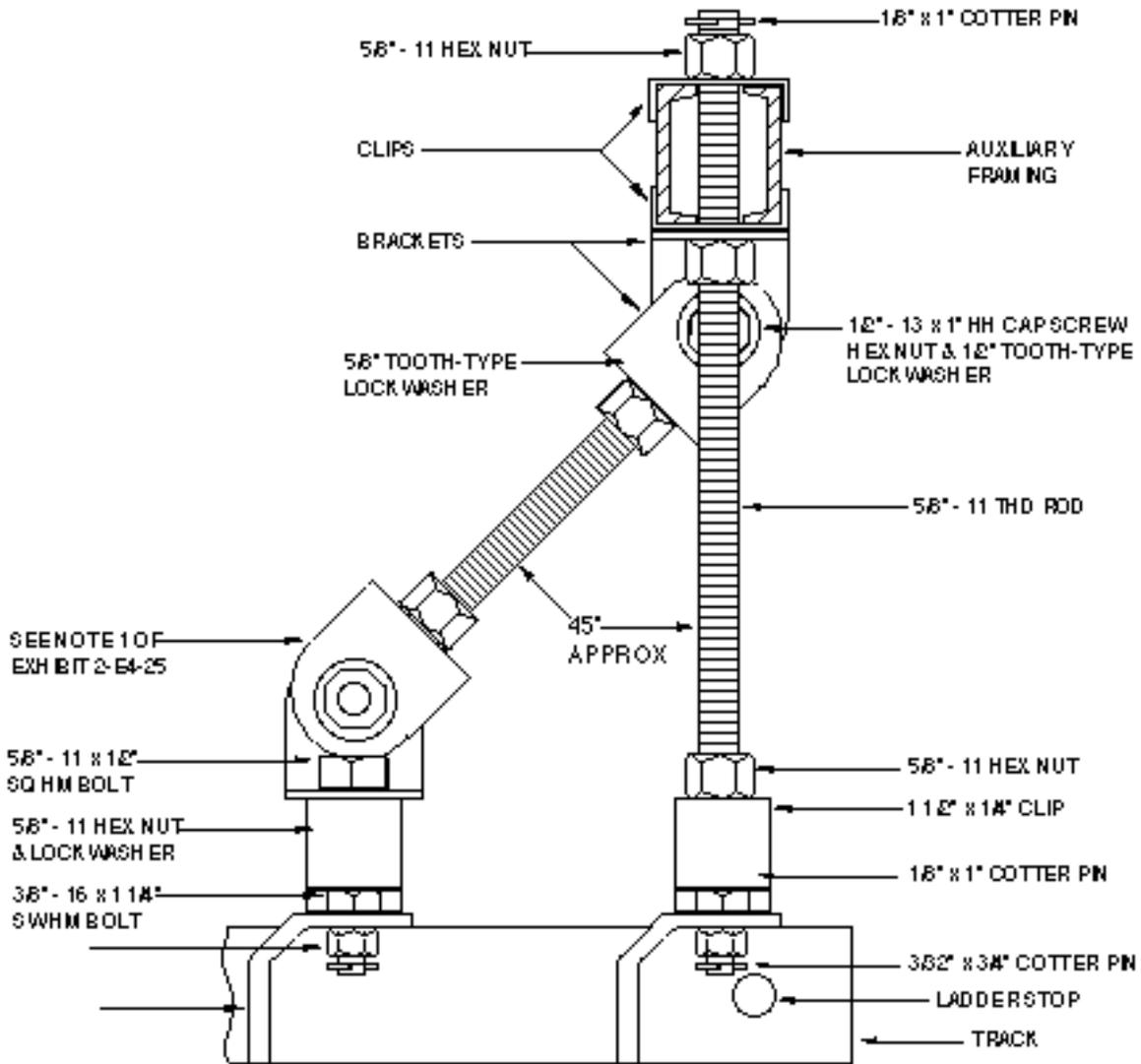


Exhibit 2-E4-24  
 Ladder Track End Brace Where Auxiliary Framing Beyond End Of  
 Track Cannot Be Used



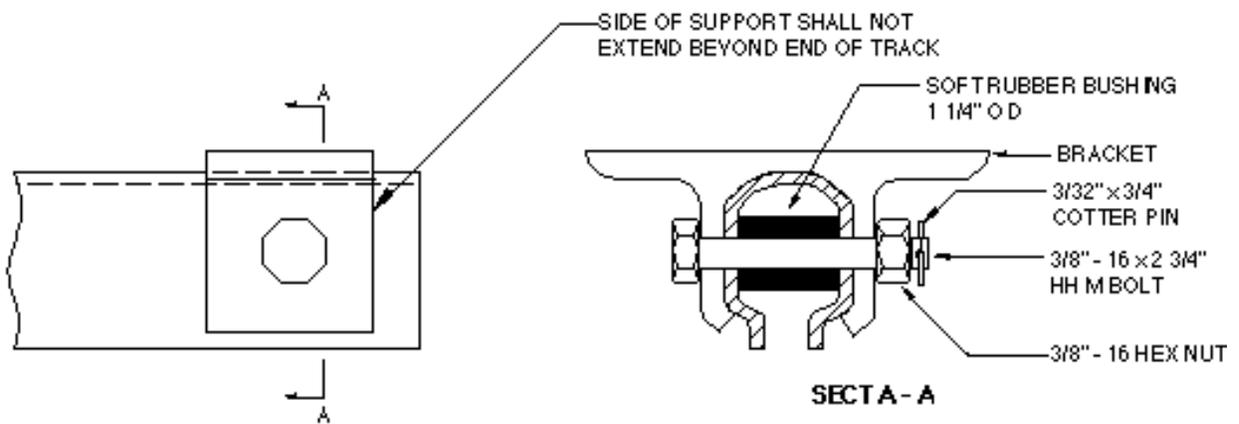
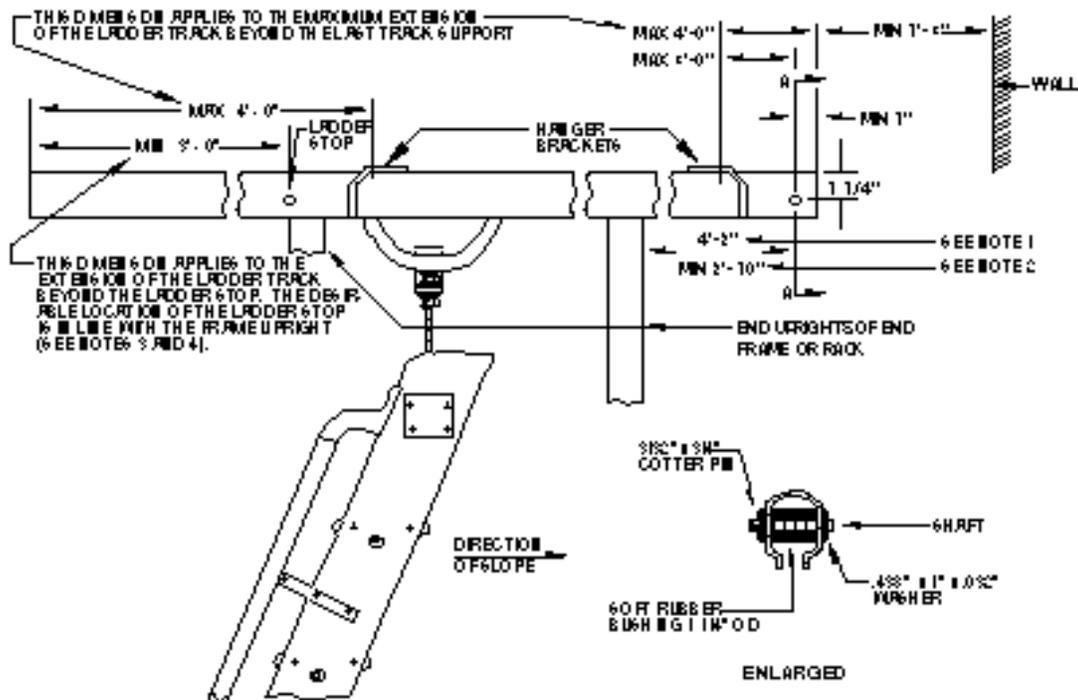


Exhibit 2-E4-26  
Ladder Stop At Support Bracket



NOTES:

1. PREFERRED LOCATION BUT NOT NECESSARILY A MAXIMUM. WHERE SPACE PERMITS AND IF REQUESTED BY THE TELEPHONE COMPANY, THE END OF THE TRACK MAY BE EXTENDED TO PERMIT THE STOP TO BE LOCATED ANY DISTANCE BEYOND THE 4'-2" SHOWN, PROVIDING THE REQUIREMENTS GOVERNING THE NUMBER AND SPACING OF THE TRACK SUPPORTS ARE MET.
2. WHEN THE LADDER TRACK SERVES EQUIPMENT IN CLOSE PROXIMITY TO PARTITIONS OR WALLS SO THAT PLATFORM-TYPE ROLLING LADDERS HAVE TO BE USED TO REACH ALL THE EQUIPMENT, THE MINIMUM SHALL BE 1'-0".
3. WHEN THE LADDER TRACK IS INSTALLED CLOSE TO AND BEYOND A COLUMN SO THAT THE ROLLING LADDER CAN NOT PASS THE COLUMN, A PLATFORM-TYPE ROLLING LADDER IS USED AND THE STOP LOCATED SO THE LADDER CAN APPROACH THE COLUMN WITHOUT TOUCHING IT.
4. WHEN ULTIMATE REQUIREMENTS FOR AN OFFICE ARE FURNISHED INITIALLY, THE LADDER STOPS SHALL BE LOCATED AT THE ENDS OF THE LADDER TRACK.

Exhibit 2-E-27  
 Location Of End Supports And Ladder Stops In Track

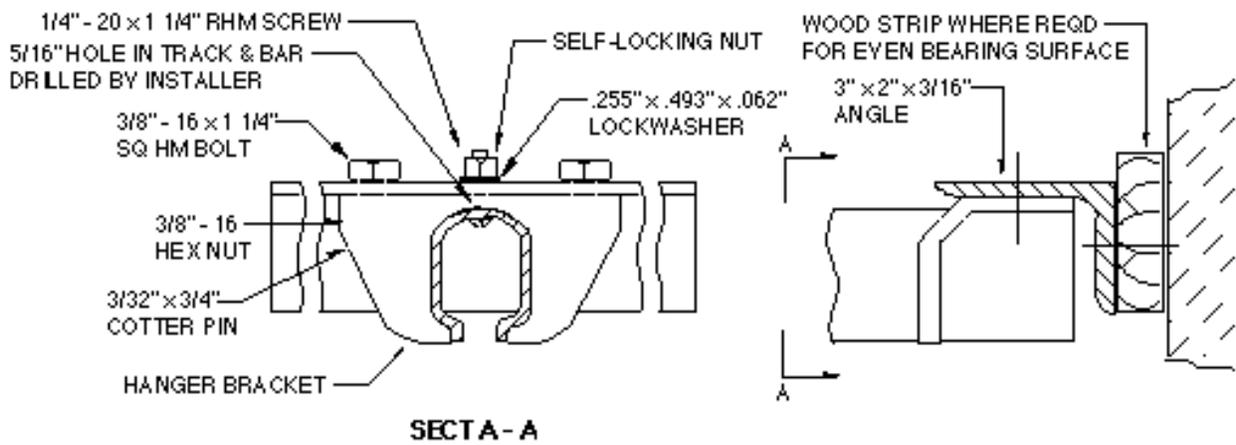


Exhibit 2-E4-28  
Ladder Track Supported From Wall

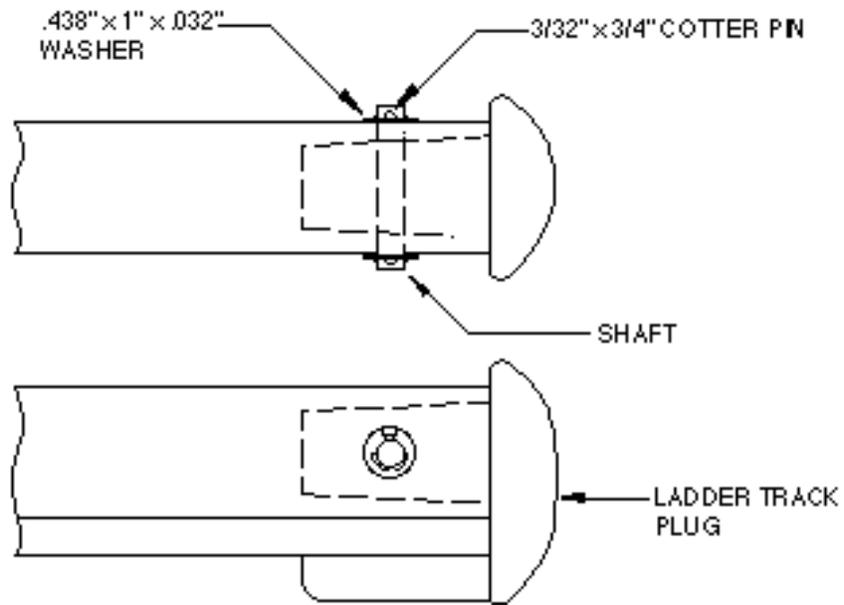


Exhibit 2-E4-29  
Ladder Track Plug

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## **6. Cable Rack and Auxiliary Framing-**

### **6.E Earthquake and Disaster Bracing**

#### **6E.1 General**

This unit covers additional requirements to be employed in the support and fastening of telecommunications equipment in areas subject to earthquake (referred to as seismic zones).

- Refer to the previous chapters on cable rack and auxiliary framing for fundamental requirements.
- Equipment bracing must meet the minimum requirements defined in this chapter.

The QWEST Representative having responsibility for Central Office Common Systems planning shall have the ability to increase the bracing requirements for specific equipment types or applications.

- For unusual building construction, ceiling heights, and framing conditions, it may be necessary to engineer custom bracing arrangements. Arrangements shall meet or exceed the intent of the requirements listed herein.

Safe load limitations for embedded ceiling inserts, expansion anchors, hanger rods, and auxiliary framing are covered in the unit on Cable Rack Requirements.

Framing parts shall be directly butted. All measurements shown in Exhibits indicate maximum allowable gap tolerances.

Arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

Refer to QWEST Standard Configurations for additional information.  
Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

**SEISMIC ZONES:** Three seismic rating systems used in the United States. They are Telcordia, the Uniform Building Code, and the Applied Technology Council. Telecommunications equipment is installed according to the Telcordia rating system. The following chart illustrates the differences between the various rating systems.

Telcordia	Uniform Building Code	Applied Technology Council
0	0	1
1	1	2
2	2	3
3	3	4 & 5
4	4	6 & 7

- Telecommunications equipment installed by and for QWEST in its equipment structures shall be braced according to the following:
- Equipment located in a Telcordia seismic zone 0, 1 and 2 shall be installed to a Telcordia seismic 2 requirement. This shall be referred to as an “Earthquake Light Environment”.
- Equipment located in a Telcordia seismic zone 3 or 4 shall be installed to a Telcordia seismic zone 4 requirement. This shall be referred to as an “Earthquake Heavy Environment”.

## 6E.2 Engineering Requirements

The splicing of hanger rods is prohibited.

**LOCKWASHERS:** In an earthquake heavy environment, externally toothed lock washers shall be used to secure all bolted details.

- Lockwashers are not shown in most exhibits to improve clarity. These lock washers shall be placed to prevent the nut from loosening.
- One lock washer is required per bolted assembly. The lock washer shall be under the nut of a bolt and nut assembly.

Examples of this include but are not limited to:

- Bolts
- Cable Rack clips
- Supporting threaded rod clips
- Bracing details
- Adjustable Cable Rack Splices

**ANCHORING:** A 1/2 inches (12mm) expansion type torque indicating anchor shall be used in all QWEST equipment installations. These anchors shall have 6000 pounds average tensile strength, and be embedded a maximum of 2 and 1/2 inches.

When the building floor is less than 5 inches thick, do not use the hammer mode after the first two inches. The floor should be rotary drilled to prevent injury to personnel or equipment on other floors.

Anchoring situations which prohibit the use of the expansion type anchors shall be referred to the QWEST representative with responsibility for Central Office Common Systems Planning for resolution.

- In these cases the QWEST representative with responsibility for Central Office planning will contact the organization managing building projects for assistance in determining the best solution.

**SPLIT NUTS:** Split type nuts and assemblies are prohibited in all heavy seismic zones.

### **6E.2.1 Auxiliary Framing**

Refer to the "Auxiliary Framing - Low Type" and "Auxiliary Framing - High Type" sections for fundamental requirements.

- Stock lengths of auxiliary framing for heavy seismic zones shall be pre-drilled on each end to accept junctioning components. Two 9/16 inches holes shall be on centers 1 and 7/32 inches and 3 and 15/32 inches from the end of the channel.

**AUXILIARY FRAMING SUPPORT:** The following practices for support of auxiliary framing shall be used within heavy earthquake zones.

- Refer to Chapter 11, Exhibit J-1 for Earthquake zone map.
- The ends of bars of channels should come no closer than 6 inches to columns, walls, etc.
- Auxiliary framing, engineered in accordance with the auxiliary framing low-type requirements shall be used for the support of the equipment.
- Where ceiling channels are provided, they are embedded in the ceiling in parallel rows, normally perpendicular to the equipment bay line-ups to support primary auxiliary framing. 5/8-inch spring nuts are furnished for fastening hanger rods or ceiling braces as shown in Exhibit 2-E5-2A.
- Where a row of frames is omitted in a ceiling supported environment, the regular framing shall be stiffened with supplementary framing bars or channels fastened at right angles. The supplementary framing must be located over the future frames.

**JOINING AUXILIARY FRAMING:** Auxiliary framing at the same level shall be junctioned per Exhibits 2-E5-8 or 8E.

- Junctioning assemblies:
  - shall be staggered to obtain a rigid junction. Junctions in multi-level framing shall also be staggered.
  - shall be positioned as to not interfere with clips used to fasten ladder tracks, lighting conduit, or cable racks.
  - junctions in the same aisle of adjacent pairs of bars or channels of auxiliary framing shall be avoided.

WHERE JOINING AUXILIARY FRAMING	USE EXHIBIT
From 11' 6" to 11' 8"	2-E5-8B
From 11' 8" to 11' 9-1/2"	2-E5-5C
With 1" difference in levels	2-E5-8C

Note: Where required, alternate pairs of existing channels shall be cut back just beyond the next to the last row of frames, so that added channels can be fastened to the last two rows of existing frames to obtain a rigid junction. Subsequent splices in auxiliary framing bars shall be staggered.

- **STIFFENING CLIPS:** Stiffening clips shall be added on 36 inch maximum centers to new auxiliary framing as in Exhibit 2-E5-2D.
- Bracing, supports, or attachments will serve the purpose of the stiffening clips where they occur.
- **FINISHING DETAILS:** 3/8 inch through bolts equipped with external tooth lock washers shall be added to the ends of the auxiliary framing per Exhibit 2-E5-2D
- A 1 and 1/2 inches spacer shall be placed between the framing channels to maintain separation.
- Finishing details shall be added where the end of framing channels is less than 6 inches from bracing details, threaded rods, etc.

**6E.2.2 Bracing Auxiliary Framing**

Each line of primary and secondary framing shall be braced as near each end as practical.

- Intermediate double braces shall be located on primary auxiliary framing levels at approximately column spacing as shown in Exhibit 2-E5-3A.
- Bracing as shown in Exhibits 2-E5-1, 2-E5-2 and 2-E5-2C shall be used for adding rigidity to the auxiliary framing structure.

DISTANCE TO CEILING OR BETWEEN AUXILIARY FRAMING LEVELS	TYPE OF BRACE
5 inches to 10 inches	Threaded Rod
Over 10 inches to 1 foot 6 inches	2 by 3/16 inch Bar
Over 1 foot 6 inches	2 by 2 by 3/16 inch Angle Bar

BRACING TO THE CEILING: A 3 inch, 5 pound channel is to be provided and bolted to the ceiling inserts for fastening braces at the ceiling.

- As an alternative to using lengths of channel, the braces may be fastened to the ceiling by 5/8 inch ceiling inserts, threaded rods, hexagonal nuts, and washers. These anchors must be located directly over the row of auxiliary framing to which the brace is attached. These anchors are “cast in” at the time of building construction. Ceiling inserts shall be installed by a qualified contractor under the direction of the building project manager.
- Where ceiling inserts are not available, 5/8 inch ceiling expansion anchors shall be used for fastening the braces to the ceiling
- The braces at the ends of the framing shall be located at the row of ceiling inserts nearest the wall. In some cases, it will be necessary to use the second row of inserts in order to avoid interference. When the second row of inserts is used, the braces may be slanted in either or both directions as required.

DOUBLE BRACES: When double braces are used, it is practical to slant the braces in both directions from a common point as shown in Exhibits 2-E5-1 and 2-E5-2. Braces slanted from a common point at the framing, as shown in Chapter 6 Unit B, may also be used.

BRACING SUPPLEMENTARY FRAMING: Bars or channels of supplementary framing where a row of frames is omitted must be braced at each end with threaded rod braces as shown in Exhibit 2-E2-2E and 2-E5-7.

- Ladder type cable rack may be used in place of supplementary channels, provided the rack is suitably braced. Braces must be attached as shown in Exhibit 2-E5-9D or 2-E5-9F at each end of the cable rack, and must slope in opposite directions. The braces shall be fastened to the ceiling as shown in Exhibit 2-E5-9D, E, or F. A bar-type cable rack over a row of omitted frames shall not serve as stiffening in place of supplementary bars or channels.

When high type auxiliary framing is used for the support of distributing frames more than 11-6 inches high, the auxiliary framing may be used as a grid from which low-type auxiliary framing is braced. The primary bars or channels of the high-type framing may be made continuous and stiffened either by cable rack or supplementary stiffening framing braced as shown in Exhibit 2-E5-2C.

#### CONDITIONAL BRACING ARRANGEMENTS:

Exhibit 2-E5-3 is included to show the obsolete method of "Boxing the column". While some offices still have this auxiliary framing bracing scheme, it has been discontinued since it damages both the bracing and the building structure in an earthquake.

In buildings with 9 foot or 11 foot 6 inch environments that have ceilings unsuitable for attaching braces, the crosswise auxiliary framing shall be continuous and extend from wall to wall. Framing shall be supported at the wall per Exhibit 2-E2-8C.

- The ends of auxiliary framing in buildings having flat ceilings that permit the use of braces shall in no case be fastened to the walls, and must end six inches or more from the walls.

### **6.3 Cabling and Cable Racking**

Refer to the "Cable Rack " section for fundamental requirements.

In heavy seismic zones all cable racks shall be the solid stringer type.

Continuous runs of ladder-type, cross-aisle cable racks fastened above and across, over-frame cable racks with J-bolt fastenings, as shown in Exhibit 2-E1-54F are preferred in heavy earthquake areas for addition to existing office configurations where ceiling heights are favorable.

ANTI-SLIP DETAILS: Anti-slip details, as shown in Exhibit 2-E5-10A, shall be installed where cable rack is used for support.

- Where short pairs of bars or channels are used, anti-slip details shall be installed where the pairs are fastened to the cable rack. Anti-slip details shall be bolted to the auxiliary framing at each side of such supports.

SCREEN AND PAN:

- Cable racks covered with plastic "pan" or "plate" resting on the cable rack is acceptable.
- Cable rack screen, supported beneath a cable rack, is prohibited in a heavy seismic zone.

CABLE PILEUP: In heavy seismic zones, cable pileup heights specified in Chapter 6 unit A section 6.4 must be observed.

- See also safe load table in Chapter 6 unit A section 6.4.

CABLING: A minimum 9 inches cable slack shall be provided at right angle turns and cable transitions.

- A minimum 9 inches cable slack shall be provided between where cable is secured leaving the cable rack and where it is secured at the vertical framework duct or distributing frame transverse arms.

VERTICAL OFFSETS: Adjustable clamps, per Exhibits 2-E1-40A and 40B, are preferred for vertical offsets.

- Where adjustable clamps are utilized the brackets shall be drilled and fastened with 3/8-16 inch nuts and bolts.

### **6.3.1 Cable Rack Support**

The following practices for cable rack support shall be used for locations within heavy earthquake zones.

- Ladder and bar-type cable racks attached directly to the auxiliary framing shall be bolted with two bolts, one at each stringer.
- All main and end aisle cable racks not attached directly to frames or to regular auxiliary framing must be supported by hanger rods as shown in Exhibits 2-E5-9. Cast in or expansion anchors shall be used for ceiling support.
- Dedicated power cable rack requires a pair of framing bars or channels under the racks for support and attachment to the hanger rods as shown in Exhibits 2-E5-9H and 2-E5-9J.
- Where ladder-type cable racks are supported by 5/8-11 threaded rods 2 inches or more above the auxiliary framing, they shall be and tied together with a flat steel bar as shown in Exhibit 2-E5-9L.

### **6.3.2 Bracing Cable Rack**

Hanger-rod supported racks shall be braced to prevent movement in both sidewise and endwise directions.

- Threaded rod, flat-bar or angle-type braces may be used. Specific bracing types and distances are identified in applicable Exhibits.
- Cable racks supported by threaded rod from cable racks below are not considered good practice in heavy seismic zones.
- Three tiered racking, where cable racks would be supported from lower racks, is not approved.
- Where double-level cable racks are required in Floor Supported Framework Environments, they shall be supported similar to Exhibit 2-E5-9L and braced downward to the lower level framing bars or channels. Braces shall be bar type and where practical shall be installed in a staggered arrangement on opposite stingers of the cable rack at approximately 10 feet intervals.

SIDE BRACING: Sidewise bracing is as shown in Exhibits 2-E5-9A, 9B, 9C, 9G and 9H.

- Cable racks supported by hanger rods shall be side braced at each support. Where practical, bracing shall be installed in a staggered arrangement, slanted in opposite directions, on opposite stingers of the cable rack.
- In the case of main aisle racks sidewise bracing is unnecessary where junctioned with lineup cable racks.
- End-aisle racks require bracing on the outside stringer only.
- Normally, one set of brace rods per run of cable rack is sufficient for bracing in an endwise direction as shown in Exhibits 2-E5-9D, 2-E5-9E, 2-E5-9F and 2-E5-9J.
- Where a hanger rod supported cable rack is attached to a frame or auxiliary framing which is braced to resist movement, no additional endwise bracing is required.
- Hanger rod supported cable racks over Distributing Frames (DF) shall be braced in a sidewise direction as shown in Exhibit 2-E5-9M.

END BRACING: End braces are required for each hanger rod supported cable rack.

- Braces shall be installed on opposite stringers and slanted in opposite directions
- Where perpendicular bracing is required, the braces shall be fastened as shown in Exhibit 2-E5-9D, 9E, and 9F.

#### **6.4 Framework Support**

**BASE SUPPORT**: Frames, floor supported cabinets, duct type frames, etc shall be fastened to the floor per requirements in Chapter 2 using the approved anchor.

- Distributing Frames (DF) and Protector Frames (PF): Additional anchors shall be installed approximately midway between the normal anchoring for light seismic zones. Additional fastenings shall be used when the base angles are attached to cable slot fascia angles. Frames 9 feet or less in height require no additional anchors. On a single-sided DF, with a 10 inch wide frame base, two anchors shall be used in each framework unit.

TOP SUPPORT: The following practices for fastening at the tops of frames shall be used for locations within heavy seismic zones. Assemblies shall include tooth-type lockwashers

- Framework support requirements are detailed in Chapter 2 and 6B.
- Distributing Frames (DF) and Protector Frames (PF) shall be ceiling supported and braced. Provide a brace at each end and at about 40 feet intervals along the frame as shown in Exhibit 2-E5-12J.

Note: When high type auxiliary framing is used for the support of distributing frames more than 11-6 inches high, the auxiliary framing may be used as a grid from which low-type auxiliary framing is braced. The primary bars or channels of the high-type framing may be made continuous and stiffened either by cable rack or supplementary stiffening framing braced as shown in Exhibit 2-E5-2C.

- Switching and toll systems, which use cable distribution systems as a means of top support for 6, 7 and 9 foot equipment frames, must meet top support requirements for the seismic zone in which they are located.
- Power systems: Earthquake bracing and anchoring requirements for all power equipment is contained in Technical Publication 77385 (see References Chapter).

## 6.5 Stanchions

Only seismically approved stanchions are allowed in heavy seismic zones. Stanchions shall be anchored using four approved 1/2 inch (12mm) torque indicating expansion type anchors.

- Framework stanchions (empty standard frameworks) and approved support stanchions shall be used for ironwork support in ladder-type floor supported environments.
- Refer to Exhibit 2-E5-4 for a typical stanchion arrangement in heavy seismic zones.
- The framework stanchions shall be located on centers of approximately 10 feet and in no case exceed 12 feet.
- Intermediate approved support stanchions shall be placed between framework stanchions at approximately 5 feet intervals, not to exceed 6 feet.

- Framework stanchions and approved support stanchions will be alternated at the start of lineups, i.e. the first lineup would start with a framework stanchion, the next lineup would start with a pipe stanchion.
- Stanchions in compartment cableway environments shall be provided per system assembly requirements.

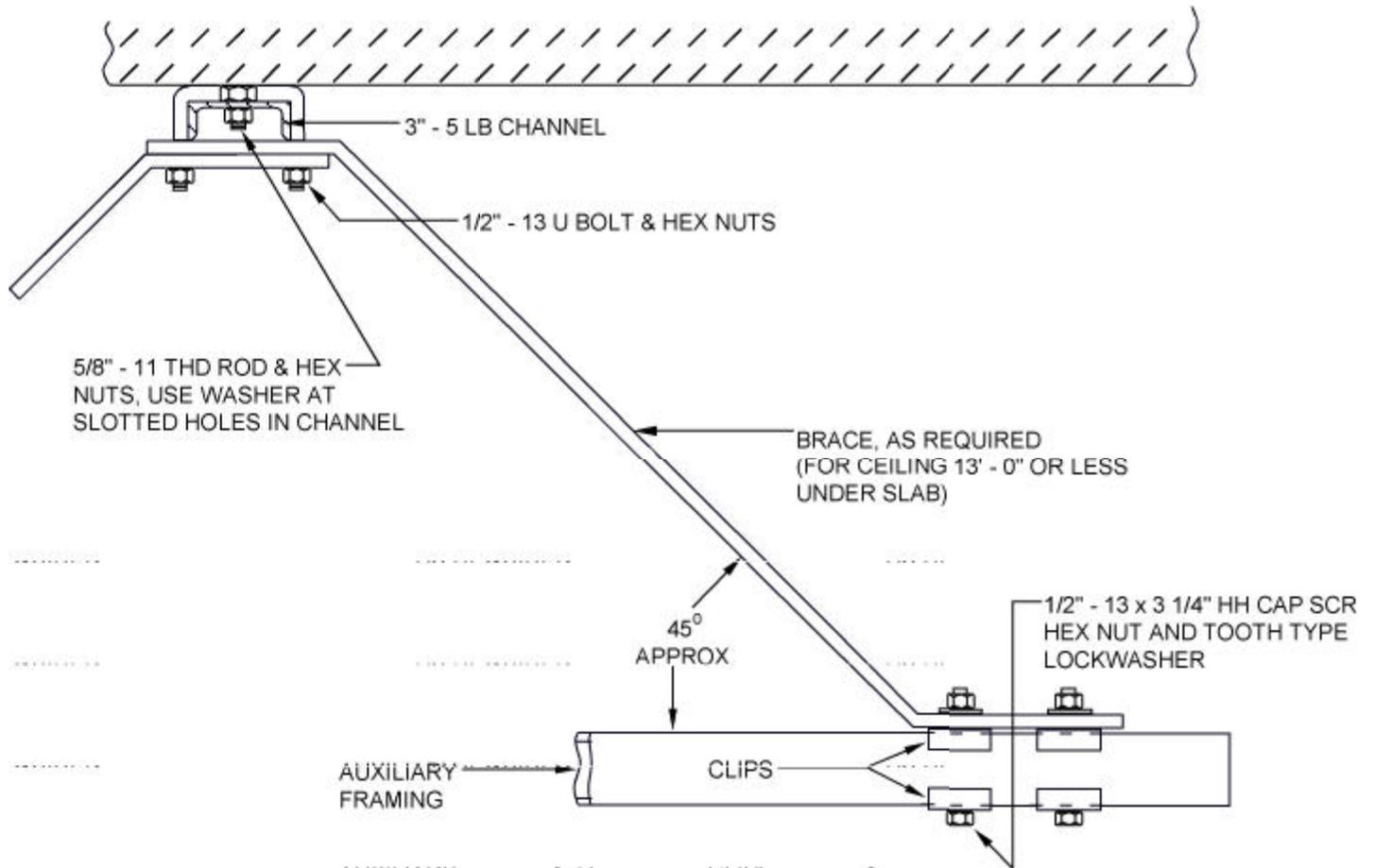


EXHIBIT 2-E5-1  
AUXILIARY FRAMING BRACE FOR USE IN LOW-CEILING AREAS

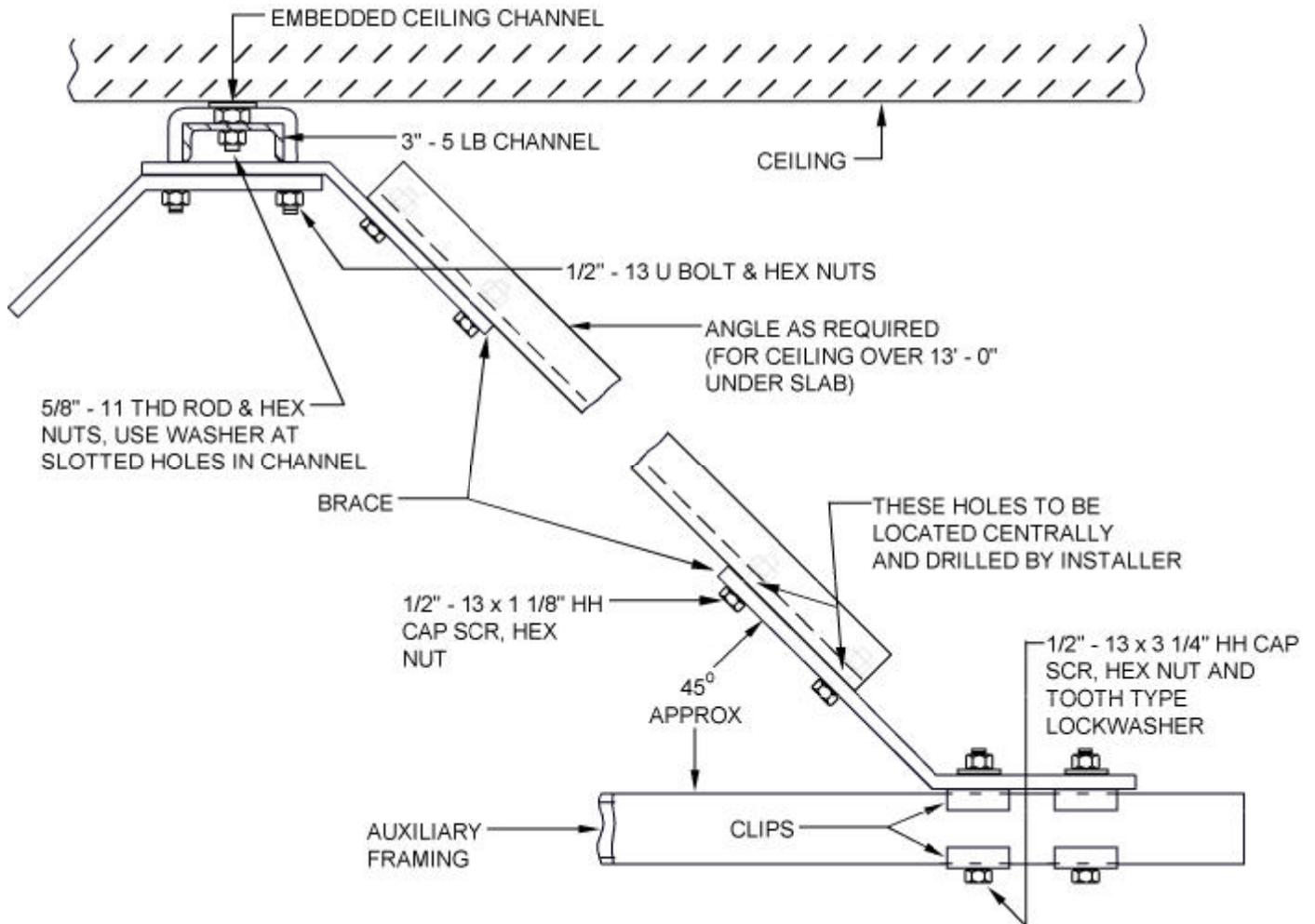


EXHIBIT 2-E5-2  
AUXILIARY FRAMING BRACE FOR USE IN HIGH CEILING AREAS

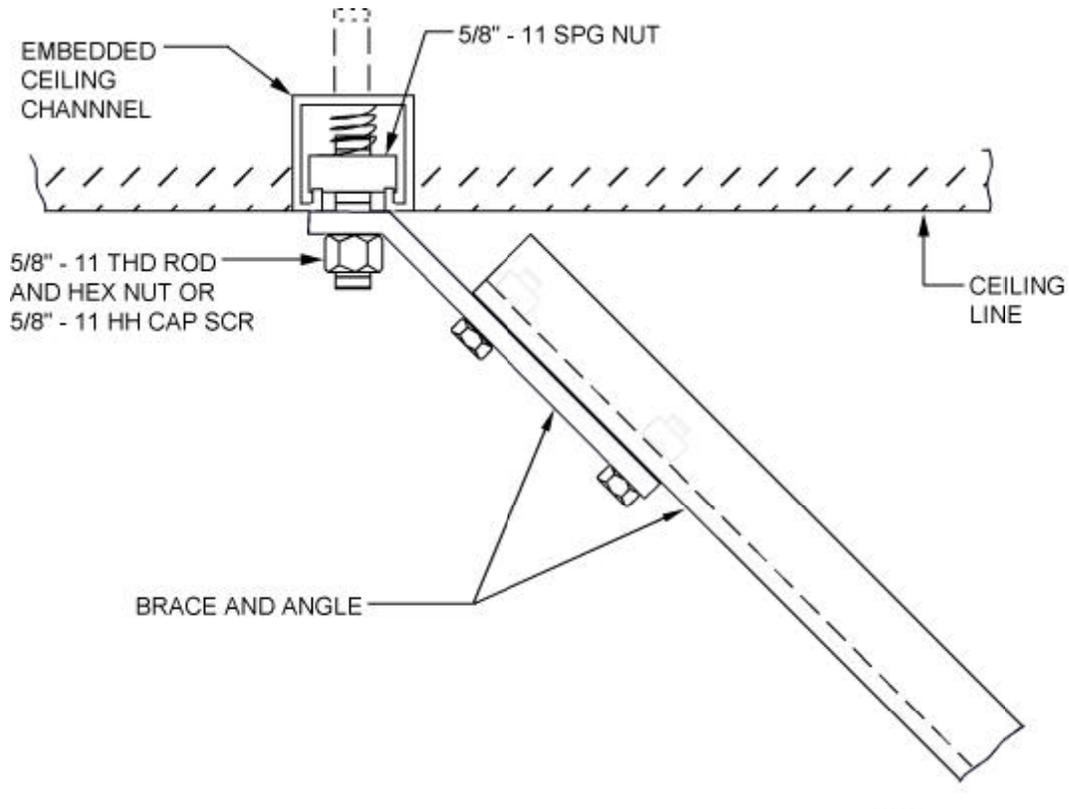
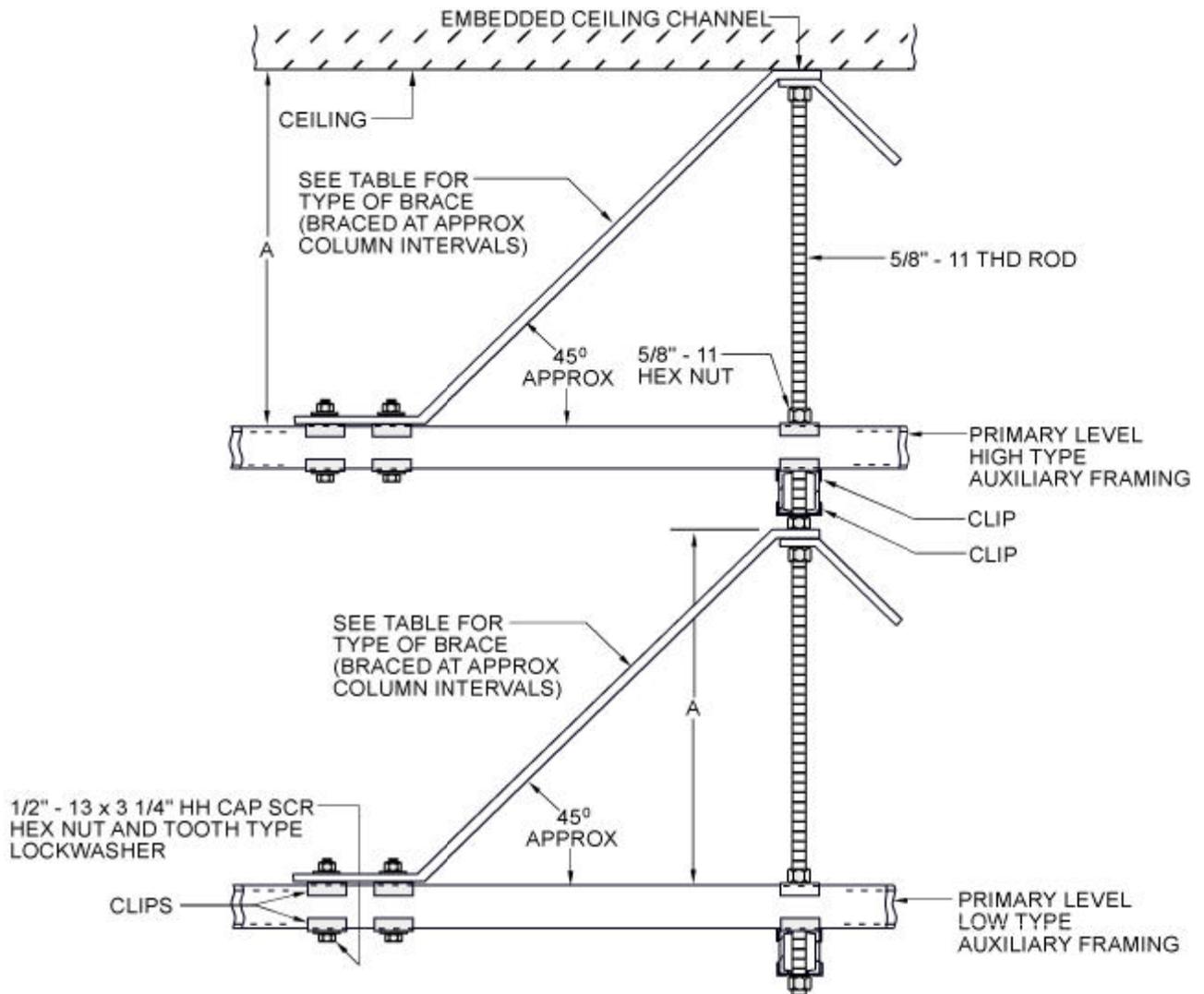
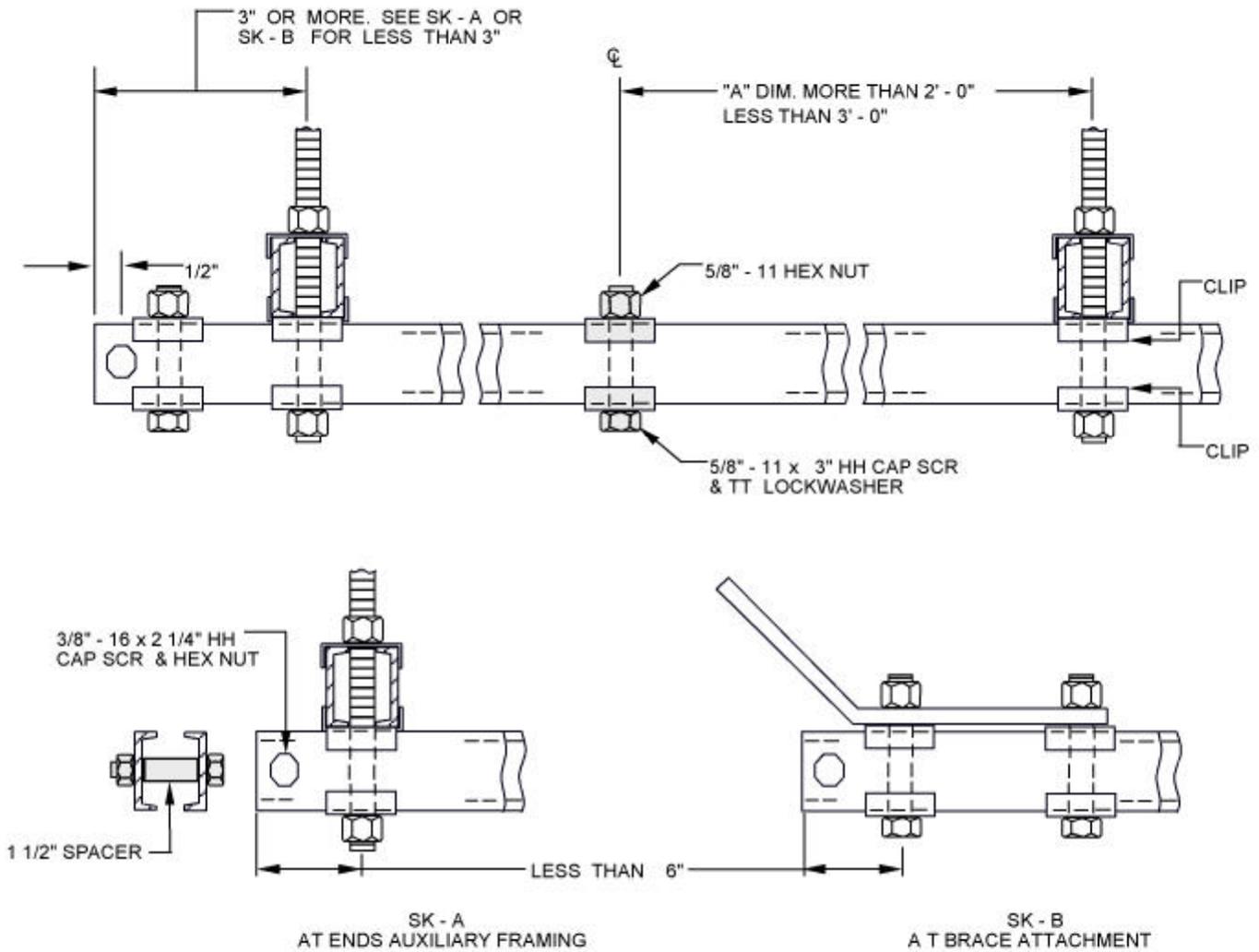


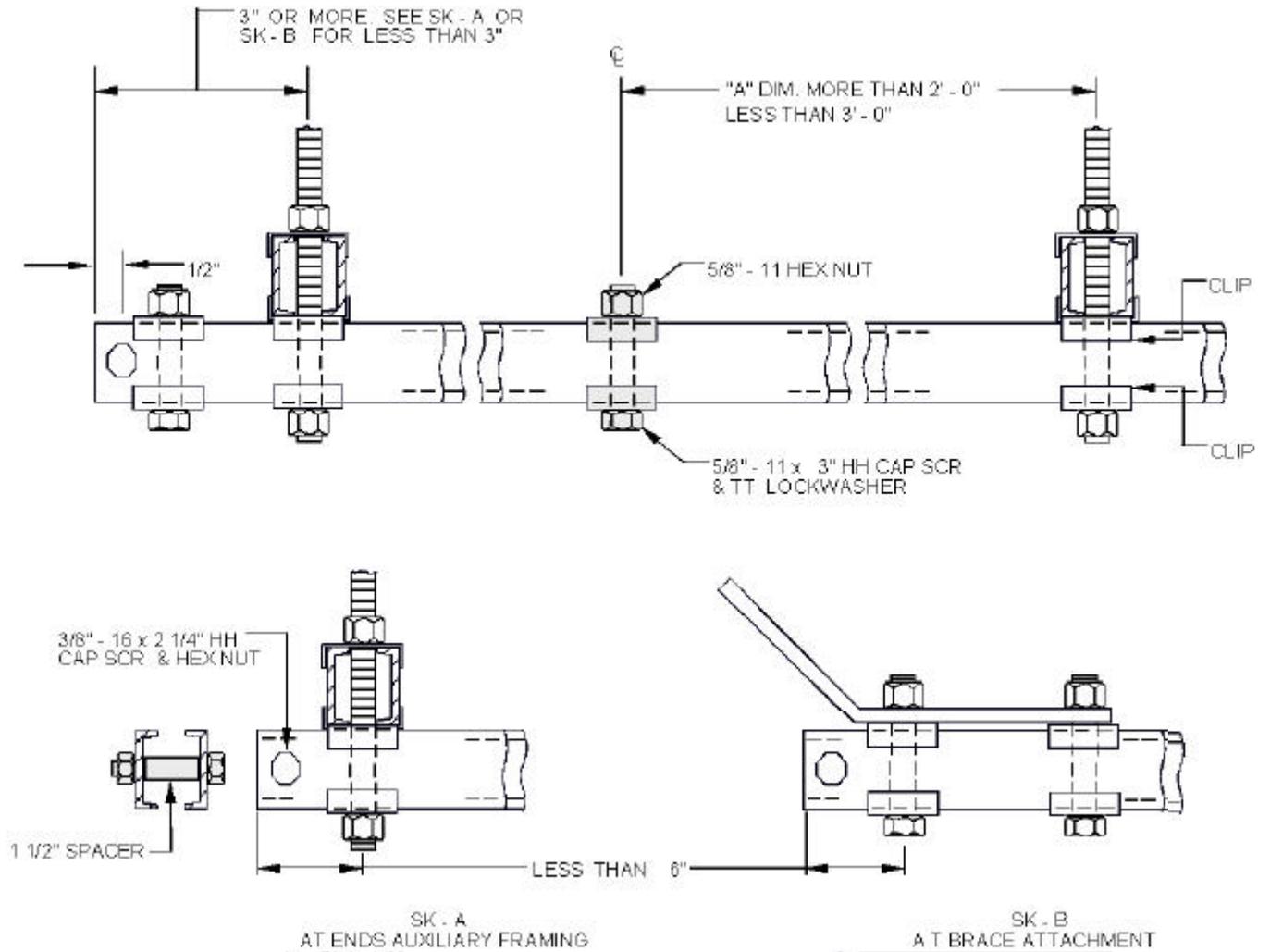
EXHIBIT 2-E5-2A  
FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL



A	TYPE OF BRACE
5" TO 10"	5/8-11 THREADED ROD AND BRACKETS
OVER 10" TO 1' - 6"	2" x 3/8" BAR,
OVER 1' - 6"	2" x 2" x 3/16" ANGLE

EXHIBIT 2-E5-2C  
 LOW-TYPE AUXILIARY FRAMING BRACED FROM HIGH -TYPE FRAMING





NOTE:  
 "A" DIMENSION REPRESENTS DISTANCE BETWEEN TWO CLIP FASTENINGS SUCH AS BRACE, CABLE RACK, HANGER ROD OR ANOTHER STIFFENING CLIP.

EXHIBIT 2-E5-2D  
 APPLICATION OF STIFFENING CLIPS AND END BOLTS IN AUXILIARY FRAMING EQ HEAVY

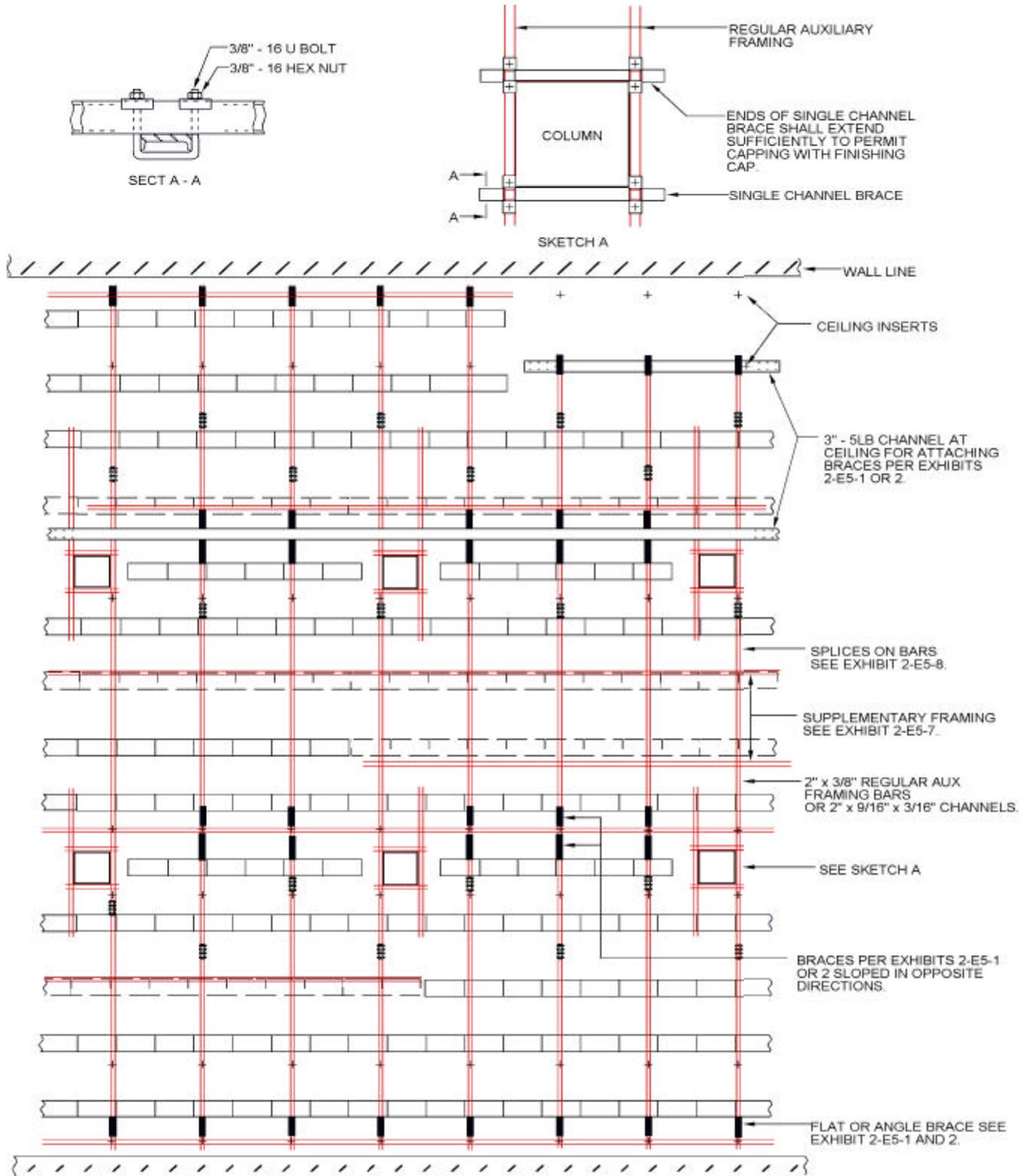


EXHIBIT 2-E5-3 (DISCONTINUED)  
TYPICAL AUXILIARY FRAMING ARRANGEMENT

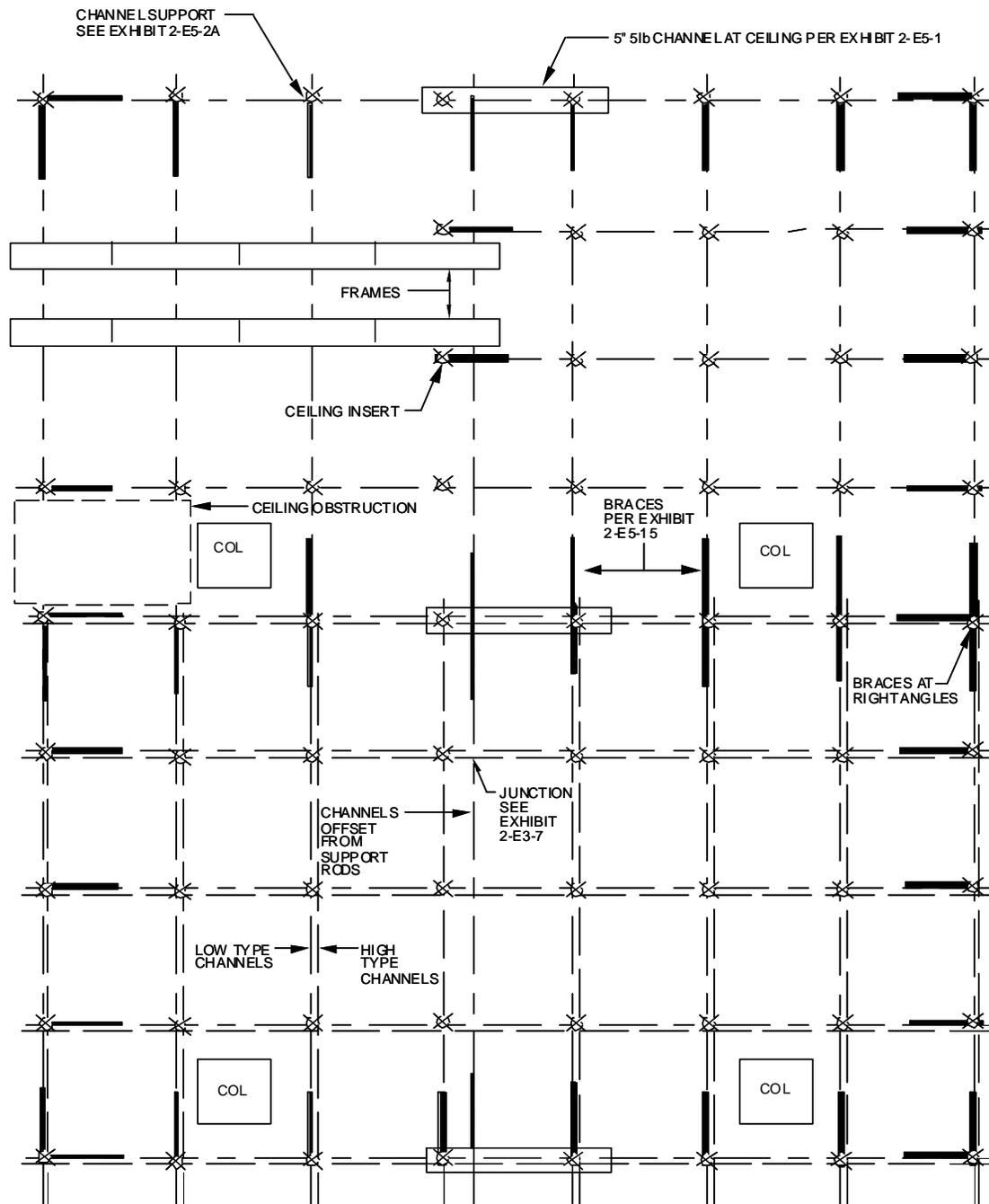
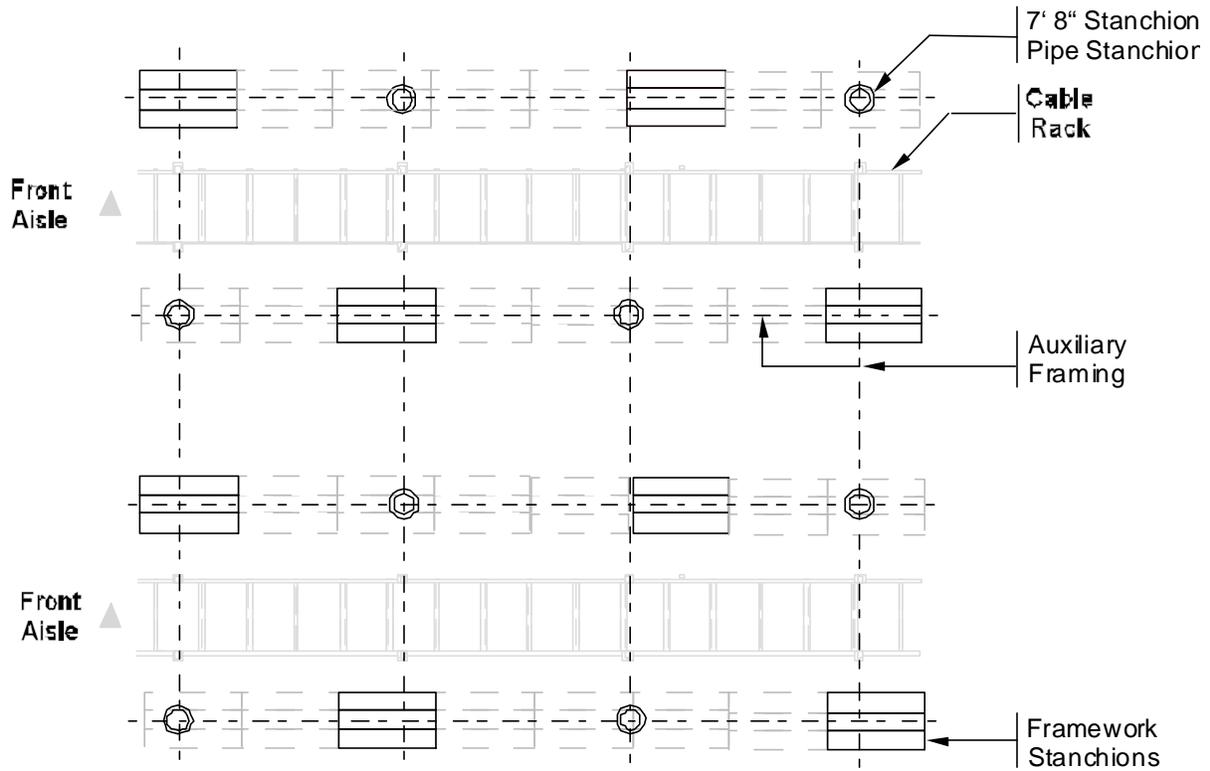


EXHIBIT 2-E5-3A  
TYPICAL EARTHQUAKE BRACING SCHEME - HEAVY



**Seismic Zones 3,4**

EXHIBIT 2-E5-4  
TYPICAL STANCHION ARRANGEMENT - HEAVY

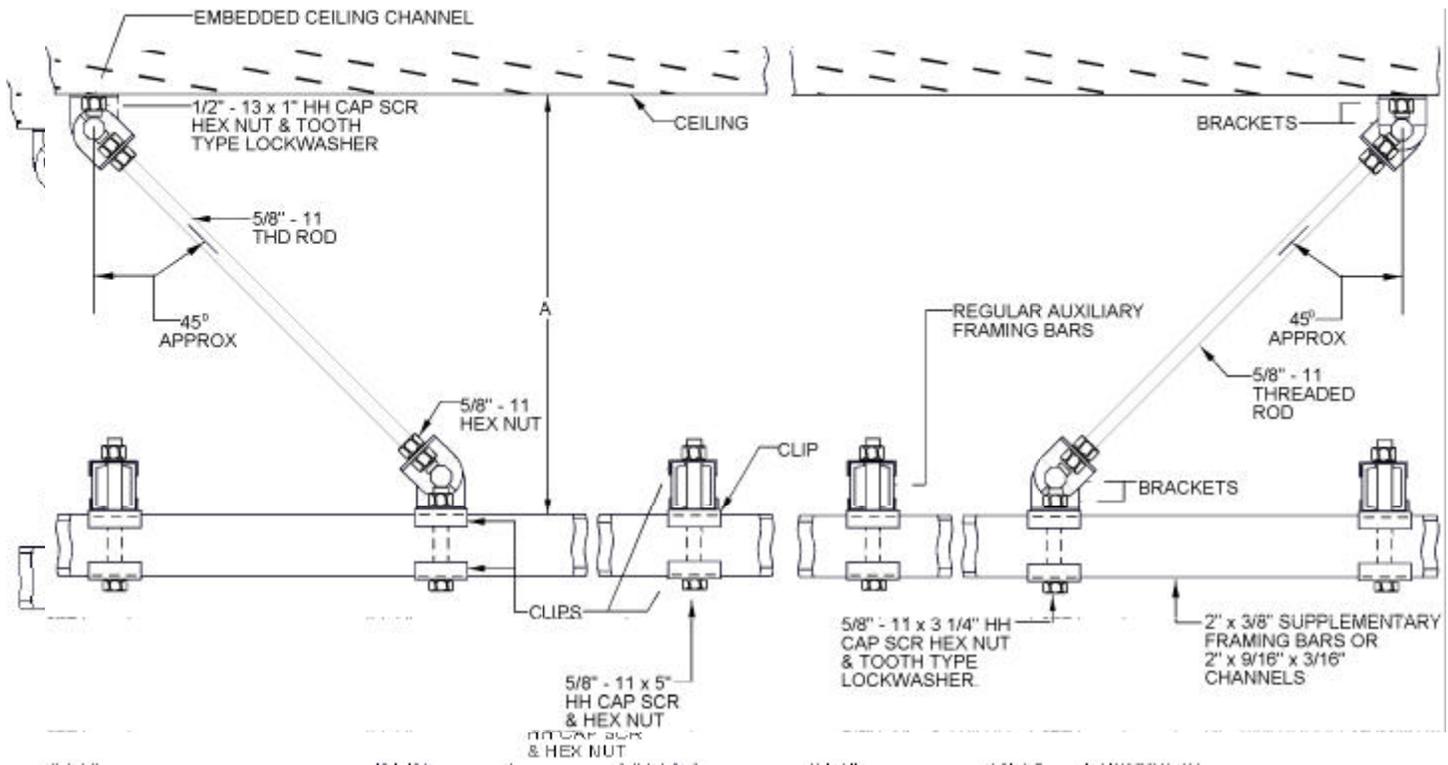


EXHIBIT 2-E5-7  
SUPPLEMENTARY FRAMING AND BRACES AT UNEQUIPPED ROWS OF FRAMES

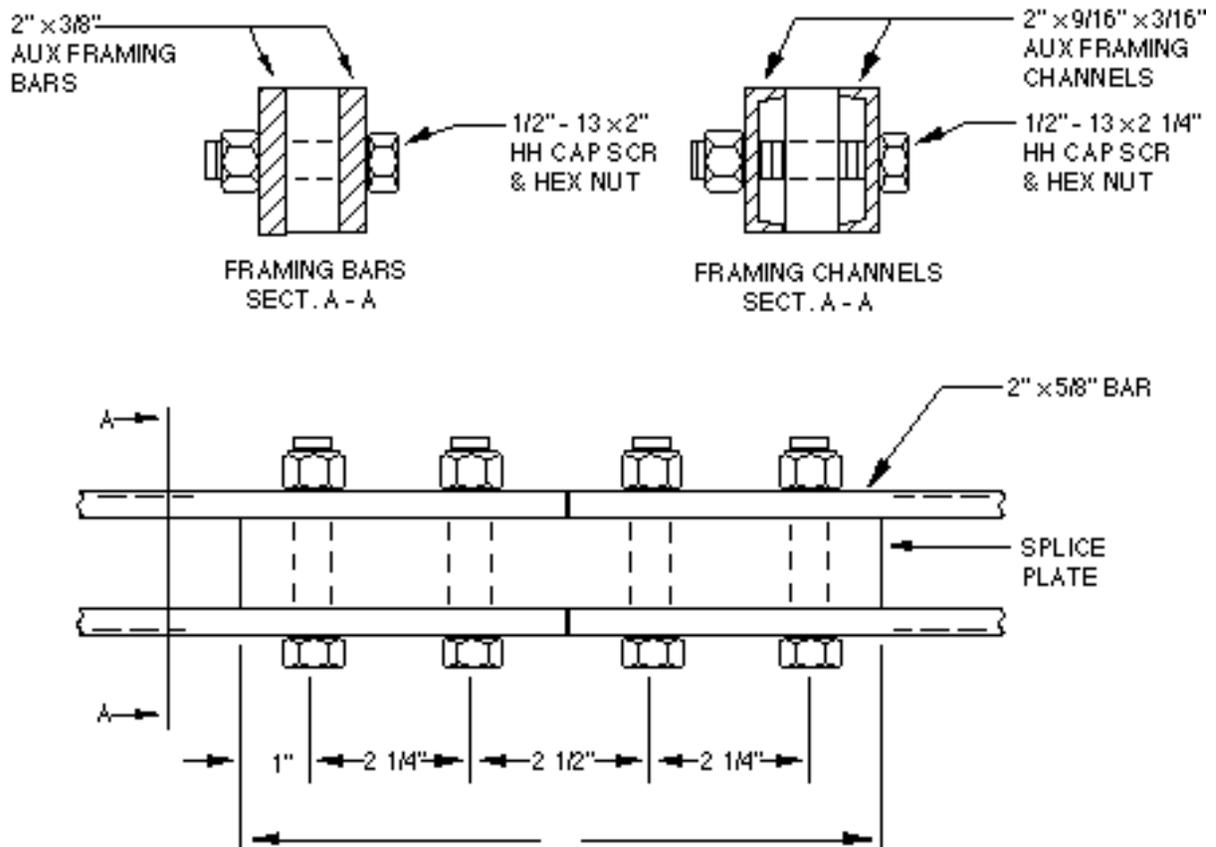


EXHIBIT 2-E5-8  
AUXILIARY FRAMING SPLICES - SAME LEVEL

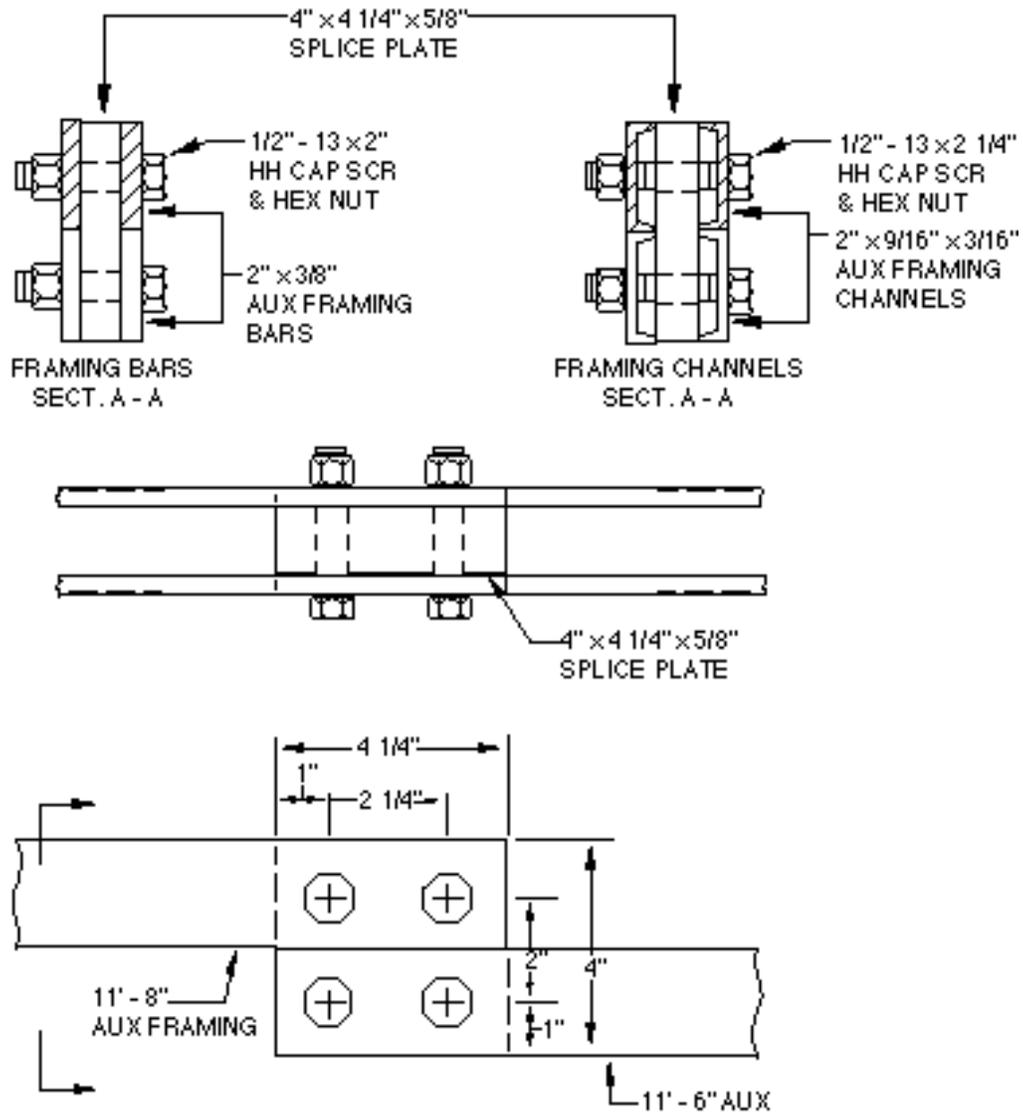


EXHIBIT 2-E5-8B  
 AUXILIARY FRAMING SPLICES - 11 FOOT 6 INCH AND 11 FOOT 8 INCH FRAMING

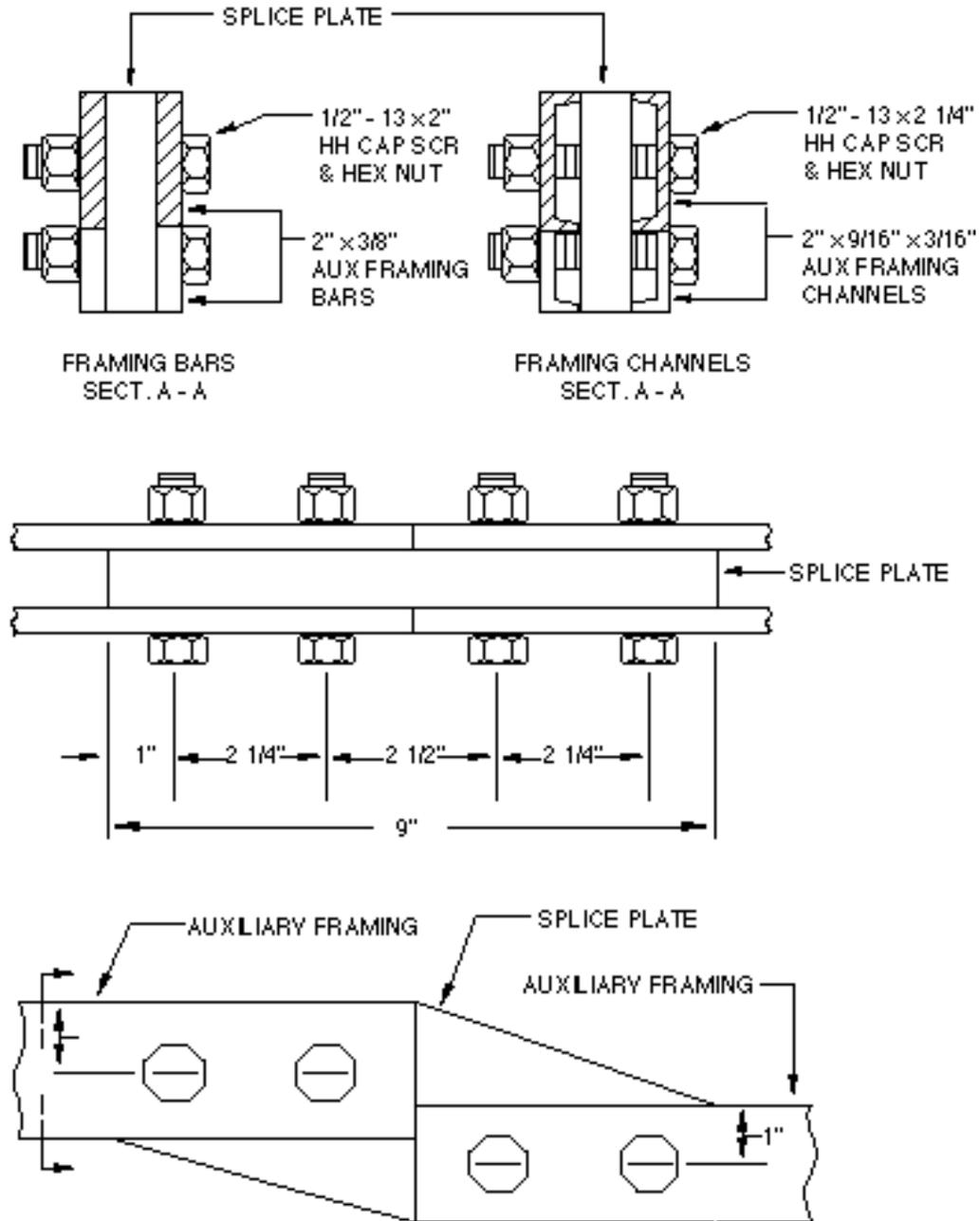


EXHIBIT 2-E5-8C  
AUXILIARY FRAMING SPLICES - 1 INCH DIFFERENCE IN FRAMING LEVELS

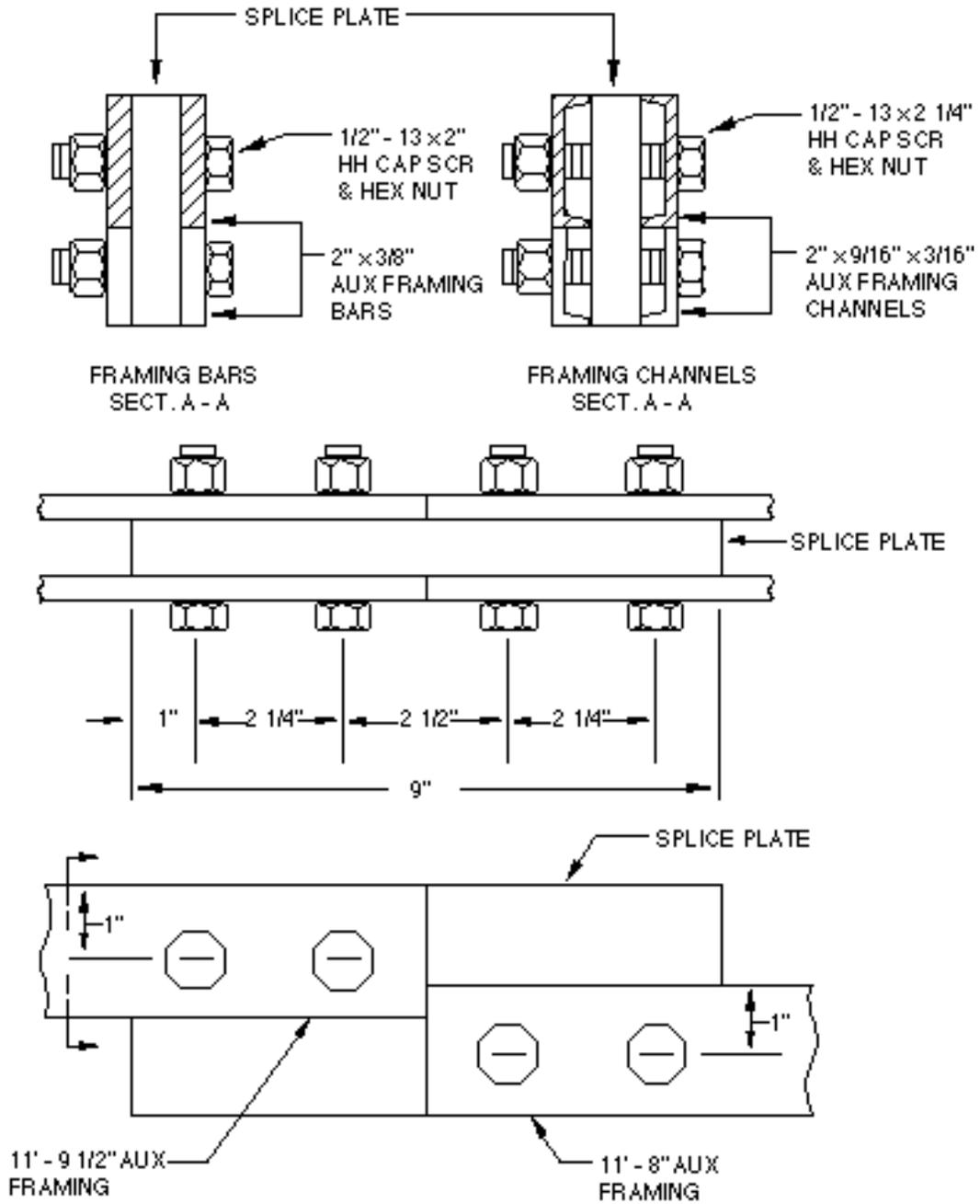


EXHIBIT 2-E5-8D  
 AUXILIARY FRAMING SPLICES - 11 FOOT 6 INCH AND 11 FOOT 8 INCH FRAMING

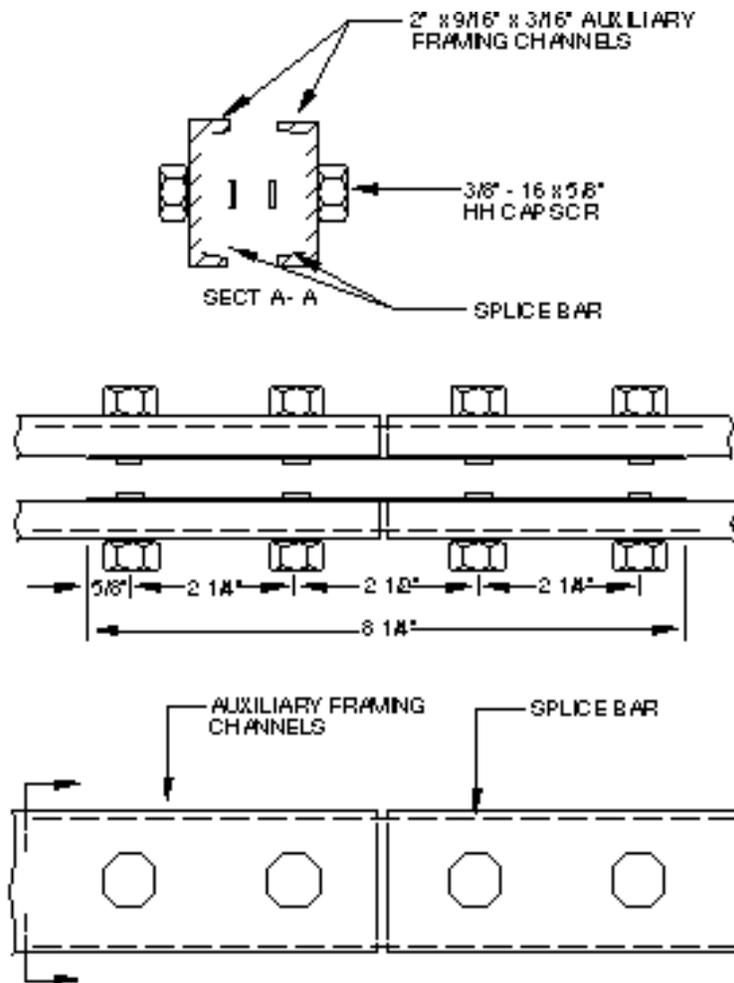


EXHIBIT 2-E5-8E  
AUXILIARY FRAMING SPLICES - SAME LEVEL

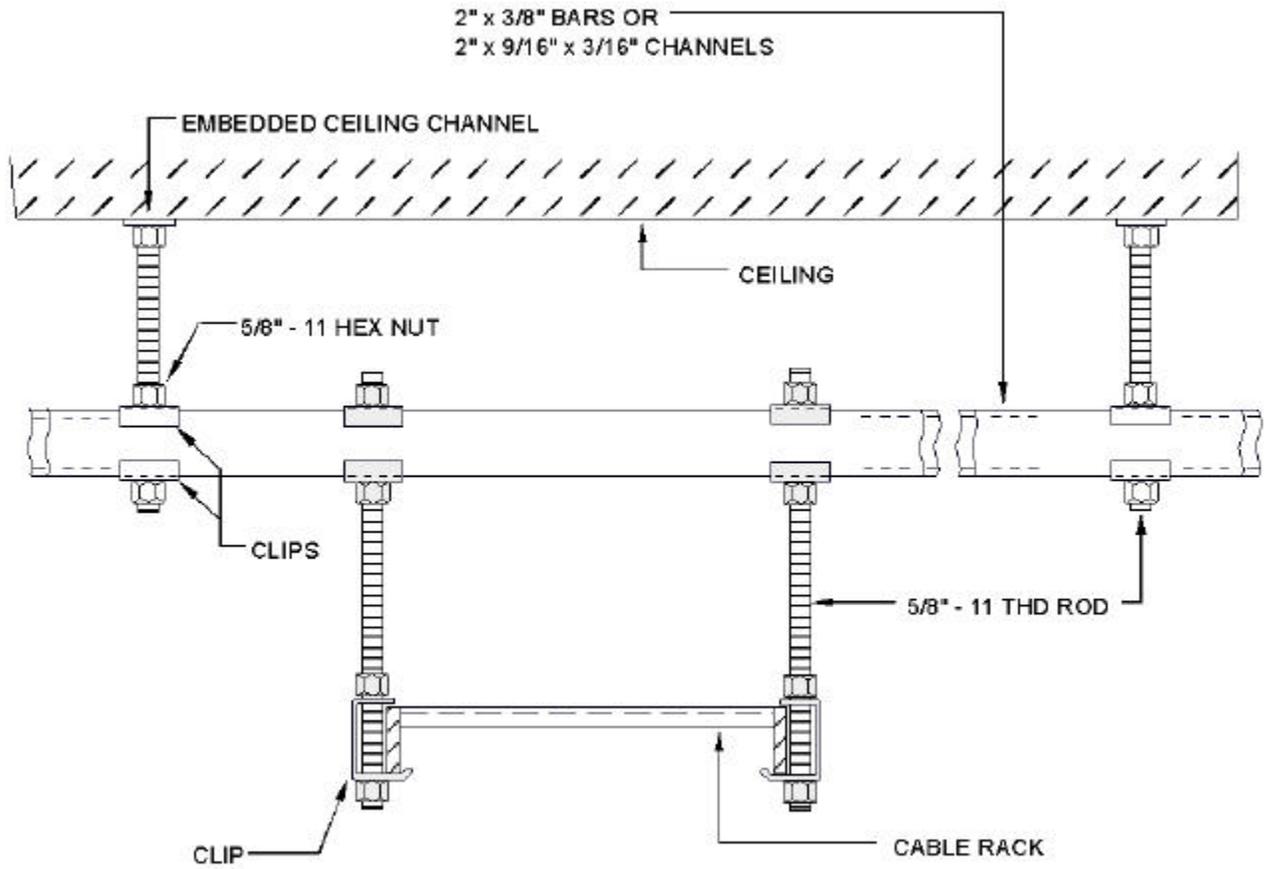


EXHIBIT 2-E5-9  
SUPPORT OF LADDER- OR BAR-TYPE CROSS-AISLE CABLE RACKS NOT ATTACHED  
DIRECTLY TO AUXILIARY FRAMING - LADDER-TYPE SHOWN

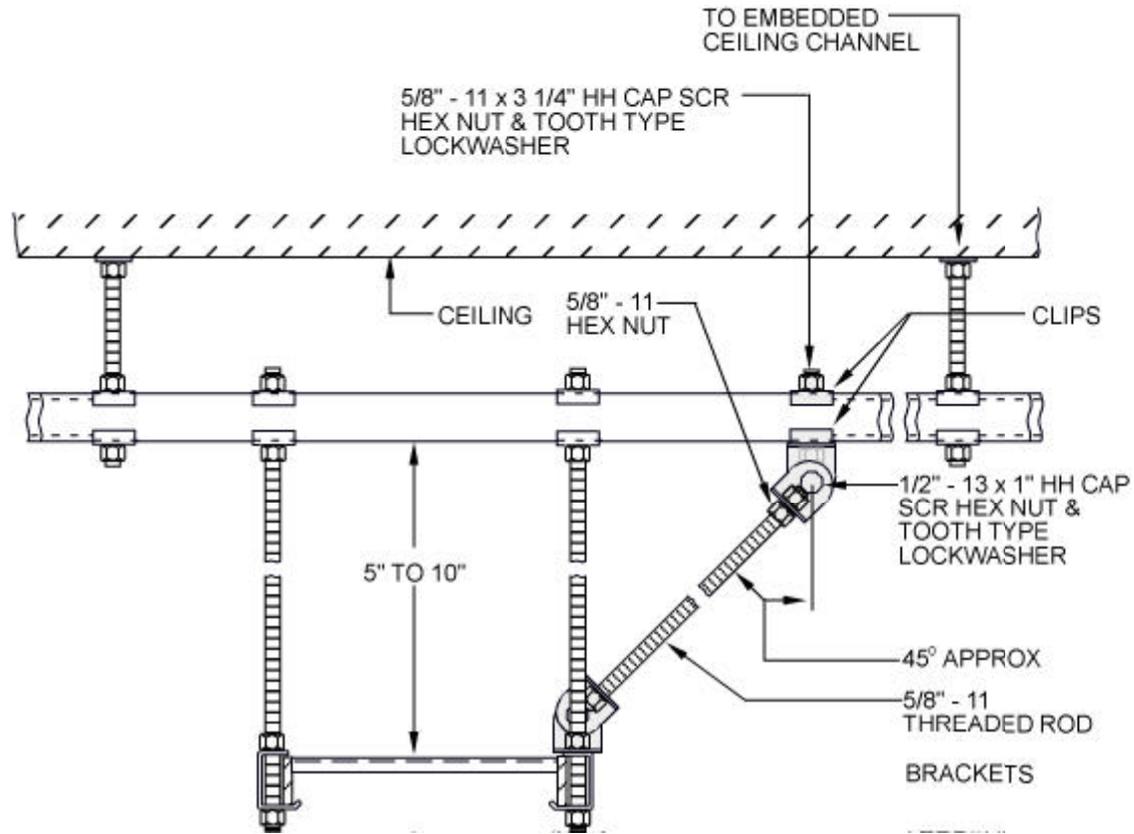


EXHIBIT 2-E5-9A  
SIDEWISE BRACING OF LADDER- OR BAR-TYPE CROSS AISLE CABLE RACK WITH  
THREADED ROD BRACES - LADDER-TYPE SHOWN

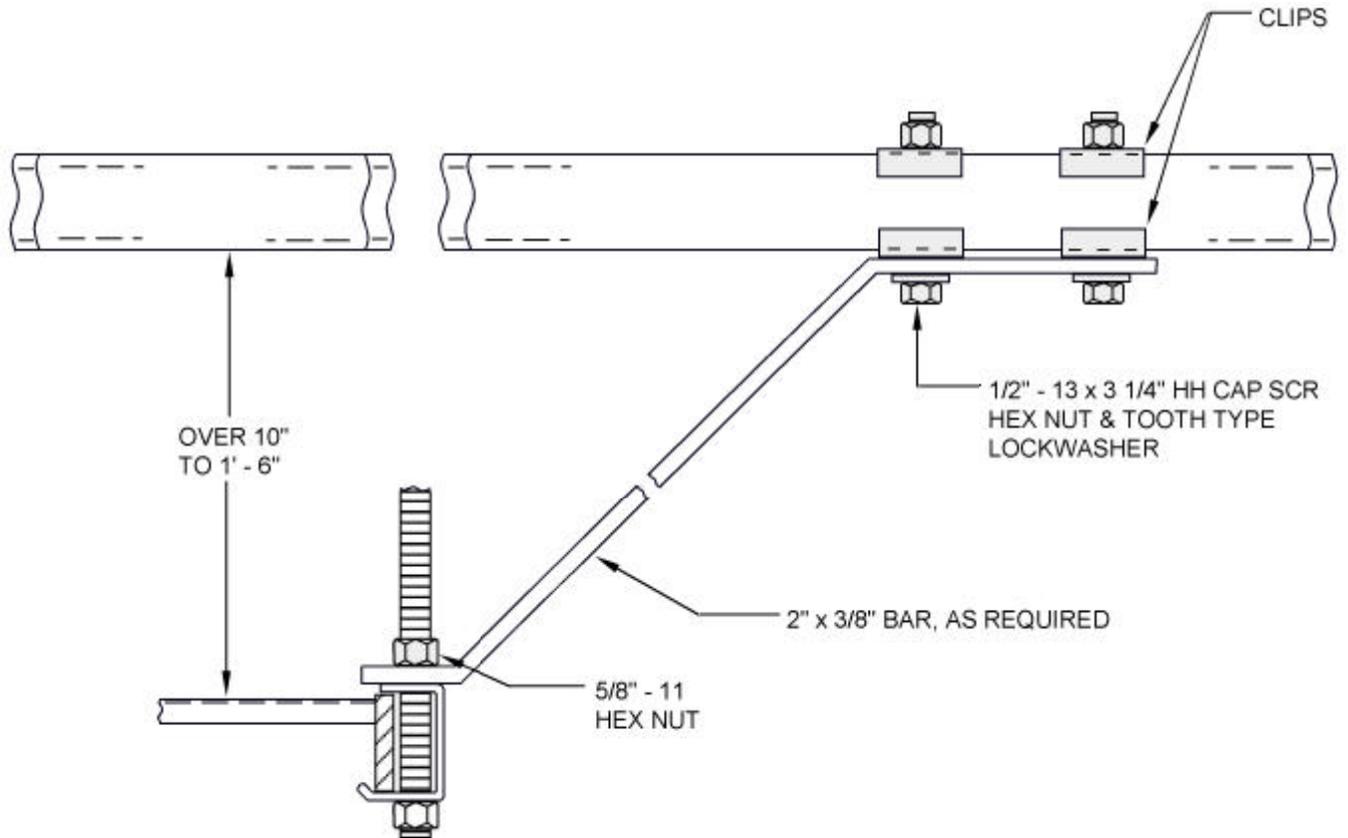


EXHIBIT 2-E5-9B  
SIDEWISE BRACING OF LADDER- OR BAR-TYPE CROSS-AISLE CABLE RACK WITH  
FLAT BAR BRACES - LADDER-TYPE SHOWN

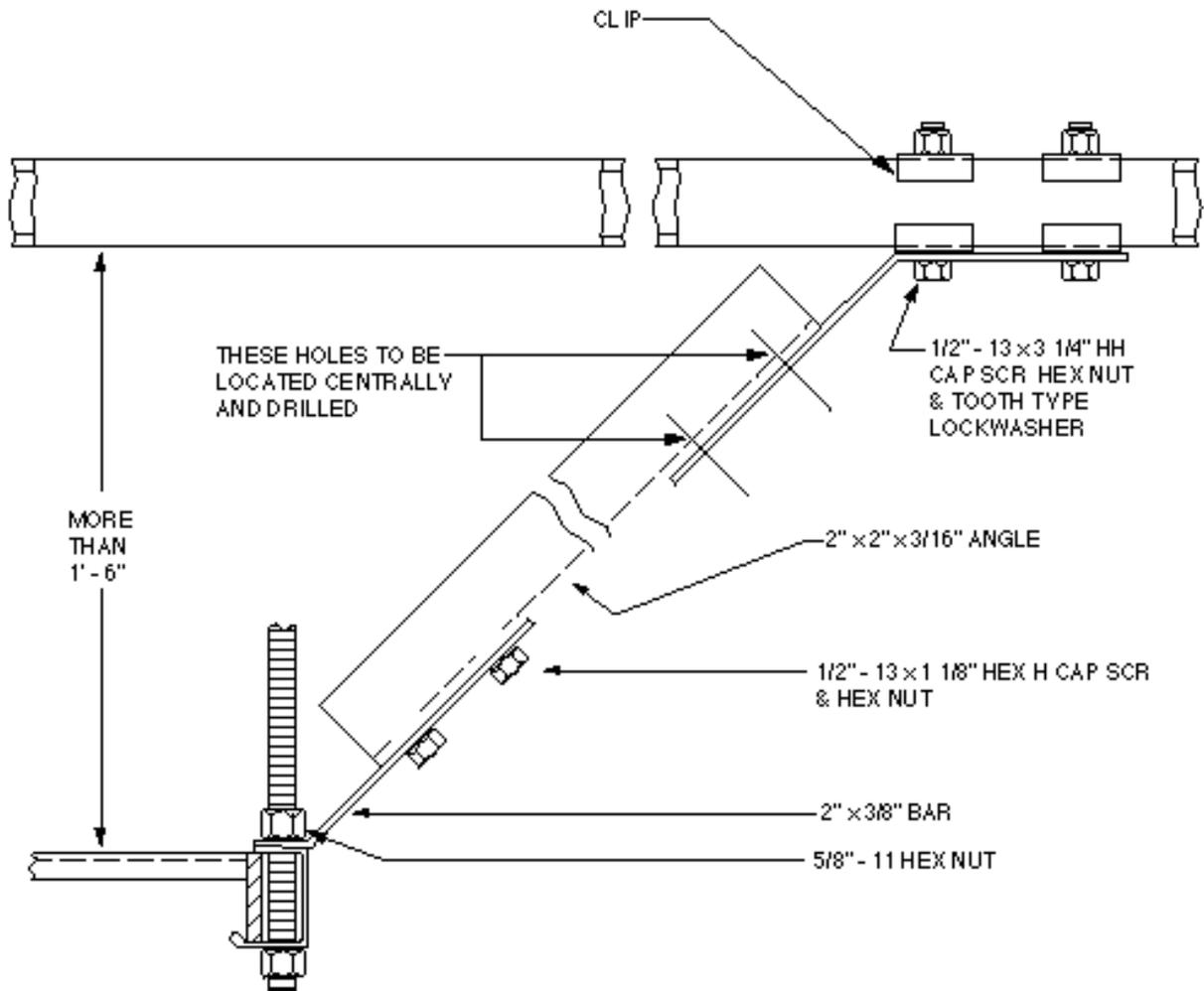


EXHIBIT 2-E5-9C  
SIDEWISE BRACING OF LADDER- OR BAR-TYPE CROSS-AISLE CABLE RACK WITH  
ANGLE BRACES - LADDER-TYPE SHOWN

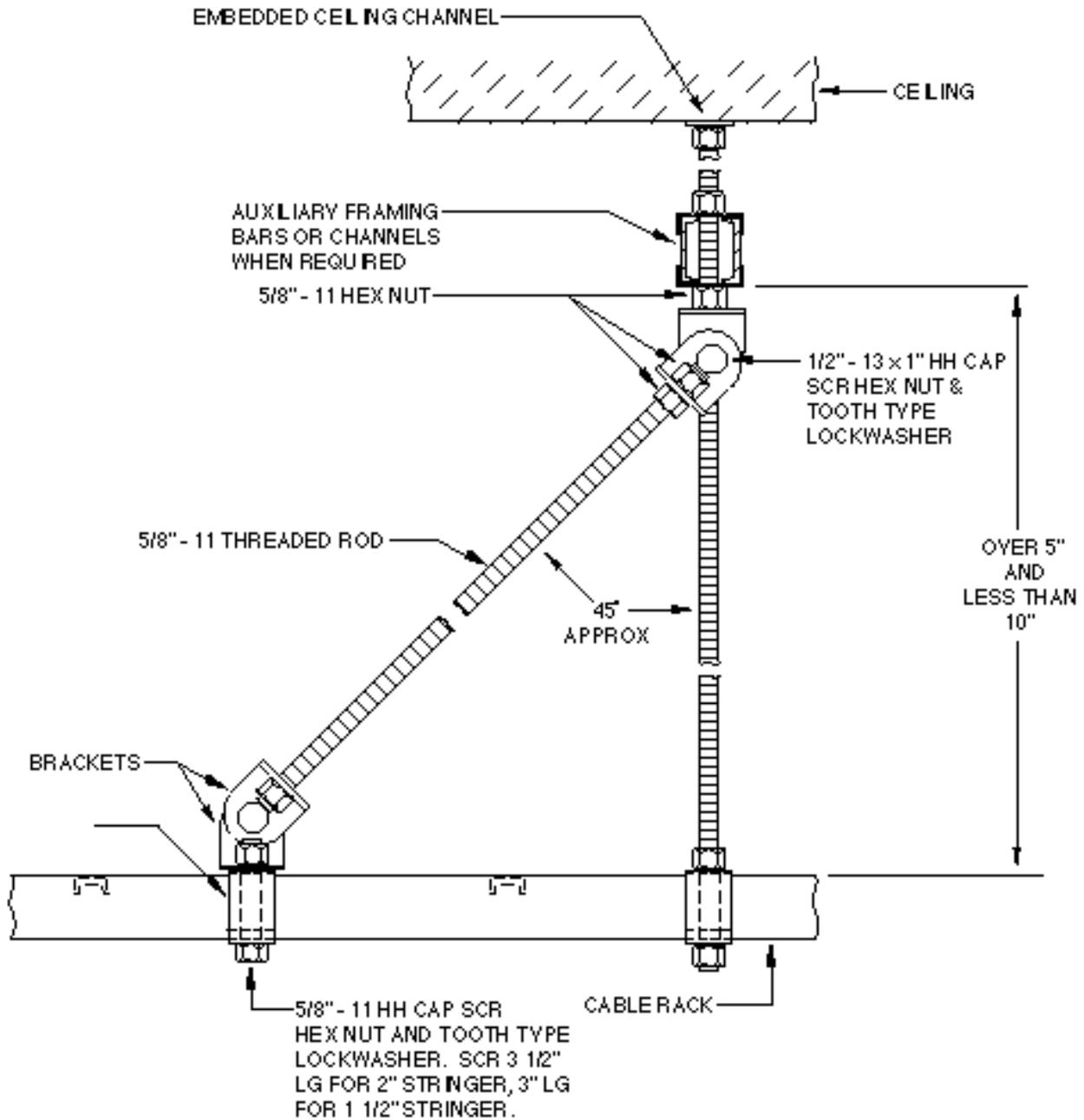


EXHIBIT 2-E5-9D

ENDWISE BRACING OF LADDER- OR BAR-TYPE CROSS-AISLE CABLE RACK WITH  
THREADED ROD BRACES - LADDER-TYPE SHOWN

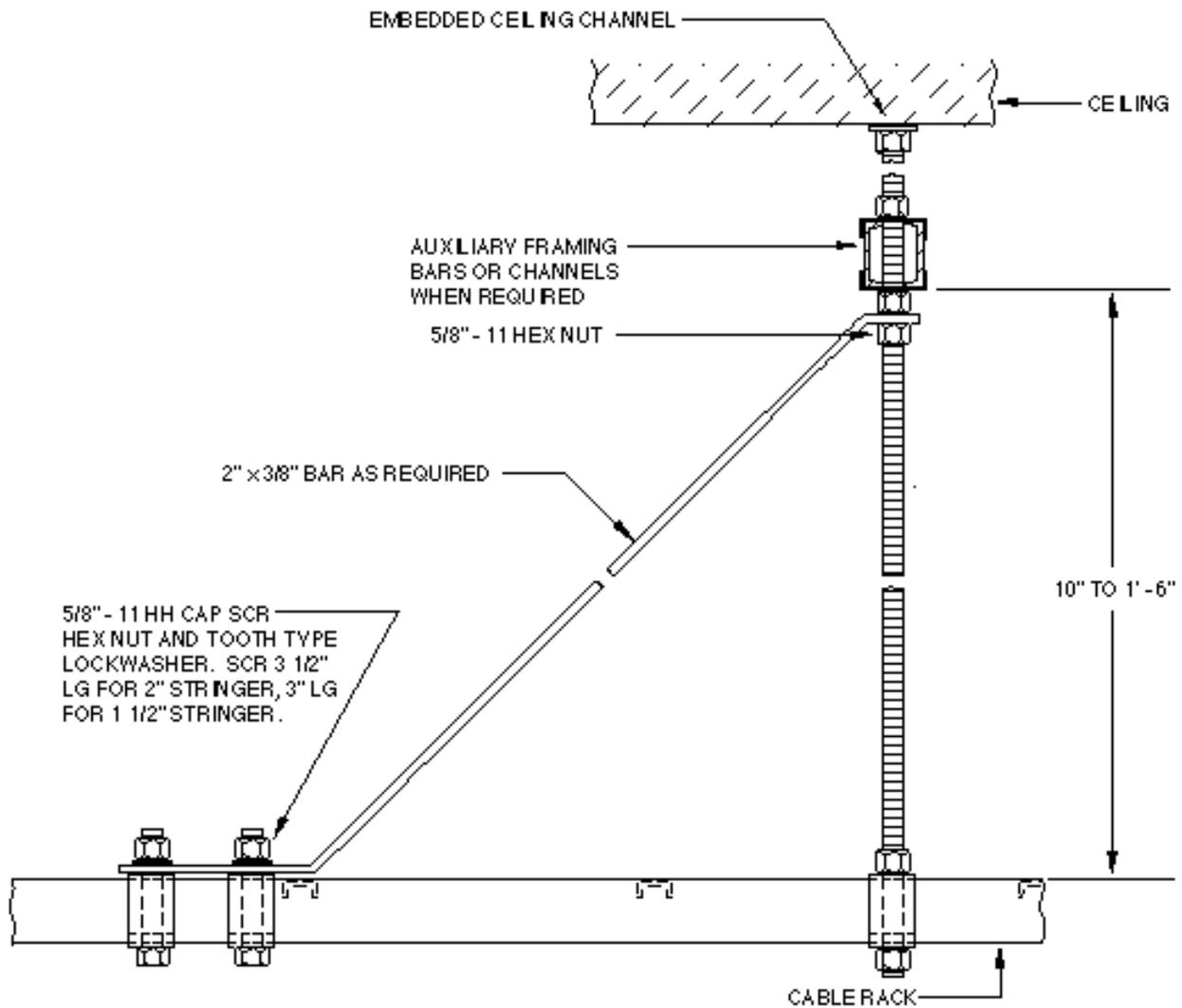


EXHIBIT 2-E5-9E

ENDWISE BRACING OF LADDER- OR BAR-TYPE CROSS-AISLE RACK WITH FLAT BAR BRACES - LADDER-TYPE SHOWN

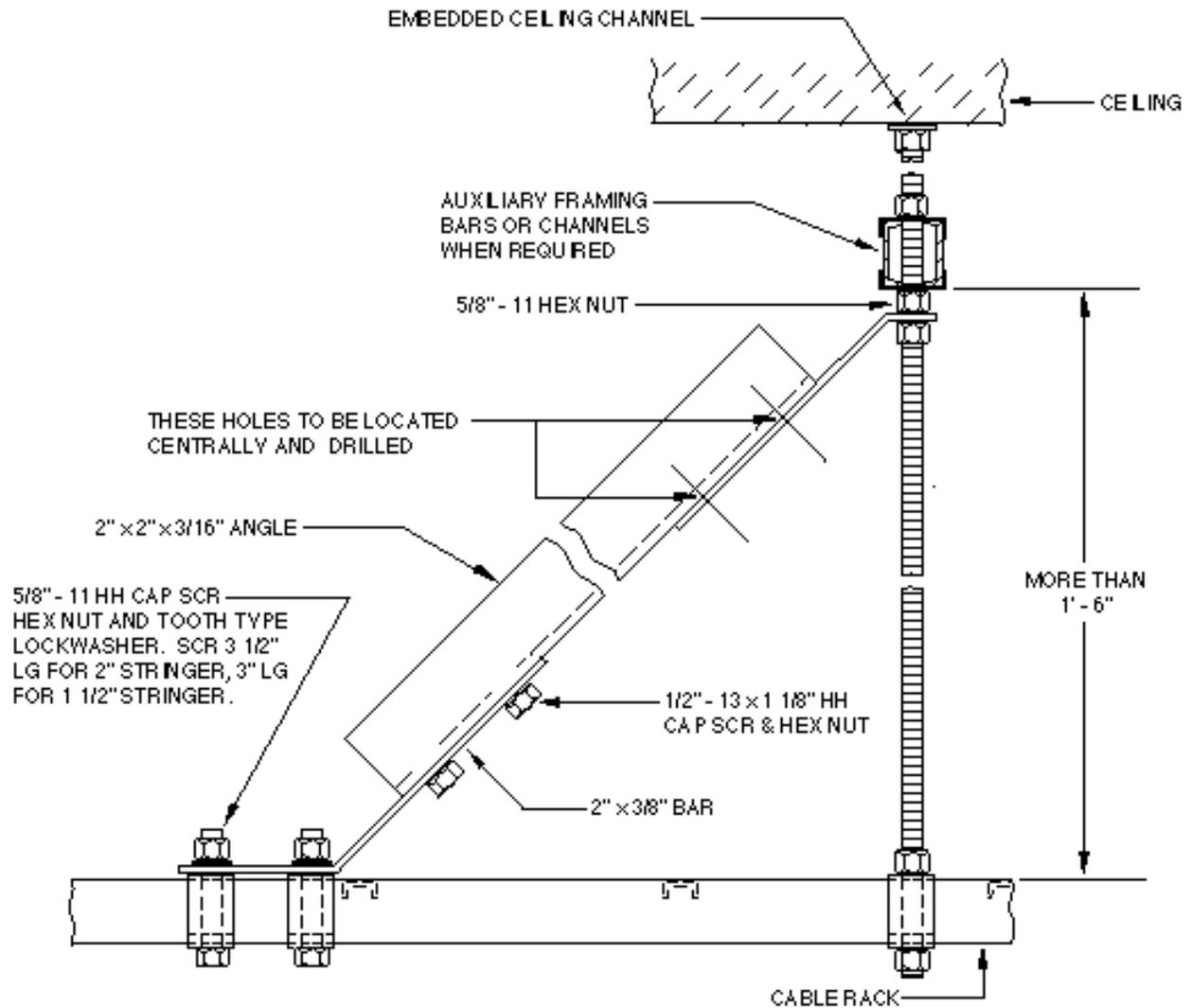


EXHIBIT 2-E5-9F

ENDWISE BRACING OF LADDER- OR BAR-TYPE CROSS-AISLE RACK WITH ANGLE BRACES - LADDER-TYPE SHOWN

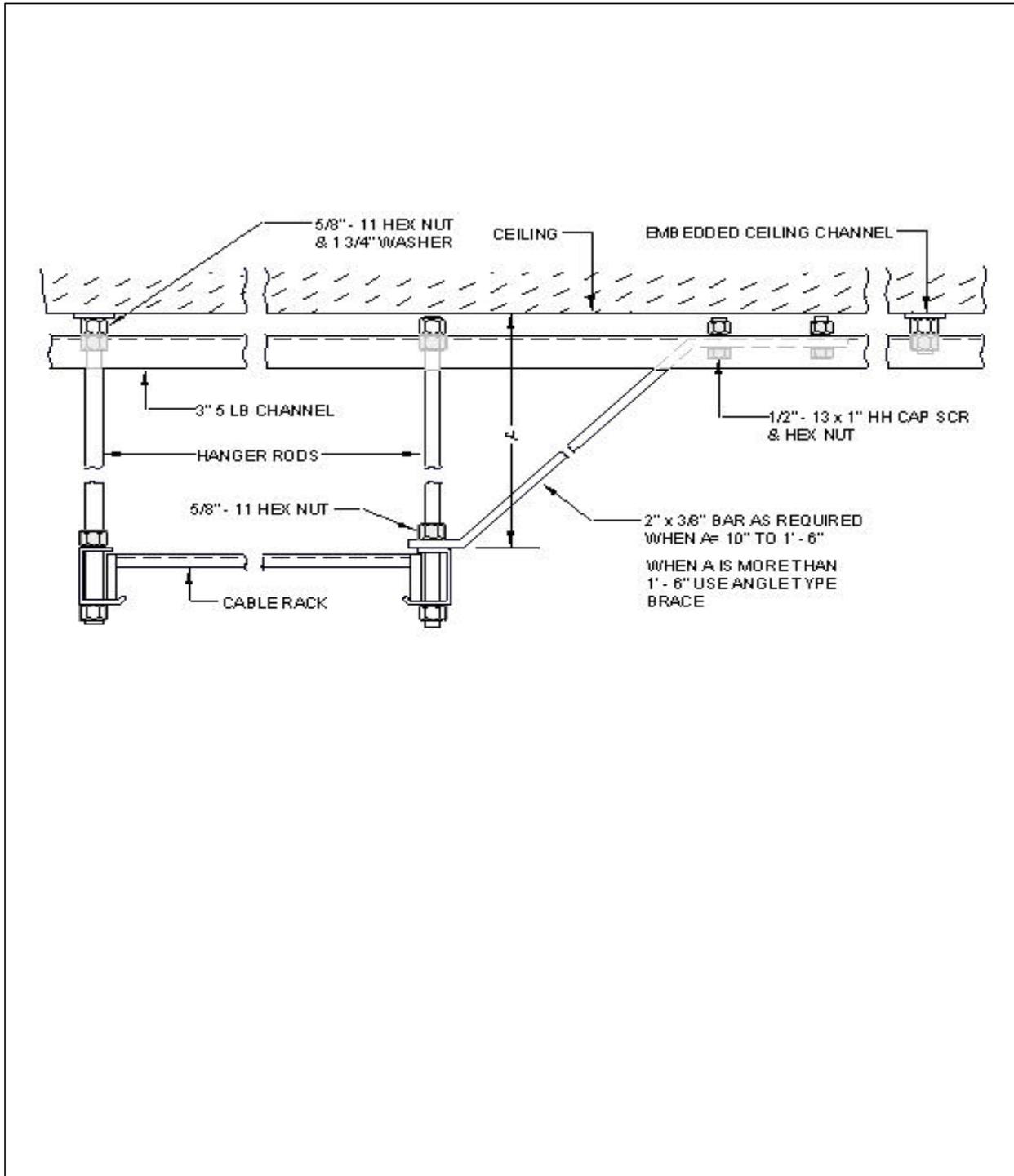
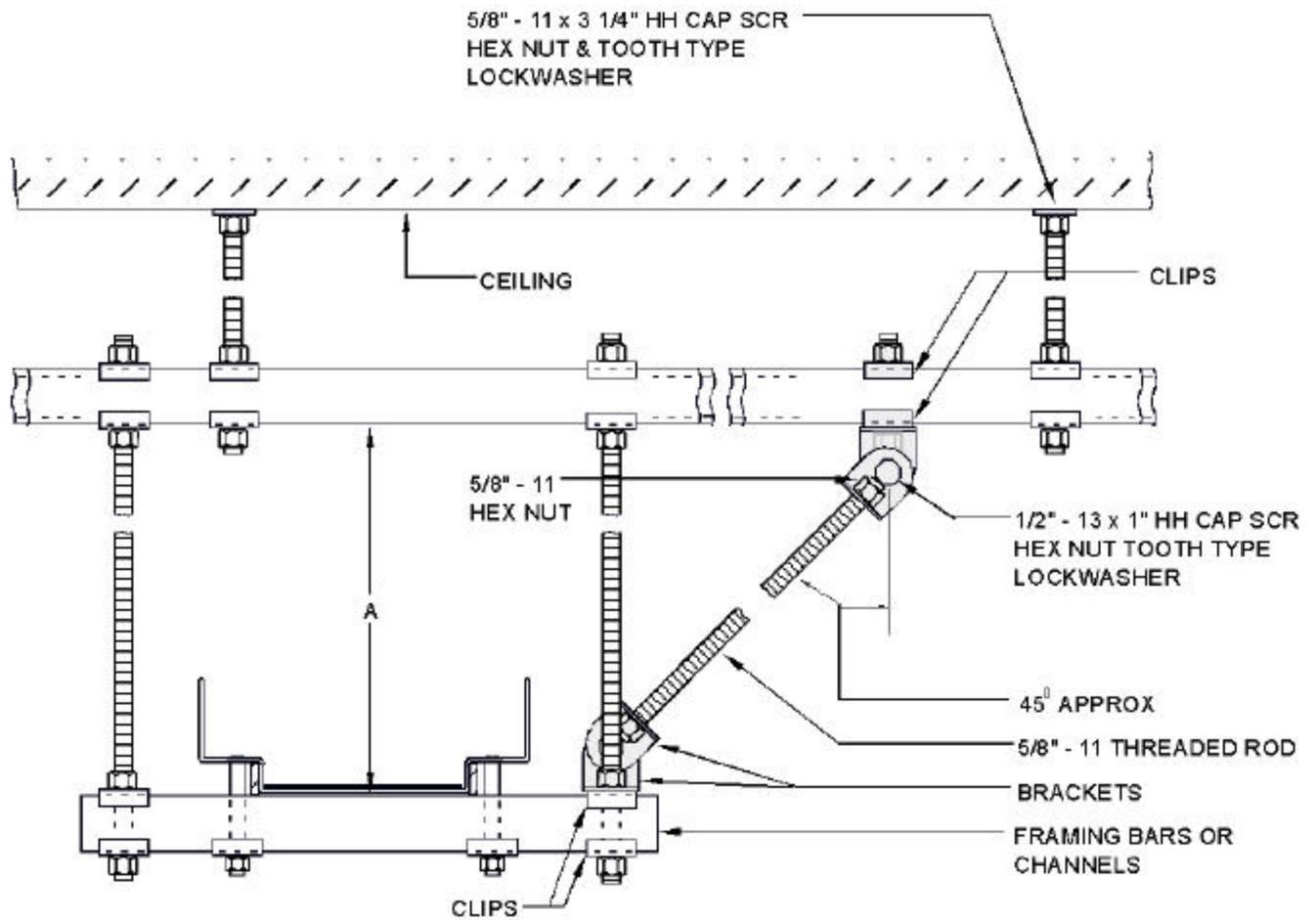
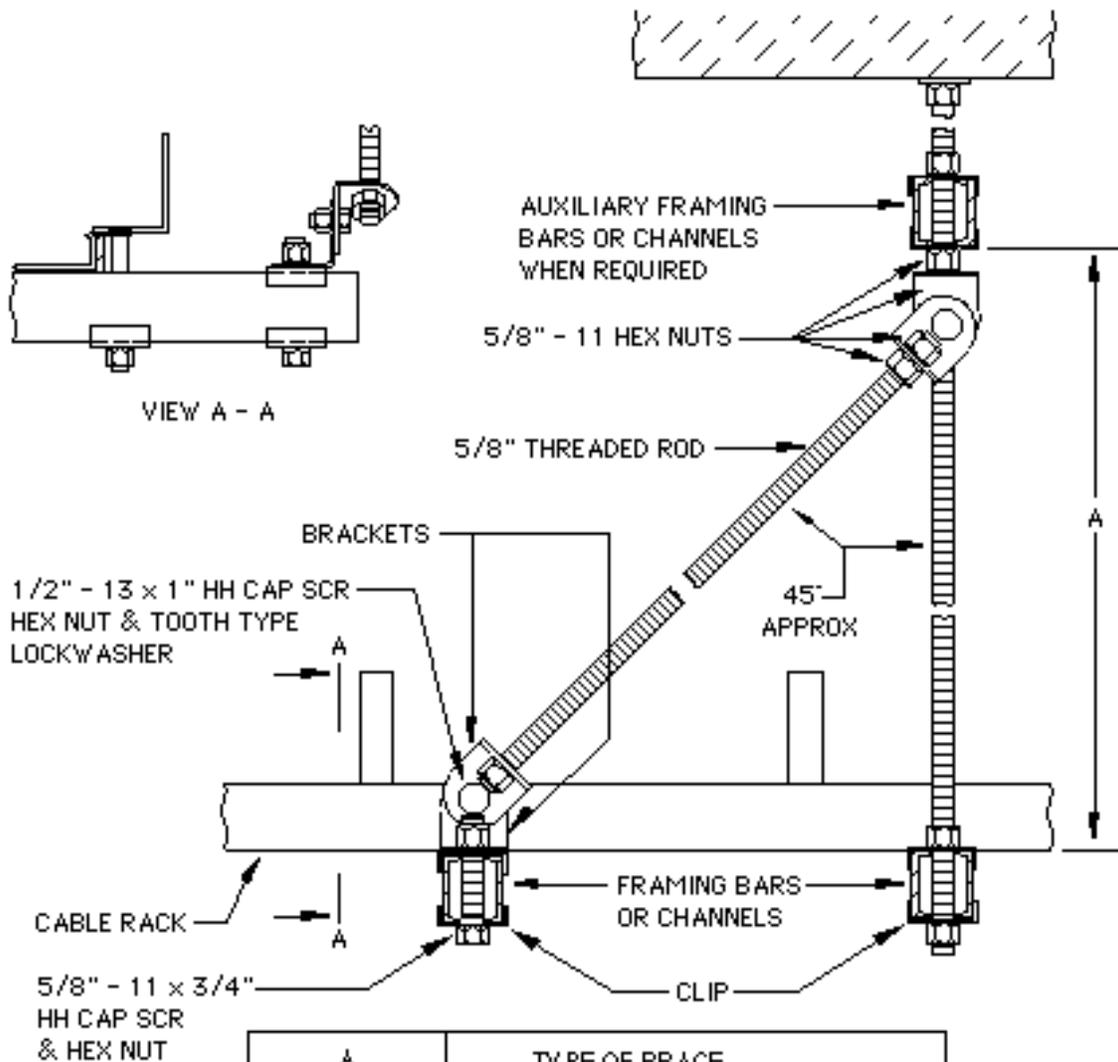


EXHIBIT 2-E5-9G  
SIDEWISE BRACING OF LADDER-TYPE CABLE RACKS IN POWER  
AND OPERATING ROOMS



A	TYPE OF BRACE
5" TO 10"	5/8" - 11 THREADED ROD & BRACKETS AS SHOWN
OVER 10" TO 1' - 6"	2" x 3/8" BAR, AS REQUIRED
OVER 1' - 6"	2" x 2" x 3/16" ANGLE WITH 2" x 3/8" BAR AT EACH END

EXHIBIT 2-E5-9H  
 SIDEWISE BRACING OF BAR-TYPE OVER-AISLE CABLE RACKS



A	TYPE OF BRACE
5" TO 10"	5/8" - 11 THREADED ROD & BRACKETS AS SHOWN
OVER 10" TO 1' - 6"	2" x 3/8" BAR INSTALLER TO CUT OFF END OF BRACE WITH UNUSED HOLE AND REDRILL REMAINING 9/16" HOLE 11/16"
OVER 1' - 6"	2" x 2" x 3/16" ANGLE WITH 2" x 3/8" BAR

EXHIBIT 2-E5-9J  
ENDWISE BRACING OF BAR-TYPE OVER-AISLE CABLE RACKS

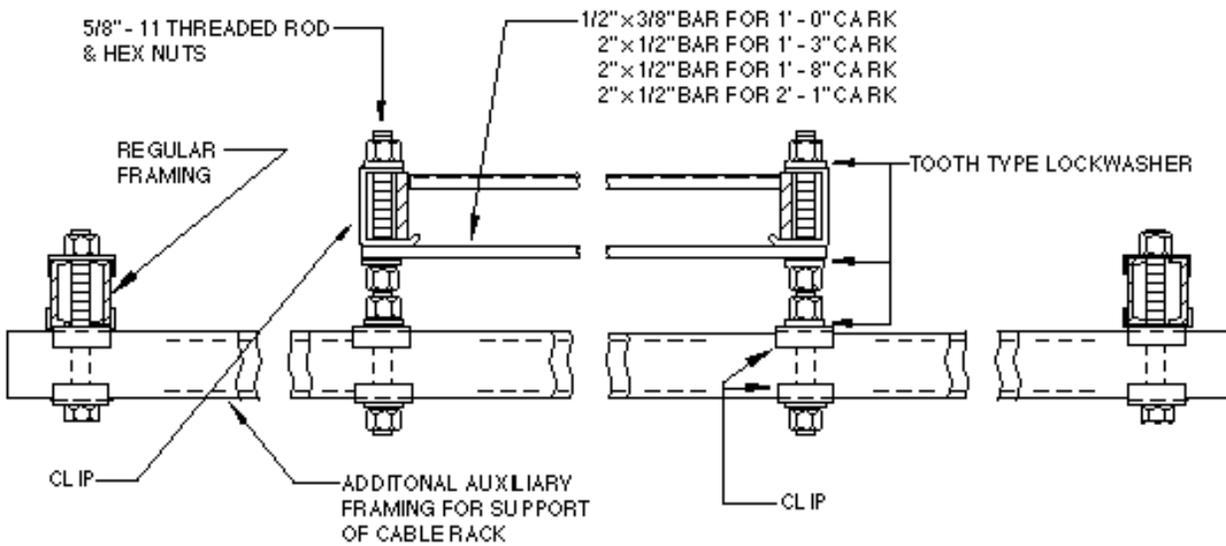


EXHIBIT 2-E5-9L  
SUPPORTING LADDER- OR BAR-TYPE CROSS AISLE CABLE RACKS 2 INCHES ABOVE  
AUXILIARY FRAMING - LADDER-TYPE SHOWN

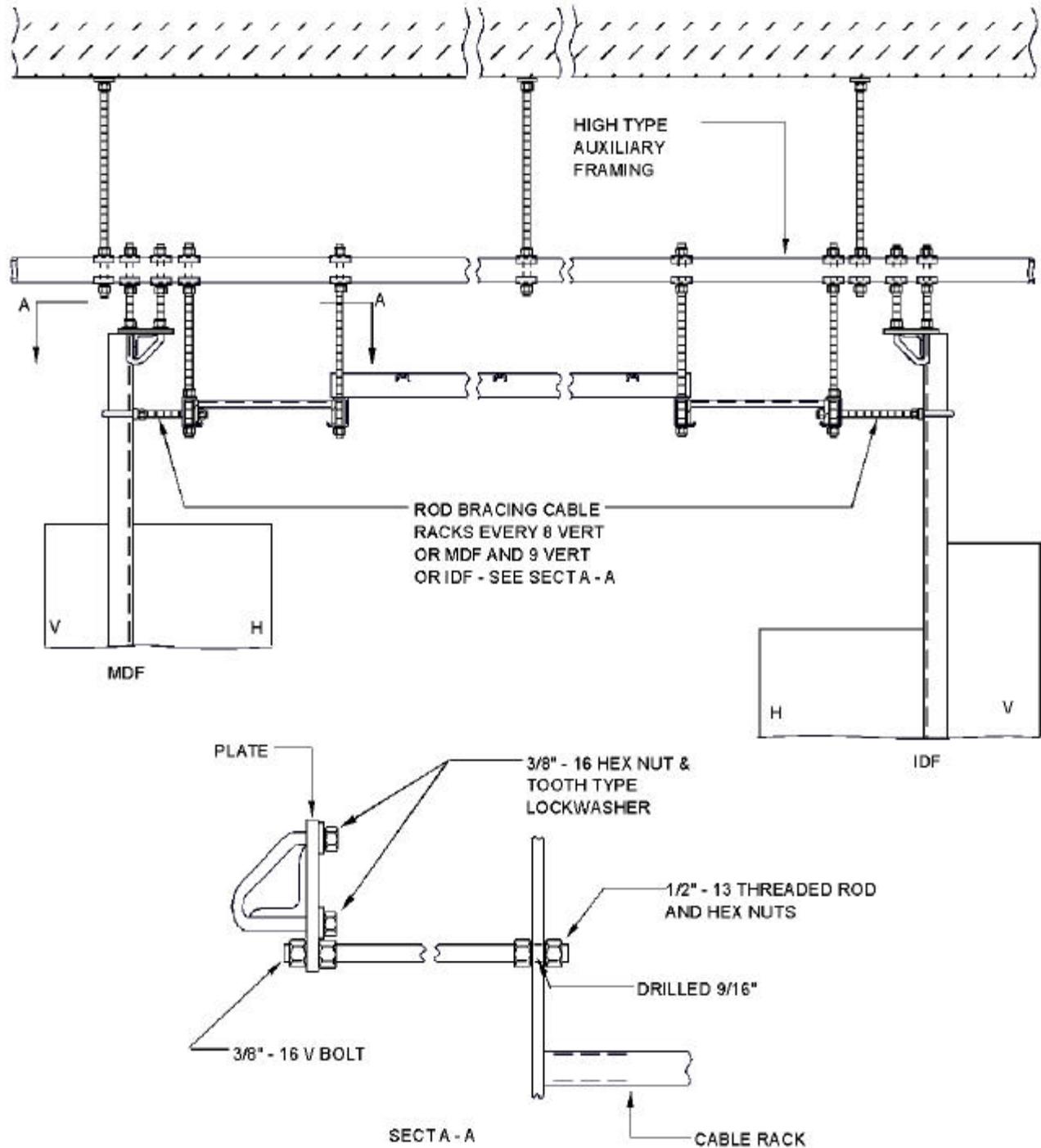


EXHIBIT 2-E5-9M  
BRACING CABLE RACKS TO DISTRIBUTING FRAME VERTICALS

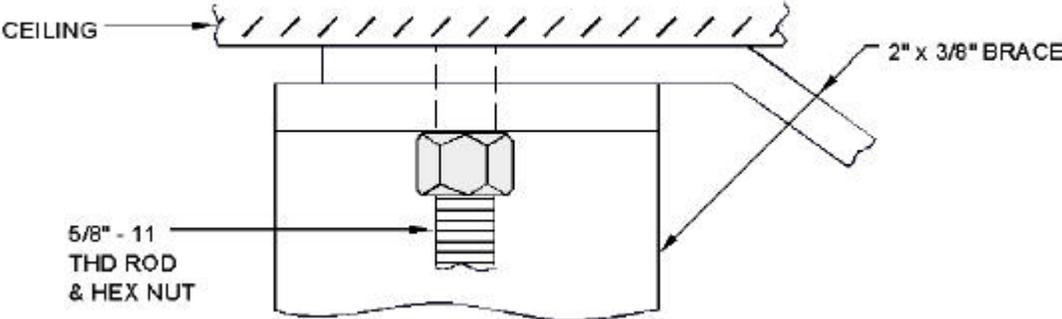


EXHIBIT 2-E5-9N  
PERPENDICULAR BRACING

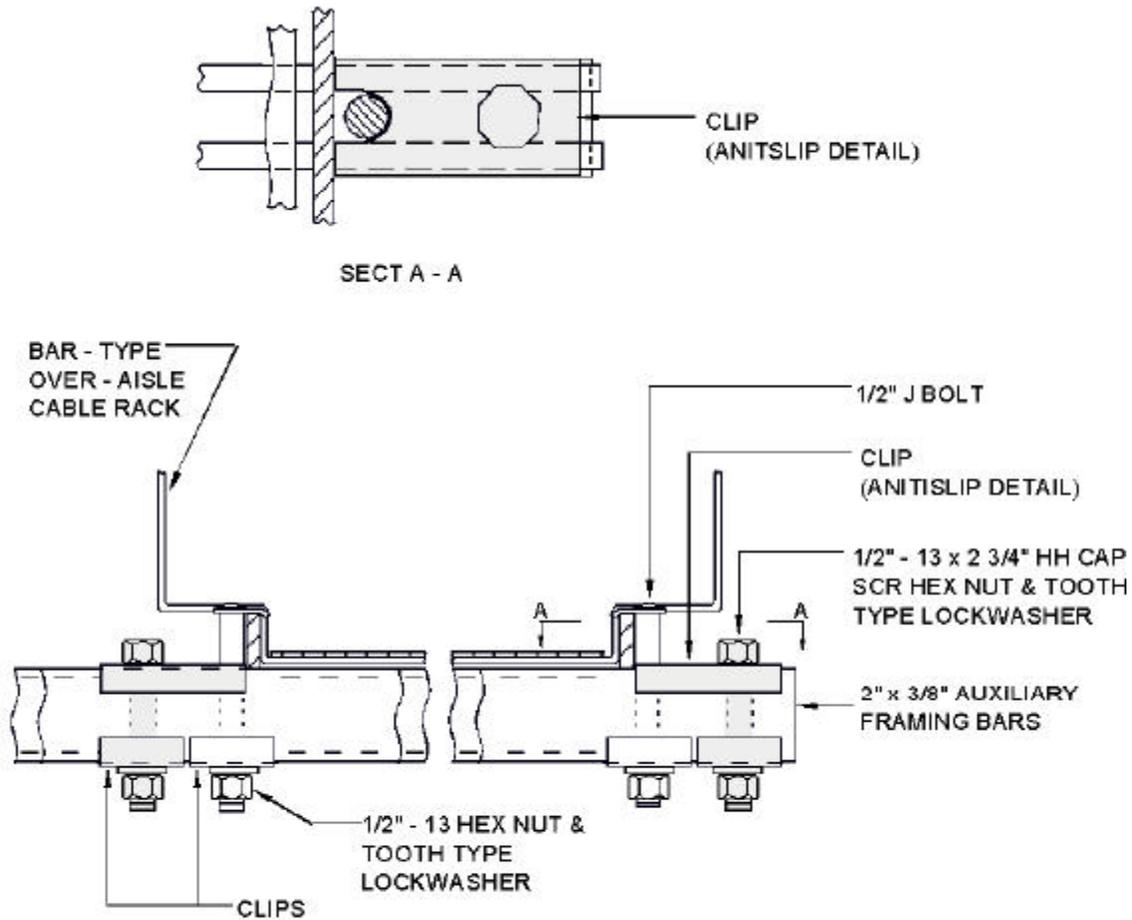


EXHIBIT 2-E5-10A

FASTENING OF LADDER- OR BAR-TYPE CABLE RACKS TO AUXILIARY FRAMING  
WHERE CABLE RACKS SUPPORT FRAMES - USE OF ANTISLIP DETAILS - BAR-TYPE  
OVER-AISLE CABLE RACK SHOWN

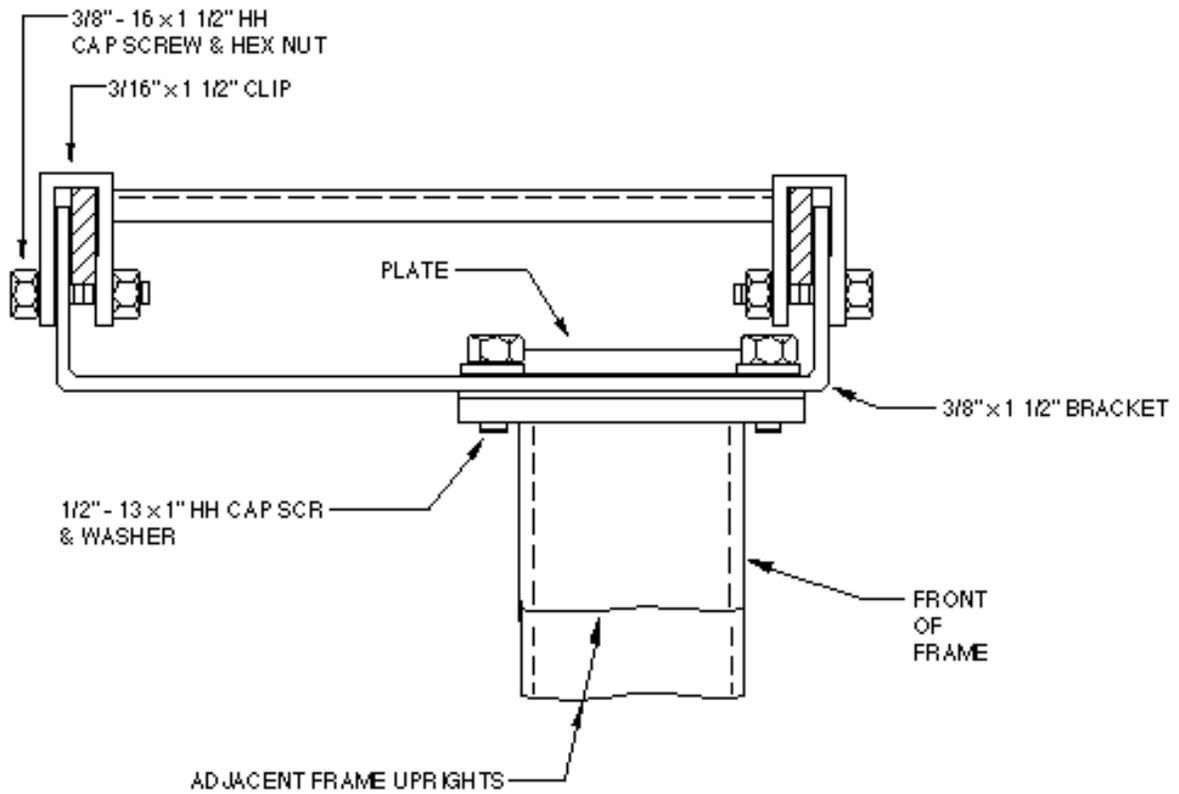


EXHIBIT 2-E5-11  
FASTENING OR LADDER-TYPE CABLE RACKS TO FRAMES IN STEP-BY-STEP OFFICES  
WITH 11 FOOT 6 INCH AUXILIARY FRAMING

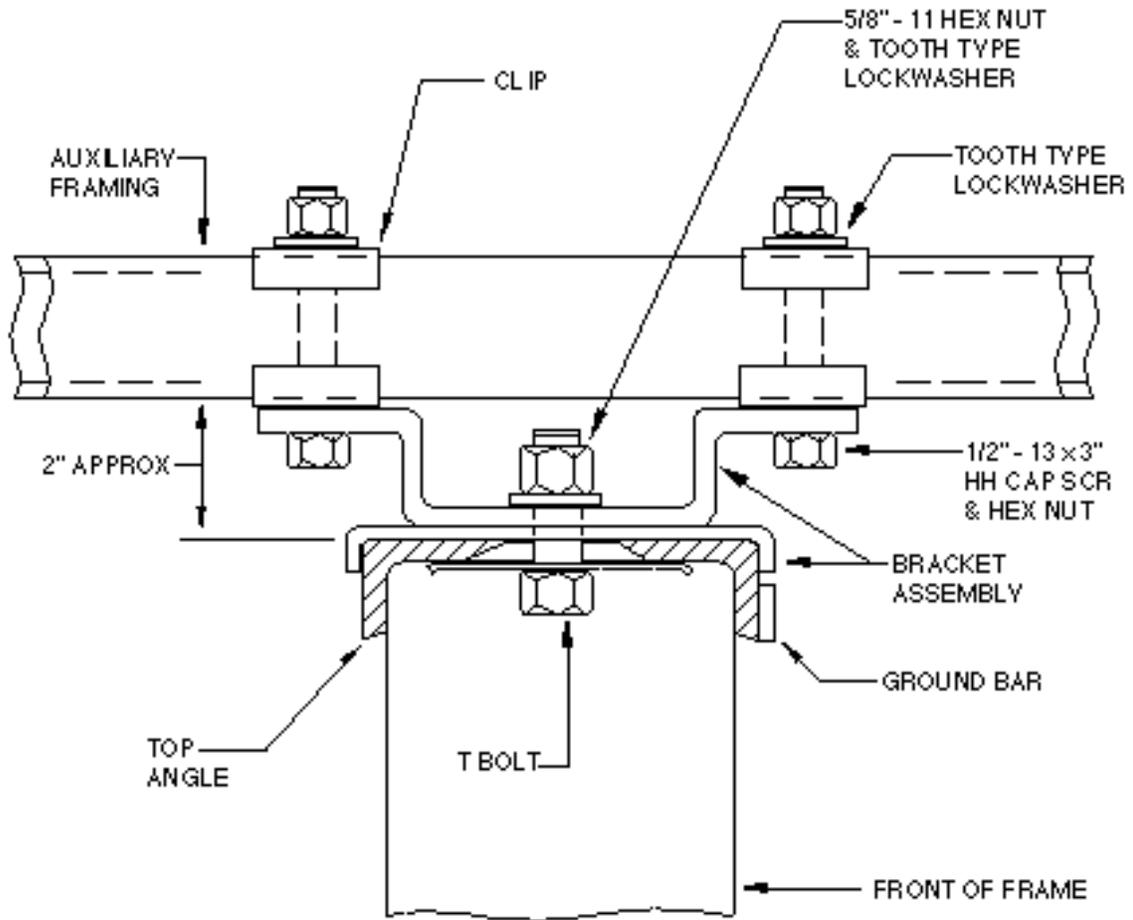


EXHIBIT 2-E5-12A (A&M)  
AUXILIARY FRAMING FASTENED TO THE TOPS OF BULB-ANGLE FRAME

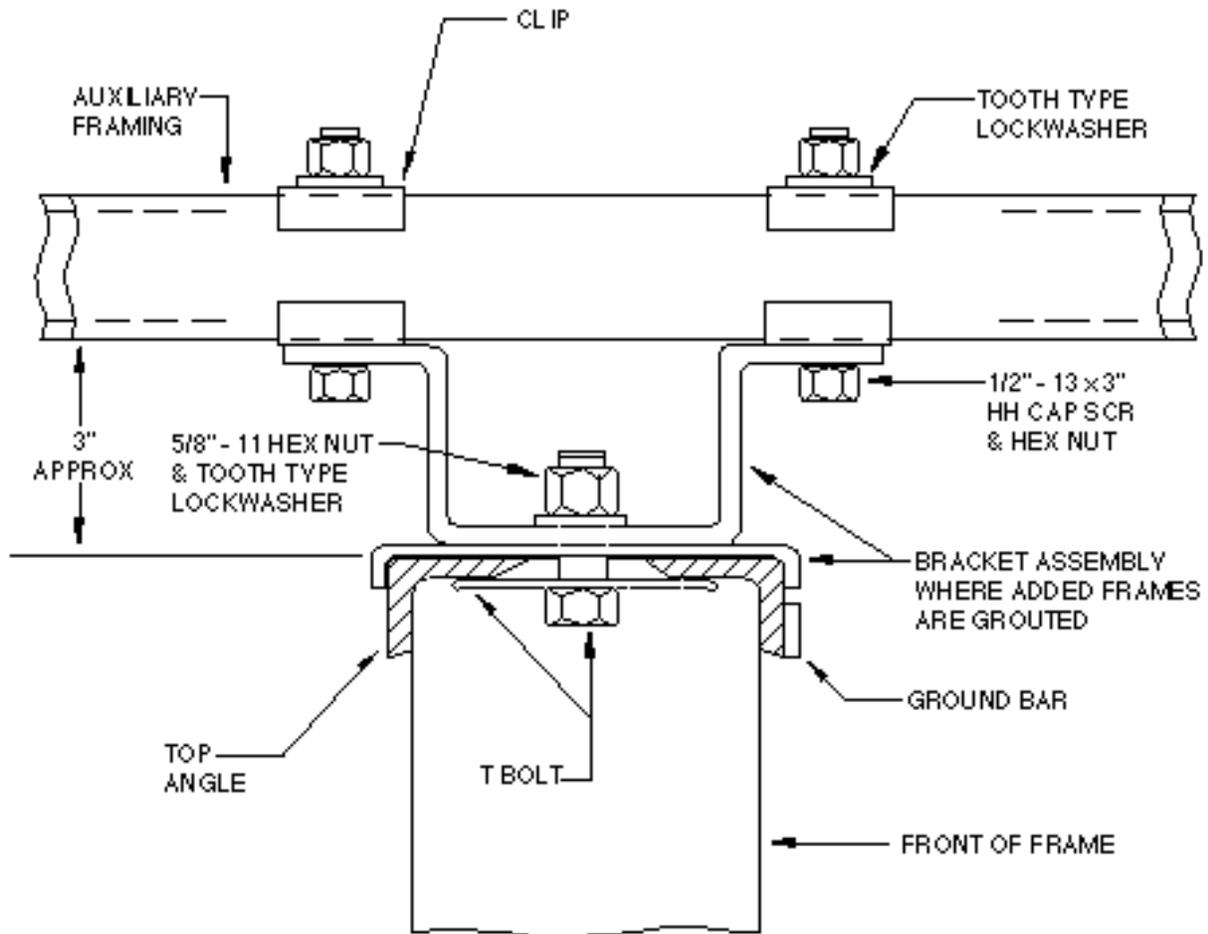


EXHIBIT 2-E5-12B (A&M)  
ADDITIONS WHERE AUXILIARY FRAMING IS FASTENED 3 INCHES ABOVE TOP-  
ANGLES OF EXISTING BULB-ANGLE FRAMES

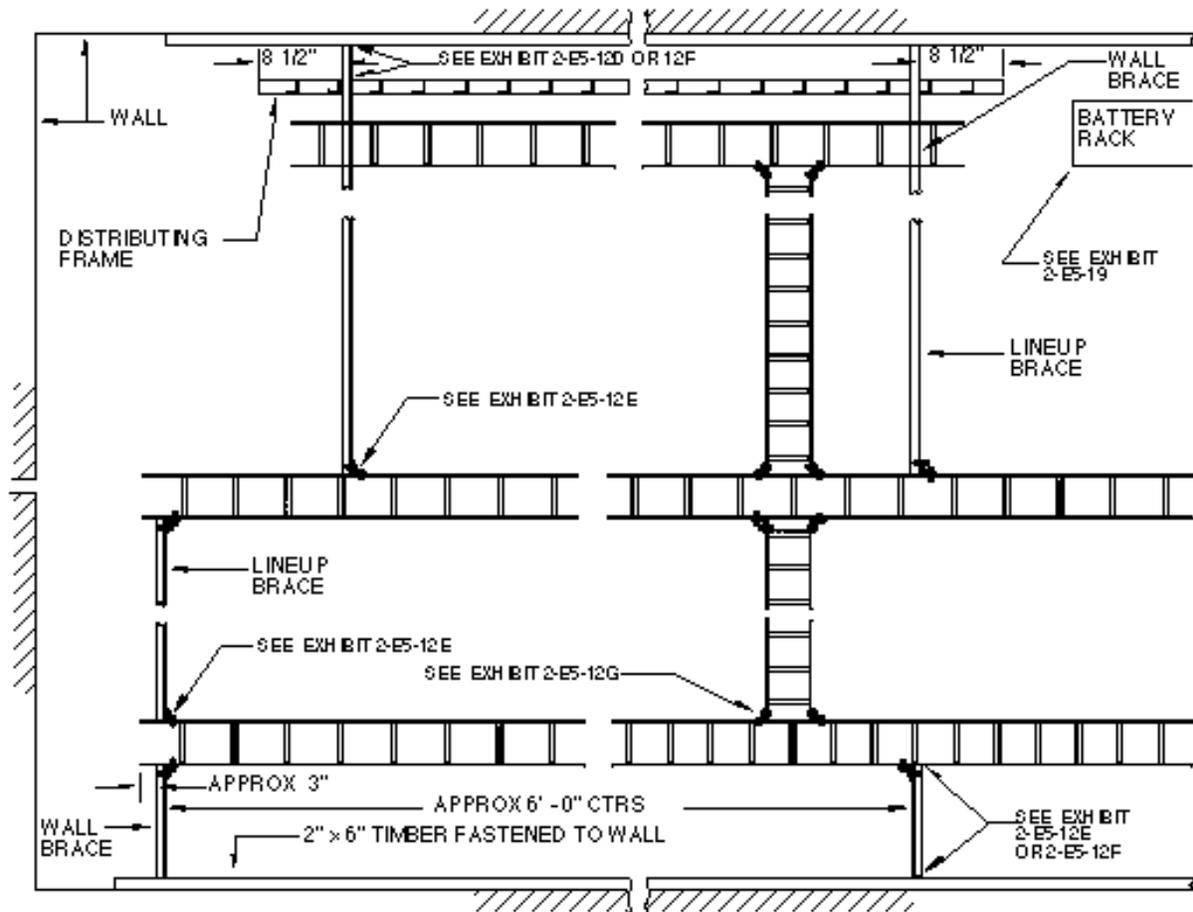


EXHIBIT 2-E5-12C (A&M)  
TYPICAL ARRANGEMENT OF LADDER-TYPE CABLE RACKS AND BRACES FOR A  
COMMUNITY DIAL OFFICE

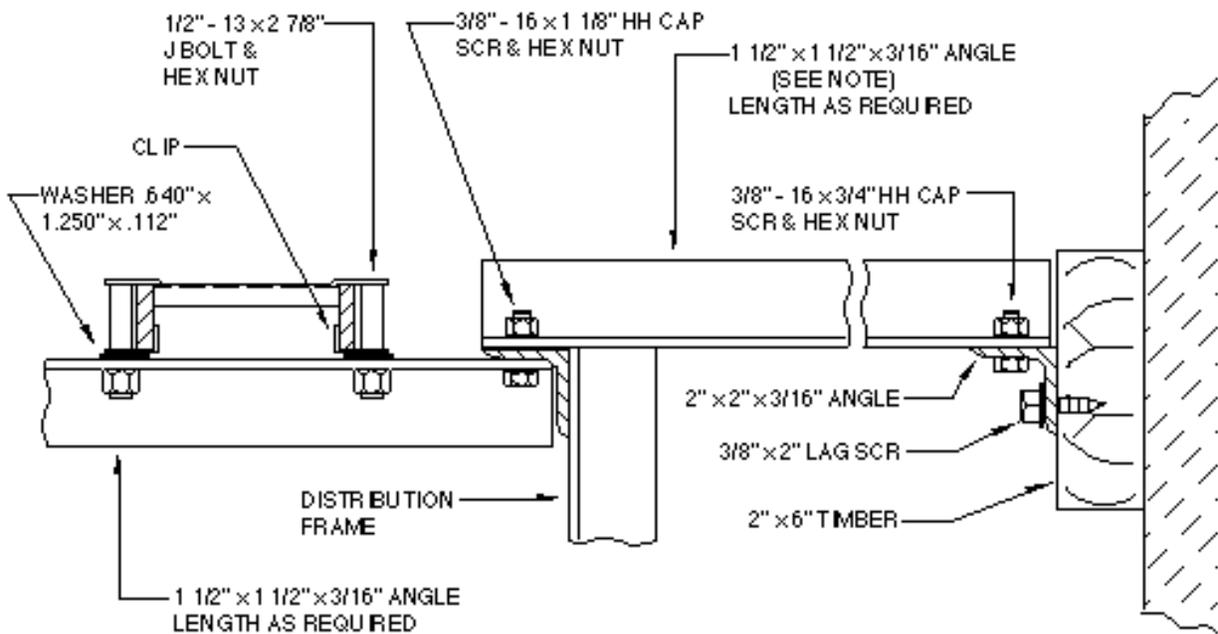


EXHIBIT 2-E5-12D (A&M)  
WALL BRACES FOR COMMUNITY DIAL OFFICE DISTRIBUTING FRAME

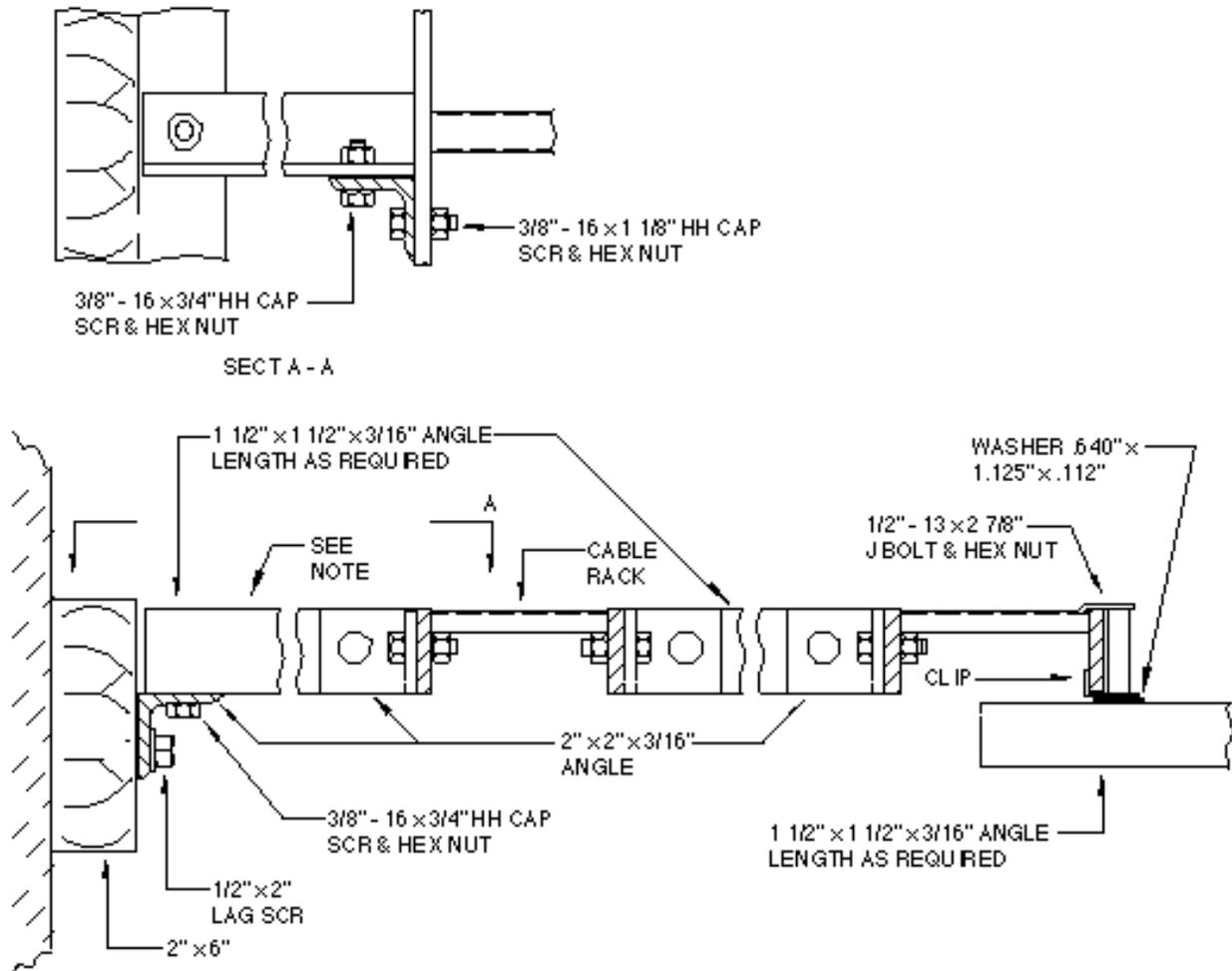


EXHIBIT 2-E5-12E (A&M)  
WALL BRACES FOR COMMUNITY DIAL OFFICE FRAME CABLE RACKS

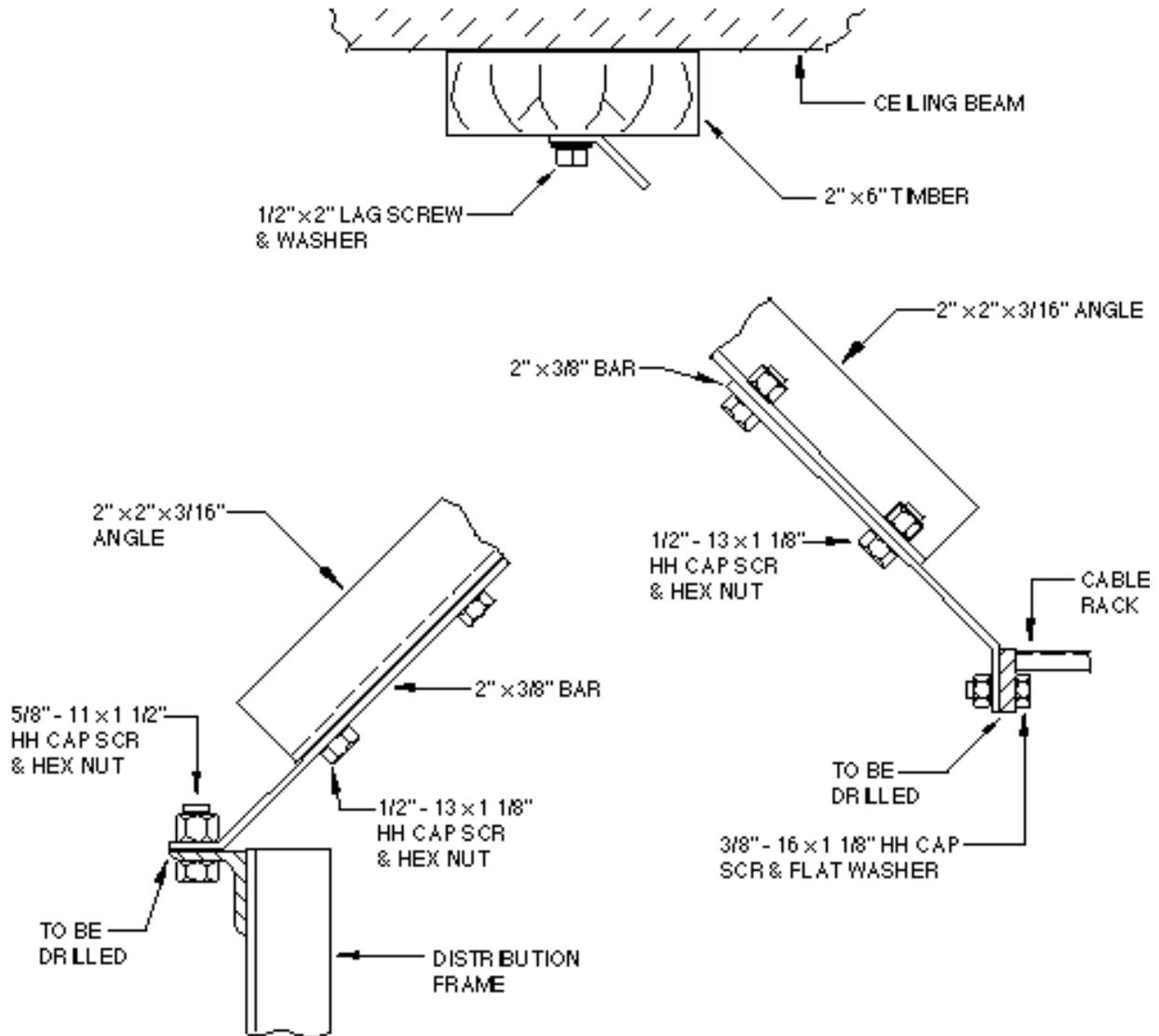
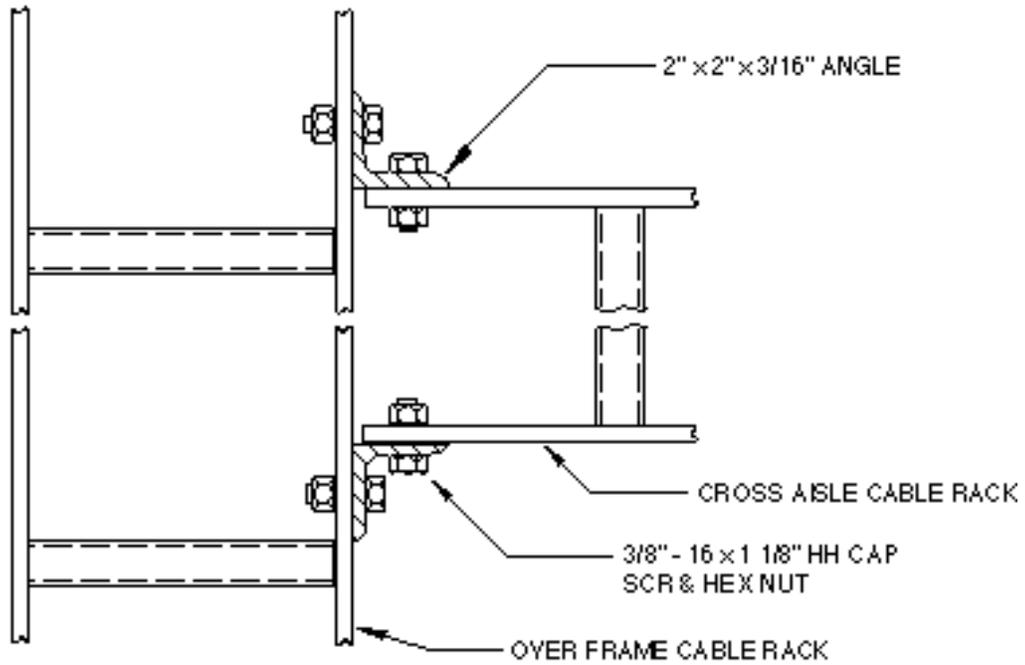
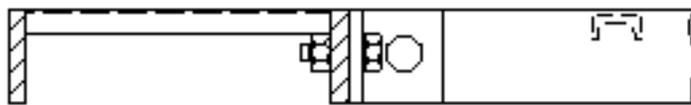


EXHIBIT 2-E5-12F  
CEILING BRACES FOR COMMUNITY DIAL OFFICE DISTRIBUTING FRAME AND CABLE RACKS

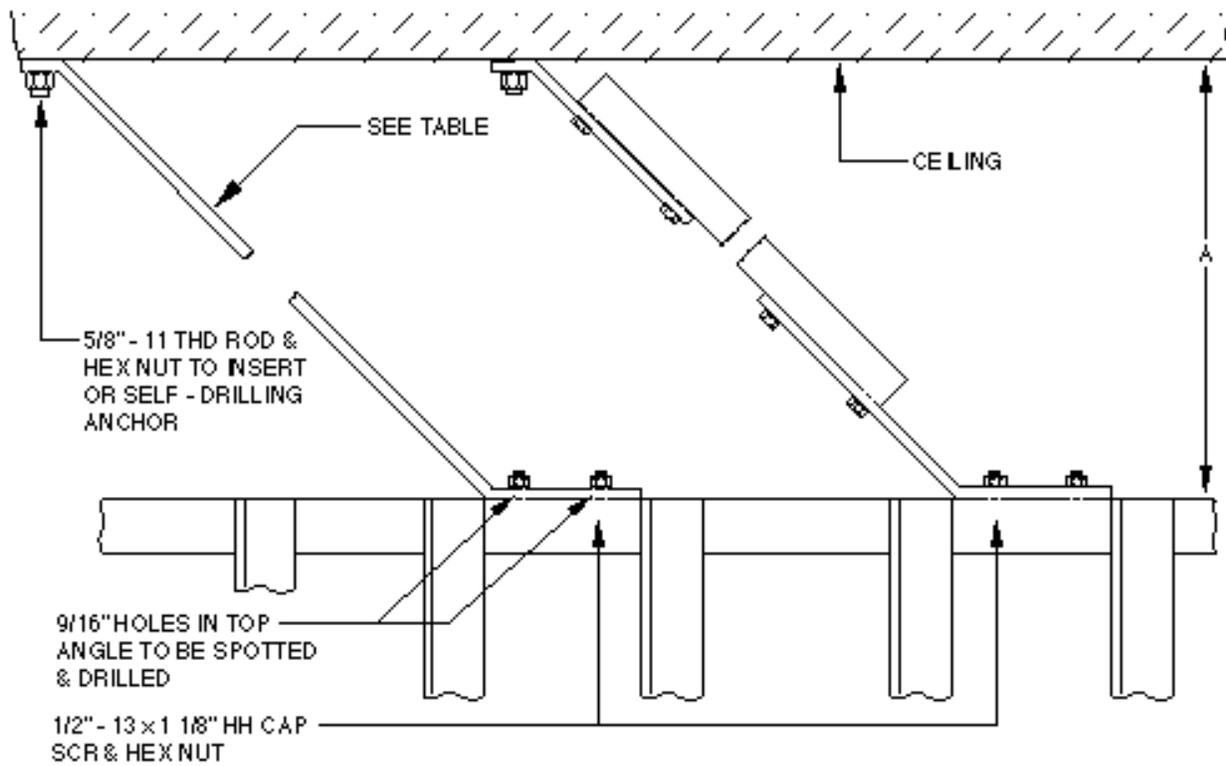


PLAN VIEW



SIDE VIEW

EXHIBIT 2-E5-12G  
FASTENING LADDER-TYPE CROSS-AISLE CABLE RACK TO OVER-FRAME CABLE  
RACK COMMUNITY DIAL OFFICES



A	TYPE OF BRACE
5" TO 10"	2" x 3/16" BAR
10" TO 1'-6"	2" x 3/8" BAR
OVER 1'-6"	2" x 2" x 3/16" ANGLE AS REQUIRED WITH 2" x 3/8" BAR AT TOP

EXHIBIT 2-E5-12J  
 ENDWISE BRACING OF DISTRIBUTING FRAMES AND PROTECTOR FRAMES

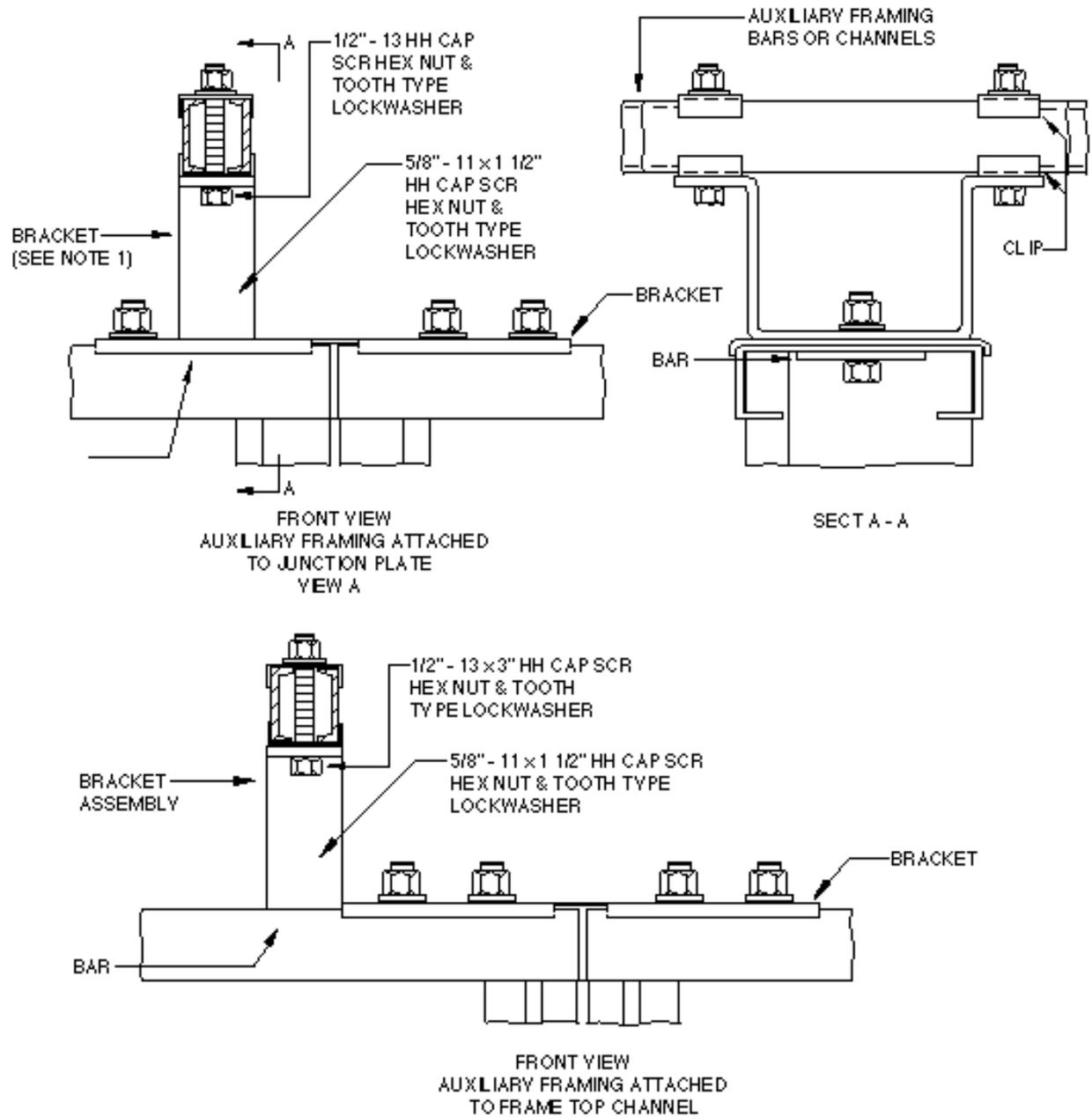


EXHIBIT 2-E5-12K (A&M)  
FASTENING OF TOPS OF CROSSBAR FRAMES

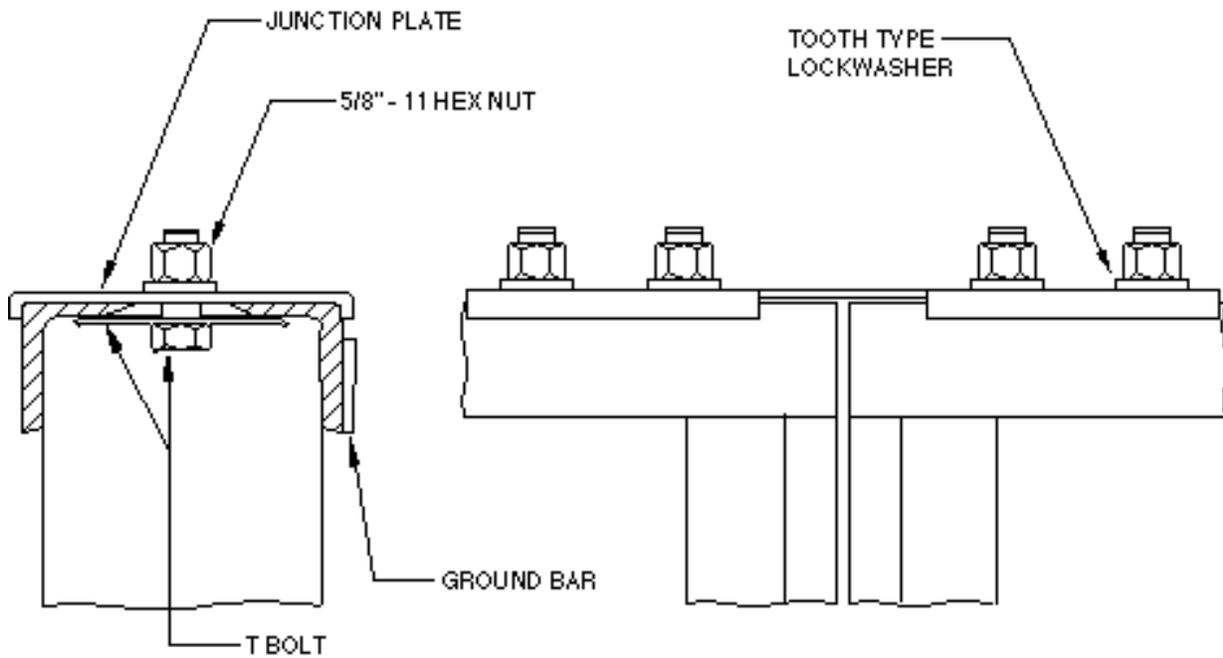


EXHIBIT 2-E5-12L (A&M)  
JUNCTIONING TOP-ANGELS OF ADJACENT BULB-ANGLE FRAMES

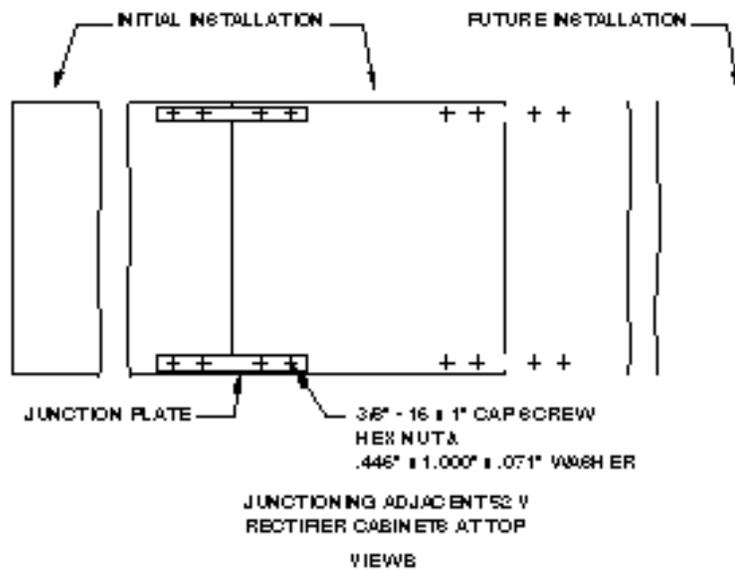
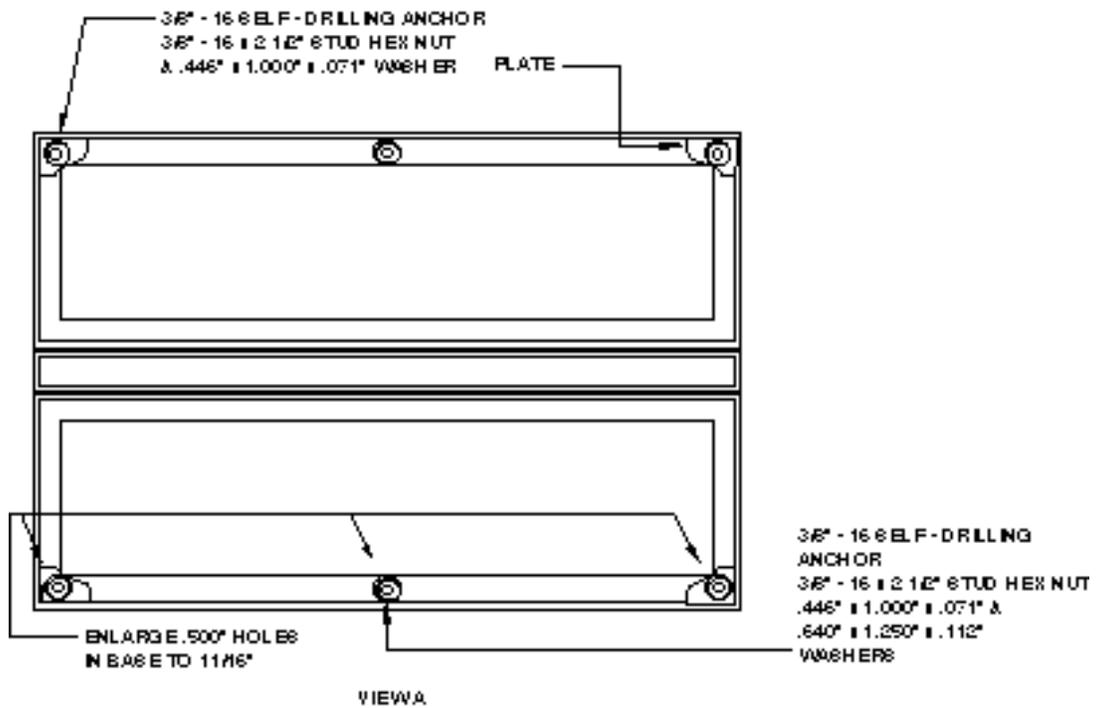


EXHIBIT 2-E5-12P  
 FLOOR-SUPPORTED RECTIFIER CABINETS - FLOOR AND TOP FASTENINGS

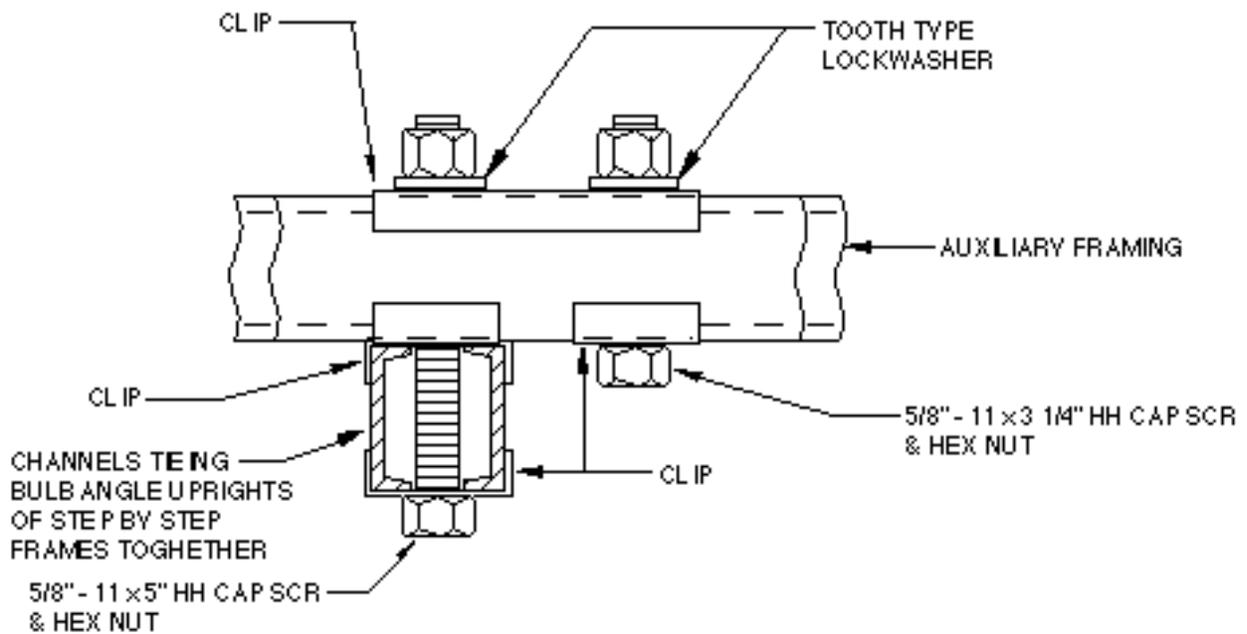


EXHIBIT 2-E5-12Q (A&M)  
JUNCTIONING OF TOP MEMBER CHANNELS OF STEP-BY-STEP FRAMES WITH  
AUXILIARY FRAMING

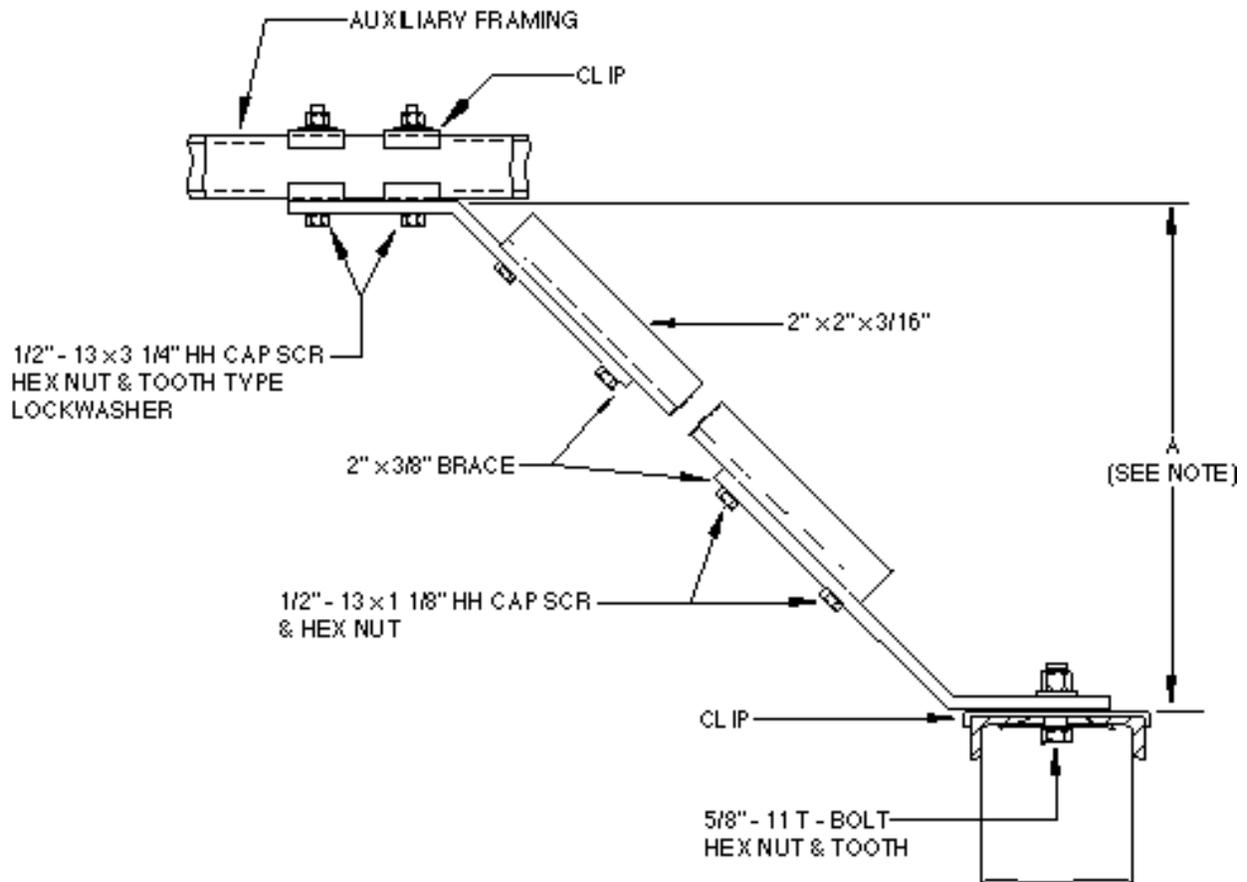


EXHIBIT 2-E5-12R (A&M)  
FASTENING BULB-ANGLE-TYPE FRAMES TO HIGH-TYPE AUXILIARY FRAMING  
WHERE "A" IS OVER 1 FOOT 6 INCHES

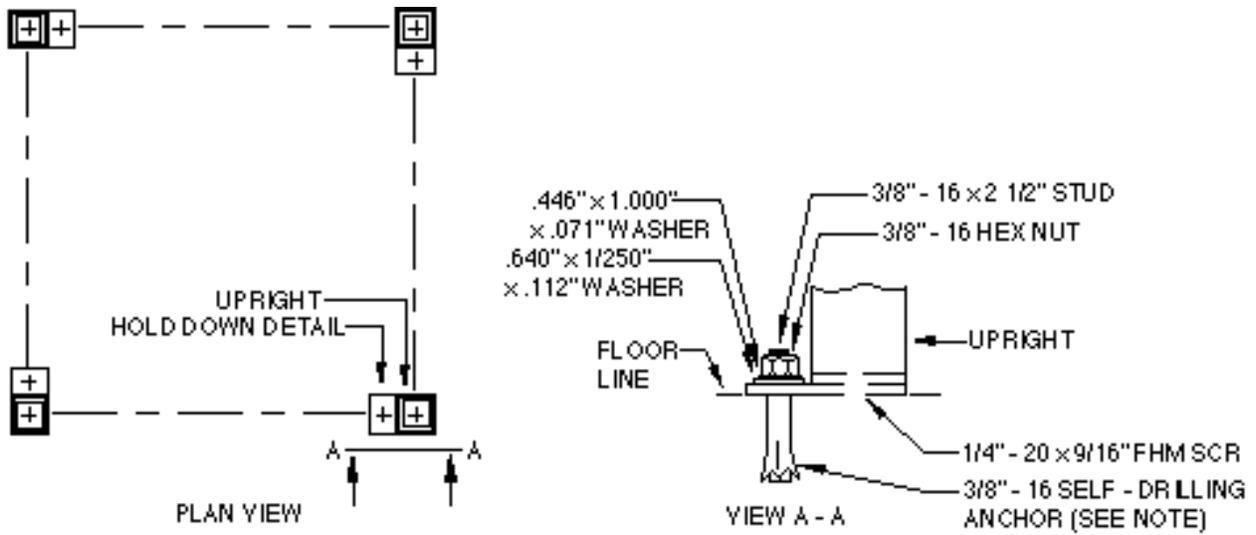


EXHIBIT 2-E5-13

FLOOR FASTENINGS FOR MACHINE TABLES WITH WELDED BEARING PLATES

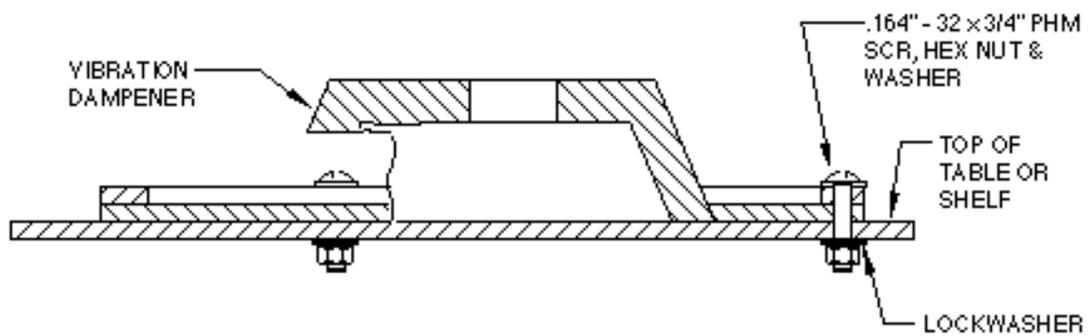
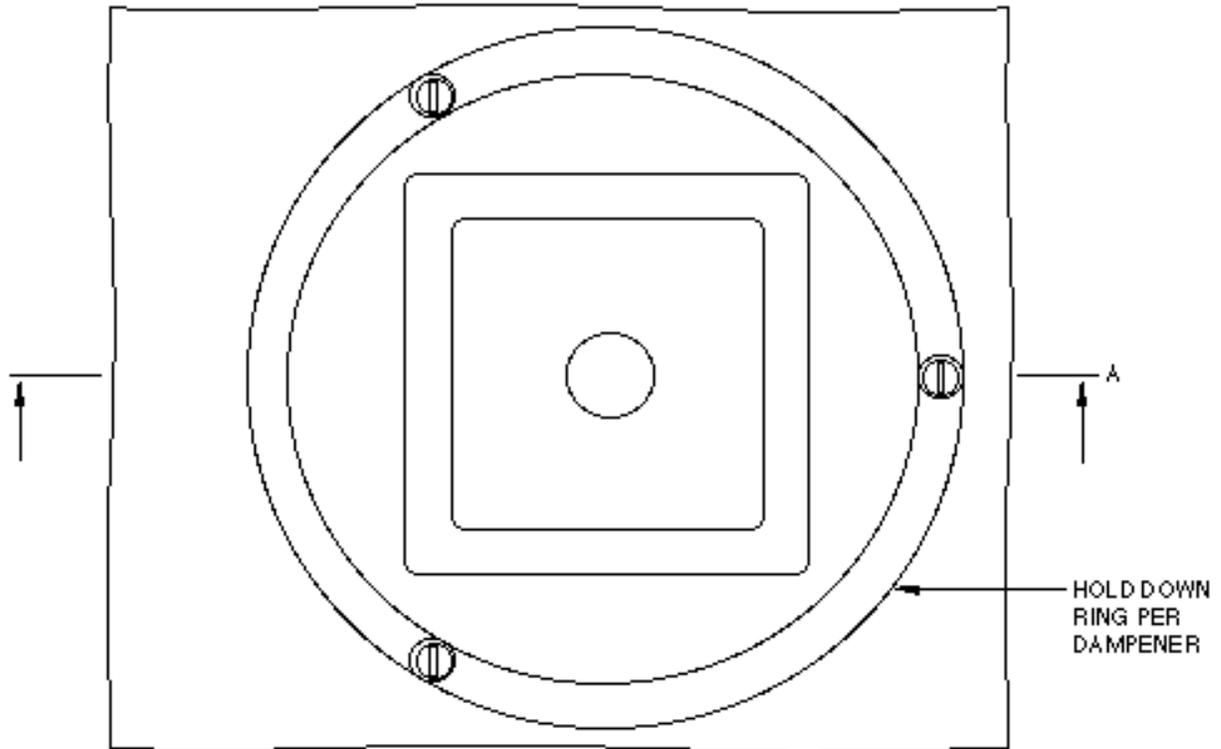


EXHIBIT 2-E5-14  
FASTENING MACHINES MOUNTED ON VIBRATION DAMPENERS

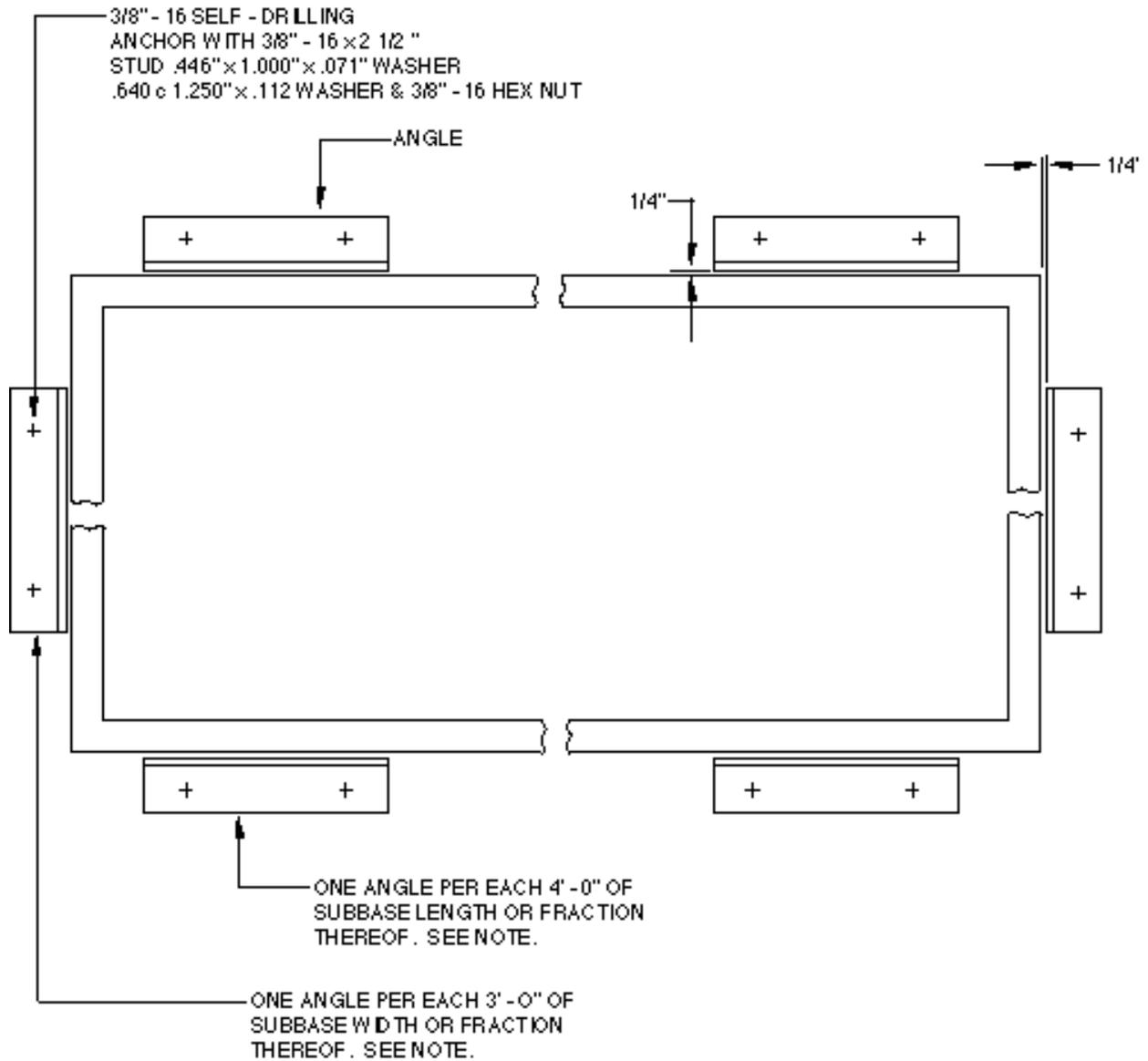


EXHIBIT 2-E5-15C  
FASTENING ENGINE-GENERATOR SETS, MOTOR-GENERATOR SETS OR SEPARATE RADIATOR UNITS TO FLOOR

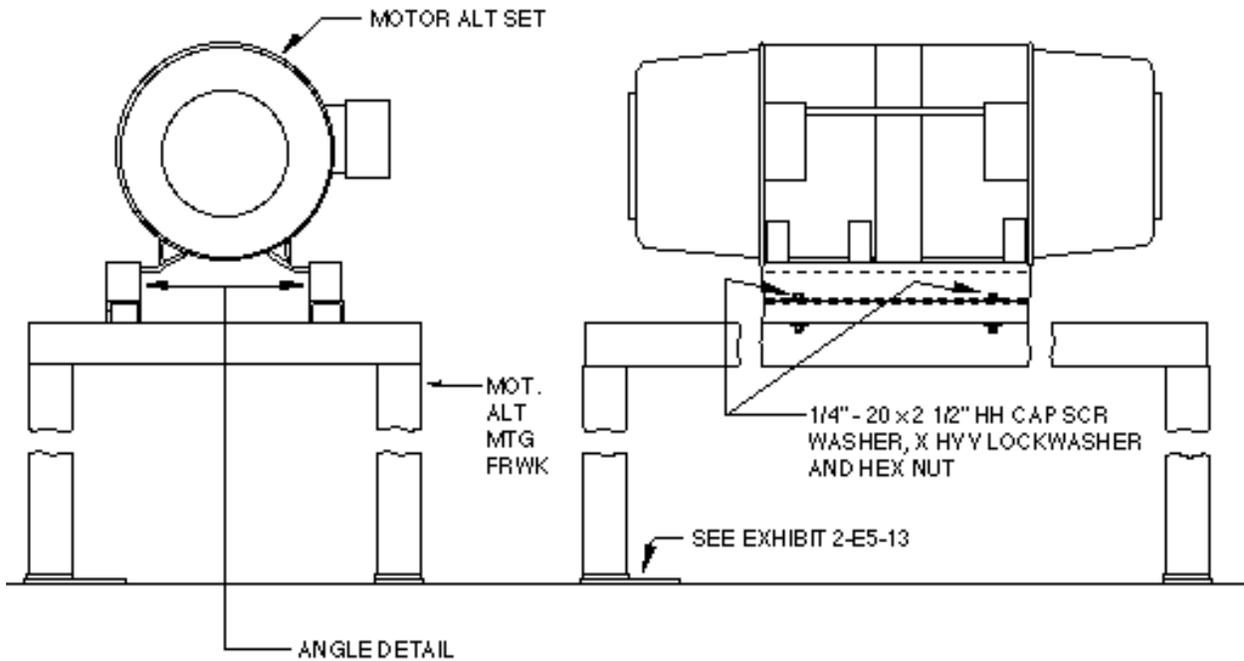


EXHIBIT 2-E5-15D  
ALTERNATORS FASTENED TO TABLES

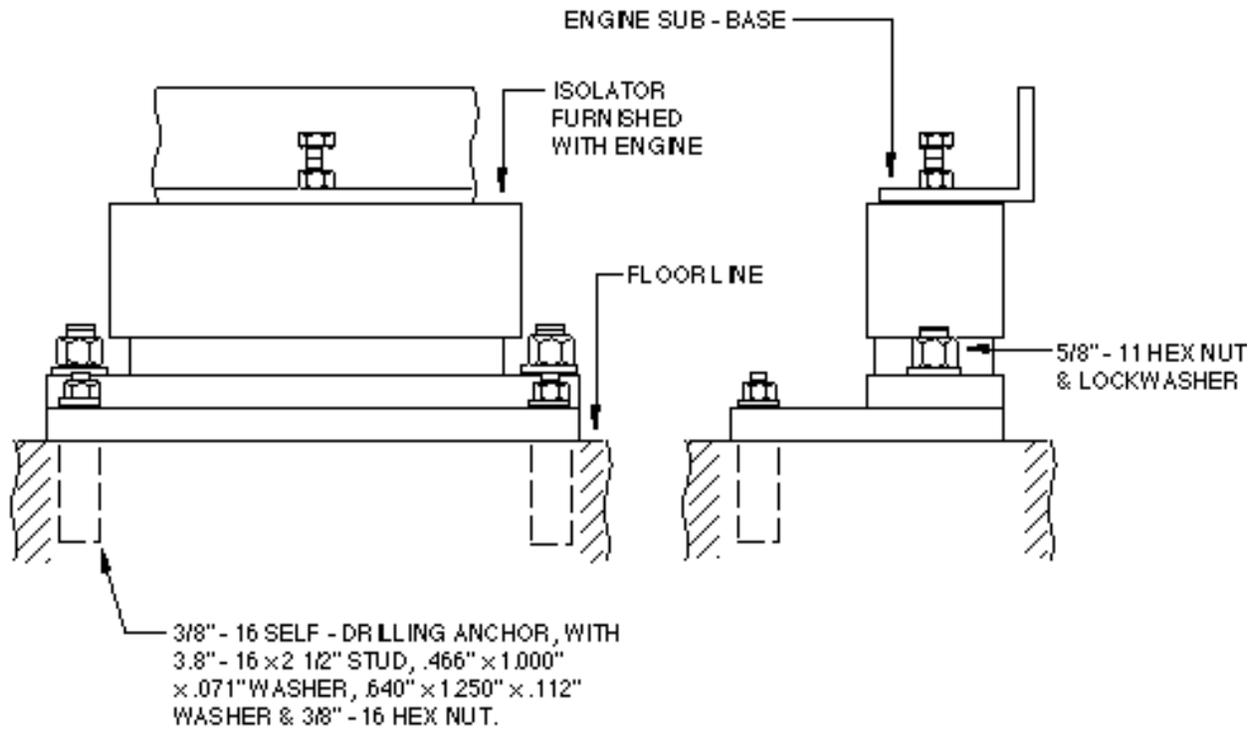


EXHIBIT 2-E5-15E  
FLOOR FASTENINGS FOR ENGINE-ALTERNATORS MOUNTED ON SPRING ISOLATORS

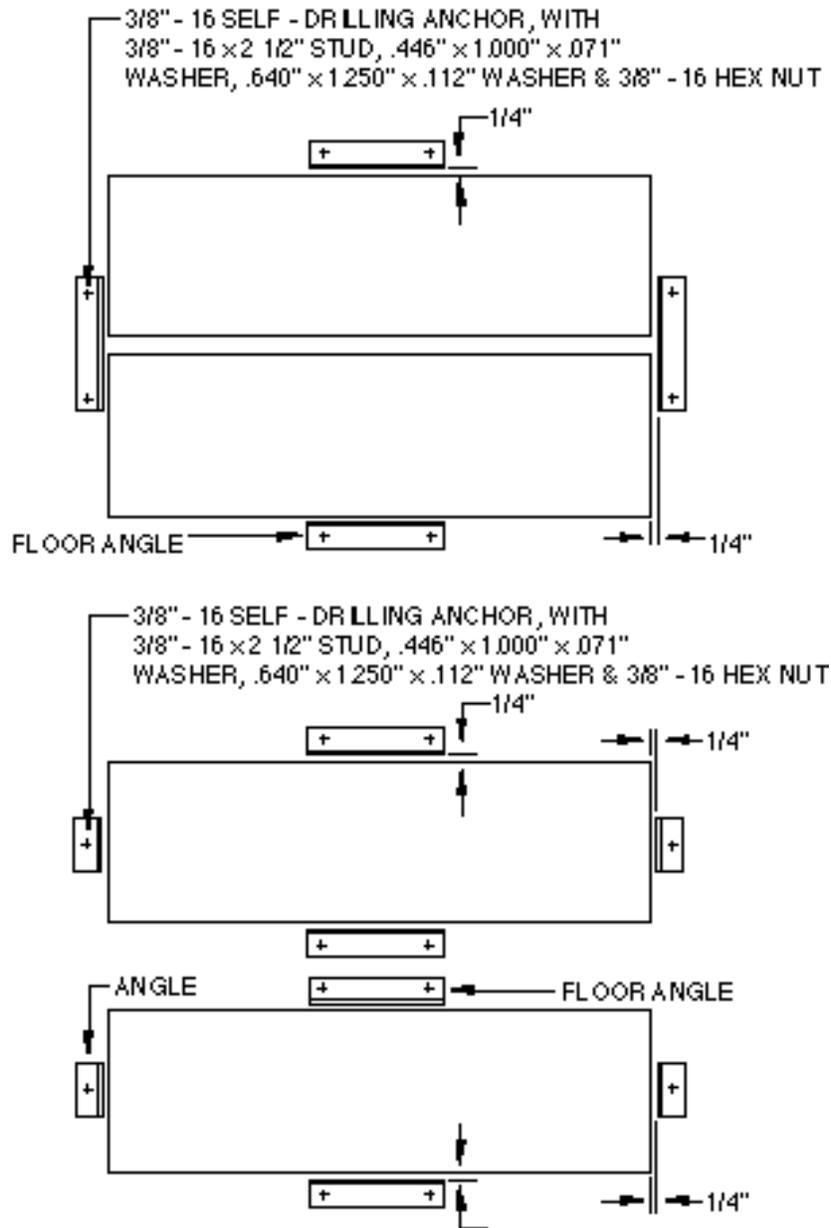


EXHIBIT 2-E5-16B  
SECURING BATTERIES MOUNTED ON FLOOR

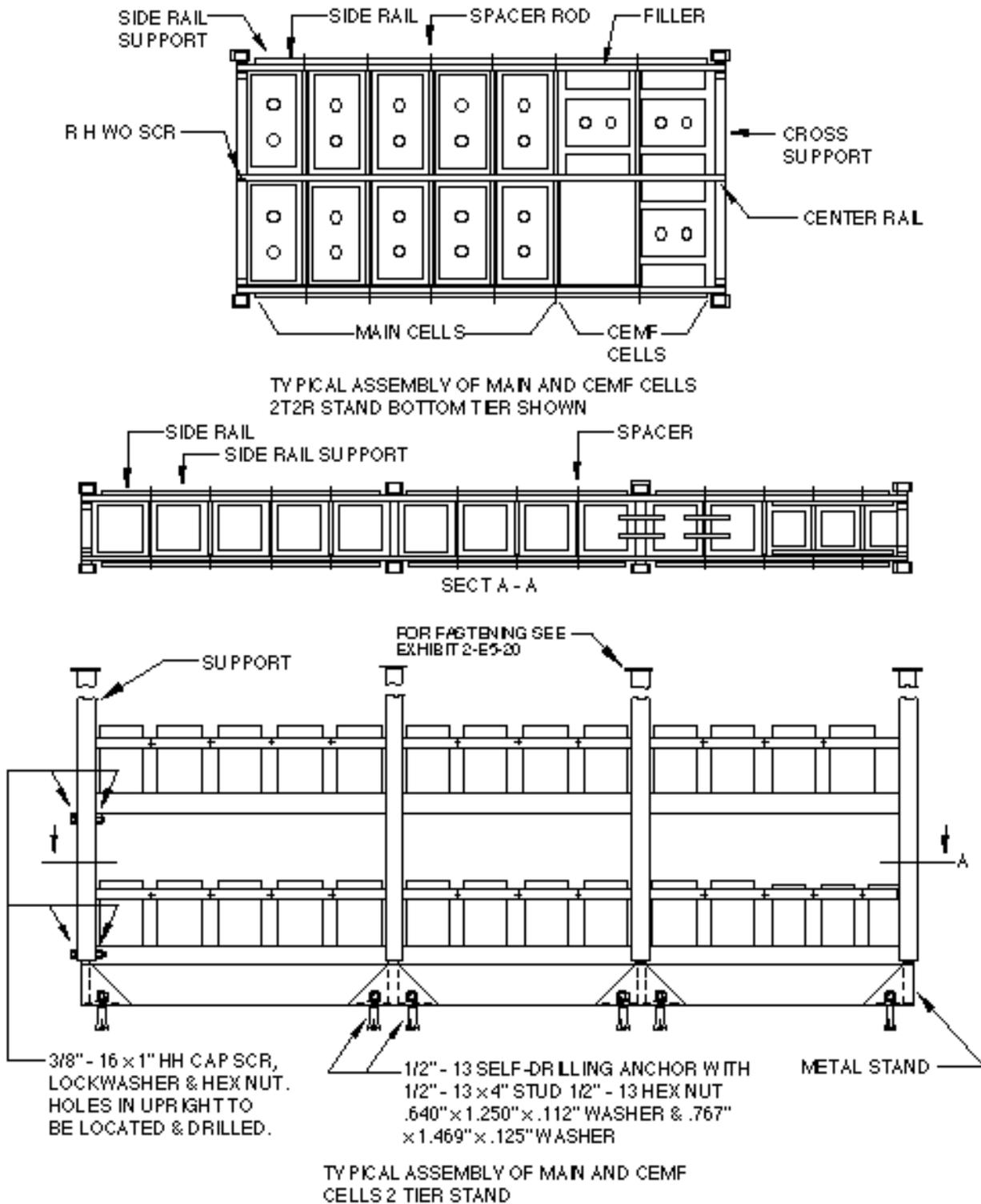
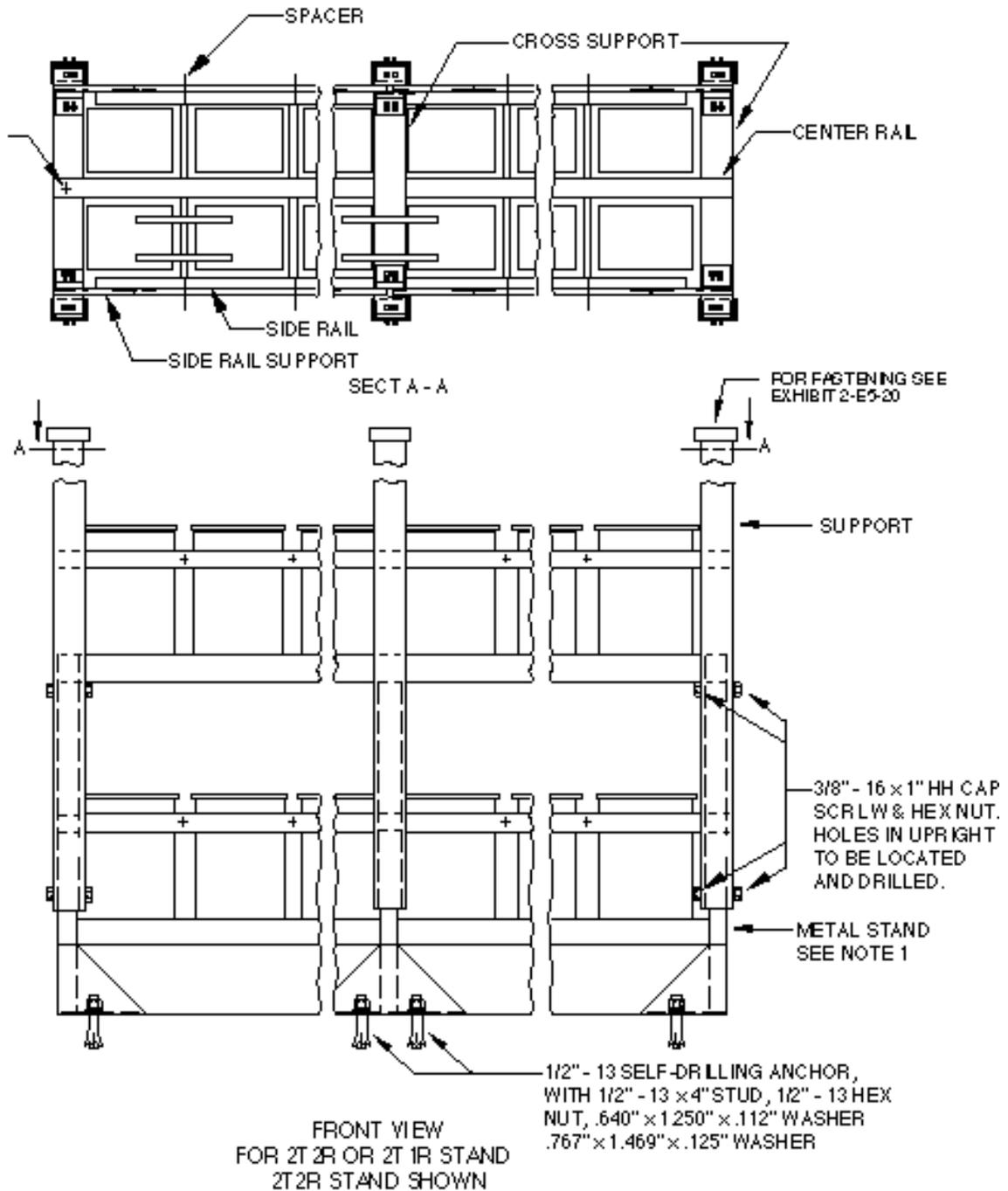


EXHIBIT 2-E5-17A

SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUS BARS OR CABLE RACKS ARE SUPPORTED DIRECTLY FROM THE STAND



**Note:** For earthquake protection details for any particular list or group no of battery. See appropriate manufacturers drawing.

EXHIBIT 2-E5-17B

SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUS BARS OR CABLE RACKS ARE SUPPORTED DIRECTLY FROM THE STAND

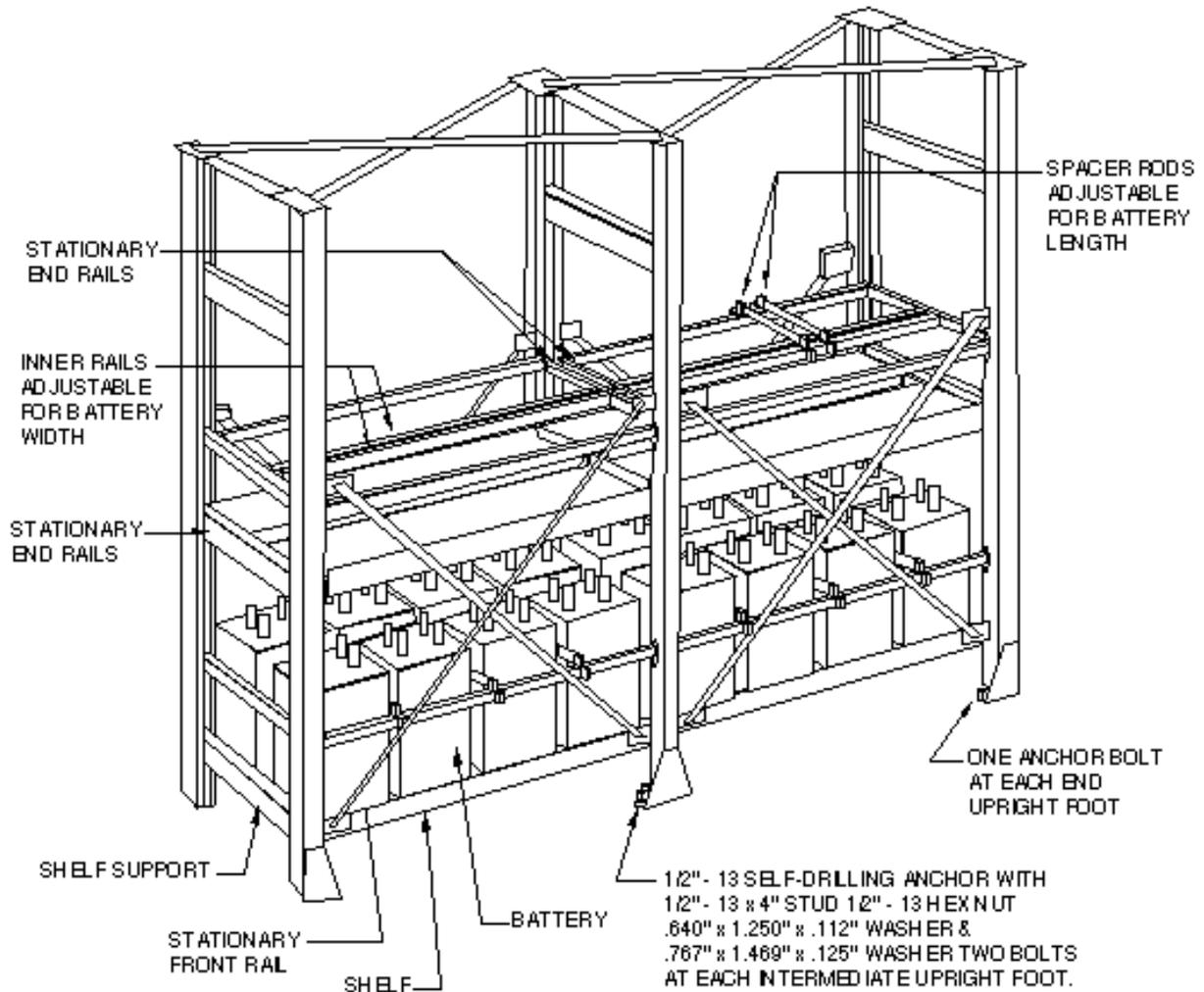


EXHIBIT 2-E5-17D  
FLOOR FASTENINGS FOR METAL BATTERY STAND

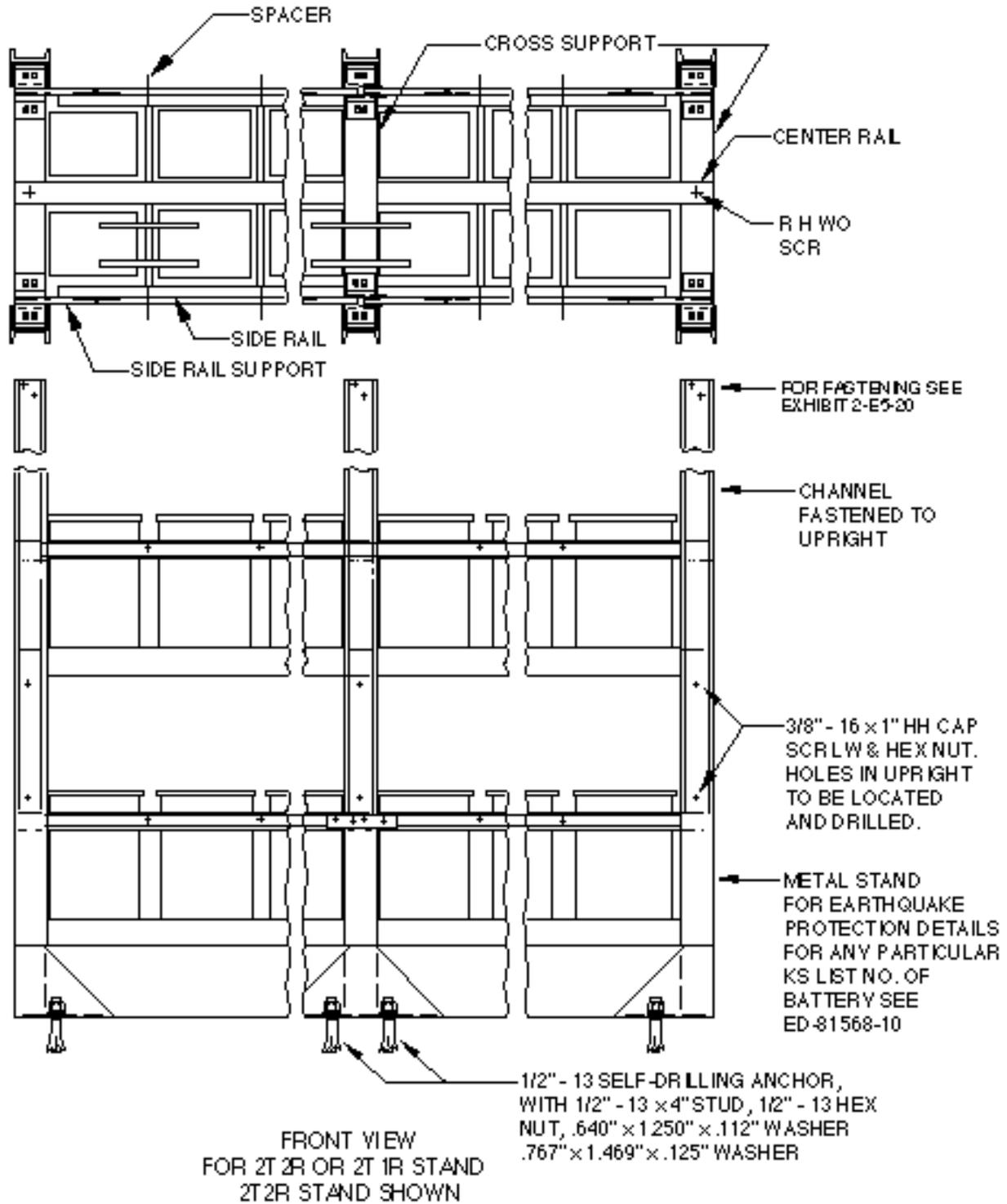


EXHIBIT 2-E5-18A

SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUS BARS OR CABLE RACKS ARE SUPPORTED FROM THE CEILING

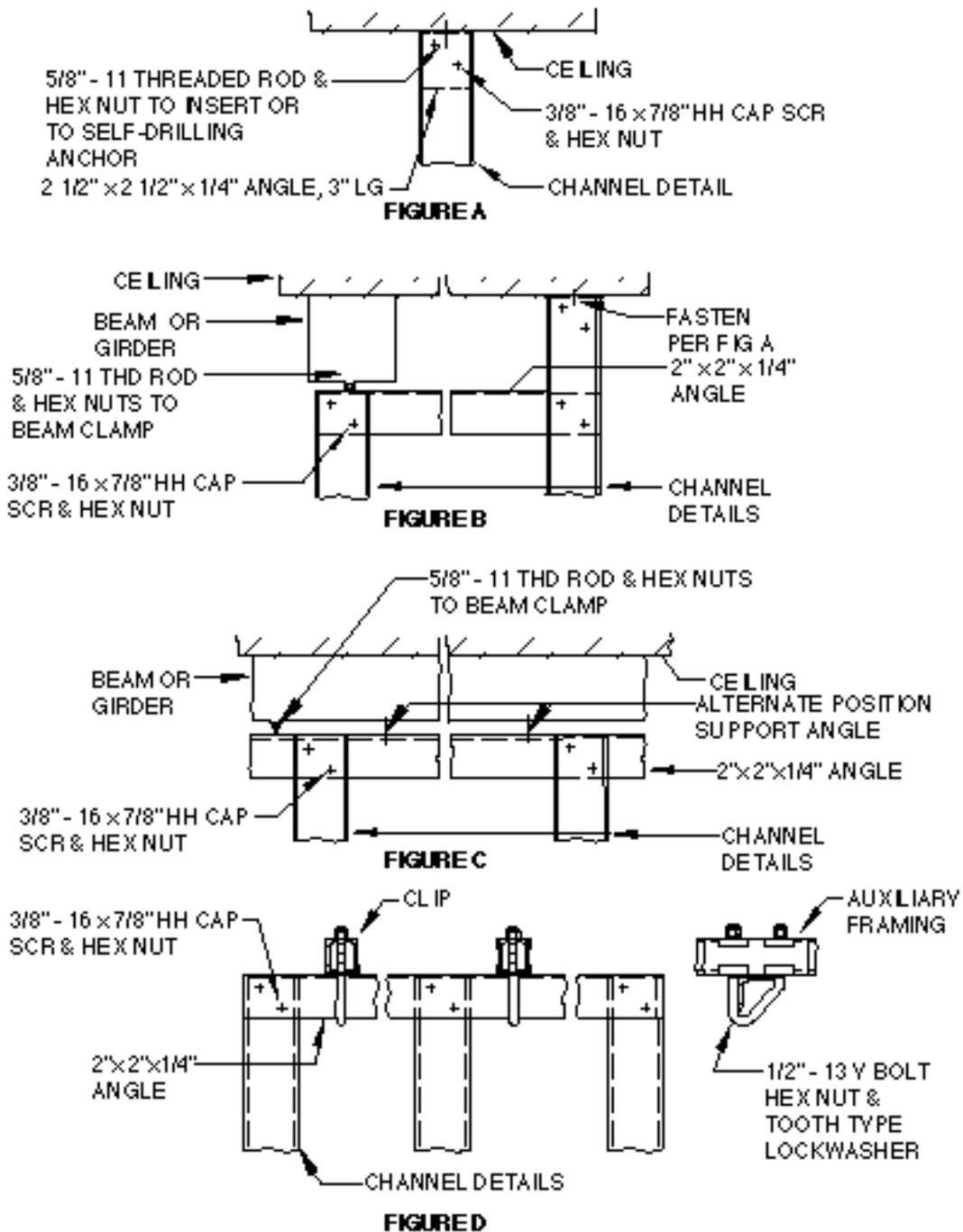


EXHIBIT 2-E5-19  
 CEILING FASTENING FOR ISOLATED BATTERY RACKS



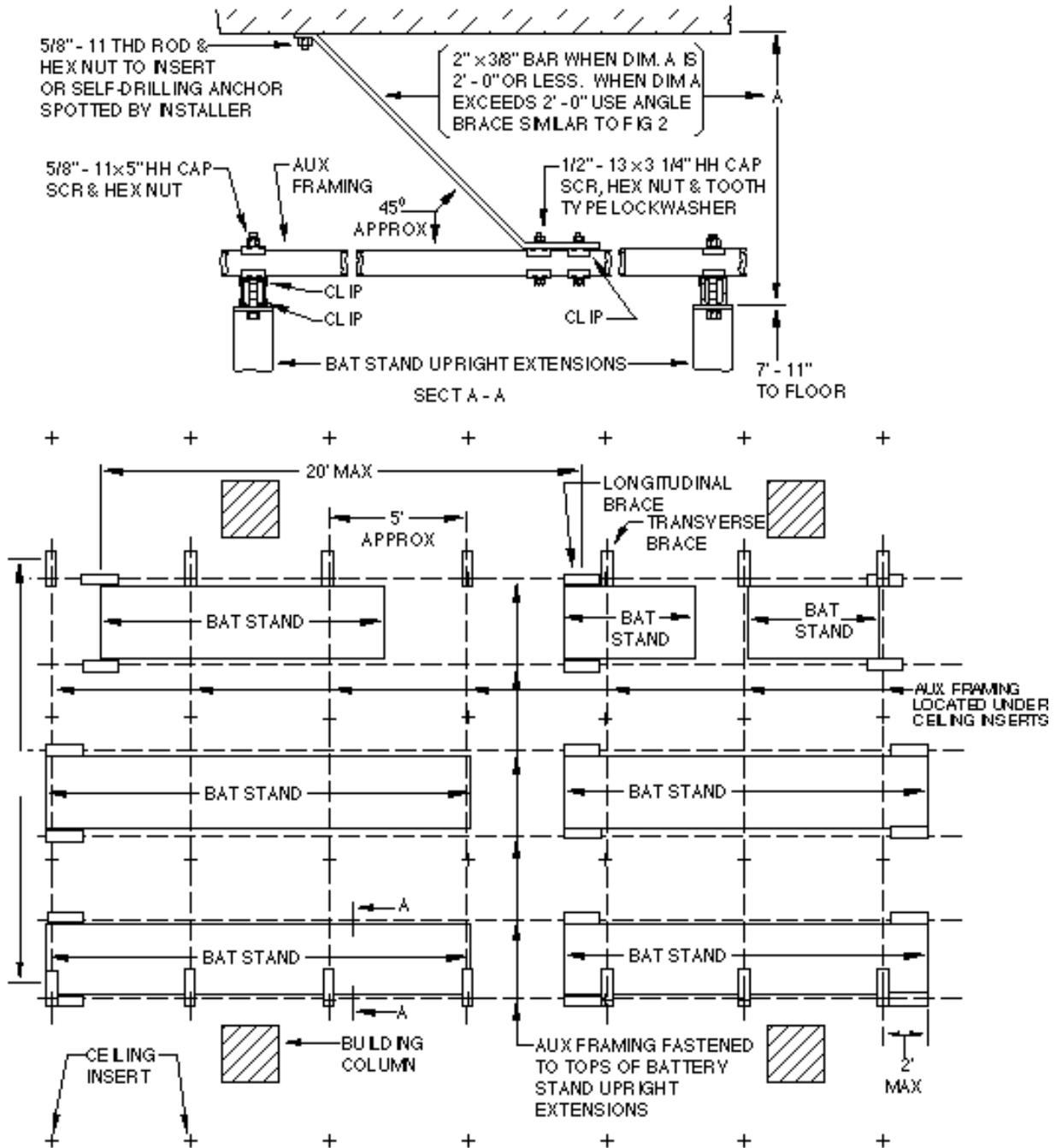


EXHIBIT 2-E5-20  
 ARRANGEMENT OF CEILING BRACES FOR METAL BATTERY STANDS ARRANGED IN PARALLEL LINES

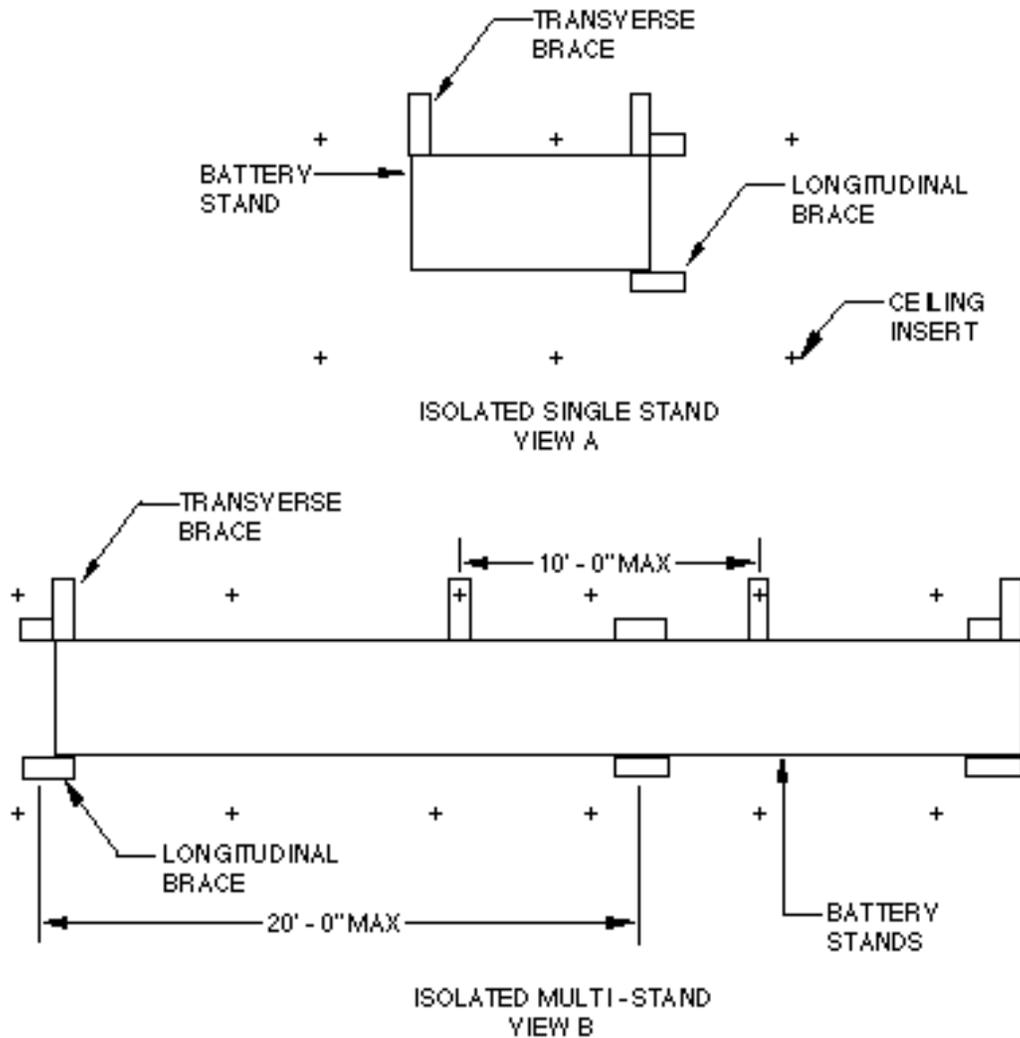


EXHIBIT 2-E5-20A  
ISOLATED SINGLE AND MULTI-BATTERY STANDS



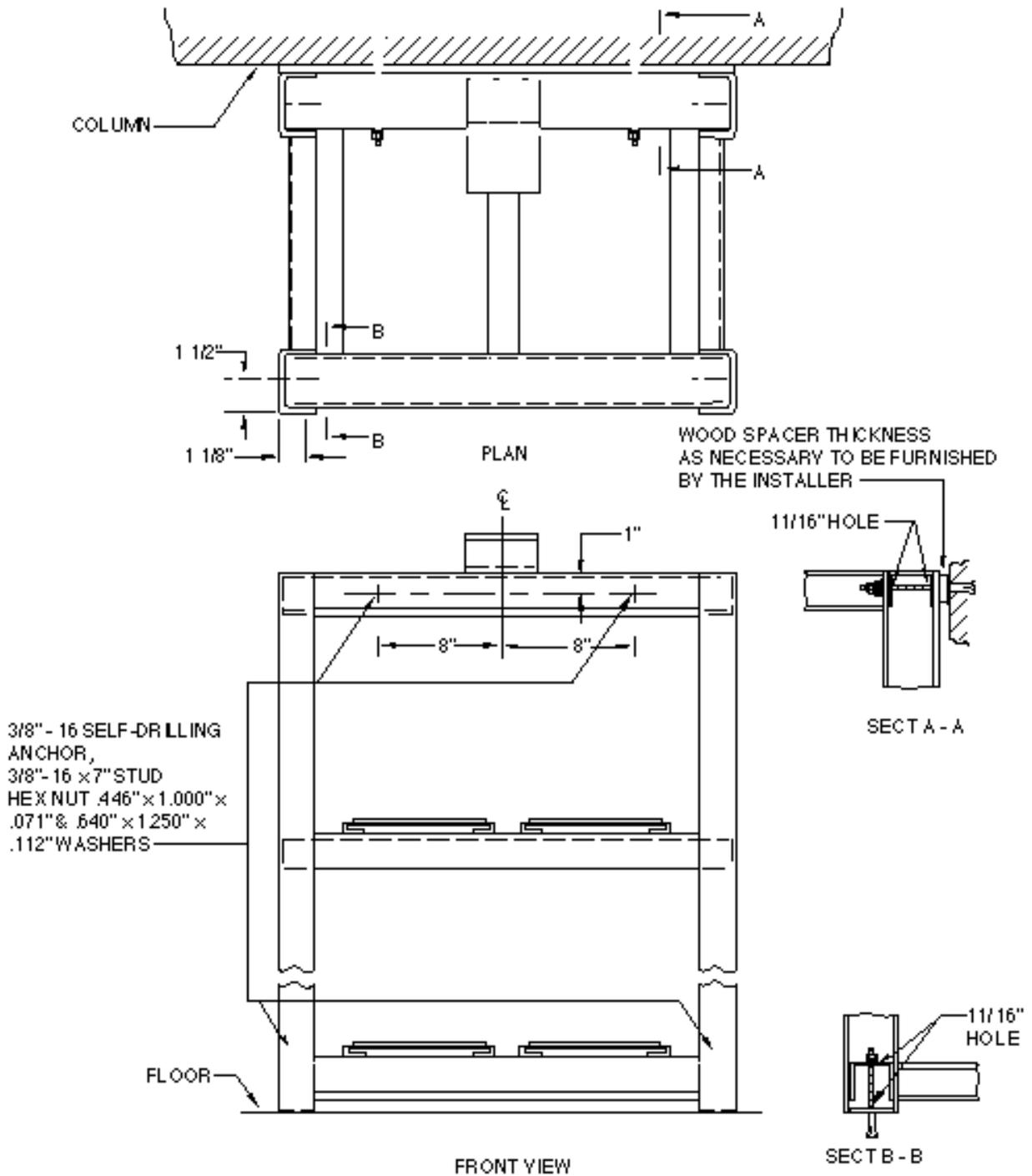
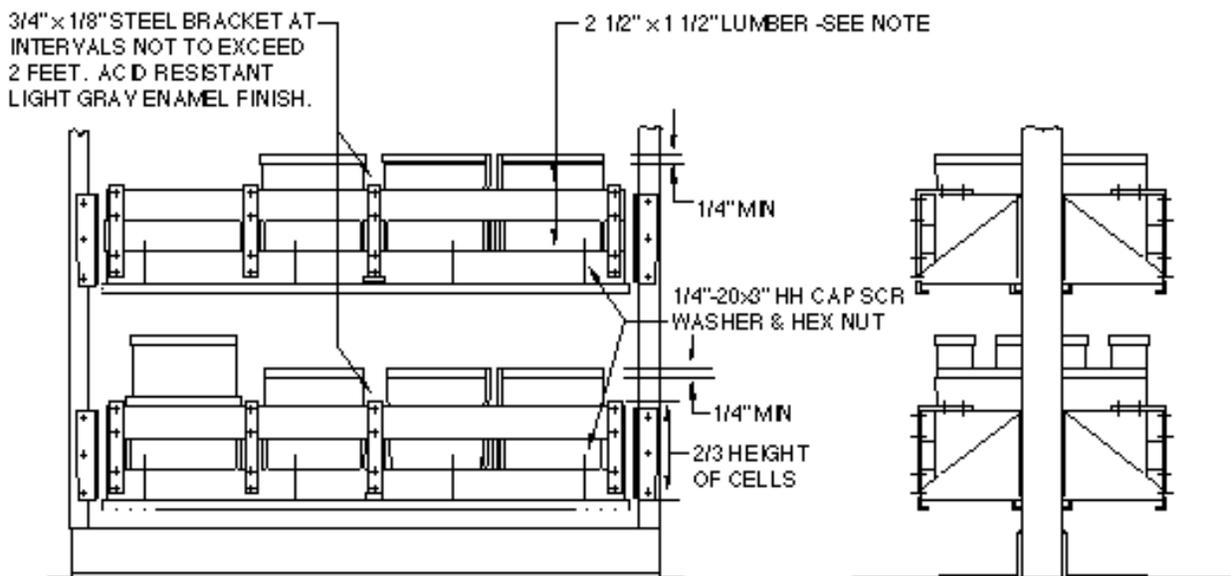
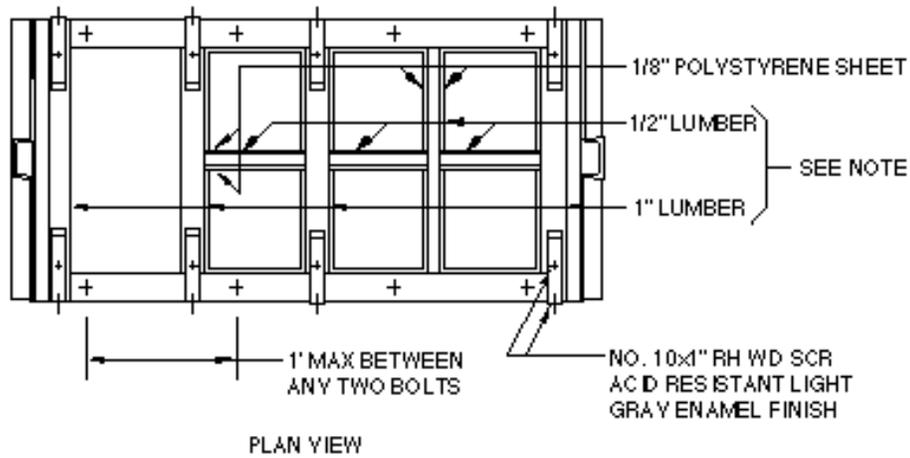


EXHIBIT 2-E5-21C  
FLOOR-SUPPORTED BATTERY CABINETS-FLOOR AND TOP FASTENINGS



NOTE:  
 ALL WOODEN PARTS SHALL HAVE A GRAY ACID-RESISTANT FINISH.

EXHIBIT 2-E5-21D  
 SUPPORTS FOR BATTERIES ON RELAY-RACK-TYPE BATTERY SHELVES

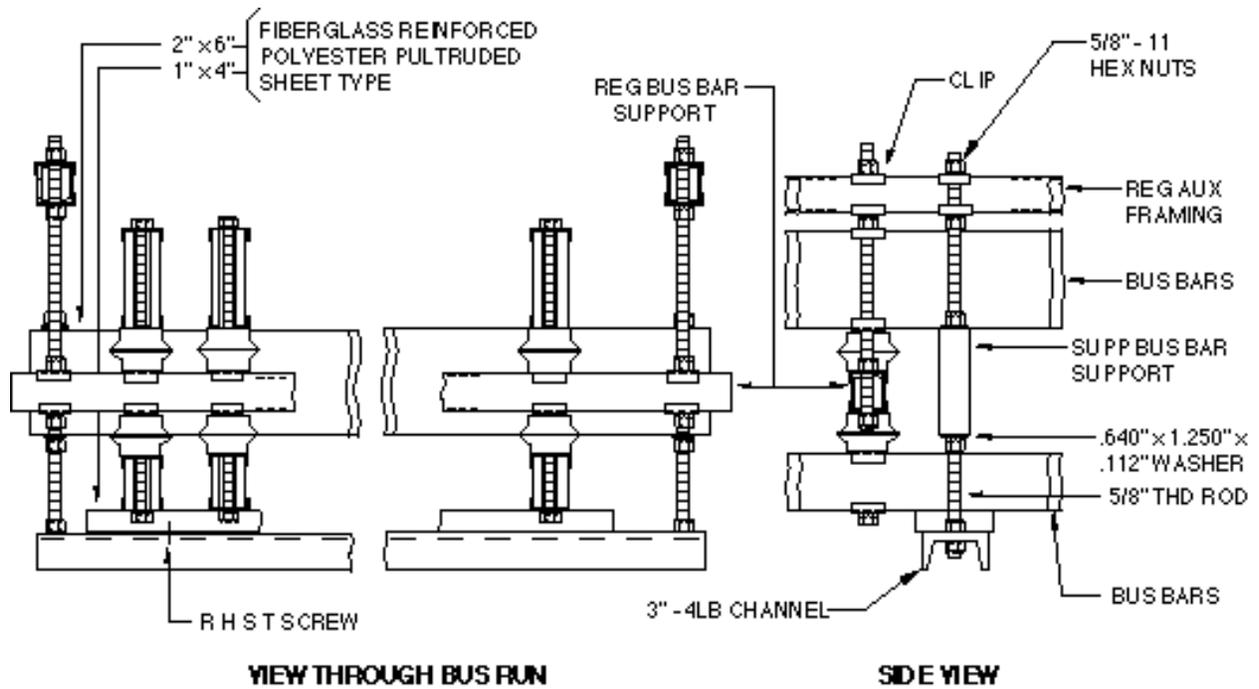


EXHIBIT 2-E5-22A  
SUPPLEMENTARY SUPPORTS FOR BUS BAR RUNS

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## **6. Cable Rack**

### **6.F Cable Distribution Systems For Conventional Floor Supported Areas**

#### **6F.1 General**

This unit covers the equipment requirements for engineering of a system of cable racking called "Cable Distribution Systems" (also referred to as compartmentized "Cableway" or "Compartment" type systems) for existing floor supported systems.

For specific hardware and application information for cable distribution systems, refer to Qwest Technical documents then manufacturers' documentation.

#### **6F.2 Cable Distribution Systems**

Cable distribution systems provide a means for cable separation or support. These types of compartmentized cable distribution systems:

- Are generally designed to attach to the top of 7-foot equipment frames.
- May be independently supported to allow for future lineup growth.
- Are intended to be toll or switch system specific and are not designed to carry cables to common application systems such as Distributing Frames (DFs) and power.
- May provide access between major like systems or unlike systems with proper hardware separation.
- To prevent corrosion, non-fiber cable distribution systems and assembly hardware should be of a non-corrosive plated type, or painted, preferably gray. Other colors may be used for limited dedicated applications and identified in Qwest Technical Publications or Standard Configuration documents.

NOTE: No cable distribution systems may be added to new non-switch areas within Qwest Central Office environments. Compartmentized cable Distribution systems are conditionally approved and restricted to extending existing line-ups. All new areas will be engineered for a 7 foot, floor supported environment. Typical existing arrangements are Digital Cableway or Electronic Switch System

### **6F.3 Requirements**

Cable distribution systems are provided over line-ups of equipment frames and are fastened to adjacent line-ups by cross-aisle racks.

- Compartmentized cable distribution systems are considered a unitized top support for associated frames in 7' floor supported arrangements. Lineups of equipment frames, which are bolted together and provided with cable distribution system, are considered to be adequately top supported. Cable distribution systems above single line-ups of equipment frames that are not fastened to adjacent line-ups and do not meet top support requirements.
- Cable distribution systems provide a covered system for the running of unsecured cable.
- Cable separations within the cable distributions systems vary by design and by manufacturer. Brackets, separators or individual compartments may be used.
- Cable may be banded with cord to maintain separation of cable types within the cable distribution system.
- Application of cable distribution systems must take into consideration cable access to the individual frames. Certain types of cable distribution systems limit access to high cable volume frames and may require cover removal or modification.

### **6F.4 Stanchions**

- Where frames are not provided under cable distribution systems, approved support stanchions shall be provided at 5 foot, but not to exceed 6 foot intervals and at junctions of cable distribution system sections.
- Sufficient clearances shall be maintained to allow for future addition of frames.
- Unless approved for heavy earthquake area use, support stanchions are not allowed in heavy seismic zones.

### **6F.5 Design Criteria**

Cable distribution systems may incorporate lighting systems, or be used to provide support for lighting systems, provided proper consideration has been given to the isolated or integrated ground planes per manufacturer's design and configuration of the source AC provided.

Overhead clearances in all aisles and equipment areas must be maintained at a minimum of 7 foot 0 inches. This includes auxiliary framing, cable rack, cableway systems, fiber duct and lighting and is required for safety reasons.

Cable distribution systems should be provided for the ultimate growth of an individual line-up whenever possible to allow for proper distribution of cabling and top support.

Cables transitioning from via racking to compartment distribution systems shall be routed and secured so that they do not block future cable additions or adversely affect the ultimate cable pileup.

Where cable from cable distribution systems is run to common systems such as DF and power, channel type cable rack and support shall be provided per Unit 1 of this section. Where cable distribution is part of an isolated ground plane, separation or insulating hardware shall be used between the two cabling systems.

#### **Caution**

When cable distribution systems and associated equipment are located within the isolated ground plane, separation from all integrated ground plane members must be maintained as specified in U S WEST Communications, Inc. Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

Cable protection materials must be provided where cables may contact metallic edges within the cable distribution system.

For additional requirements regarding the use of cable distribution systems in seismic (earthquake) zones, refer to Unit E of this Module.

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## **6G Cable Rack - Cable Distribution for Fiber Optic Cable**

### **6G.1 General**

This section covers the engineering guidelines for cable distribution systems used to support and protect all fiber optic cable required by telecommunications equipment frames placed within a QWEST Central Office environment.

Fiber optic cable must be segregated from other types of Central Office cables to provide the required isolation and protection.

The types of fiber cables found in QWEST Central Offices are discussed in this document are:

- Fiber Entrance Cable
- Fiber Distribution Cable

Within QWEST Central Offices, buildings and facilities, there are two main support and routing systems utilized for these types of fiber optic cables.

- Ladder type cable racks for the heavily sheathed, inter-office fiber optic riser cables (fiber entrance and fiber distribution cable).
- Fire rated plastic duct-type Fiber Protection Systems for the fiber optic patch cords or jumpers.

Specific hardware and application information is located in QWEST Standard Configuration documents. Any deviation from the requirements listed below shall be directed to the QWEST Representative responsible for Common Systems standards unless stated otherwise. Cabling, cable rack and FPS engineering standards not specifically identified in this document shall adhere to the intent of the requirements defined herein.

### **6G.2 Fiber Entrance Cable**

To accommodate future growth for interconnecting fiber services, all new interoffice and loop fiber will be terminated onto the Fiber Distribution Frame (FDF).

Fiber entrance cable must adhere to several requirements:

- Fiber optic entrance cable will maintain a minimum bend radius of nine inches to meet transmission requirements, minimize signal degradation and prevent cable damage.
- The outdoor rated fiber entrance cable must be spliced and converted to the lower smoke producing, fire rated inter-office fiber riser cable within 50 feet of the cable's entrance into the building. Letters of deviation exempting an office from this standard will not be considered valid.
- If site specific conditions will not allow the installation of a Fiber Splice Frame (FSF) within 50 feet of entering the building, the outdoor rated fiber entrance cable must be completely encased in conduit the entire route from the cable entrance to the FDF. Fire stopping is mandatory.
- An orange, panned and bracketed ladder type cable rack shall be used to support the fiber optic cable from the fiber entrance facility to the FDF (or FSF where applicable) and from the FSF to the FDF.

- No outside plant facilities innerduct or coreflex will be used within the Central Office Equipment (COE) floor space.
- Approved slack boxes or storage devices shall be provided near or within the CEF to allow for slack, when required.

**Note:** Fiber optic cable will not be run through holes used to distribute cables into a conventional Distributing Frame (DF), even if the hole is not shared with copper cable. Placing fiber cable on the main frame exposes the fiber to the high fuel load of the main frame.

### **6G.2.1 Innerduct**

**Note:** Plastic type innerduct products that do not pass NEC standards for fire propagation and smoke emission levels will not be used inside any Central Office on a going forward basis.

Innerduct will be terminated in the cable entrance facility and plugged for gas protection at the entrance to the building. As existing innerduct is vacated, it will not be reused, but will be removed from the building as soon as possible. Existing innerduct can also be removed during trigger events, such as the reterminating of fiber cables onto the FDF.

Plastic enclosures, such as splice cases and terminal boxes, must be enclosed in a fire resistant wrap called a fire "blanket".

Fiber optic cable from the CEF shall not be run through holes used to distribute cable into the conventional main frames, even if the hole is not shared with copper cables. Placing fiber cable on the main frame exposes the fiber to the high fuel load of the main frame.

### **6G.3 Fiber Splice Frames**

Where the FDF cannot be located within 50 feet of the outside plant sheath penetrating into the office, the installation of a Fiber Splice Frame (FSF) is required as stated under the NEC, Article 770.

The FSF, which contains only fiber splicing trays, should be installed in all medium and large size Central Offices. The splice frame is used to convert from the outside plant rated fiber cable to the inter-office, riser type fiber cable.

The FSF has several requirements:

- It shall be located no more than 50 feet away from the outside plant sheath penetrations into the office, per exception under the NEC, Article 770.
- Where indoor/outdoor fire rated "riser" or "plenum" type fiber cables are used and meet NEC requirements, the FSF placement need not be restricted to within 50 feet from the cable entrance.
- Where a FSF is required, a fiber tie cable is necessary from the FSF to the FDF allowing termination of the fiber on the FDF. This ONFR riser rated inter-office tie cables must be installed on the approved orange, panned and bracketed ladder type cable rack.
- The FSF will not require a FPS access as no patch cords or jumpers are terminated on the frame.
- The fiber only cable rack supporting fiber entrance cable should be sized for future growth.

#### **6G.4 Fiber Distribution Cable**

Fiber distribution cable is the fiber cable connecting the Fiber Distribution Frame (FDF) to the fiber equipment bays. This fiber cable can be supplied in two types: Inter-office fiber riser (OFNR) cable and Fiber patch cords or jumpers.

##### **6G.4.1 Inter-office fiber riser (OFNR) cable**

- Multiple or single fibers
- Long to moderate runs
- Floor and wall penetrations
- Brightly colored (desired), outer sheathed PVC jacket with a strengthening central member.
- Inter-office fiber riser cables with a dielectric central member to provide Electro Magnetic Interference (EMI) immunity is not a mandatory requirement.

##### **6G.4.2 Fiber patch cords or jumpers**

- Single or small numbers of fibers
- Brightly colored, fire rated outer cover
- Short distances only
- No floor or wall penetrations

For the detailed specifications on fiber optic cable approved for use within QWEST central offices and buildings, contact the QWEST-representative for fiber cable standards.

### 6G.4.3 FIBER DISTRIBUTION CABLE SUPPORT

The support systems for the fiber optic, distribution cables differ depending on the type of fiber optic cable sheathing and their composition. The table below provides the guidelines for supporting fiber optic distribution cables.

Inter-Office Fiber Optic Cables	Can be run in a Fiber Protection Duct System	Can be run on Fiber Only Cable Rack
Fiber Jumpers or Patch Cords	Yes	No
OFNR Type Fiber Cable: 1 to 12 fibers	Yes (*)	Yes
OFNR Type Fiber Cable: over 12 fibers	No	Yes

\*Restrictions apply. Small quantities of fiber cables only (less than 10 total) or existing office conditions prevent the installation of a new cable rack system. *It is not recommended to run fiber patch cords/jumpers together with OFNR type fiber cables. Due to the size and often the quantity of OFNR fiber cables, the ability to access or add fiber patch cords/jumpers is often compromised.*

The support of fiber patch cords or jumpers by cable rack is prohibited unless the cable is constructed to satisfy the appropriate sheathing and component requirements.

Fiber cables shall not transition from one horizontal support system to another. The support system shall be consistent. Fiber cables shall not be placed on cable rack then transition into a FPS.

Fiber cables or jumpers shall not be run on cable horns or brackets.

Letters of deviation for installing new duct type systems for the support of large quantities (more than 10 total) of 1 to 12 fiber counts or any fiber cable of more than 12 count fiber counts are not considered valid.

### 6G.4.4 BEND RADIUS

Fiber optic cable must maintain a minimum bend radius to fulfill transmission requirements, minimize signal degradation, and maintain cable integrity. The bend radius must be preserved at all times; this includes but is not limited to vertical drops and horizontal changes in level.

#### Inter-office fiber riser (OFNR) cable

- Minimum bend radius of 6" unless manufacturer's recommendation is more stringent

#### Fiber patch cords or jumpers

- Minimum bend radius of 1-1/2" unless manufacturer's recommendation is more stringent

#### **6G.4.5 SECURING**

Securing the inter-office, fiber optic riser cable to the gray horizontal or vertical and the orange vertical ladder type cable rack shall follow a standard procedure.

- Only the heavily sheathed inter-office, riser type of fiber optic cable will be secured. The OFNR cable will be wrapped with fiber sheeting where it is tied with cord to every cable rack cross member (strap) on vertical runs and every fourth cross strap on horizontal runs.
- The OFNR fiber cable must be closely monitored for possible cable crimping where it is tied.
- Cable ties are prohibited on any type of fiber optic cable.
- Fiber optic patch cords or jumpers will not be secured within the FPS.

#### **6G.5 Fiber Distribution Frame Cabling**

The Fiber Distribution Frame (FDF) is the point of connection between the fiber equipment frames and the FSF or directly to the outside plant fiber. At the FDF:

- A FPS supports the fiber jumpers from the fiber equipment bays and is positioned in front of the bays.
- An orange fiber only ladder cable rack supports the inter-office fiber riser cable from the FSF, or fiber equipment bays and is positioned to the rear of the bays.
- The FDF shall be placed within dedicated lineups to allow for short jumper lengths and easy access.

Refer to Chapter 3 of this publication for additional information on the FDF.

#### **6G.6 Intra-System Fiber Optic Cable**

A system is defined as a dedicated, multi-lineup arrangement of telecommunication equipment frames performing a specific function. One bay or a single lineup does not constitute a system.

Fiber optic cable (either OFNR or patch cords) internal to a switch or system must be clearly and uniquely labeled to allow for identification, maintenance, and to protect the cable from damage.

Any specific arrangements for intra-system fiber optic cable must be approved and identified in QWEST Standard Configuration documents prior implementation.

#### **6G.7 Fiber Only Cable Rack**

The approved orange, panned and bracketed ladder type cable rack is the standard support medium for all new inter-office fiber riser (OFNR) cable installations.

### 6G.7.1 Orange, Panned and Bracketed Ladder Cable Rack

- Must be segregated for fiber cable only
- Standard - will be engineered and ordered for all new installations.
- Does not require stenciling or labeling
- The horizontal inter-office fiber riser cables will not be secured.
- The pan will be comprised of approved fire rated plastic only.
- Metal pan or screen is prohibited.

### 6G.7.2 Existing Gray Fiber Ladder Cable Rack

- Conditional - will not be installed on new installations, but may be used to finish existing gray lineup fiber cable racks of less than 10 feet.
- Main or end aisle extensions shall use the standard orange fiber rack.
- Will not have pan or screen of any kind nor cable brackets so the fiber optic cable can remain as visible as possible at all times.
- The cable rack stringer (side rail) shall be stenciled "Fiber Optic Cable Only" every 5 feet on each side.
- Horizontal inter-office riser type fiber cable run on gray cable rack will be wrapped with fiber sheeting and secured to every fourth cross strap.

### 6G.7.3 COMMON REQUIREMENTS

The table below provides a quick reference for the two colors of fiber ladder cable rack.

<b>Fiber Only Ladder Cable Rack</b>	Gray	Orange (standard)
Screen & Brackets	No	Yes
Fiber Cables Must be Secured	Yes	Vertical only
Cable Rack Must be Stenciled	Yes	No

When using any color of ladder-type fiber only cable racking:

- All bend radii must be preserved. Corner brackets (Exhibit 2-E1-34) will be installed on each horizontal turn and 90 degree turns (Exhibit 2-E1-53) for vertical drops will be utilized.
- Running fiber optic cable of any type with copper cables is strictly prohibited. Letters of deviation allowing commingling of copper and inter-office fiber optic cables will not be considered valid.

## **6G.8 Fiber Protection Systems**

Fiber patch cords or jumpers initiating on the FDF shall be continuously protected within an approved FPS until they are terminated on the fiber equipment bays. A Fiber Protection System will be engineered and installed in concurrence with the National Electric Code (NEC), all applicable fire codes, and QWEST standards.

The approved fire rated, duct type FPS must be dedicated for fiber optic patch cords, jumpers, or small quantities of OFNR fiber cables. Refer to the table in Section 6G.4.3 FIBER DISTRIBUTION CABLE SUPPORT.

### **6G.8.1 FPS REQUIREMENTS**

Approved FPS must meet several general requirements:

- The FPS shall be manufactured with a bright coloring to allow easy identification of the fiber patch cords. This bright coloring eliminates the stenciling or labeling requirement.
- Fiber Protection Systems (FPS) are designed for the easy addition of fiber optic cables (fiber patch cords or jumpers) not equipped with a heavy protective sheathing.
- FPS ducts modified or cut to allow the exiting of fiber optic patch cords shall be either adapted with a grommet material or smoothed to eliminate any sharp unprotected edges.
- The FPS are engineered to allow fiber patch cords to be laid carefully within this duct arrangement, all fittings shall be installed accordingly.
- Only round head screws are used to secure the duct sections or fittings, any other type would damage the fiber optic cables located inside.
- This totally enclosed protection system shall be equipped and installed with covers on all fittings and straight sections, both horizontal and vertical.
- End caps are required on the end of all horizontal or vertical sections.

### **6G.8.2 FPS RATINGS**

Any questions regarding the rating of a manufacturer's FPS product shall be directed to the QWEST representative responsible for Common Systems standards or QWEST Standard Configuration documents.

**STANDARD** - QWEST requires the use of the “standard” fiber protection system for all-new Central Office facilities and buildings.

**CONDITIONAL** - An existing FPS constructed from a non-standard manufacturer can be extended only if the product is rated “conditional”.

### **6G.8.3 GROWTH**

It is especially important that the FPS, when initially installed, is designed to allow for future growth. Modifications to an existing duct arrangement supporting live fiber can generate potential complications effecting service.

The FPS shall not interfere with existing or future cross aisle cable racking and shall adhere to the minimum 12 inch clearance requirements for cable racks, allowing for the maximum cable buildup.

### **6G.8.4 HEIGHT**

The height of the FPS is measured from the floor to the bottom of the duct.

Entry of the height, size, and routing information for the FPS is required on the fiber layers of the Central Office records.

### **6G.8.5 Horizontal FPS**

Horizontal Fiber Protection Systems require:

- A solid duct for all horizontal Fiber Protection Systems. Slotted duct is prohibited on all horizontal runs and vertical offsets.
- A main support at 5 foot intervals, with a maximum spacing of every 6 feet. A main support is defined as an attachment to auxiliary framing, cable rack stringer (side rail), or framework upright.
- Additional support may be required at fitting and duct junction points.
- Secondary supports every 1 foot 6 inches if the FPS manufacturer uses a contingent support system such as unistrut.

### **6G.8.6 Vertical FPS**

Vertical Fiber Protection Systems:

- Are utilized at the equipment frames to protect the fiber optic patch cords terminating on the fiber shelves.
- One vertical duct arrangement shall be provided for every fiber frame requiring patch cord termination. Sharing a single duct between two bays does not meet QWEST standard requirements and is prohibited.

Vertical Fiber Protection Systems designed with a split flexible tubing arrangement must follow specific guidelines:

- Split flex tubing is restricted to be used for the transition between a horizontal duct arrangement and vertical duct located on the fiber equipment frame upright.
- Using the split flex tubing in place of slotted vertical duct is strictly prohibited.

- No holes will be cut in any flex tubing arrangement to provide an exit for the fiber optic patch cords.
- Sharp, unprotected edges will damage the fiber optic cables.

### **6G.9 Slack Storage**

Cable slack storage in any type of cable rack or fiber protection system is strictly prohibited. Letters of deviation will not be considered valid.

### **6G.10 Fire and Electrical Requirements for Optical Fiber Cables**

Per the 1990 NEC, all optical fiber cables and any raceway containing them will be resistant to the spread of fire and to specific levels of smoke emissions. As a result, all fiber cable racks will be fire and smoke stopped when passing through walls, floors and ceilings. FPS will not pass through walls, floors or ceilings.

Only the following cables may be installed as riser, plenum or general purpose cables with special protection:

- Optical Fiber Nonconductive Plenum (OFNP) and Optical Fiber Conductive Plenum (OFCP) cables are tested as suitable for use in ducts, plenums and other space used for CO environmental air.
- Optical Fiber Nonconductive Riser (OFNR) and Optical Fiber Conductive Riser (OFCR) cables are listed as suitable for use in horizontal runs, vertical runs, shaft-to-shaft, or floor-to-floor applications.
- Optical Fiber Nonconductive and Conductive cables are suitable for general purpose uses, but will not be installed as riser or plenum in a CO environment. Outside Plant (OSP) cables do not have the required American National Standards Institute (ANSI) ratings and will not be run in the CO environment.
- Outside Plant (OSP) cables do not have the required American National Standards Institute (ANSI) ratings and will not be run in the CO environment.
- Conduit, including the innerduct through which the cable enters the vault, must be plugged to prevent water, gas, and vapors from seeping into the cable entrance facility. The inter-building cable rack must be firestopped at each floor or wall. If conductive cable is used, the sheath or metallic strength member must be bonded and grounded at the CEF. See QWEST Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".
- Only intermediate and rigid conduit may be used as vertical or horizontal raceways in extreme situations for cable that doesn't meet fire propagation and smoke emissions standards.

### **6G.11 Responsibilities**

The QWEST Representatives:

- Will maintain a record for each FDF, showing equipment zoning and spread considerations. To maximize the useful life of the FDF, all future installations should conform to this layout.
- Will engineer the fiber equipment floor plan to provide that the high-speed equipment bays are positioned closer to the FDF than the lower speed equipment bays.
- Or engineering contractors will design the FPS layout to prevent interference with future or existing cable racks, cross aisle racks, vent ducts, etc.
- The fiber layer of the QWEST Central Office drawing for each office will be updated to reflect current office FPS routes, heights, sizes and types.
- Cable layers of the QWEST Central Office drawing for each office will be corrected to reflect changes, removals or additions of fiber only cable racks. The dedicated fiber cable racks will be designated "Fiber Cables Only" on office drawings.
- Size the fiber only cable racks supporting fiber entrance and distribution cable for future growth.

Any deviation from the initial FPS design by installation shall be communicated to the QWEST representative responsible for detail engineering prior to the initiation of any installation work.

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## **7. Frame and Aisle Lighting**

### **7.A Fluorescent Type Lighting**

#### **7A.1 General**

This unit outlines engineering requirements for framework supported lighting systems employing fluorescent fixtures. All wiring, conduit, and fixtures installed in Qwest locations will meet the requirements of the National Electrical Code (NEC), Underwriters Laboratories (UL), and the National Board of Fire Underwriters.

All equipment in the entire conduit system shall be permanently and effectively grounded using green AC equipment ground conductor(s) enclosed in the same raceway with the phase conductors.

There are two distinct types of lighting found in Qwest Central Office environments. Building or Egress Lighting is installed and maintained by Qwest Real Estate. Building Lighting provides general lighting for an area, not the equipment. System or Equipment Lighting is supported from the equipment frames or ironwork to provide lighting specifically for the telecommunications equipment.

Lighting and lighting arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines defined herein.

Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

#### **7A.1.1 SYSTEM LIGHTING**

In some cases, specifically Stored Program Control System (SPCS), fluorescent lighting is provided as an integral part of the equipment system. In such cases, light fixtures other than the QWEST standard may be acceptable and will be documented in QWEST Standard Configuration documents.

In areas other than the Central Office switch areas:

#### **7A.1.2 LOW-INTENSITY LIGHTS**

General low-intensity lighting is to be provided by connecting two fixtures in alternate apparatus aisles to a single switch. For large offices where this load may require several branch circuits, the switch is to operate a -48v DC contactor. The contactor is normally located near the center of a block of frames.

#### **7A.1.3 HIGH-INTENSITY LIGHTS**

The high-intensity lights in each apparatus aisle are to be controlled by a 3-way switch at the end of each aisle.

## **7A.2 Conduit**

### **7A.2.1 REQUIREMENTS**

1. Conduit shall be securely fastened at intervals of 6 feet or less.
2. Conduit shall not be run in locations normally occupied by auxiliary framing, cable racks, etc.
3. Conduit shall, where possible, be run parallel and adjacent to the superstructure to assure maximum headroom and to provide easy access to cable racks.
4. Conduit shall not be run in cable racks with telephone equipment cables or DC power cables.
5. Conduit shall not be run in the maintenance area of a lineup.
6. All conduit fittings shall be nonferrous.
7. Conduit and lighting arrangements for 7 feet low-level environments shall be provided per QWEST Standard Configuration documents.
8. Conduit and conduit arrangements for existing 9 feet and 11 feet 6 inch environments shall be per QWEST Standard Configuration documents or arrangements previously established for those areas.
9. Conduit arrangements for Cable Distribution Systems (CDS) shall be provided per Standard Configuration and specific CDS manufacture drawing requirements.

## **7A.3 Lighting Circuits**

Lighting circuits supplied by polyphase service shall be assigned in such a manner as to balance the load on the different phases as closely as practicable.

- The same branch circuit shall not supply lighting equipment and appliance outlets. Wiring for both may be run in the same conduit wherever possible.
- National Electrical Code (NEC) approved solderless connectors shall be used for making all splices in junction boxes and fixtures.
- On the basis that maximum utilization of wiring capacity is realized when power factor correction is made at the lamp, all ballasts are to be high power factor type. A conservative value of 90 percent power factor is to be used for calculation.

## **7A.4 Fluorescent Light Fixtures**

Only approved single and double tube fluorescent lighting fixtures may be installed in equipment areas of Qwest Central Offices.

Double tube fluorescent fixtures are required in all lineup equipment front (maintenance) aisles.

Single bulb fixtures are installed only in the rear (wiring) aisles of equipment frames requiring rear maintenance.

The Qwest Representative responsible for Common Systems standards prior to engineering or installation must evaluate any deviation from the approved fixtures.

### **7A.5 3-Way Switches**

When switches for controlling apparatus aisle fixtures are employed, they are located in the end guard at each end of the aisle.

- One 3-way switch is located on the left upon entering the aisle and the other on the right when leaving. The switches shall be AC rated and may be used to full capacity on either fluorescent (inductive) or tungsten loads except, when low-intensity lighting is controlled by -48v DC contactors, the control switches shall be T-rated.
- At end rows and at incomplete rows, where the absence of an adjacent line of frame prevents the mounting of the switch at the left of the row of lights, the switch shall be mounted on the right upon entering the aisle. When the incomplete row has been filled out, the switch shall be relocated to the standard location.

### **7A.6 Single Pole Switches**

For aisles having an ultimate length of 15 feet or less, a single pole switch shall be used to control the aisle fixtures.

- This switch shall be mounted on the end toward the main cross-aisle. In cases where only one fixture is required, this fixture may be connected in the low-intensity circuit.
- If the line of frames is less than 15 feet, but it is to be extended at a later date, a 3-way switch shall be provided at the originating end. Initially, this switch is connected for single-pole operation, when the line-up is extended, another 3-way switch shall be provided for the growing end and the switches shall be connected for 3-way operation.

### **7A.7 Lighting Drawings**

Due to the interrelationship of AC power supplies for lighting and for appliance outlets, the conduit and junction box arrangements for both are shown on office lighting drawings.

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## **7. Frame And Aisle Lighting -**

### **7.B Appliance Outlets And Miscellaneous Conduit**

#### **7B.1 General**

This unit covers requirements for appliance outlets and miscellaneous conduit equipment in Central Offices (CO). All wiring, conduit, and fixtures installed in Qwest locations will meet the requirements of the National Electrical Code (NEC) and Underwriters Laboratories (UL).

Appliance outlets and outlets arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

#### **7B.1.1 SYSTEM APPLIANCE OUTLETS**

In Stored Program Central System (SPCS) equipment

- ? Appliance outlets will be provided as an integral part of the switching system. The appliance outlets will be placed as deemed appropriate by the suppliers.
- ? In no instance will appliance outlets be added to any SPCS equipment without meeting the entire interface and grounding requirements of that SPCS equipment.

#### **7B.2 Engineering Considerations**

Typical arrangements shown in Qwest Standard Configuration documents may be varied as required to meet specific equipment requirements.

- All equipment in the entire conduit system shall be permanently and effectively grounded using green AC equipment ground conductor(s) enclosed in the same raceway with the phase conductors.

Adjacent lineups shall be on separate outlet circuits. I.e. lineup 0100 and 0102 would be on one circuit, lineup 0101 and 0103 would be on another circuit.

#### **7B.3 Appliance Outlets**

- Outlets are to be furnished in the first bay and subsequently every third bay (6 feet) in a Central Office environment.
- In equipment areas other than main Central Office switch environments, appliance outlets for equipment frames shall be installed in the base (both the front and rear) of each bay requiring an outlet.
- When only one bay is furnished initially in a line-up, an outlet shall be provided in that bay.

- All appliance outlets shall have 3-Wire parallel-polarized receptacles of the duplex type.
- Only outlets designed to provide continuity between the mounting yoke and the grounding terminal will be permitted in Qwest Equipment Locations.
- Special use outlets (Orange) as identified in Exception #4 of Article 250-74 in the NEC are **prohibited** in all Qwest facilities.
- Appliance outlets are not provided in power bays such as a BDFB.

#### **7B.4 Risers**

Risers including risers for outlets in frame gaps

- Shall be located at the non-growth end of partial lines of frames and at either end of complete lines.

#### **7B.5 Conduit And Fittings**

All conduit:

- Shall be securely fastened at maximum intervals of six feet in earthquake light environments or five feet in earthquake heavy zones.
- Conduit shall not be run in locations normally occupied by auxiliary framing, cable racks, ladder tracks, etc.
- Conduit shall be run parallel and adjacent, but not interfere with the superstructure.
- Conduit shall be metallic and nonferrous.

#### **7B.6 Armored Cable**

Armored cable as defined by the NEC:

- Shall be a maximum of three feet in length (~~horizontal~~ vertical only).
- Shall be run only in the locations and in the manner shown in Qwest Technical and Standard Configuration documents.
- Armored cable shall never be run in any cable rack with switchboard or power cable.
- Uncoated armored cable is preferred. When coated armored cable is approved for use, it shall meet the same three feet maximum vertical length requirement as the uncoated armored cable.

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## **7. Frame And Aisle Lighting**

### **7.C Emergency Lighting**

#### **7C.1 General**

This unit covers requirements for emergency lighting equipment used in Qwest locations.

Emergency lighting and lighting arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines.

Refer to QWEST Technical Documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

#### **7C.1.1 REQUIREMENTS**

- ? The preferred emergency lighting arrangement is DC lights powered from the Central Office (CO) main power plant.
- ? The DC lighting should be minimal, and the current requirements should be provided to the engineer when these lights are used to ensure a proper sizing of the CO battery plant.
- ? AC inverters will not be used solely to provide emergency lighting.
- ? The emergency lighting systems may be controlled either manually or automatically as specified by the Qwest Engineer.
- ? For small emergency lighting installations, manual control is generally provided by means of switches.
- ? Larger installations may have automatic control.
- ? For unattended offices with manual control, the control should be located near the main entrance to the building to allow the craft person to operate the emergency lighting upon entering the building.
- ? All wiring for the emergency lighting will conform to the CO grounding requirements including proper routing through the ground window when applicable.

#### **7C.2 Lighting Placement**

##### **7C.2.1 GENERAL EQUIPMENT AREAS**

- ? Emergency lights are to be placed to enable the maintenance forces to find their way around the CO in case of a power failure. For this purpose, lamps should be placed near two diagonally opposite corners of the room thus insuring some light on all four walls.
- ? Additional lights are placed where directed by the engineer, usually near exits, in stairwells, or on unlighted aisles.

### **7C.2.2 POWER AREAS**

- Emergency lighting is used in power rooms and is located in a position to illuminate all of the power equipment, particularly the control board.
- The emergency lighting at the control board should be adequate for the craft person to read any meters or switches required to perform necessary restoral functions.
- One or two additional emergency lights are to be used in battery areas and located so as to give the best light distribution throughout the room.
- Emergency lighting should also be provided in the standby engine room and located to enable starting the engine during a power failure.
- Additional emergency lighting may be required near the manual transfer circuits to allow the craft person to restore the building AC power.
- All battery and ground leads for DC power units shall be run on open cable racks. In areas that there are no cable racks, the leads will be run in conduit.

### **7C.3 Stand-Alone Rechargeable Units**

For stand-alone, rechargeable units, the manufacturers' specifications shall be followed.

- Stand-alone units, when provided, must meet the National Fire Protection Association (NFPA) and the American National Standards Institute (ANSI) standards, and be installed in accordance with the National Electrical Code (NEC), NFPA and applicable ANSI standards.
- Stand-alone units require additional maintenance. The maintenance included the purchase and inspection of otherwise unnecessary batteries.
- Due to the reduction of personnel in the COs, these systems are no longer considered practical.

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## **8. Operations Systems**

### **8.1 General**

This part covers standards for the installation of computers as a subsystem of Operations Systems (OS). These systems perform various maintenance, monitoring, or recording functions associated with the switching network, and transmission facilities.

All new OS should adhere to these standards. Modifications to existing OS should be engineered to incorporate these requirements.

The computers utilized in these applications are typically off-the-shelf supplier items. This section provides information regarding special requirements of this type of equipment.

Due to the large variety of such systems, only general information is included in this section. Where system documentation is provided containing the necessary information, that documentation will take precedence over this document.

### **8.2 Location And Layout**

In general, the weights of OS components are well within the range of live loads specified for Central Office Equipment (COE), and standard computer room configurations. However, some computer installations may be located in other than the two previously mentioned space types. In these instances, the engineer, or space and power planner, should determine floor loading based upon equipment weight information, and system configuration from the computer manufacturer's specifications, to determine the viability of installation at that location.

Many OS require the use of a raised floor. If raised floors or decks are utilized, a notation of such may be made in the requisition for Central Office Materiel/Services. Raised floors or decks are typically provided for systems for cable control and for underfloor cooling requirements. Such cabling is required for interconnecting components of the system and to provide connections to the serviced equipment.

When raised floor is used as an air plenum, the cabling requirements will be in keeping with the "Data Processing Facilities - Cabling requirements in Plenum's agreement", dated February 8, 1991, which is summarized as follows:

- Data processing interconnecting cables and connecting cables do not require a plenum rating if the plenum meets the criteria of the National Fire Protection Association (NFPA) 70-465, and the plenum has a smoke detection system.
- QWEST Communications International Inc. will strive to obtain and use, where feasible and available, plenum rated interconnecting cables, data cables, connecting cables and power cables meeting the requirements of type CMP, MP or MPR, when used in a plenum space.
- Communication cables, as defined in the NFPA 70-800-51, must meet the listing requirements of types CMP, MP or MPR for use in ducts, plenums and other space used for environmental air.
- These are the minimum requirements, and local codes may be more stringent. Therefore, prior to beginning any large-scale data processing cabling project, the local codes should be reviewed.

Raised floor designs must provide an insulating floor surface. The raised floor grid is utilized as a signal reference plane and should be a part of the single point grounding system.

Metallic hardware that penetrates the floor or wall and contacts the metal under surface or support structure (building steel) is prohibited. It is recommended that nonmetallic fasteners be utilized.

Within the Central Office (CO) environment, metal hold down bolts for OS frame work that penetrates a floor shall be furnished with nylon bushings or other suitable nonconductive hardware so that there is no electrical continuity through the bolting material. Within the Information Technologies (IT) data centers the computer hardware is not bolted through the floor.

### **8.3 Environmental Controls**

Computers are designed to operate within relatively tight environmental constraints. Exceeding these limits will increase the probability of processing errors and/or system failure.

Documentation on individual hardware configurations can be obtained from the appropriate hardware vendor or the hardware planner.

Temperature alarms shall be set to alarm at 5 degrees Fahrenheit (5° F) above and below the thermostatic control set point. Relative Humidity alarms shall be set to alarm at 10 percent Relative Humidity above and below the set points, depending on the local conditions.

For OS the set point for relative humidity shall be 55 percent Relative Humidity wet bulb.

When the OSs are clustered in one location the system with the most stringent temperature and humidity requirements shall be discussed with the hardware planners and the Space and Power planners to determine the most prudent direction for the environment.

Operation of the computers at altitudes greater than 8000 feet above sea level may require additional precautions and restrictions.

Operations System (OS) equipment is sensitive to excessive vibration and shock. Isolation from the source of the vibration and shock is required.

For maximum reliability of operation, OS should not be exposed to electromagnetic fields with intensities, which exceed 0.5 v/m in the frequency range 10 kHz to 1 GHz.

Methods to isolate the OS equipment from electromagnetic radiation from sources such as radar, radio or television transmitters, or similar emitters shall be investigated prior to installation.

### **8.4 Power Requirements**

A master disconnect switch shall be provided and controlled from a location near the main AC control panel and the exit doors. This disconnect switch must discontinue the flow of power to all equipment in the OS area.

**Note:** This master disconnect switch within the Information Technologies (IT) computer rooms are known as Emergency Power Off (EPO) buttons.

The procedures for grounding OS are contained in the Protective Grounding part of this publication. (See Module 1, Chapter 4, 4.5.)

The OS single point grounding system in most cases are dependent on ground paths provided in the AC distribution system. To clarify that interrelationship, the various sources and combinations of AC supplies that can be used to power OS installations are summarized below.

Existing Conditions - To clarify interrelationships, the various sources and combinations of AC supplies that can be used to power OS installations are summarized as follows:

- Unconditioned commercial AC power is the least expensive form of power supply suitable for OS installation. This supply is not adequate for most OS installations. Commercial power sources are subject to interruptions, spikes, sags, surges, and other transients generated on the incoming lines. Computers served by unconditioned commercial power can be expected to experience numerous processing interruptions and occasional damage to components.
- Standby power from an engine generator is generally available in CO's to provide power to units classified as essential loads. Essential loads are defined as loads that are capable of tolerating power interruptions of more than 5 seconds without damage. This scenario is not an acceptable alternative in the IT data centers.
- Standby inverter plants operated from the CO battery supply switch standby AC power during commercial power failure to loads classified as protected. Such loads are those that can tolerate interruptions from a few milliseconds up to 5 seconds without interfering with operation. Such interruptions are too great for OS that require no-break power, and are not normally suitable for OS processors.
- Uninterruptable Power Supply (UPS) is utilized in cases where the OS cannot tolerate processing interruption. Within the CO environment this system is utilized when a CO battery system is not available.

When commercial AC supply does not allow satisfactory operation of OS, the supply shall be conditioned. Available devices for treating the commercial power include Line Voltage Regulators (LVR), isolating transformers, motor-alternators, inverters and UPS. Logical combinations are acceptable. Line Voltage Regulators (LVR) or nonregulating transformers may be interposed between the power source and the load to regulate sags, surges, and to block spurious line transients. Conditioning devices may be used to establish a separately derived system.

Autotransformers do not interrupt the AC neutral. Certain UPS employ an autotransformer that allows the neutral to be continuous from the main AC switchboard to the OS. Units that maintain neutral continuity from feeders to downstream distribution circuits shall not provide local ground to the distribution grounded (neutral) conductor.

Certain conditioning units isolate the grounded (neutral) conductors of the distribution circuits from the neutral of the feeder circuit, if a feeder neutral is provided. When so arranged, the output circuitry is classed as a separately derived system that requires its own grounding electrode conductor, as described in National Electrical Code (NEC) 250-5 (d) and 250-26. Note that every unit that conditions power should be examined to determine whether it is a separately derived system. Care should be taken to never provide a second grounding electrode conductor to ground a neutral that is grounded upstream.

A LVR may be interposed between the power source and the panel board serving the OS, to address voltage sags. Unless an autotransformer is used, the LVR establishes a separately derived system.

Isolating transformers provide isolation from transients and high frequency common-mode noise. Isolating transformers always create a separately derived system.

- Isolating transformers are used:
  1. When other equipment attached to the building AC imposes excessive noise on the feeder serving the OS.
  2. In place of LVR when voltage sags are not a problem.
  3. As part of some power distribution units.

Inverters operated from a DC power plant (e.g., CO battery) are employed to supply interruption proof AC power when the OS cannot tolerate processing interruptions. The AC output is not affected by the noise that could occur on the commercial AC supply. An inverter is customarily connected to a panelboard on a one-to-one basis; however, when the load is restricted to the capacity of one inverter, a pair of inverters may be connected to one panelboard to protect the system if an inverter fails.

### **8.5 Communications Protocol**

All OS protocol shall be in compliance with Electronic Industries Association (EIA) protocol standards.

### **8.6 Alarms**

At a minimum, alarm systems shall be provided for the OS which include the following:

- Computer insanity alert (such as a watchdog or sanity check circuit)
- Loss of power to the OS
- Operation of fire detection
- Failure of HVAC system (Heating, Ventilating and Air Conditioning)
- High and low humidity
- High and low temperature
- Water alarms
- Loss of commercial power
- Computer Monitoring Systems

The OS shall be alarm compatible with external maintenance and monitoring systems. The QWEST equipment engineer will specify interconnection requirements for external maintenance and monitoring.

The alarm system should function whether using normal or emergency power.

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## **9. Alarms and Operational Support Systems (OSS)**

### **9.1 General**

This part of Module 1 covers local and remote surveillance requirements for all equipment owned or maintained by QWEST.

Surveillance indicators shall be designed to provide information of any service affecting or potentially service affecting condition that may exist in all Network Elements (NEs) deployed within QWEST.

### **9.2 Alarms**

There are three levels of severity of alarm indications common to "Switching" and "Transport" NEs.

- Critical alarms shall be used to indicate that a severe, service affecting condition has occurred and that immediate corrective action is imperative, regardless of time of day or day of the week.
- Major alarms shall be used for hardware or software conditions that indicate a serious disruption of service or the malfunctioning or failure of important circuits. These troubles require immediate attention and response of the technician to restore or maintain system capability. The urgency is less than in critical situations because of a lesser immediate or impending effect on service or system performance.
- Minor alarms shall be used for troubles that do not have a serious affect on services to customers or for troubles in circuits that are not essential to NE operation.

Each alarm should uniquely identify the trouble(s) being reported. When more than one trouble is being reported by a single notification, each should be uniquely identified.

#### **9.2.1 Commands**

Each remote command shall be associated with a unique response notification. The response notification shall be provided to confirm that the NE has implemented a command properly. This notification shall be sent after the NE has completed and verified the requested actions.

If the actions requested will take more than two seconds to complete, the NE shall send a response notification confirming that it has begun the requested actions.

The NE shall send a notification periodically, confirming that the requested actions are progressing normally and giving appropriate status information. The period shall range from a maximum of ten minutes for routine actions, down to one minute for critical actions such as system recovery.

If processing of the request fails, the NE shall send an appropriate trouble notification within two seconds.

### **9.2.2 Local Notifications**

Local notifications shall be provided for all troubles that trigger remote alarms. For switching NEs, local notifications shall also be provided for all troubles that trigger remote non-alarmed notifications.

Local notifications shall be consistent with the remote notifications.

A local alarm is an on site visual and/or audible indication of or NE trouble condition that requires maintenance action.

Local alarms shall be provided in all Central Offices (COs). The following guidelines should be used when engineering local alarms:

- Audible/visual alarms must be provided for all Network Elements with local alarm capability.
  - Audible/visual alarms must distinguish between critical, major and minor alarms.
  - Use standard alarm lead sets as defined by the manufacturer of the NE.
  - Provide a visual indication when only one local alarm lead is available.

### **9.2.3 Central Office (CO) Alarm Cut-Off (ACO)**

A local control shall be provided for CO audible ACO.

The ACO shall silence CO audible alarms for that NE and shall not inhibit subsequent CO audible indications, which indicate additional failures. The ACO shall not retire any visual or remote indications, and shall not issue a clear indication.

The CO audible/visible alarm system shall provide the following functions for ACO:

- Audible alarms shall be silenced.
- Visible indications shall be changed from an unacknowledged state (i.e. flashing) to an acknowledged state (i.e., non-flashing).
- The ACO shall silence audible alarms for the NE and not inhibit subsequent audible indications that indicate additional failures.
- Local and remote visible indications must not be retired by the ACO.

- A local control shall be provided for CO audible ACO. Capability shall be provided to remotely activate the ACO. The operation of the ACO shall not affect the Remote Telemetry Indicators.

#### **9.2.4 Audible Alarm**

The critical alarm stroke shall consist of a double stroke, the first separated from the second by approximately 0.5 second or less, followed by another double stroke approximately 1.5 seconds later. Each double stroke shall be clearly distinguishable from other double strokes.

The major alarm stroke rate shall consist of one stroke approximately every 1.5 seconds. Each stroke shall be clearly distinguishable as an evenly timed sequence of strokes.

Either a continuous indication or a spurt indication lasting 5 seconds may be used for minor alarms. The spurt indication shall not be used for minor power plant alarms.

#### **9.2.5 Visual Indications**

The colors red, yellow or amber, green, and white shall be used on physical control and status display panels to indicate the various alarm and status conditions of the NE at the equipment location and the Maintenance Center (MC).

Color assignments for physical panels shall be as follows:

- Red shall be used to signify a condition that has or may have a significant affect on service or revenue.
- Yellow or amber shall be used to signify a condition that has or may have a minor effect on service or revenue, or to signify a condition or state of a unit for which the technician should use caution.
- Green shall be used to signify a condition that is favorable or active.
- White shall be used to provide information and signify conditions that have none of the connotations of red, yellow, or green, (e.g., ACO).

Specific color assignments of CO visible alarms such as aisle pilots and for other supplementary alarm panel lamps shall be made according to the following chart.

<u>Alarm classification</u>	<u>Color</u>
Alarm Circuit Alarm	Red
Alarm Cut-Off	White
Critical Alarm	Red
Major Alarm	Red
Major Power Plant Alarm	Red
Minor Alarm	Yellow or Amber
Minor Power Plant Alarm	Yellow or Amber

### **9.2.6 Environmental Conditions**

Any conditions in associated support equipment having a potential for upsetting the normal operating environment required for the proper functioning of the NE shall generate alarmed trouble notifications as well as CO audible/visible alarms.

## **9.3 Remote Telemetry Design Criteria**

This section sets forth-general design criteria for engineers to follow for new remote telemetry systems, additions to existing remote telemetry systems and connection of NEs to the remote telemetry system.

If remoting of alarms is not specified in the Requisition for Central Office Materiel/Services, the detail engineer must check with the QWEST Equipment Engineer to determine if remoting is required.

Specific design criteria may vary within QWEST Communications International Inc. It is the responsibility of the equipment engineer to furnish front equipment, grouping, equipment and assignment terminal block layouts, adhering to the alarm-planning document to the detail engineering vendor.

### **9.3.1 Remote Telemetry System**

The remote telemetry system is that system which is used to collect and transmit the surveillance information of a NE to the Operation Support System (OSS). Refer to Exhibit 2-H-1 for block diagram of remote telemetry system.

### **9.3.2 Location and Numbering**

Remote telemetry systems and their associated terminal blocks should be collocated in the same relay rack or frame. The basic remote telemetry unit within the system shall be numbered one, and each expansion unit associated with the system shall be numerically incremented by one, starting with two.

### **9.3.3 Assignments**

Discrete alarm scan points of the remote telemetry equipment shall be assigned sequentially, starting with alarm bit number one of the first designated discrete alarm display.

Discrete control points of the remote telemetry equipment shall be assigned sequentially, starting with control bit number one.

Discrete alarm scan and control points of the remote telemetry system basic unit and expansion shelves shall terminate on the assignment terminal block when the discrete alarm capacity is greater than two displays or 128 discrete alarm points.

### **9.3.4 Firmware**

Unipolar alarms with memory (AT&T Firmware List 118) shall be the standard default firmware alarm scan point attribute. With this attribute, the scan point will retain the alarm condition for one additional telemetry scan after the actual clearing of the alarm in the NE. The memory attribute guarantees that a brief alarm does not avoid detection by the OSS.

### **9.3.5 Network Elements (NEs)**

All NEs shall be connected to a remote telemetry and local alarm system.

QWEST approved standard interconnect drawings shall be used for all connections outside of the frame or shelf.

The standard interconnect drawing, for the NE, shall also include standard discrete or serial alarm scan and control points as defined by the manufacturer or as defined by the QWEST Communications, Inc. Surveillance Alarm Committee.

Network Elements (NEs) shall be configured to utilize the serial alarm reporting option when available.

Normally closed dry relay contacts shall be used for the discrete alarm points in NEs that have the option of normally open or normally closed dry relay contacts. Contacts are in a loop condition with relay energized and in a nonalarmed condition.

When a NE provides only local alarm lead sets, these leads may be used for Remote Telemetry. Because of the ACO function, use only the visual alarm leads.

Network Elements, which provide alarm battery as an alarm indication, shall not be terminated directly on the equipment terminal block. A relay or solid state device, which converts the alarm battery input to a ground or loop closure output, shall be used with these network elements that provide alarm battery. The ground or loop closure output from the relay or solid state device shall terminate on the equipment terminal block.

### 9.3.6 Assignment, Equipment and Grouping Terminal Blocks

The use of assignment, equipment and grouping terminal blocks are required when the maximum discrete alarm capacity of the remote telemetry system is greater than two displays or 128 discrete alarm points.

Terminal block numbering shall be numerically incremented by one, starting with one for each equipment, assignment and grouping terminal block.

Network Elements (NEs) and telemetry equipment leads shall terminate on the rear of the associated terminal blocks. Alarm lead grouping on the grouping terminal block or cross-connects between the various terminal blocks shall be made on the front.

- Assignment Terminal Blocks
  - a. Assignment terminal blocks shall terminate the discrete alarm and control point leads of the remote telemetry device.
  - b. The assignment terminal block pin arrangement, as viewed from the front, shall be as follows:
    - 1) Numbered from top to bottom.
    - 2) Numbered from left to right.
    - 3) When the remote telemetry equipment is equipped with Status Indicator (SI) and Status Indicator Return (SIR) alarm scan leads, alternating columns of SI and SIR leads shall be assigned on the assignment terminal block.
    - 4) When the remote telemetry equipment is equipped with SI alarm scan points without return leads, each column of the assignment terminal block shall be assigned as an SI lead.
    - 5) When the remote telemetry equipment is equipped with Command Control (CC) and Command Control Return (CCR) control points, the control points shall terminate on the far right hand side of the assignment terminal block, with alternating columns of CC and CCR leads, as viewed from the front.
    - 6) When the remote telemetry equipment is equipped with CC control points without return leads, the control points shall terminate on the far right hand side of the assignment terminal block, as viewed from the front with each column assigned as a CC lead.
    - 7) Assignment of all alarm points on the assignment terminal block shall be sequentially from top to bottom and left to right, as viewed from the front.
    - 8) Assignment of all control points on the assignment terminal block shall be sequentially from top to bottom and right to left, as viewed from the front.

- Equipment terminal blocks
  - a. Equipment terminal blocks shall terminate the discrete alarm and control point leads of each NE.
  - b. The Equipment terminal block pin-arrangement, as viewed from the front, shall be as follows.
    - 9) Numbered from top to bottom.
    - 10) Numbered from left to right.
    - 11) Assignment of all NE Alarm and control point leads shall be sequentially from top to bottom and left to right, with alternating columns of SI and SIR leads, as viewed from the front of the equipment terminal block. There shall be no partitioning of the equipment terminal block.
    - 12) When the remote telemetry equipment has SI alarm scan points without return leads, all punchings of every other column (i.e., 2, 4, 6, . . . 32) shall be strapped common with each other and connected to ground of the telemetry System. This will allow for loop closure alarms within the NE when required.
    - 13) When tie cable is required to the Distributing Frame (DF) or some other location, it should terminate on the far right hand side of the terminal block or terminal block mounting, starting with the highest numbered column and growing toward column one.
    - 14) There shall be no grouping of like alarms on the equipment terminal blocks, except as follows:
      - Fuse panel alarms of like potentials
      - Office maintenance equipment
- Grouping terminal blocks
  - a. Grouping terminal blocks may be used to terminate the discrete alarm scan control points of Digital Loop Carrier (DLC) equipment (i.e., SLC® 96, SLIM, SLC® Series 5, etc.)
  - b. Assignment of the DLC grouping terminal block pins shall be alternating rows of SI and SIR leads per bay, starting at the top left hand side of the block and growing toward the bottom.

- c. Grouping terminal blocks shall not be mounted at the end of equipment line-ups, in the middle of equipment line-ups or at the end of aisle. It is recommended that the grouping terminal blocks be located in the same frame as the assignment terminal blocks.
- d. Vendor specific documentation shall be referred to for the number of systems and leads that can be grouped together for various NEs.

## **9.4 Detail Engineering Requirements**

### **9.4.1 Network Element (NE) Additions or Removals**

When NEs are added to a CO, it is the responsibility of the detail engineering vendor to assure that the remote alarm and control points of the NEs added are connected to the remote telemetry system and local alarm system in accordance with the Requisition for Central Office Materiel/Services and this publication.

The detail-engineering vendor is responsible for identifying and ordering all necessary equipment, cable and wire required to connect any NEs added to the appropriate remote telemetry system and local alarm system. Specific details are outlined in the Telephone Equipment Requisition and Module 2 of this Publication.

### **9.4.2 Remote Telemetry System Additions or Removals**

The detail engineering vendor is responsible for identifying and ordering all necessary equipment, cable and wire required to connect all NEs and the new remote telemetry system. Specific details are outlined in the Requisition for Central Office Materiel/Services and Module 3 of this publication.

### **9.4.3 Central Office (CO) Base Drawings**

The detail engineering vendor is responsible for identifying, marking and creating all the appropriate QWEST Communications International Inc. Central Office base drawings; for all equipment added, removed or assigned to.

Specific requirements shall be outlined in the Requisition for Central Office Materiel/Services.

General requirements are outlined in the Engineering Services Records Group - General Procedures Handbook (ESRG - GPH) (previously known as the Central Office Records Center (CORC), and in Modules 1, 2 and 3 of this Publication.

The corrected CO base drawings, along with a ESRG Issue Request Form RG-47-0011, shall be sent to:

Engineering Services Records Group  
6912 S. Quentin  
Englewood, Colorado 80112.

## 9.5 Power Equipment

Failure of any power equipment, circuits, fuses, and feeders shall generate remote alarm trouble notifications, as well as local audible/visual alarm indications. The following is a minimum definition of power alarm lead sets, which will be used in sites which are not equipped with remote power monitors:

- Power facilities - Battery/Rectifiers (AC/DC) Refer to: Technical Publication 77385
- Power facilities - Converters (DC/DC) Refer to: Technical Publication 77385
- Power facilities - Inverters (DC/AC) Refer to: Technical Publication 77385
- Power facilities - Standby AC Power Refer to: Technical Publication. 77385
- Power facilities - Ring, Tone and Cadence Plants. Refer to: Technical Publication. 77385
- Fuse Bay (FB) and Battery Distribution Fuse Board (BDFB) panel alarms shall be monitored according to potential (i.e., -24v, +24v, -48v, -130v, ringing, etc.). Fuse Bay (FB) or BDFB and potential should be identified as part of the OSS database.
- Controls shall be provided per local agreements.

Offices equipped with a Power Systems Monitor Controller (PSMC) shall have the PSMC perform front-end control and status functions for the DC power plants within the CO.

Refer to: Power Facilities - Power Systems Monitor Controller, Module 1, Chapter 3, 2.00 and 3.00, for standard monitor and control points.

Standard surveillance lead set of the PSMC (i.e., major, minor and watchdog), shall be terminated on the equipment terminal block of the facilities remote telemetry system.

## 9.6 Building/Environmental

Building and environmental alarms shall be provided to meet the fire, life and safety requirements of QWEST Communications International Inc.

It is the responsibility of the equipment engineer to furnish a list of Standard environmental alarms, which adhere to the alarm-planning document to the detail-engineering vendor. These alarms shall be transported from the demarcation point to the Network Monitoring and Analysis (NMA) system. The trouble indication will then be routed to the responsible alarm center.

All building/environmental alarms shall be "normally closed" dry relay contacts.

## 9.7 Central Office (CO) Switches

Remote telemetry capability shall be provided for the surveillance of digital, electronic switches and electromechanical switches. The telemetry device shall be connected to appropriate OSS.

### **9.7.1 Digital and electronic switches**

In digital and electronic switches, surveillance indications are generated within the switch, regarding the condition of the switch and integrated facilities. The switch message shall be transmitted to the switching OSS for analysis and delivered to the appropriate center. The integrated facility messages shall be transmitted to the facility OSS for analysis and delivered to the appropriate center.

These offices shall be equipped with separate remote telemetry devices, which will monitor the condition of all other NEs.

### **9.7.2 Electromechanical switches**

In electromechanical switch locations, remote telemetry equipment shall be installed to report surveillance indications to the appropriate OSS for all NEs.

## **9.8 Performance Monitoring (PM)**

Performance Monitoring refers to the continuous monitoring of digital transmission quality. The three key components of performance monitoring are:

- Detection of transmission degradation.
- Derivation of useful performance parameters from the detected degradation.
- Communication of these parameters to a surveillance OSS.

All PM data, e.g., events, alarms and reports from the NEs, will be reported to the QWEST Communications International Inc. Network Monitoring and Analysis - Facility Modules.

## **9.9 Transmission/Facility Equipment**

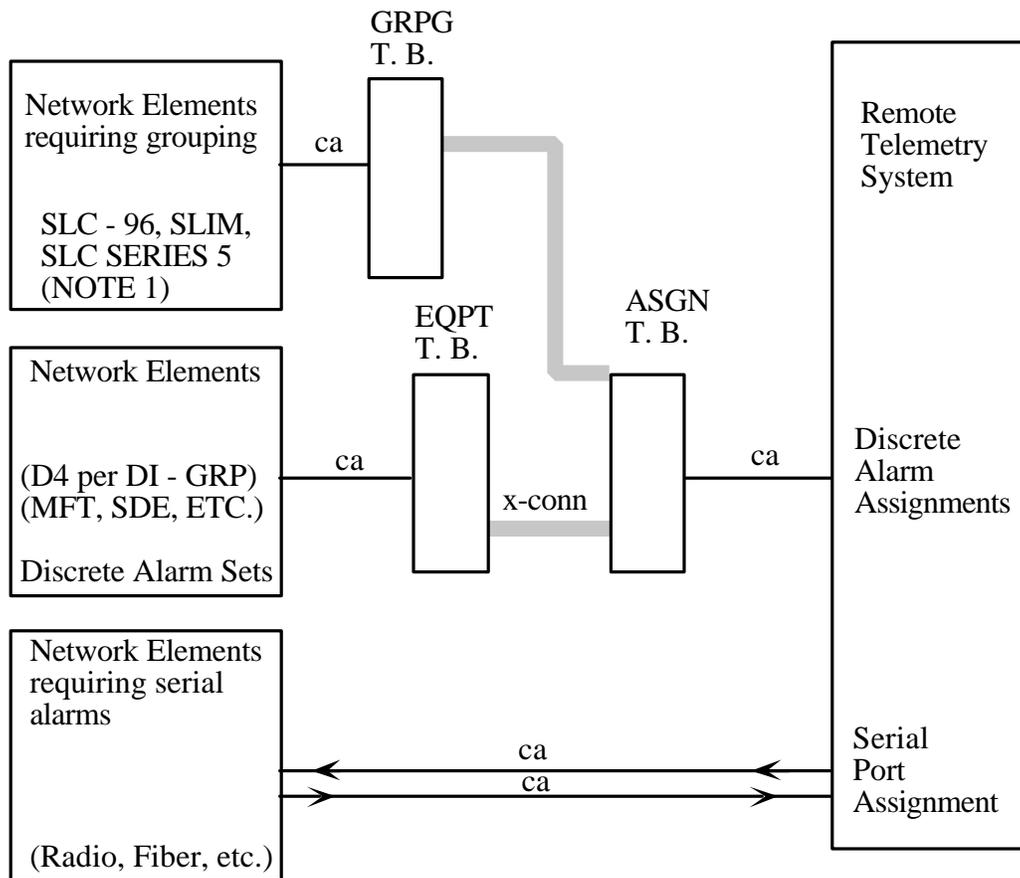
Remote telemetry capability shall be provided for the surveillance of all NEs in both switching and non-switching sites. The telemetry device will be connected to the appropriate OSS.

Non-switching sites

- The QWEST Communications International Inc. owned or maintained equipment located in radio sites, facility equipment rooms, Controlled Environment Vaults (CEVs), DLC huts, fiber and repeater huts, and Customer Premise Equipment (CPE) locations must be monitored.

Switching sites

- The transmission/facility equipment located in switching sites, which are not integrated facilities of the switch (refer to Paragraph 6.00 of this Section), must have remote telemetry capability provided and connected to the appropriate OSS.



LEGEND:

GRP T. B. = Grouping Terminal Block  
 EQPT T. B. = Equipment Terminal Block  
 ASGN T. B. = Assignment Terminal Block  
 ca = cable

Notes:

1. SLC® 96 - MJ, MN CLF, PMN, FE, NE, FA, BLB, RACO, AND RTN'S ° ONCE PER MAXIMUM 48 SYSTEMS. SID, P/M AND RTN'S ° ONCE PER BANK OR SYSTEM.
2. SLM - MJ, MN, CLF, PMN, FE, NE, FA, BLB, RACO, AND RTN'S ° ONCE PER MAXIMUM 48 SYSTEMS. SID, P/M, ACO, INC AND RTN'S ° ONCE PER SYSTEM.
3. SLC® SERIES 5 - MJ4, RMN1, CLF1, PMN1, FE1, NE1, DI GRP AL, DI GRP B1, DI GRP C1, DI GRP D1, RT MISC 1A, RT MISC 1B, RT MISC 2A, RT MISC 2B, RACO AND RTN'S ONCE PER BAY.  
 - 1DUX1, 1DXL1 AND RTN'S ° ONCE PER BANK OR SYSTEM.

Exhibit 2-H-1  
 Telemetry Block Diagram

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## 10. Wire And Cable Requirements

### 10.1 General

This part of the Engineering Standards presents the requirements for selecting and installing wire and cable. Engineering suppliers must meet or exceed these requirements.

Specifications, drawings or other supplementary documents usually specify the types and gauges of wire to be used for a particular product. These requirements have often been formalized into drawings, particularly in switching systems, which govern the use of wire within these systems, including the color code of the wire to be used. The requirements given in those documents will be followed unless specified otherwise in the Requisition for Central Office Materiel/Services. The standards that follow will be used when the equipment supplier does not specify the type of wire and cable to use.

### 10.2 General Considerations

Conductors of all wires shall be tinned copper wire, unless otherwise specified.

The majority of wire used for telecommunications applications utilizes solid copper conductors. Wire with stranded conductors is available and may be specified when its use is advantageous, such as where flexing or vibration may occur.

American Wire Gauge (AWG) will be used unless otherwise specified.

Insulation must meet the fire and abrasion resistance requirements in Chapter 11 of this Module. Low smoke, low flame plenum type cables should be used. When voltages on both sides of ground are employed, wire should be insulated for the maximum potential difference between them.

The maximum rated operating temperature must be higher than the sum of service ambient temperature and temperature rise caused by operating conditions.

The maximum current carrying capacities recommended by the manufacturer should not be exceeded. When using wire and cable, the allowable ampere capacity for the wire and cable will be based on the approved National Electrical Code (NEC) ratings.

The wire must be covered (conductors sheathed) in an insulating jacket. A light gray Polyvinyl Chloride (PVC) jacket is recommended, unless otherwise specified.

Selection of a suitable type of wire requires consideration of such electrical factors as voltage drop, transmission properties, frequency, capacitance, inductance, voltage breakdown and corona. Mechanical factors requiring consideration include abrasion resistance, tensile strength, ease of termination, the possibility of damage from soldering heat and conductor breakage under severe handling or operating conditions. Cost requires consideration in the selection of wire and cable. Also, certain types of wire are Underwriter's Laboratories (UL) listed or approved. When this is so, specific usage should be in accordance with UL documents.

### 10.3 Uses Of Wire And Cable

#### 10.3.1 Switchboard Cable

When selecting large cables to be spread over several equipment units, consider the amount of stripped cable that can be handled conveniently.

Switchboard (sheathed) cable will be run on cable racks in offices designed for them, and will not have bends in the cable which are more acute than those recommended by the cable manufacturer and/or QWEST Communications International Inc. Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines".

The necessity of isolating certain leads is also a consideration in selecting large cables. There are five types of wiring that require segregation, designated C, C1 C2, C4 and C5. When the equipment manufacturer does not specify segregation requirements, the following standards will be used:

- C-WIRING is wiring carrying noise inducing currents of low intensity which requires limited segregation.

- a. No segregation is required on wiring when used as:

Local cable

Formed ends of switchboard cable

Loose wire forms

Loose wire in fanning rings or other

Wire retaining devices

Wire on cable racks

Surface wiring within a unit

- b. Wiring must be segregated from C2-Wiring and all wiring not marked on the circuit schematic when run as:

- 1) Switchboard cable

- 2) Sewn local power cable

- c. Wiring may be combined in the same switchboard cable or sewn local power cable with other leads designated C or C5, provided the conductors used for circuits of different voltages, or with potential on both sides of ground are insulated for the maximum potential difference in the cable.

- C1-WIRING is wiring taped and run in a separate cable form, for electrical reasons. C1-Wiring is placed inside of the regular form when running it on the outside of the form would interfere with the hinge action, or other required movements of the regular form. The same rules for segregating and grouping C 2-, C4- and C5-Wiring apply to C1-Wiring.
- C2 WIRING is wiring carrying noise inducing currents of high intensity, which require segregation throughout the entire length. The conventions to follow are:
  - a. No segregation is required on wiring run when used as:
    - 1) Wire on cable racks
    - 2) Loose wire forms
    - 3) Loose wiring in fanning rings or other wire retaining devices
    - 4) Surface wiring within a unit
  - b. Wiring must be segregated from all leads marked C, other leads (except C2 leads in other identical circuits) C4 and C5 leads, as well as from all other leads not marked on the circuit schematic when run as:
    - 1) Local cable
    - 2) Switchboard cable
    - 3) Formed end of switchboard cable
    - 4) Sewn local power cable
  - c. The only C2 leads that may be grouped together are identical C2 leads from other identical circuits.
- C4-WIRING is wiring carrying commercial power within a unit, which must be kept separate from all other wiring. The conventions to follow are:
  - a. No segregation is required within the unit on surface wired equipment.
  - b. All C4 leads may be grouped together.
- C5-WIRING is wiring carrying noise inducing currents of medium intensity, which requires segregation throughout the entire length, but is not critical enough to require complete isolation from other noise inducing wiring. The conventions to follow are:
  - a. No segregation is required on wiring run when used as:
    - 1) Wire on cable rack
    - 2) Loose wire format
    - 3) Loose wiring in fanning rings or other wire retaining devices
    - 4) Surface wiring within a unit

- b. Wiring shall be segregated from all leads marked **C2** and **C4**, as well as from all other leads not marked on the circuit drawing when run as:
  - 1) Local cable
  - 2) Switchboard cable
  - 3) Formed ends of switchboard cable
  - 4) Sewn local power cable
- c. All **C5** leads may be grouped together in the same cable with other **C5** leads.

### **10.3.2 Distributing Frames (DFs)**

Horizontal Side - The leads from one cable may be spread over a maximum of 45 inches. A cable entering the horizontal side from the vertical side, either above or below, should be butted approximately in the center of the group of terminal strips served, or per the applicable systems method of cable drawings.

Vertical Side - A cable may be formed over an entire vertical or any portion of it, as required.

### **10.3.3 Fuse Bays (FBs)**

A cable may be formed over any number of fuse panels in one bay, regardless of whether the panels are adjacent.

### **10.3.4 Relay Racks**

The leads from one cable may be formed over one or more groups of mounting plates or relay rack units, but should not be spread over more than one relay rack bay, with the following exceptions:

- Cables employing an Irradiated Polyvinyl Chloride (IPVC) covering of 22 and 24 gauge solid conductor may be formed over five adjacent bays, or the equivalent. The cable should be butted on the cable rack, near the center of the group, and the leads run as loose wires.
- For bay-wired equipment having terminal strips and associated fanning rings, or suitable carrying devices at the top to the bay, cables employed other than IPVC 22 and 24 gauge solid copper conductor (except cables containing shielded pairs) may be formed over more than one bay. For such equipment, one cable may be formed over five adjacent bays, or the equivalent. It is often preferable to butt the cable at the center bay of the group.

### 10.3.5 Wire Not In Switchboard Cable

Supplier document should be consulted for the type of wire to use in a particular system. Otherwise, the following guide should be used in selecting the appropriate type of wire.

- Local cable or loose wiring solder type terminations:
  - a. Use IPVC 22 or 24 gauge, solid copper conductor
- Local cable or loose wiring nonsoldered terminations:
  - a. Use PVC 22, 24 or 26 gauge, solid copper conductor
- Local power cable:
  - a. Use Polyvinyl Chloride, Cotton, Braid, Lacquered (PVC CBL) 20, 22, or 24 gauge solid copper conductor Surface wiring:
  - b. Use IPVC 22 or 24 gauge solid copper conductor
- Extra strength/abrasion resistance:
  - a. Use PVC CBL 20, 22 OR 26 gauge solid copper conductor
- Shielded wire - Use Polyvinyl Chloride, Cotton and Lacquered (PVC CL), shielded, PVC jacket 22 or 24 gauge solid copper conductor, or Polyethylene (PE), shielded, PVC jacket, 22 or 24 gauge solid copper conductor.
- Wiring not in switchboard cable run on cable racks:
  - a. In general, only one to four leads should be run without using cable.
  - b. Use PVC CBL, 20, 22 or 24 gauge solid copper conductor
- Wire run in conduit:
  - a. Use PVC CBL, 20, 22 or 24 gauge solid copper conductor
- Surface wiring is run loose and dressed near or against the mounting plate or panel, or adjacent to the plane of the mounting surface. The colors commonly used are:
  - Green - General wiring (except battery and ground wires)
  - Red - Battery wires
  - Black - Ground wires

Other colors may be used, when required for a specific purpose, or to facilitate supplier requirements.

### 10.3.6 Cross - connect Wire

The type, gauge and color of cross-connection wire should be determined from the supplementary specifications and drawings for particular types of frames.

As a general guide, the following can be used on DF with solder type connections:

<u>GAUGE</u>	<u>NO. OF CONDUCTORS</u>	<u>TIP</u>	<u>RING</u>	<u>COLOR SLEEVE</u>	<u>LAMP OR MESS REG</u>
20	1	brown	black		
20	2	brown	black- brown		
22	2	white	black		
22	3	white	black	red	
22	4 (spiral four)	white	black	red	green
22	4 (mult twin)	(side 1) black- white (side 2) red	black   green		

- The following chart can be used as a general guide on DF with quick connect connections:

<u>GAUGE</u>	<u>NO. OF CONDUCTORS</u>	<u>TIP</u>	<u>RING</u>	<u>COLOR SLEEVE</u>	<u>LAMP OR MESS REG</u>
22	1	brown			
22	2	yellow	blue		
22	3	yellow	blue	orange	
22	4 (spiral four)	yellow	blue	orange	brown
22	4 (mult twin)	(side 1) yellow (side 2) orange	blue   brown		

- QWEST Communications International Inc. will provide cross-connect wire for DF unless otherwise specified.

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## **11. Central Office Equipment Building Environment Requirements**

### **11.1 General**

This part of Module 1 defines the desired environment for Central Office Equipment (COE). Included are such considerations as temperature, humidity and air quality as well as earthquake bracing, electromagnetic compatibility, etc. Specifically excluded are those considerations, which fall under the control of the Environmental Protection Agency (EPA); i.e., air and ground pollution that results from Central Office (CO) activity. Such considerations are described in instructions provided by the Director of Environmental Affairs.

Some of the requirements in this section will appear to apply only to manufacturers of equipment. However, they are presented here to ensure that the engineering supplier will select cable, wire, and ancillary equipment that will meet or exceed these requirements. Also, the overall installed job must meet these requirements.

The environmental requirements apply to all COE systems including associated cable distribution systems, distributing and interconnecting frames, power equipment, operations systems, and Cable Entrance Facilities (CEFs) (see Note 1), etc. These requirements are in all ways compatible with, and at least as stringent as, the standards presented in "Part 1910 - Occupational Safety and Health Standards" (Title 29-Labor, Chapter XVII OSHA, Department of Labor). These requirements apply to buildings with a controlled environment. The engineer should consider the environment in which the equipment will be working to ensure satisfactory operation.

### **11.2 Network Equipment Building System Equipment Testing Requirements**

Equipment to be located within QWEST equipment structures (central offices, remote huts, fiber hubs etc.) shall meet NEBS level one requirements. These include but are not limited to:

- System Fire Test and Material/Components Criteria

As referenced in Bellcore Document GR-63-CORE, "Network Equipment - Building System (NEBS) Requirements: Physical Protection".

- Electrical Safety
- Listing Requirements
- Bonding and Grounding
- EMI-Emissions (or FCC Part 15 compliance)
- Short Circuit Test
- Lightning Immunity (Second Level)

As referenced in Bellcore Document GR-1089-CORE, “Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment”.

Equipment directly connected with the local loop shall also pass the following NEBS level one tests:

- Current Limiting Protector Test
- AC Power Fault Immunity (second level)
- Voltage Limiting Protector Test

As referenced in Bellcore Document GR-1089-CORE.

Equipment classified as telecommunications equipment that is service affecting must also pass these additional tests:

- Operational Thermal (Operating (NEBS 2) and Short-Term (NEBS 3) Conditions)
- Earthquake (Zone 4 Level (NEBS 3))
- Office Vibrations (NEBS 2)
- Storage Environments and Transportation and Handling (NEBS 3)
- Airborne Contaminants (Indoors Levels) (NEBS 2)

As referenced in Bellcore Document GR-63-CORE.

- ESD (Installation and Repair (NEBS 3)
- EMI Emissions (Open Doors) (NEBS 3)
- Lightning Immunity (First Level) NEBS 2)
- EMI Immunity (Open Doors) NEBS 3)

As referenced in Bellcore Document GR-1089-CORE.

Equipment Directly connected with the local loop:

- Steady state Power Induction Requirements (NEBS 2)

Equipment located in the outside plant environment must also pass

- Steady State Power Induction Conditional Requirements (NEBS 3)

Equipment located in Central Office lineups shall meet these additional other criteria requirements as they apply to the specific equipment:

- Spatial Requirements
- NEBS-2000 Framework Requirements
- Altitude
- Thermal Heat Dissipation
- Acoustic Noise
- Illumination
- DC Potential Difference
- Corrosion
- Lightning Surge laboratory test equipment must meet Bellcore requirements

### 11.3 Thermal

All equipment shall remain operational within the following room ambient temperature and humidity limits (see Note 2). Thermal requirements for Operation Systems (OS) can be found in Module 1, Chapter 7.

Operating Temperature:	+41°F to +104°F
Short-Term Temperature: (see Note 3)	Minimum +29°F Maximum +122°F
Nominal Temperature:	+65°F to +85°F (focused sites) and +55°F to +85°F (non focused sites)
Maximum Rate of Temperature Change:	2.5°F in 10 min. (not to exceed 15°F per hour)
Operating Relative Humidity:	20% to 55% (Focused sites) 5% to 90% (Unfocused sites)
Short-Term Relative Humidity: (see Note 3)	Minimum 10% Maximum 80% (Maximum of 0.024 lbs. of water/lb. of dry air)

**Note:**

1. Subsurface CEFs will generally not have permanent facilities for heating and thus may be subjected to low temperatures and moisture conditions.
2. Room ambient refers to conditions at a location 5 feet above the floor and 15 inches in front of the equipment in the hottest point in the office. (At the 7 foot level and same frontal distance, the temperature will be less than 5 degrees Fahrenheit (5° F) above the specified upper temperature limits.)
3. Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in one year. Relative humidity considerably less than 80 percent will occur for ambient temperatures above 95° F. At the short-term condition of 122°F, the relative humidity will be below 20 percent.

For maximum energy conservation, fan systems will be thermostatically controlled and will operate only when the heating and cooling units operate. Equipment systems requiring continuous fan operation; i.e., digital technology equipment, will be considered special, and requirements would be noted in the Qwest Standard Configurations and in other system requirement documentation.

All equipment shall remain operational when installed in COs located from 200 feet below sea level to 14,000 feet above sea level.

The average system equipment area heat load shall not exceed 80 watts/foot squared (80W/ft<sup>2</sup>) unless special equipment frame as well as equipment room cooling provisions are made. To determine if this limit is met, all equipment is considered in one of three classes:

- System Equipment is designed as part of a major system and with a specific plan; e.g., Stored Program Control System (SPCS). The average system equipment area heat load shall not exceed 80W/ft<sup>2</sup>. The average equipment area heat load is determined by adding all the individual frame heat loads and dividing by the floor area including maintenance aisles, wiring aisles, equipment footprint, cross-aisles between line-ups, open area in building column lines, and any adjacent perimeter or access aisles not partitioned separately. Within that system area, however, any one 20 foot by 20 foot square area may average up to 100W/ft<sup>2</sup>, and any individual item, such as a single equipment frame may dissipate up to 120W/ft<sup>2</sup>, provided the total system equipment area average does not exceed the 80W/ft<sup>2</sup> limit.
- Common Systems Equipment (Power, Distributing Frames (DFs), and Alarm Equipment) is designed without knowledge of what other equipment might be installed adjacent to it. Transmission systems and data systems equipment may fall in this category in many offices. The heat dissipation shall not exceed 80W/ft<sup>2</sup> calculated on any one 20 foot by 20 foot square area. An individual equipment frame may dissipate up to 120W/ft<sup>2</sup> provided it is not expected to be located near another frame with comparable dissipation.
- Equipment designed for forced air-cooling will typically have the fans located inside the equipment cabinet. Using fans increases the equipment cooling capabilities and reduces the heat buildup from adjacent equipment. For effective removal of heat from the equipment room and for maintaining normal aisle temperatures with present cooling systems, the average equipment area heat load shall not exceed 100W/ft<sup>2</sup>. Within this equipment area, however, any 20 foot by 20 foot building bay area may average up to 120W/ft<sup>2</sup>. An individual equipment

cabinet may dissipate up to 150W/ft<sup>2</sup> provided sufficient local airflow is maintained to prevent aisle temperature buildup.

1. The floor area used to calculate these limits always includes the associated aisles. For example, in the case of an individual equipment frame, the area is that of a rectangle outlined by the frame sides and the center lines of the standard front and rear aisles.

Information on equipment heat dissipation shall be included Qwest Standard Configuration documents and equipment specifications. The data should be as accurate as possible to avoid uneconomical power and air conditioning facilities. Equipment area heat loads expected to exceed 40W/ft<sup>2</sup> in any one building bay should be clearly identified and a note added that special equipment room cooling is required. This will alert planners of the need to provide special air distribution. If the heat dissipation of the system averaged over its heat producing area exceeds 80W/ft<sup>2</sup> (100W/ft<sup>2</sup> with forced convection-cooled equipment cabinets), aisle spacing should be increased to limit heat dissipation to these values. If aisle spacing deviates from the standard in Module 1, contact the Qwest Representative responsible for space planning. If the heat dissipation for an individual frame exceeds 120W/ft<sup>2</sup> the specific cooling plan must be indicated particularly if it involves other than natural convection. These recommendations should appear in Qwest Standard Configuration documents and equipment specifications.

#### 11.4 Fire Resistance

The following specifies fire resistance requirements for new COE systems. All materials, components and cables used in equipment and cable distribution assemblies shall satisfy the requirements found in the following paragraphs.

Equipment and cable distribution assemblies should be fabricated from fire resistant materials so that they will meet the assembly requirements outlined in the following paragraph. Assemblies consisting of materials, components and cables that have all of the following properties will generally satisfy this requirement.

- All polymeric materials used in equipment and cabling should have an oxygen index of at least 28 percent in accordance with the American Society for Testing Materials (ASTM) D-2863-77 "Flammability of Plastics Using the Oxygen Index Method."
- Materials should not sustain flaming when an open flame source is removed. When tested according to the "Vertical Burning Test for Classifying Materials 94 V-0, 94 V-1 or 94 V-2," Underwriters Laboratories Publication UL 94, "Tests for Flammability of Plastic Materials" they must possess a rating of 94 V-0 or 94 V-1.
- Components selected for use in assemblies shall be fire resistant when tested according to the International Electrotechnology Commission (IEC) Standard IEC 695 "Fire Hazard Testing," Part 2-1 "Glow Wire Test," Part 2-2 "Needle Flame Test."
- Cables shall not propagate fire to the top of the 8 foot test cable rack when subjected to the Institute of Electrical and Electronic Engineers (IEEE)-383 "Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations," performed in an 8 by 8 foot enclosure, in accordance with clause 2.5 excluding sub-clause 2.5.4.5.

- If internal fans are employed, provisions should be made for restricting the air flow through the cabinet to facilitate use of a portable fire extinguisher in the event of a fire within the frame.

Equipment and cable distribution assemblies shall meet the following requirements.

- In equipment assemblies, including wiring and overhead cable, fire spread shall be contained within the structural elements of the assembly (for example, within a 2 foot, 2 inch wide equipment frame) so that flames will not spread into adjacent equipment assemblies. Such assemblies shall generate a severity of fire no greater than that which can be permanently suppressed by a Class 5BC portable fire extinguisher (a 10 lb. CO<sub>2</sub> charge) 15 minutes after flame outbreak in the assembly. [As specified in Bellcore Technical Reference TR-NWT-000063, "Network Equipment-Building System (NEBS) Generic Equipment Requirements (A Module of LSSGR, FR-NWT-000064 and of TRGR, FR-NWT-000440)"].
- In cable distribution assemblies, flame shall not be propagated horizontally more than 6 inches when subjected to "Cable Distribution Assembly Horizontal Flame Spread." Cables installed in indicated one (1) hour fire-rated structures, such as conduit, ducts, chases, or cable vaults, equipped with fire-rated cable penetration closures capable of a minimum one (1) hour fire resistance, need not be subjected to the above noted requirement.

### **11.5 Earthquake And Office Vibration**

Equipment facilities struck by earthquakes will be subject to motions, which depend mostly upon size, type, and strength characteristics of the structure, as well as the nature of the seismic ground motion. Because of the mass-stiffness characteristics of the supporting structure, the frequency of the most significant seismic inputs to equipment generally falls below 15 Hz. Where possible, equipment and frameworks should be designed to have natural frequencies above this value to avoid resonant amplifications. Exhibit J-1 shows the earthquake-zoning map. Zone 4 corresponds to the most active earthquake prone areas, Zone 3 is the next most active seismic area, and Zone 2 and 1 are the lowest-risk regions. Non-zoned regions are considered to present no substantial earthquake risk. In areas where earthquakes are a problem, the engineering supplier will verify that the equipment is engineered to meet the criteria presented here.

Central Office Equipment (COE) shall remain operational when subjected to earthquake environments even though some physical damage may occur. Consideration should be given to which earthquake zone the equipment will be installed in, the elevation in the structure on which installed, and method of attachment to the structure.

Equipment that may be installed in all zones shall meet the earthquake floor response spectra criteria. This may be accomplished by designing equipment to survive in the earthquake environment, or by employing add-on stiffeners, isolators, bracing, etc. to enable less capable designs to meet the criteria.

Equipment installed in light (seismic) zones 1 and 2 should be engineered to zone 2 criteria. Equipment installed in heavy (seismic) zones 3 and 4 should be engineered to zone 4 criteria. Central Office lineup equipment frames required to directly support overhead ironwork, cable rack, lighting, etc. shall meet heavy (seismic) zone 3 and 4 criteria.

A low-level vibration environment may be imposed on equipment installed in COs. This vibration may be caused by nearby rotating equipment, rail or truck traffic outside the building, or construction work in adjacent buildings. Surveys of COs have indicated that these floor vibrations are generally less than 0.1g peak in the frequency range 0.1 to 60 Hz. Components mounted within equipment frames may be subjected to higher levels due to amplifications in the frame support system. The amplified motions may be determined analytically or experimentally from tests of full-scale assemblies. In the absence of such data, components shall be designed to withstand vibration levels up to 1.0 g over the specified frequency range. Specific earthquake bracing requirements are shown in Module 1, Chapter 6, Unit E of this publication.

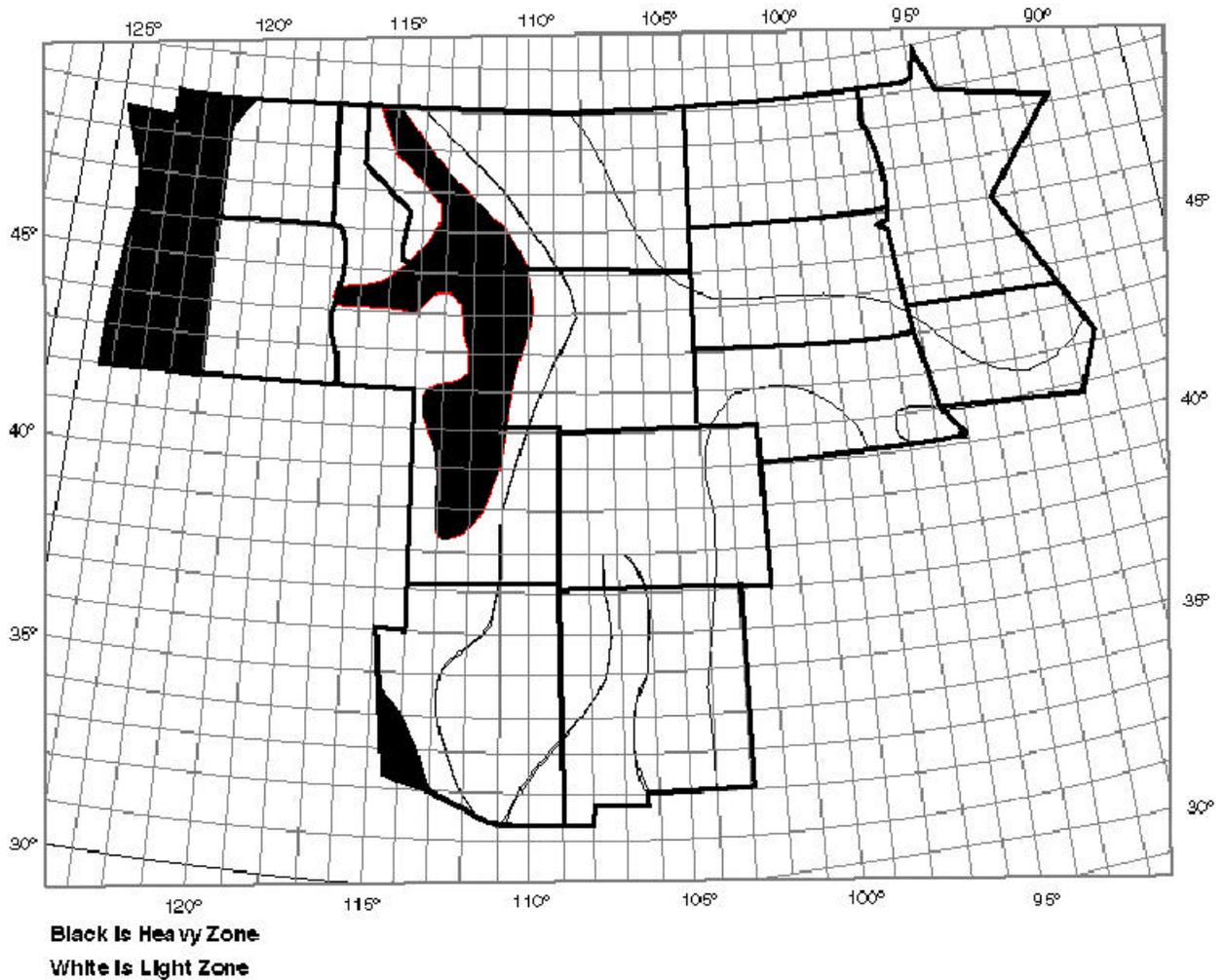


EXHIBIT J-1  
EARTHQUAKE ZONING MAP

## 11.6 Airborne Contaminants

QWEST Communications International Inc. has recognized the need for a cleaner and more protective equipment environment. All equipment must remain operational when exposed to any of the atmospheric environmental conditions found within the CO.

Some of the undesirable effects of airborne contaminants are known and the means to protect equipment from them must be provided. Failure to adequately provide suitable protection can result in substantially reducing the useful life of the equipment and increase the potential for unexpected service interruptions.

An example of a potential problem is the accumulation of airborne contaminants on circuit boards, which can result in the bridging of electronic circuits. The composition of the contamination is of particular importance if the particles of contamination are hygroscopic or conductive in nature. Contamination may be introduced by dust, textile fibers, human debris, soil, products of combustion, etc.

Equipment can be protected from airborne contaminants by providing adequate air pressure and filtration. Measurements of air quality are done periodically and should be done if air quality is in doubt and in conjunction with CO construction and modification.

Normal CO operating conditions will be maintained to a class 100,000 (i.e., not more than 100,000 particles of 0.5 microns in size or greater per cubic foot of air). All COE shall be designed to operate satisfactorily for its full service life. The manufacturer shall subject their equipment to qualification tests to verify satisfactory operation and service life according to the requirements of this guideline.

## 11.7 Acoustical Noise

Central Office (CO) telephone equipment shall not produce sound levels above the limits shown in Figure J-A.

The outdoor limits specified are applicable to that equipment which, when installed within a central office building, will emit substantial noise external to the building. An example is auxiliary power generating equipment which emits noise with the exhaust.

The maximum levels specified in Figure J-A are only slightly below levels normally set to ensure against hearing damage. Lower levels are desirable. For example, at 65 dBA, the maximum distance for a conversation in a normal voice is 35 feet. Although lower levels, based on annoyance, cannot be set in general, equipment noise emission should be kept to as low a level (below 60 dBA) as practical.

The sound levels specified in Figure J-A are those measured by a sound-level meter meeting American National Standards Institute (ANSI) Standard S1 4-1961, "General Purpose Sound-Level Meter," set to the A-weighting scale and the slow meter response setting. Measurement shall be made in accordance with ANSI-S1 18-1971, "Measurement of Sound-Pressure Levels."

Sound levels produced by equipment shall comply with the indoor limits specified in Figure J-A, at points 5 feet above the floor and 2 feet all around, and at all points corresponding to the head level of any operator position or position likely to be occupied by CO personnel. Sound measurement shall be made in a room or enclosure which duplicates as much as possible the acoustical properties of a CO and the actual service environment. Any appreciable noise that is released outdoors shall comply with the outdoor limits, specified in Figure J-A at all points 20 feet away from what will be external CO wall, and at points corresponding to the head level of any personnel. For such measurements, any baffles, screens, mufflers, silencers, etc., required in service may be used.

EQUIPMENT		SOUND LEVEL (dBa)
Indoor	Equipment to be located in power rooms or special sound tested areas.	83
	The maintenance control center of an equipment system where normal speech and telephone communications are required.	65
	An individual equipment frame that maybe located in a lineup with other equipment.	60
	All other equipment	75
Outdoor	All equipment	90

**Note:** The dB values are referenced to  $20 \mu\text{N/m}^2$  (threshold of hearing at 1000 Hz), and the "A" refers to the A-weighting scale of a standard sound-level meter. The maximum levels are applicable to all equipment.

FIGURE J-A  
 SOUND LEVEL LIMITS

The sound-level limits apply to the operating conditions, loaded or unloaded, partial or full power, etc. that produce the loudest noise. This includes all components and applicable accessories, as well as any acoustical shields or other apparatus, which will be part of the equipment.

## **11.8 Illumination**

Minimum levels of illumination (see Exhibit J-2) shall be maintained in COE areas. New lighting systems should provide initial illumination levels at least 25 percent higher (to account for losses due to lamp lumen depreciation and dirt accumulation in the luminaire), but no more than 50 percent higher than the levels listed in Exhibit 4-3.

Illumination measurements can be affected by light meter characteristics and accuracy, the way the meter is used, and by the arrangement of lighting equipment. Field measurements should be made with a light meter which gives the correct relative responses to light arriving from all directions within the hemisphere.

The control of glare is a responsibility of both the equipment designers and lighting designers.

Excessive luminance (photometric brightness) differences within the field of view cause discomfort, fatigue, and reduced efficiency. The luminance's of surfaces immediately adjacent to the visual task should be at least one-third that of the task, and they should not exceed the luminance of the task. For more remote surfaces, the luminance of any significant surface normally viewed directly should be between one-third and five times the luminance of the task.

In all new installations, fluorescent lamps should be used in equipment and operating areas because of their relatively high light output per watt. As a standard practice, it is recommended that cool white fluorescent lamps be used.

AREA	LEVEL (FOOT CANDLES)
EQUIPMENT FRAME AREA Maintenance Aisle Wiring Aisle (Use portable lighting units during maintenance)	15 (Note 1) No design level
DISTRIBUTING FRAME AREA Maintenance Aisle Wiring Aisle	20 (Note 1) 10 (Note 1)
POWER AND BATTERY AREAS Aisles and open spaces AC switchboards and DC Battery Distribution Boards (BDBs) (Measure at center of board)	30 (Note 2) 20
CABLE ENTRANCE AREA Aisles and open spaces (Use portable lighting units during maintenance)	5 (Note 2)
CONTROL, TEST, AND MAINTENANCE AREAS Control center or test frame (measure on shelf) Print display board (measure at center of board) Desk top (measure on writing surface) Light Emitting Diode (LED) display	50 50 50-70 Under study

- Note:** 1. Measure illumination on vertical equipment surface 30 inches above floor with meter aimed across aisle. Do not allow shadows to fall on light sensitive cell.
2. Measure illumination in aisle center, 5 feet above floor, with meter aimed upward.

EXHIBIT J-2  
 MINIMUM MAINTAINED ILLUMINATION LEVELS

### **11.9 ElectroMagnetic Compatibility**

The following stipulates the minimum electromagnetic compatibility objectives for all new equipment intended for operation in CO. These objectives are intended to ensure that:

- The equipment is compatible with respect to emission of, and susceptibility to, electromagnetic interference generated within the system.
- The equipment will remain operational in a conductive and radiated electromagnetic environment.
- The equipment does not interfere with licensed broadcast transmissions outside the office. The equipment does not exceed radiated and conducted emission limits as specified in Network Equipment - Building System (NEBS) -Level 3

The objectives cover complete systems, equipment frames, and individual units. Whichever of these is representative of the equipment to be installed will be referred to as the Equipment Under Test (EUT).

### **11.10 Electrostatic Discharge (ESD)**

This section states the Electrostatic Discharge Control (ESDC) concerns for all new equipment assemblies intended for use in COs. The ESDC extends to the handling, shipping and storage of the equipment. Discharge of electrostatic voltages on or near equipment assemblies can be a significant cause of failures or malfunctions. Equipment is susceptible to Electrostatic Discharge (ESD) effects at all stages of production, assembly, test, installation, use and maintenance. Failures or malfunctions occur when ESD effects extend to the device level and cause device damage. Protective circuitry, isolated ground paths and similar features designed into equipment help reduce ESD effects below the damage threshold at the device level and allows equipment to withstand a certain amount of ESD on external surfaces without a detrimental effect on function.

If a completed equipment assembly fails to meet static electricity resistance requirements, (as specified in Bellcore Technical Reference TR-NWT-000063, (see Reference Section) the equipment documentation shall indicate so (e.g., specification or Qwest Standard Configuration documents, etc.). Also a sticker shall be mounted on the front of the equipment assembly stating "This equipment does not meet static electricity resistance requirement. Be extremely careful not to discharge static electricity to this equipment" or similar wording.

Clearly specify any special environmental conditions such as humidity or choice of materials for furniture. Maintenance information supplied to field personnel should contain explicit warnings to prevent electrostatic damage during installation, adjustment, or field repair. Warnings to use only static dissipative packaging materials will appear as appropriate in the documentation.

All handling of ESD sensitive equipment anticipates that the technician or installer will wear a properly fitted and grounded ESDC wrist strap.

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## **12. General Interaction Requirements**

### **12.1 General Interaction Requirements**

This Part covers interconnection requirements for equipment to be engineered and installed in QWEST Communications International Inc. offices. Additionally, this part includes information concerning equipment removed for reuse, human interactions, interconnect records and QWEST points of contact.

### **12.2 Equipment Interconnect Requirements**

The equipment installed in Central Offices (COs) shall meet performance, quality, reliability and service life requirements while operating in the environments specified in Module 1 of this publication.

In general, relay racks and bay framework should conform to existing frame types, heights and widths, or to those specified by the QWEST equipment engineer.

Miscellaneous equipment mountings and shelves shall be engineered to support equipment in an adequate manner. Mountings must also allow suitable ventilation for normal operation of equipment. *Mountings and shelves which have been tested and meet appropriate QWEST approved measurement standards, which are provided as part of a standard equipment design arrangement by approved suppliers may be assumed to have met this requirement.*

The QWEST representative in charge of common systems shall ensure that the various types of equipment to be added have the proper hardware, software, and/or transmission interfaces, including cable rack, electrical, mounting, protocol, signaling and cable interfaces. The QWEST Representative in charge of equipment engineering shall be contacted if there are any interconnect conflicts.

### **12.3 Equipment Removed For Reuse**

The installation supplier will make a visual inspection of the equipment being removed for reuse, identifying and documenting physical defects and (or) missing parts, such as bent or broken terminals, warped shelves, missing hardware etc. The inspection shall be made prior to equipment being tagged or shipped to the reuse coordinator.

The installation supplier shall verbally notify the QWEST design engineer as soon as possible, and in writing within 72 hours of the verbal notification, if the equipment shows physical damage, defects, or any other condition which would impair its installation, maintenance or working capabilities when placed in service. Written documentation shall contain the installation suppliers company name, QWEST job number, the inspection date and a detailed description of the location and (or) condition of the equipment damage.

The installation supplier shall not ship equipment to the Reuse Equipment Disposition Group which appears to have physical damage or any condition which would obstruct its installation, maintenance or working capabilities when placed back in service, unless otherwise directed by the equipment engineer.

The equipment engineer will contact the Reuse Equipment Disposition Coordinator when notified that a piece of equipment identified for reuse is damaged or defective. The coordinator may request the equipment be scrapped, based on the information provided by the equipment engineer.

The installation supplier will use the proper tools, methods and procedures during all phases of removing the equipment identified for reuse, to ensure that equipment is not damaged during removal. If damage does occur in the removal process, the installation supplier shall notify the equipment engineer as noted in Chapter 11, 11.3.

The Reuse Equipment Disposition Coordinator will supply, one time only, equipment identification tags for equipment identified for reuse. Tags will be placed on frame or bay uprights and on the outside of shipping cartons.

If equipment identification tags are lost, the equipment supplier will make arrangements for their replacement. Tags shall have an adhesive backing, be 1-3/4 inches x 7 inches in size and contain the information specified in the material transfer report. Replacement tags shall not be hand written.

The installation supplier shall sign, date and return photocopies of all material transfer reports to the Reuse Equipment Disposition Coordinator prior to shipment of equipment.

The equipment engineer shall make arrangements for the installation supplier to receive the shipping and packing materials necessary for shipment of unmounted units to the Reuse Equipment Disposition Group.

The installation supplier will utilize the packaging manufacturers carton assembly instructions when preparing to ship equipment removed for reuse. All equipment must be packed and secured as specified in the packaging manufacturers instructions to safeguard against possible equipment damage during shipment.

Unmounted units shall be palletized using QWEST standard pallets. Cartons shall be stacked on pallets so that all tags are visible.

All frames being shipped for reuse shall be transported uncrated in an electronic air ride van with an internal hoist, unless otherwise specified in job documentation. The equipment engineer will make the necessary transportation arrangements.

During shipment, equipment frames shall be adequately spaced, positioned and securely fastened, to eliminate the possibility of damage to exposed wiring, apparatus, terminals, equipment shelves, etc. Under no circumstances shall equipment frames be stacked one on top of another during shipment.

## 12.4 Human Interaction Requirements

Human interaction requirements must be considered in the detail engineering of a QWEST project. The equipment installation design, for example, should ensure that Central Office Technicians have an optimum interaction with installed equipment.

Interconnect added equipment with the Maintenance Control Center (MCC) or Switching Control Center (SCC) via data links, when possible. Information on these interaction systems is shown on CO records.

Engineer equipment being added to a CO to provide equipment maintenance performable by one person, either at the fault location, or at the MCC. The equipment added to a CO should be engineered to provide assurance, at either location, that it has received and understood maintenance commands, and is responding appropriately.

Engineer equipment in a manner that allows maintenance routines or repairs to be performed without interrupting calls in progress. One exception is permanent switched connections, which do not have spare equipment or maintenance channels.

When required for work operations, all working equipment must be taken out of service by QWEST. Instructions to installers should include directions to contact QWEST personnel for assistance.

Mount common indicator lamps, manually operated switches so they are visible from all angles at the front of the frame. They should not be obscured by cable, equipment, framework or wire.

Mount fuses and power converters in the same relay rack or shelf as the equipment that uses them. If connectors and fuses must be placed elsewhere, mark and arrange them to permit quick, accurate locating of the proper fuse and converter. Add notes to the detail specification informing the installer of the required marking.

Provide a uniform system of easily read frame identification markings and horizontal and vertical circuit pack location markings for all circuit pack positions on the equipment shelves and frames. Functional designations, abbreviations and markings should be consistent and lettering should be readable with the illumination levels specified in the following table.

AREA	LEVEL (FOOT CANDLES)
EQUIPMENT FRAME AREA Maintenance Aisle Wiring Aisle (Use portable lighting units during maintenance)	15 (Note 1) No design level
DISTRIBUTING FRAME AREA Maintenance Aisle Wiring Aisle	20 (Note 1) 10 (Note 1)
POWER AND BATTERY AREAS Aisles and open spaces AC switchboards and DC Battery Distribution Boards (BDBs) (Measure at center of board)	30 (Note 2) 20
CABLE ENTRANCE AREA Aisles and open spaces (Use portable lighting units during maintenance)	5 (Note 2)
CONTROL, TEST, AND MAINTENANCE AREAS Control center or test frame (measure on shelf) Print display board (measure at center of board) Desk top (measure on writing surface) Light Emitting Diode (LED) display	50 50 50-70 Under study

- Note:**
1. Measure illumination on vertical equipment surface 30 inches above floor with meter aimed across aisle. Do not allow shadows to fall on light sensitive cell.
  2. Measure illumination in aisle center, 5 feet above floor, with meter aimed upward.

**Table A Minimum Maintained Illumination Levels**

Install equipment so that the machine readable bar code label on front of the circuit pack may be read by an optical scanning device while the circuit pack is located in an equipment frame.

### **12.5 Interconnect Documents**

During the preparation of a design work package, interconnect documents may be required for major equipment additions. Interconnect documents show the cabling, connections and mounting arrangements required for the equipment being added. They provide a permanent record of the equipment interconnections and allow the equipment to be easily installed.

Interconnect documents including but not limited to text, drawings or charts, will be engineered and provided by QWEST Communications International Inc.

Interconnect documents will show interconnections such as wire size and type, power leads, alarm connections, signal leads, fiber optic connections and maintenance/switching control leads for the equipment.

For additional information on interconnect documents, refer to Chapter 6 of this module.

### **12.6 Supplier Point Of Contact - Engineering**

In general, the single point of contact for engineering and jobs in progress is the QWEST equipment engineer whose name and telephone number are listed on the Requisition for CO Materiel/Services. Contact specifics are noted below:

Project control is retained by the design engineer, who provides the point of contact for equipment additions and issue escalation.

The design engineer is the first point of contact for questions regarding the detail specification, including fusing, placement, power and other detail specification issues (For example, an installer who has questions about work items noted in the detail specification).

The design engineer is the initial contact on all questions or problems that have a time charging or monetary impact.

The procuring entity shall be the first point of contact for material shortages on a job specification. The QWEST design engineer is a secondary point of contact.

Only the QWEST design engineer can authorize additional work that will result in additional charges.

The installation supplier should contact the supplier of the equipment first about material shortages.

### **12.7 Supplier Point Of Contact - Assignment/Reservations**

Assignment/reservations are required whenever CO floor space, Distributing Frame (DF) space, manual Digital Cross-connect (DSX) panels/jacks, fuse boards and Battery Distribution Fuse Boards (BDFBs) are affected by an engineering order. The purpose of a formalized assignment/reservations procedure is to comply with the law as specified in the Modified Final Judgment (MFJ), requiring the Regional Bell Operating Companies to treat all suppliers/vendors in an even and equitable manner. In addition, collocation assignments must be tracked under strict legal constraints and time frames.

The Central Office Equipment - Facility Management (COE-FM) system tracks assignments/reservations for equipment floor space, DFs (conventional, fiber and modular), manual DSXs fuses and BDFBs. This applies to QWEST owned space within QWEST buildings, as well as collocation assignment requirements. The design engineer is responsible for contacting the QWEST representative responsible for common systems if changes are to be made within QWEST telecommunications equipment structures.

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### 13.1 Acronyms

ABC	Area Bus Centers
AC	Alternating Current
ACEG	Alternating Current Equipment Ground
ACO	Alarm Cut - Off
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWG	American Wire Gauge
BDB	Battery Distribution Boards
BDFB	Battery Distribution Fuse Board
CC	Command Control
CCR	Command Control Return
CEF	Cable Entrance Facility
CEV	Controlled Environment Vaults
CO	Central Office
COE	Central Office Equipment
CO GRD	Central Office Ground
CPE	Customer Premise Equipment
CSPEC	Common Systems Planning and Engineering Center
D4	D4 Channel Bank
DACS	Digital Access Cross Connect System
DC	Direct Current
DF	Distribution Frame
DLC	Digital Loop Carrier
DSX	Digital Cross Connect
EMI	ElectroMagnetic Interference
EMT	Electrical Metallic Tubing
EPA	Environmental Protection Agency
EPO	Emergency Power Off

ESD	Electro Static Discharge
ESDC	Electro Static Discharge Control
FB	Fuse Bay
FDF	Fiber Distributing Frame
FDP	Fiber Distributing Panel
FLM	Fiber Optic Multiplexer
FDP	Floor Plan Data
FPS	Fiber Protection Systems
FSF	Fiber Splice Facility
HVAC	Heating, Ventilating and Air Conditioning
IEC	International Electrotechnology Commission
IPVC	Irradiated Polyvinyl Chloride
LVR	Line Voltage Regulator
MBPS	Megabits per second
MC	Maintenance Control
MCC	Maintenance Control Center
MGD	Main Ground Bus
NE	Network Elements
NEBS	Network Equipment Building System
NEC	National Electrical Code
NEPA	National Fire Protection Agency
NMA	Network Monitoring and Analysis
OFCP	Optical Fiber Conductive Plenum
OFNP	Optical Fiber Non-Conductive Plenum
OFCR	Optical Fiber Conductive Riser
OFNR	Optical Fiber Non-Conductive Riser
OPGP	Office Principle Ground Point
OPGPB	Office Principle Ground Point Bus
OS	Operating System
OSHA	Occupational Safety and Health Standards

OSP	Outside Plant
OSS	Operational Support Systems
ORB	Office Repeater Bay
PE	Polyethylene
PDFB	Power Distribution Fuse Boards
PM	Performance Monitoring
PSMC	Power Systems Monitor Controller
PVC	Polyvinyl Chloride
PVC CL	Polyvinyl Chloride, Cotton and Lacquered
PVC CBL	Polyvinyl Chloride, Cotton, Braid, Lacquered
SCC	Switching Control Center
SI	Status Indicator
SIR	Status Indicator Return
SLC	Subscriber Loop Carrier
SPCS	Stored Program Control System
SXS	Step-By-Step
UL	Underwriter's Laboratories
UPS	Uninterruptable Power Supply

## 13.2 Glossary

### **Cross- Connection**

A system of connecting equipment to cable by use of a jumper, or short transmission path between two stationary locations on the distributing frame.

### **Grounding**

An engineered low impedance path from equipment chassis or framework to the structure driven ground.

### **Frame Mask**

A block diagram of present and future placement of fiber cables and equipment on the fiber frame panels

### **Integrated Ground**

An engineered path to ground that may have several branches. Usually found in toll areas of the telecommunications structure.

### **Interconnection**

A system of connecting equipment to cable by connecting the equipment cable directly to the fiber. The cable has a stationary

### **Isolated Ground**

An engineered single path to ground from an equipment system or switch. Does not refer to the splitting of ground and neutral leads in commercial AC circuits.

### **Spreading**

Ensuring the placement of equipment in several locations (in the DSX ) line up

### **Vault**

A special environment within a central office used to organize outside plant copper and fiber cables before they enter the central office environment. Outside plant sheathed cables may penetrate this space without regard to length.

### **Zoning**

Reserving a certain area for specific equipment

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## 14. References

### 14.1 National Electrical Code.

NEC                      *National Electrical Code*, July 1992

### 14.2 Telcordia Documents

GR-63-CORE            *Network Equipment - Building System (NEBS) Requirements: Physical Protection*, Issue 1, October 1995

GR-347-CORE           *General Requirements for Central Office Power Wire*, Issue 1, November 1996

GR-1089-CORE         *Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment*, Issue 2, December 1997

TR-NWT-000295       *Isolated Ground Planes: Definition and Application to Telephone Central Offices*, Issue 2, July 1992.

### 14.3 QWEST Technical Publications

PUB 77350              *Telecommunications Equipment Engineering, Installation and Removal Guidelines*. Issue K, June 2001.

PUB 77355              *Grounding - Central Office and Remote Equipment Environment*. Issue C, July 1999.

PUB 77385              *Power Equipment and Engineering Standards*, Issue F, January 2001.

#### 14.4 Ordering Information

All documents are subject to change and their citation in this document reflects the most current information available at the time of printing. Readers are advised to check status and availability of all documents.

Those who are not QWEST employees may order;

American National Standards Institute (ANSI) documents from:

American National Standards Institute  
Attn: Customer Service  
11 West 42nd Street  
New York, NY 10036  
Phone: (212) 642-4900  
Fax: (212) 302-1286

ANSI has a catalog available which describes their publications.

Telcordia documents from:

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International Telecommunications Union documents may be ordered from:

International Telecommunications Union  
General Secretariat  
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Geneva 20, SWITZERLAND

QWEST Technical Publications from:

<http://www.uswest.com/techpub>

Federal Communications Commission (FCC) documents may be obtained from:

Superintendent of Documents  
Government Printing Office  
Washington, D. C. 20402  
Phone: 202 783-3238

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