CenturyLink™
Technical Publication

CenturyLink Engineering Standards

General Equipment Requirements

Module 1

77351
Issue H
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NOTICE

COMMENTS on PUB 77351 Module 1

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CenturyLink™
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Littleton, CO 80120
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Was the information accurate and up-to-date? YES ______ NO ______

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Contents

1 Introduction

1.1 General

These standards have been prepared to provide Telecommunications Equipment Engineering Services Suppliers and CenturyLink 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 CenturyLink, and to make certain equipment is installed safely and efficiently.

1.2 Reason for Reissue

Added clarifying information to several engineering chapters. This information is intended to make the intent of the chapters clearer. Some exhibits have been completely redrawn. Whenever this publication is reissued, the reasons for reissuing will be provided in this paragraph. Added Chapter 13 for Raised Floor Environments.

1.3 Background

These engineering and documentation requirements are the standard for CenturyLink Engineering Services Suppliers, to which engineering and performance will be compared for job acceptance purposes. CenturyLink 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, transport, data, 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 CenturyLink Standard Planning and Engineering Guidelines, policies or Configuration Documents.

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 CenturyLink. 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 CenturyLink.

1.5 Online Access

CenturyLink technical publications are available externally by typing in "Tech Pub" in the web browser and selecting the CenturyLink Technical Publication site or at the following website:

http://www.centurylink.com/techpub

1.6 Priority of Standards

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

1.7 Scope of Document

To establish general engineering standards for Network Facility Equipment installation for use by engineering suppliers and CenturyLink 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 CenturyLink Central Office (CO) Environments. The CO environments include, but are not limited to central office buildings, fiber huts, regen sites, Controlled Environment Vaults (CEV's), Right of Ways (ROW), and radio sites.

To provide guidance to engineering services suppliers and CenturyLink personnel on the required methodology and symbology to be used in constructing or correcting records, to insure standardization of Network Facility records within CenturyLink.

To ensure engineering compatibility with CenturyLink Technical Publication 77350 "Central Office Telecommunications Equipment Installation and Removal Guidelines", compliance with this document by engineering personnel performing work for CenturyLink 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 CenturyLink.

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 CenturyLink Design 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 Network Facility. Some situations where a Letter of Deviation will not be accepted or considered valid will be documented in a CenturyLink 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 CenturyLink Planning and Engineering Guidelines, Common Systems Planner, or CenturyLink Engineer responsible for the structure prior to issue. Only the CenturyLink engineer responsible for the long-term management of the network facility 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 CenturyLink Technical Publications and Standard Configuration documents.
- Ensuring engineering accomplished for CenturyLink 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 Network Facility 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 CenturyLink 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	Network Facility Grounding	Grounding Issues in a Network Facility
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	Fiber Protection System (FPS)
7A	Frame and Aisle Lighting	Fluorescent Type Lighting
7B	Frame and Aisle Lighting	Appliance Outlets and Miscellaneous Conduit
7C	Frame and Aisle Lighting	Emergency and Task 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	Network Facility Equipment	Building Environment Requirements
12	General Interaction Requirements	Communication Channels within Engineering
13	Raised Floor Environments	Raised Floor Engineering Requirements

14	Acronyms/Glossary	Acronyms/Glossary
15	References	References

1.11 Terminology

Shall or Must - 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 Network Facility 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:

Planning and Engineering Guidelines
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 Equipment Layout

Chapter 1 of Module 1 covers the general requirements for telecommunications equipment Common Systems engineering for a Network Facility environment. This information includes CenturyLink 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 CenturyLink Technical documents and Standard Configurations for additional information. Standard Configurations may include essential information, specific arrangements, approved products, or directions for applying engineering requirements.

NOTE: The requirements outlined in this chapter are intended to be implemented on a going forward basis from the publish date of this document. The existing office conditions or existing equipment arrangements may remain unless otherwise specifically identified.

2.2 Equipment Layout Requirement

Standard space criterion applies to telecommunications equipment located within CenturyLink Network Facilities and buildings. This includes equipment frames, distribution or interconnecting frames, and DC power plant equipment.

All existing areas and lineups (7′, 8′, 9′, 10′ and 11′-6″) within a network facility environment may continue engineering and installation of equipment until the logical conclusion of that environment area and lineup where current standard/minimum aisle spacing can be maintained (see Table 2.1).

The engineering and installation of equipment above the 7′ level shall be prohibited in those legacy local network facilities in which it has been previously established as a company standard. Existing legacy environments (8′, 9′, 10′ and 11′-6″) may continue to engineer and install equipment above the 7′ environment level with engineering considerations made for the following:

- Equipment shall not be installed in bay extenders.

- Overall total weight of the equipment and cabling must be evaluated and determined it will not exceed manufacturer's documented maximum allowable weight based on dynamic loading.
- Overall total heat dissipation of the equipment must be evaluated and determined that adequate cooling can be provided to support proper equipment operation and to prevent equipment failure.
- Overall total depth of the equipment must be evaluated and determined that adequate floor spacing is available to maintain front and rear aisle spacing of the equipment and does not violate the minimum aisle spacing requirements outlined in section 2.2.1 of this document. Aisle spacing measurements are made from any guard rail extenders required to support the equipment installed and equipment does not extend beyond the footprint of the framework including any guard rail extenders.

All new areas and lineups (minimum of 2) within a Network Facility environment shall be engineered and installed with the standard 7′ floor supported arrangement as defined in the CenturyLink 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. A base guardrail (front and/or rear) is required on ALL equipment frames.
- 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 is 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 should be used in CenturyLink Network Facility frame line-ups whenever possible.
- A maximum difference of 4 inches in total depth (1 inch front maximum, 3 inch rear maximum) is allowable for framework or cabinets within a single Network

Facility lineup. The depth difference is based on the smallest framework to the largest framework within the same lineup.

- Guard rail adapters are required for front and rear to transition between the depth of one framework to an adjacent framework with a different depth.

2.2.1 Aisle Spacing

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

The following requirements shall be considered when planning and engineering for equipment aisle spacing for installation of equipment framework/cabinets in an existing lineup, new equipment lineups, or environments in a CenturyLink Network Facility.

- **Heat Dissipation and Cooling:** The ability to provide adequate cooling for not only the equipment being installed, but sufficient cooling capacity for the entire lineup and adjacent aisle lineup. Additional consideration must be made for the ability to exhaust the heated air out of the lineups to prevent re-circulating the heated air back into the equipment, thus reducing equipment life.
- **Floor Loading:** The anticipated combined weight of the equipment framework/cabinets, shelves, cabling, etc. shall be considered when planning/engineering the aisle spacing requirement. Floor loading is calculated based on the footprint of the equipment bay plus ½ the front aisle spacing and ½ the rear aisle spacing to determine the floor loading (lb/sqft) capacity. Equipment framework/cabinets placed at the end of the lineup will also include ½ the side aisle width when opposite other equipment, or the full side aisle width when opposite a wall, in the total footprint of the equipment. Heavier equipment may require increased front and/or rear aisle spacing to maintain the building floor loading design (verify floor loading capacity with your local corporate real estate project manager). Equipment installed where no other equipment will be placed in the front or rear aisle can utilize the full front or rear aisle distance in determining the floor loading calculation.
- **Egress:** A requirement to maintain proper egress aisle spacing throughout the building for the ability to exit the office safely. In some instances, the aisle spacing between two lineups may be considered as the Main Egress.
- **Equipment Access:** The ability to maneuver equipment through the building, in particular through equipment aisles for installation and/or removal of the equipment to/from its final equipment location.

- **Cable Capacity:** High cable density equipment in equipment lineups may result in exhausting cable rack capacity thus blocking cable access to the remainder of the lineups. Planning and engineering should consider an increased aisle spacing to compensate for a larger cable rack, providing adequate cable capacity for the equipment lineups.

TABLE 2.1: EQUIPMENT AISLE SPACING

Equipment Type	Engineering Standard Front (Maintenance)	Engineering Minimum Front (Maintenance)	Engineering Standard Rear (Wiring) Aisle	Engineering Minimum Rear (Wiring) Aisle
Low Heat Density Equipment Framework or Cabinet (up to1200 Watts totall per frame/cabinet)	3'	2'-6"	3'	2-6'
High Heat Density Equipment Framework or Cabinet(over 1200 Watts total per frame/cabinet)	Custom Engineering	4'	Custom Engineering	3'
FDF	4'	3'	3'	3'
Switch	3'	2'-6"	2'-6"	2'-6"
Flooded Battery Stand (2 Tier /2 Sided)	3'-6"	3'	3'-6"	3'
Flooded Battery Stand (Single Sided)	3'	3'	6" from the wall (one long side only)	6" from the wall (one long side only)

VRLA Battery Stand	3'	2'6"	2'6"	6"
AC Equipment and Panels (less than 480V)	3'6	3'0"	3'6	6"
AC Equipment and Panels (480V and greater, or 240V Delta))	4'0"	3'6"	4'	6"
Cosmic Frame	4'	4'	4'	4'
CDF, MDF or Mini Cosmic Frame	4'	4' 3' (3'-6" if required as egress)	4'	3' (3'-6" if required as egress)
DSX	4'	3'	4'	3'
Main Aisle, Egress	4'	3'-6"	4'	3'-6"

NOTE: Aisle spacing will be clear and unobstructed from any protrusions into the aisle (including columns, AC panels, cable holes, PICS storage cabinets, desks, etc).

<u>Low Heat Density Equipment Framework or Cabinet (up to 1200 watts total)</u> is defined as traditional telecommunications equipment with a total heat release of less than 1200 Watts per bay or cabinet.

<u>High Heat Density Equipment Framework or Cabinet (over 1200 watts total)</u> is defined as technologically advanced and concentrated telecommunications equipment with a total heat release greater than 1200 Watts. Rectifier shelves/bays may fall into this category.

<u>Battery Stands measurements are taken from either the outside foot of the battery stand or the outside edge of the individual battery stand containment.</u>

<u>Raised Floor Environment shall adhere to the equipment aisle spacing as outlined in Table 2.1. Increased aisle spacing may be required due to tile access. Additional requirements shall be discussed in Chapter 13.</u>

Main Aisle in a Network Facility 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 regardless of the number of bays within the lineup. 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. A 4 foot egress aisle shall be established when floor space permits, and in no case shall be less than 3 feet.

2.2.1.2 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 or walls are determined by finding the dimension from the farthest most point on the column face or wall to the outer most edge of the frame guard rail or guardrail extension directly opposite the column. Lineups will be planned so aisle spacing will be unobstructed from any protrusions into the aisles (including columns, AC panels, cable holes, PICS storage cabinets, desks, etc).
- 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.

2.2.1.3 Main Aisles

- Each grouping of 50-foot lineups will be separated by a 4-foot main aisle.
- A main aisle/egress is required at the 20ft end of any dead-end lineup.
- Main aisles will run perpendicular to a Network Facility 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.

2.2.1.4 Additional Power Aisle Spacing Requirements:

- VRLA Battery stands and power equipment frames shall have a minimum rear aisle spacing of 6 inches to the wall or any other obstruction when possible. Certain locations including CEV's, customer premises, or other non-CO type environments may be exempt from this requirement. Additional aisle spacing may be required and will be specified in the standard configuration guide. Side access to VRLA battery stands or power equipment frames may be required based on individual equipment and will be specified in the standard configuration guide.
- A minimum dimension of 3 feet is required on all sides of flooded battery stands. The only exception allowed for 2 tier, 2 sided~~,~~ flooded 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. Refer to Figure 2.1.
- For a single sided, two-tier battery stand, a minimum 3-foot clearance is required on all sides except the back (long side). A minimum of 6 inches is required from the back of the single sided, two-tier battery stand to the wall. Refer to Figure 2.1.
- The minimum measured clearance applies to all obstructions including columns.

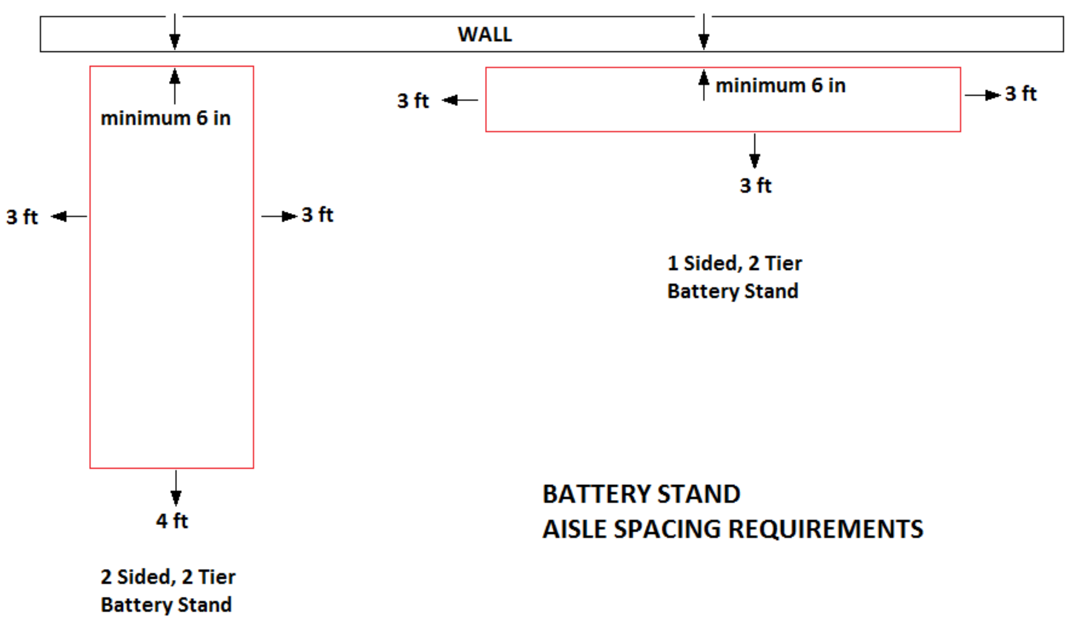


FIGURE 2.1: BATTERY STAND AISLE SPACING

- AC panels including rectifiers with an input voltage of less than 480V shall have a minimum front aisle clearance of 3′. Rear aisle clearance may vary based on equipment type and accessibility requirements of the equipment.
- AC panels including rectifiers with an input voltage of 480V and greater (or 240V delta) shall have a minimum front aisle clearance of 3′6″. Rear aisle clearance may vary based on equipment type and accessibility requirements of the equipment.

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 a minimum 3 foot egress, 2-4″ front aisle, or 2 foot rear aisle equipment spacing to add new equipment in a CenturyLink Facility are strictly prohibited, shall not be approved 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.

TABLE 2.2: WALLS AND COLUMNS

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 the3 foot egress, 2′-4″ front aisle, or 2 foot rear aisle equipment spacing for new equipment added to a CenturyLink Facility will not be accepted and are not considered valid.

2.2.3 Heat Dissipation

Frame Heat Dissipation describes the heat dissipated from the equipment in 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 fully utilized or carded heat release per frame that will be emitted in an operating office as documented in the equipment configuration guide. The fully utilized or carded heat release is calculated by adding the List 1 normal (typical) operating heat dissipation of each shelf as documented by the equipment manufacturer.

2.2.3.1 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 total heat dissipation higher than 1200 Watts per bay or cabinet will require wider aisles and possible office HVAC upgrades to allow sufficient airflow or cooling to ensure equipment operability and reliability.
- 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.

- Standard equipment air flow shall be front air intake and rear air exhaust regardless of anticipated heat dissipation values. Equipment requiring a side to side air flow may result in increased aisle spacing and a custom real estate engineering solution to provide adequate cooling.
- The CenturyLink 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 network facility impacts.

2.2.4 Lineup Length

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

- Equipment frame line-ups shall not exceed a total of 50 feet in length. An average side clearance or space of 1/8 of an inch will normally be provided in equipment lineups, between adjacent frames. This dimension as well as any spacers, endguards, or vertical cable management panels must be considered when planning the number of frames to configure a 50 foot lineup.
- Lineups greater than 20ft in length 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 network facility 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 including associated spacers and end guards in these lineups shall be a minimum of 6 inches to the wall.

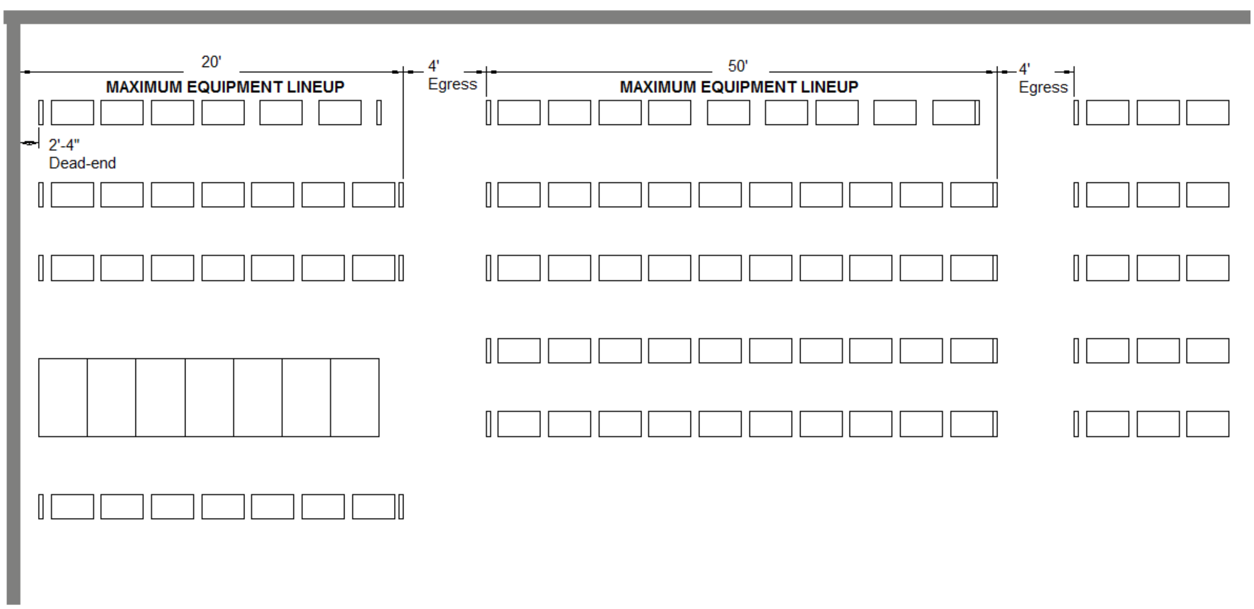


FIGURE 1.2: EQUIPMENT LINEUP LENGTHS

2.2.5 Floor Loading

Floor load (lb/ft^2) is determined by totaling the weight of all equipment over/under a particular floor area and dividing by that area. The area includes aisles and open areas associated with the frames.

Increased weight may be attributed to ceiling supported cable rack and structure which may be present on the ceiling beneath the equipment floor being evaluated. This additional weight shall also be included in determining the total floor load weight.

2.2.5.1 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^2) 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^2).
- The floor loading for standard floor plan arrangements is averaged across the associated floor area and excludes the cable distribution system.

2.2.5.2 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^2).
- Any such building bay area will meet the floor loading limit requirements of 115 pounds per square foot (115 lb./ft^2), regardless of the location relative to the columns.

2.2.5.3 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^2) floor load allocation for all equipment (including cable and lights) will be observed.
- The CenturyLink 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 4 inches in depth (maximum 1 inch front, maximum 3 inches rear) is allowable for frames or cabinets within a system lineup while maintaining adequate front and rear aisle spacing requirements outlined in Table 2.1.
- 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 CenturyLink 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 was in conformance with standard Floor Plan Data (FPD) requirements. Floor Plan Data (FPD) documents were established and published by Bellcore (now Ericsson (Telcordia)).

CenturyLink 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 CenturyLink facilities must be in conformance with standard Network Equipment - Building System (NEBS) requirements identified by CenturyLink. Network Equipment - Telcordia (formerly Bellcore) publishes Network Equipment 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 network facilities 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 suggested equipment layouts and cabling systems to be compatible with network facility 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. CenturyLink requires vendors to test equipment to the Extreme Environment Level 3. The requirements should apply to all new network facility equipment systems. There are three levels of NEBS testing plus the General Criteria:

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

All CenturyLink network facility drawings shall be marked to reflect the equipment placed on the drawing. 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 network 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 CenturyLink 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.
- Bolted frameworks or cabinets are prohibited.
- 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 CenturyLink 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 a minimum of 3 feet wide and 7 feet high. Increased access may be required for equipment larger than the standard doorway dimensions, including fully loaded cabinets which may require 4 feet wide and 8 feet high access.

2.5.2 Ratings

Framework assemblies are rated for use within CenturyLink network facilities and other telephone buildings. These two ratings describe the applications and restrictions.

Prior to the installation of a frame, CenturyLink Strategy and Development Representative 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.

CenturyLink 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 using approved products only. .

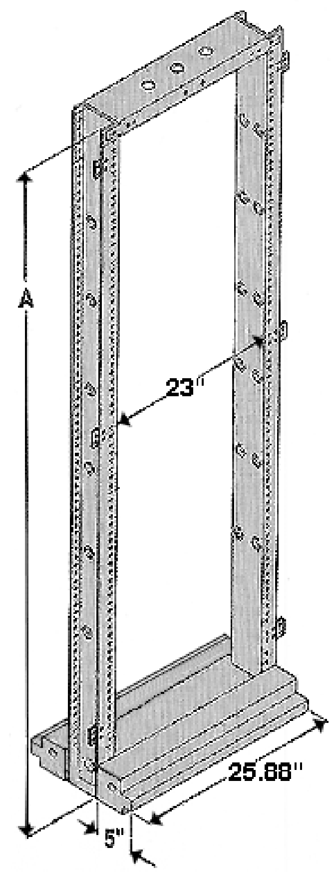
2.5.3 Approved Network Assemblies

The overall dimensions of equipment frames approved for use within CenturyLink network facility environments are detailed in the exhibit below.

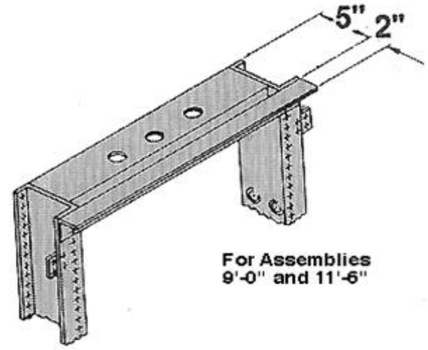
The Standard Framework as shown on the following page should be used for all new installations unless the CenturyLink Standard Configuration documents specify otherwise.

CenturyLink Strategy and Development Representative must approve all other framework assemblies prior to placement within the equipment areas of any CenturyLink Telecommunications Facilities.

2.5.3.1 Standard Framework Attributes:



- Type: Network
- Height: 7 foot; (8 foot; 9 foot; 10 foot; 11 foot 6 inches where the existing environment dictates)
- Width: 25.88 inches overall;
  - 23 inch nominal inside mounting. Actual inside dimensions may vary between manufacturers.
  - 19 inch inside mounting (when site requires). Actual inside dimensions may vary between manufacturers.
- Mounting Plate Spacing:
  - 1-3/4 inch (standard)
  - 2 inch (customer/equipment required)
- Depth: 15 inches (5-5-5)
- Base Footprint: 5 inches (front guard rail)- 5 inches (upright)- 5 inches (rear guard rail)
- Framework Top Support Angle:



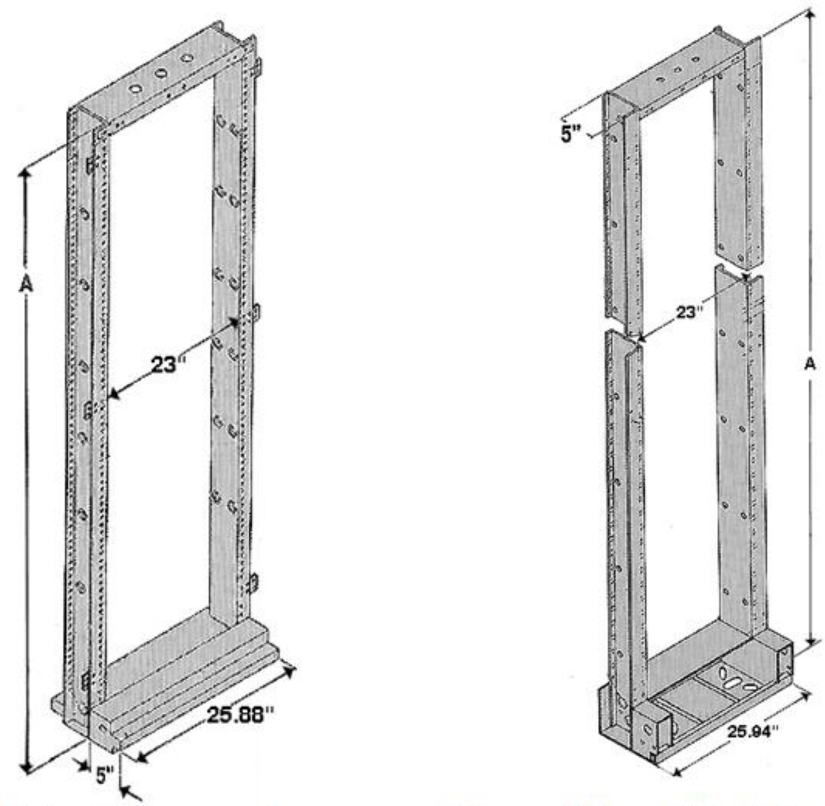
Framework Top Support Angle

(Height to match the existing environment)

FIGURE 2.3: STANDARD FRAMEWORK ATTRIBUTES

2.5.3.2 Conditional Framework Attributes

- Type: Network; Unequal Flange (Duct)
- Height: 7foot; 8 foot; 9 feet, 10 foot; 11 foot 6 inches
- Width: 25.88 (NTWK), 25.84 (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)
- Examples of Base Footprints (not all inclusive):
    - 5 inches – 5 inches – 2 inches
    - 2 inches – 5 inches – 5 inches
    - 6 inches – 5 inches – 1 inch
    - 1 inch – 5 inches – 6 inches
    - Additional framework footprints may be available based on individual equipment requirements and outlined in the equipment standard configuration.



Network Framework
12″ base footprint

Unequal Flange (Duct) Framework

FIGURE 2.4: CONDITIONAL FRAMEWORK ATTRIBUTES

2.5.4 Standard Cabinet Assembly

The standard network facility cabinet will be used for:

- Equipment configurations with -heat dissipation greater than 1700 Watts when equipped with an approved optional top fan assembly and applicable aisle spacing.
- Network Facility equipment with an overall shelf depth (including connectors) larger than 26 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 provided adequate cooling and aisle spacing is available.

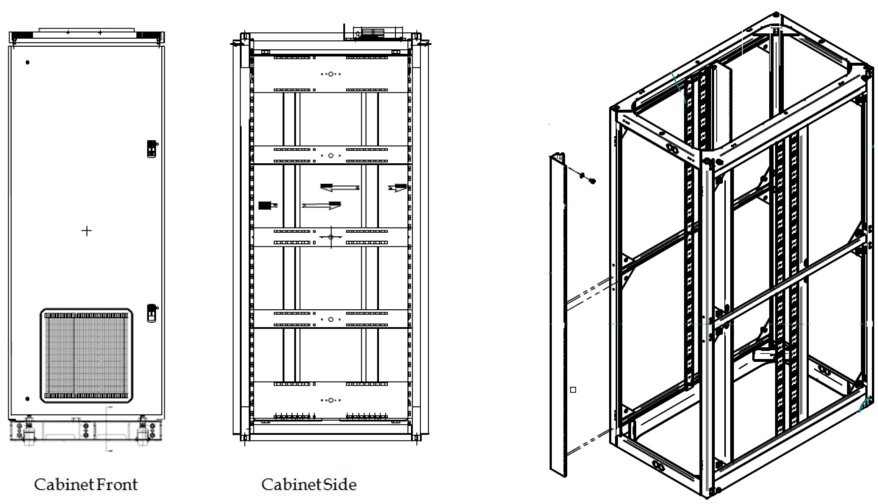
<u>Engineering Considerations</u>

- 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 4 inch difference (maximum 3” in front, 1” in rear) is allowed between the outside depth for cabinets in a network facility lineup.

2.5.4.1 Standard Cabinet Attributes

- Height: 7 foot ONLY
- Width: 29.5 inches (outside); 23 inch inside equipment mounting
- Mounting Plate Spacing: 1-3/4 inch and 2 inch
- Depth: 24 inches, 35.5 inches or 47.5 inches (outside) Construction: Welded Steel
- Optional Components: Top Mounted 6 Fan Unit, Front & Rear AC outlet, Side Panels, Doors



Closed Cabinet with fan assemblies, side panels and doors (rack and stack build)

Open Cabinet with optional fan assemblies, side panels and doors (custom build)

FIGURE 2.5: STANDARD CABINET ATTRIBUTES

2.5.5 Bay Extenders

Several heights of equipment frames are commonly installed in CenturyLink network facility environments; 7 foot, 8 foot, 9 foot, 10 foot, and 11foot 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 CenturyLink. The CenturyLink Technology Selection Representative must evaluate and verify NEBS compliance prior to any installation. Unapproved frame extenders are prohibited in all CenturyLink network 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 be equipped with a 2 inch top support angle.
- 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 CenturyLink 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 all seismic zone areas of CenturyLink. The "A" dimension indicates either 12 inches (7-'0" extended to 8'-0"), 24 inches (7'-0" extended to 9'-0"), 36 inches (7'-0" extended to 10'-0") or 54 inches (7'-0" extended to 11'-6") height.

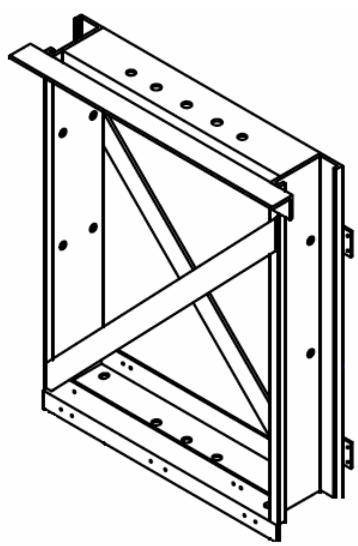


FIGURE 2.6: FRAMEWORK EXTENDER

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.

2.5.6.1 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 CenturyLink standard torque indicating anchor bolts to secure CenturyLink 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 CenturyLink 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.

2.5.6.2 Anchoring Telecommunications Equipment:

- There is one toll anchor bolt assembly approved for all telecommunications equipment placed within CenturyLink Central Offices and network 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 CenturyLink Representative responsible for Common Systems standards.
- All battery stands and other equipment placed in CenturyLink 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.

  NOTE: When shims are required for use with battery stands, the standard toll equipment anchor may be used in place of the battery anchor.

- 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 CenturyLink 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.

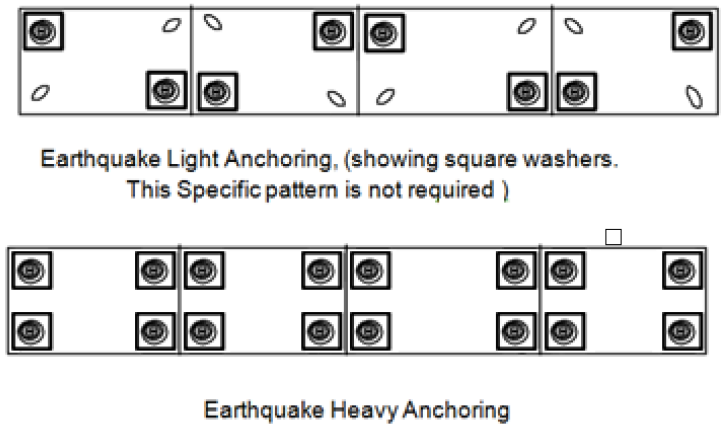


FIGURE 2.7: FRAMEWORK ANCHORING

2.5.7 Top Support

All equipment frames, relay racks, bays and cabinets placed within space designated for general purpose telecommunications equipment 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 CenturyLink Standard Configurations. New areas equipped with 7 foot frames, bays, and cabinets, including isolated frames, will be floor supported where approved by the CenturyLink representative responsible for Common Systems standards.

Framework assemblies, bays and cabinets in 7 foot floor supported arrangements will uphold the overhead structure using 5/8 inch, threaded rods. Top supports made with threaded rods or bolts may not exceed 8 inches in length (measured from top of frame to the bottom of the first level of auxiliary framing bars).

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 CenturyLink with the exception of power. For the numbering configuration of power bays refer to the CenturyLink, 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 in the front and rear of each shelf.

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.
- Shelf number should be made starting from the bottom, up and left to right.
- Heat baffles (HB 01, HB02), fan unit (FAN 01, FAN 02), writing shelves (WS 01, WS 02), inter-bay management panels, etc. associated with the active network element shall be labeled for identification purposes.
- Blank panels, blanking plates, etc do not require labeling.

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 legacy CenturyLink Telecommunication Facilities previously established as a company standard. System or equipment specific exceptions, if any, will be documented in CenturyLink Standard Configurations.
- Letters of deviation violating the restriction for mounting above the 7′ level will not be accepted and are not considered valid in legacy offices where placement of equipment above the 7′ level was not approved
- Equipment shall not be mounted in a bay extender.
- 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. As a general rule, installation of equipment requiring more than one person to safely handle the equipment (i.e. greater than 40 lbs) shall be mounted in the bay or cabinet at or below approximately 7 feet. In no case shall this equipment be mounted above 7 feet in any framework environment (7′, 8′, 9′, 10′, 11′-6”).
- 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 air flow. Additional space may be required between shelves of equipment by the manufacturer for fan intake and exhaust or heat release.

2.5.10 Equipment Lineup Numbering

General guidelines for numbering equipment lineups in a CenturyLink Facility shall be applied to equipment racks, relay racks, cabinets, distributing frames, power boards, rectifiers, etc.

The following number standard is required for the interface into other systems requiring a specific numbering convention (ie. TIRKS).

- Equipment bays and cabinets should continue existing number convention as already designated in the legacy office equipment lineup until the logical conclusion of the lineup unless the specific equipment installed contradicts with the number standard required for the interfacing system.

- New equipment lineups for bays or cabinets shall follow the standard numbering convention:

  Floor Designation: AA (requires two characters)

    - Reading from left to right, the first two digits signify the floor. First floor: 01, Second floor: 02, Tenth Floor: 10, etc.

  Aisle/Lineup Designation: BBBB (maximum of four characters)

    - The second two to four digits signify the equipment lineup on the floor: First lineup: 01, Second lineup: 02, etc

  Bay Designation: CC (requires two characters

    - The last two digits signify the equipment bay location within the lineup: First bay: 01, Second bay 02, etc.

  RR/Equipment Location Example: AABBBB.CC

Examples:

  - 1st Floor, Fourth Lineup, Fifth Bay: 0104.05
  - 3rd Floor, Eleventh Lineup, Fourteenth Bay: 0311.14

- Equipment lineups shall not begin with 00. Equipment bays within the lineup shall not begin with 00.

- Underground Floors (basements and sub-basements) shall be labeled as follows:
  - 1st level below surface: 0001.01 to 0099.99
  - 2nd level below surface: 0A01.01 to 0A99.99
  - 3rd level below surface: 0B01.01 to 0B99.99

- Equipment cabinets where equipment is placed in both the front and rear cabinet elevation, and requires a separate bay number for the front and rear, shall utilize the above naming convention for the front side of the cabinet. The back/rear side of the cabinet shall utilize the same front numbering convention, but followed with an "R" (ie.. Front: 0105.07, Rear: 0105.07R). Exceptions will be required for equipment placed in the back/rear side of the cabinet in which equipment interface to other systems prevents the use of alpha characters in the naming convention.

- Floors in which the number of lineups is expected to exceed 99, odd and even lineup numbering should be used. (Example: First Lineup: 0101.01, 0101.03, 0101.05….. Second Lineup: 0101.02, 0101.04, 0101.06…)

- Equipment lineup numbering should begin from the non-growth end of the lineup (ie nearest the main aisle, or wall) starting with bay 01 and continue in the growth direction of the lineup.

- Lineups separated by a perpendicular main or egress aisle are considered separate lineups and shall be identified with a unique lineup numbering.

- Equipment frames or cabinets separated by a space or building column shall be considered within the same lineup unless a designated aisle way is established.

- Refer to section 2.7.6 for Power Equipment numbering.

- Additional lineup numbering conventions may be required based on individual site conditions that may vary from the above standard. Specific locations requiring a unique numbering convention should follow the standard convention first to ensure interfacing into other systems.

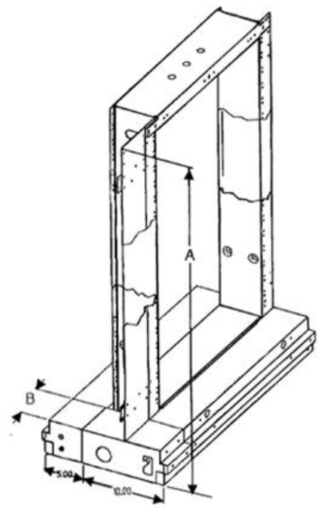
2.5.11 Spacers

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 whenever possible. Two piece duct covers for 9' or 11'6" frames are prohibited.
- CenturyLink 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 CenturyLink network facilities unless specifically stated in CenturyLink Standard Configuration documents or evaluated and approved by the CenturyLink Planning and Engineering Guidelines prior to implementation.

Illustrated in the figure below 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

FIGURE 2.8: FRAMEWORK SPACERS

2.5.12 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 8 feet, 9 feet, 10 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.

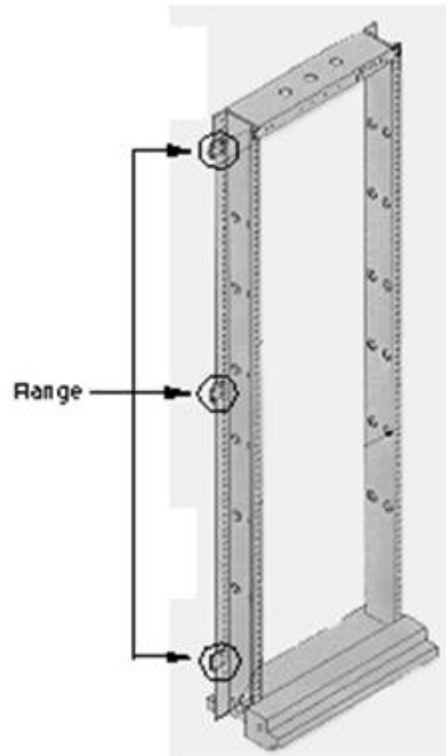


FIGURE 2.9: FRAMEWORK JUNCTION PLATES

2.5.13 End Guards / End Shields

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

2.5.13.1 End Guards

End Guards shall be supplied for the first and last framework assembly within a CenturyLink network facility 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.
- End guards shall be used at the end of a cabinet lineup where a light switch is to be installed.
- The CenturyLink 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 on the front of the end guard. Base guard rail adapters are not necessary on the rear of the end guard.
- All end guards shall be constructed as one solid unit. Approved multi-piece end panel assemblies are the exception. 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 whenever possible. Where not possible, a nearby column or wall is acceptable.

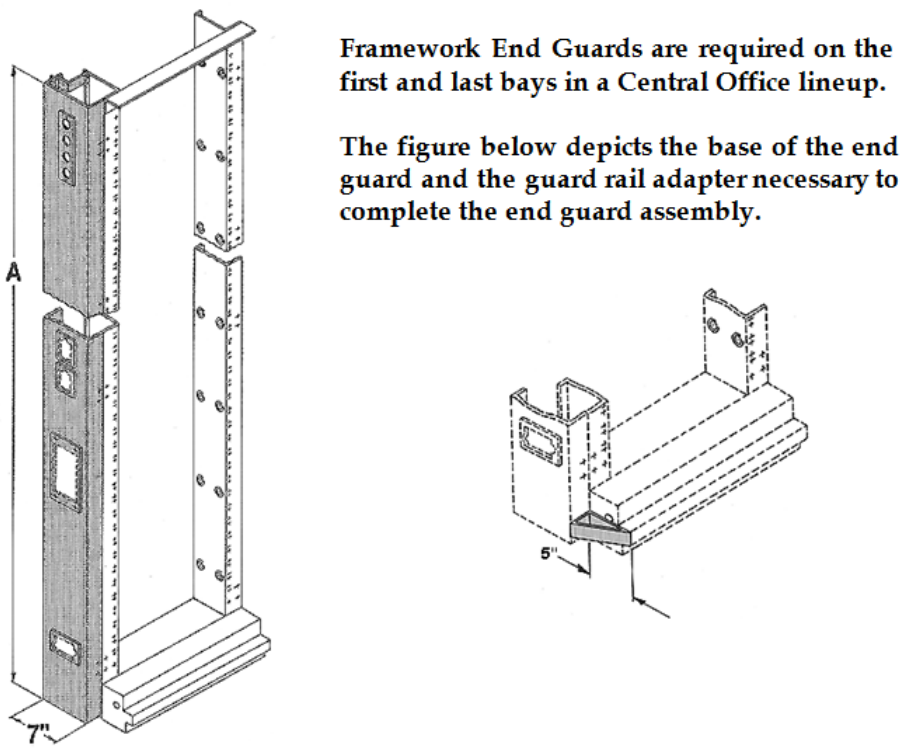


FIGURE 2.10: FRAMEWORK END GUARDS

2.5.13.2 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^2). 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.

2.5.13.3 Base AC Outlets

- Base mounted AC appliance outlets are required in every new CenturyLink network facility lineup. The following information describes the parameters, purpose, and use of these outlets.
- Base mounted duplex AC outlets are required, both front and rear, every 6 to 10 feet located in CenturyLink network facility frame line-ups (or more frequently if required by equipment or standard configurations).
- 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 CenturyLink Network Facilities and buildings.

2.6 Cross Connects

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

DISTRIBUTION FRAMES: Frames that are not installed in line-ups with equipment frames, such as, the Main Distributing Frame (MDF), and the Intermediate Distributing Frame (IDF).

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:

- Circuit Concentration Bay (CCB)
- Electronic Digital Cross-connect frames (EDSX)
- Group Distributing Frames (GDF)
- Digital Cross-connect (DSX)
- Quick Connect Cross-connect (QCX)

- 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. Refer to section 2.2.1 for aisle spacing requirements.

2.7 DC Power Equipment

Specific power standards and requirements are identified in the CenturyLink 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.

2.7.1 Height

General power equipment located in a separate power room or area 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.

2.7.2 Floor Loading

Engineers shall verify with local Real Estate Project Manager to determine if a structural analysis is required to identify the maximum floor loading requirements for the initial layout of the power plant and batteries, or when changes have been made to the original design in which the size, type or orientation of the equipment (power bays, batteries) has changed. General power equipment will have a weight allowance of up to 150 pounds per square foot (150 lb./ft^2) where available. 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^2), 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.

2.7.3 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 network facility environment. Power equipment shall comply with both light and heavy Seismic zone requirements per the CenturyLink Earthquake Standards Map shown in Exhibit J-1 of this module.

2.7.4 Standard Configurations

A CenturyLink Standard Configuration document is available for approved power systems. Floor plans will conform to the standard building requirements; 10 feet clearance height and 150 pounds per square foot (150 lb./ ft^2) floor load. Power systems are often loaded on the base slab of buildings that may in fact support loads greater than 150 pounds per square foot (150 lbs./ft^2). Power system placement shall reflect standard Network Facility aisle dimensions, while allowing adequate space for the routine operation and maintenance functions.

2.7.5 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 CenturyLink Engineer immediately upon identification.

2.7.6 Power Equipment Bay and Lineup Numbering

- Each lineup of power boards should be given a lineup and frame number in accordance with the system of numbering relay racks as related in section 2.5.10, except that power boards, BDFB, rectifier, battery stands, etc shall be prefixed with the letter "P". Example: P0101.01.

- Rectifiers located in the same lineup as power boards shall retain a common lineup number and proper bay numbering in accordance with their location in the lineup.

- Rectifiers located in their own lineup shall be assigned a separate lineup number. Rectifier bays placed back to back should consist of the same lineup numbering, however the rectifiers facing the front aisle shall be suffixed with the letter F

(P0101.01F) and rectifiers facing the rear aisle shall be suffixed with the letter R (P0101.01R).

- Battery Stands shall follow the same power numbering system as identified above. Multiple battery stands in the same room/area can utilize the same equipment lineup numbering and continue with numbering the battery stands with the appropriate location designation (P0101.01, P0101.02, P0101.03).

Contents

FIGURES

TABLES

3 Cross-Connect Systems

3.1 General

The Network Facility cross-connect systems are comprised of the voice grade Distributing Frame Systems cross-connect (DFS), the Digital Signal cross-connect frame systems (DSX), and the Fiber cross-connect Distributing Frame systems (FDF). They share a common purpose; to provide the interconnection vehicle for cross-connecting facilities and equipment.

3.2 Distributing Frame Cross-Connect Systems (DFS)

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

Voice distributing frames (DF) are manually operated interconnection (cross-connection) devises, generally comprised of iron or sheet metal structures. They are used in telephone equipment buildings and network facilities to interconnect circuit elements such as cables and switching systems to provide basic telephone voice and data services to subscribers over the outside plant local exchange copper cable network.

The voice distributing frames support:

- Traditional POTS (plain old telephone services), which include subscriber voice communication public telephone service provided via switched facilities.
- Special Services (designed or enhanced telephone service), which include subscriber communication service with or without dial tone, designed and enhanced with additional transmission or transport equipment.
- Digital Subscriber Line (DSL) services which provide a combined voice/internet data service or just internet data service (naked DSL) over the outside plant local exchange network.
- Certain DS0 level services that are carried over the outside plant local exchange network. The Digital Signal 0 (DS0) is a basic digital signaling rate of 64 kbit/s, corresponding to the capacity of one voice-frequency-equivalent channel.
    - Besides its use for voice communications, the DS0 rate may support twenty 2.4 kbit/s channels, ten 4.8 kbit/s channels, five 9.67 kbit/s channels, one 546 kbit/s channel, or one 64 kbit/s clear channel.

A distributing frame system consists of one frame or several distinct lineups of framework. Planning and engineering specifications include operational procedures and assignment constraints.

The Distributing frame systems should be planned carefully, as they often outlive several generations of facilities and equipment, making service lifetimes of 30 or more years typical.

3.2.1 DF Systems Planning and Engineering

- The long range planning for a given central office or network facility and the surrounding offices and facilities is considered when planning and engineering a DF system. It should be viewed as a single, integral unit, including all aspects of engineering and administration.
- DF Systems may consist of one or more distributing frames, each of which performs some or all of five specific distributing frame functions:
  - Termination of facilities and equipment, such as subscriber local exchange cable (CP), switch line equipment (LE), transport or transmission equipment (TE), miscellaneous equipment (ME), and test access systems (TA).
  - Cross-Connection of Circuits, so as to provide "total interconnection flexibility", meaning, any facility or equipment is able to be cross-connected to any other facility or equipment.
  - Electrical Protection, from possible foreign voltages and currents present on the outside plant facility cables. All new protected connector blocks should use an appropriately rated "5-pin plug in type" protection unit. Frames that contain hardware specific protected connectors that accept protection units of a different type of pattern shall use an appropriately rated unit.
  - Test Access, where circuits can be physically opened and tested.
  - Temporary Disconnection, where the circuit can be opened without removing the cross-connections.

3.2.2 DF Networks Planning and Engineering

- In a distributing frame network, the physical frame configurations may consist of one or more frames with similar or varying hardware types. The DF network contains four basic elements:
  - Functional Frames, determined by the type of outside plant facilities terminated on them (e.g. MDF, SMDF, TMDF, and IDF as defined below in section 3.2.3).
  - Physical Hardware, or the structural framework, and all terminating apparatus mounted on it. (e.g. Conventional, Modular, Cabinet, etc…)
  - Terminations Allocation, consisting of the placement of all required facilities and equipment terminations on "specific functional DF's".
  - Tie Pairs, or permanent cable links interconnecting the DF's, (e.g. intra-frame tie pairs, inter-frame tie pairs), when two (2) or more DF's exist.

3.2.3 DF Functional Frames

- DF Functional Frames consist of four (4) basic types:

Main Distributing Frame (MDF)

- It terminates subscriber local exchange cable pairs along with trunk cable pairs, and is paired with the office voice-switch equipment terminations.
- The recommended hardware for new frames is a conventional distributing frame.
- It may function with a secondary Trunk Main Distributing Frame (TMDF) or an Intermediate Distributing Frame (IDF) in large distributing frame networks to complete the network.
- It may be referred to as a Combined Main Distributing Frame (CMDF), or a Combination Distributing Frame (CDF), depending on its terminations.
- The CDF function terminates both subscriber and trunk cable pairs, as well as all office equipment requiring termination. It may be the only frame in the office.
- The CMDF function terminates both subscriber and trunk cable pairs, along with test access and miscellaneous equipment. It may function with a secondary CXRDF (Carrier DF or High frequency frame) or a TMDF (Trunk Main DF). The CMDF function is not recommended for new offices.

Subscriber Main Distributing Frame (SMDF)

- It terminates subscriber local exchange cable pairs only, and is paired with the office voice-switch line equipment terminations.
- Existing offices may continue growth and maintenance of the existing frames. This function is not recommended for deployment in new offices.
- This function exists in the network and may use hardware such as the Modular COSMIC I, IA, II, IIA, the CAM IV, V, VI, the Augat DF-300, and the CODS1/2 distributing frames.
- An SMDF requires a secondary TMDF to complete the DF Network and may exist with either a separate or an integrated protector frame
- An SMDF with multiple lineups shall contain a TPDF (Tie Pair Distributing Frame) or direct ties.

Trunk Main Distributing Frame (TMDF)

- It terminates inter-office trunk cable pairs, along with all terminations required for a given office, except for the subscriber local exchange cable and the voice-switch line equipment terminations.
- The recommended hardware is a conventional distributing frame.
- A TMDF requires a primary MDF, CMDF, CDF, or SMDF to complete the DF Network.

- Although most inter-office copper trunk cables are obsolete, and have been replaced by fiber, this frame may still contain active trunk cables, along with transport carrier (D-type carrier or earlier), transmission, and repeater equipment.

Intermediate Distributing Frame (IDF)

- It has no direct outside plant cable terminations.
- The recommended hardware is a conventional distributing frame.
- An IDF used to terminate tie pairs that interconnect two or more modular SMDF frame lineups is known as a Tie Pair Distributing Frame (TPDF). The TPDF should consist of the same modular hardware as its SMDF.
- An IDF used to terminate demodulated carrier channels is known as a Carrier Distributing Frame (CXRDF), sometimes referred to as a Toll IDF (discontinued).
- An IDF used to terminate Collocation DS0 facility terminations is known as a DS0 Inter-Connection Distributing Frame (ICDF).
- An IDF used to terminate Subscriber Digital Loop Carrier DS1 transmission levels is known as a Subscriber Digital Distributing Frame (SDDF).

Protector Frames, (PF)

- Protector frames provide for protected terminations of outside plant cable pairs, have no provisions for cross-connects, and are typically used in conjunction with separate distributing frames.
- Protector frames require cable connections, often referred to as a strap cable, to the main frame for cross-connecting to other network equipment terminated on the distributing frame.
- Considered an integral part of the MDF functional distributing frame. (Example: A COSMIC IA SMDF with a separate PF is functionally the same as a COSMIC IIA SMDF with an integrated PF).
- Not considered a distributing frame or cross-connect frame, therefore, it is not classified as a Functional frame.
- A single PF may serve both an SMDF and a TMDF, but dual appearance of the same cable facility, (bridged), is not recommended and shall be avoided.
- Existing separate PF's should be utilized to capacity, and extended only when necessary. Integration to the main frame shall be considered prior to growth of an existing protector frame.
- For existing PF's that require additions, the recommended hardware option is the Single Sided Low Profile conventional frame. Integration to the main frame shall be considered prior to growth of an existing protector frame.
- A new protector frame shall be integrated if possible, and exist as part of the MDF, CDF, or SMDF functional frame.

3.2.4 DF Physical Hardware

Distributing frame hardware consists of two (2) basic types:

- Conventional frame: A distributing frame with a framework characterized by an open lattice structure of vertical and horizontal members.
- Modular frame: A distributing frame made up of a number of sheet metal structures called modules. Each module is arranged to mount terminal blocks and is configured so as to provide pathways for cross-connect (jumper) wire and equipment cables.

The recommended framework for use in new central offices or network facilities is a conventional frame equipped with the appropriate termination apparatus, protection, and cross-connect wire.

- The DSLPDF (Double Sided Low Profile Distributing Frame) may be used for any distributing frame function.
- The SSLPDF (Single Sided Low Profile Distributing Frame) may be used as a CDF or an IDF but is limited to a maximum growth of 25 verticals.

DF Framework types, present in some existing offices, but currently not approved for use in new offices, consist of the following:

- The modular Cosmic I, IA, II, IIA, and mini distributing frames.
- Earlier versions of tall conventional double or single sided distributing frames
- The Modular ESS distributing frames.
- The Modular Augat DF-300 and DF-330 type distributing frame.
- The modular CODS1 and CODS2 distributing frames
- The modular CAM IV, V, and VI distributing frames

All other additions and modifications to existing variations of distributing frames shall be addressed on a case-by-case basis, following the guidelines set for the applicable Generic DF Network in use.

Termination apparatus:

Termination apparatus consists of block type units which mount on the frameworks. The two types of apparatus are:

Connector blocks:

- Also referred to as protected connector blocks, they shall provide the electrical protection and test access capability for outside plant local exchange facilities and trunk cable facilities, where present.

- The blocks may exist with or without a cross-connect field, and are generally dependent on the framework type.
- Protected connector blocks, without cross-connect ability, shall be mounted on separate protector frames, and cabled to a connecting block on the associated MDF, CDF, or SMDF for cross-connect access to the network equipment.
- Protected connector blocks with cross-connect ability shall be mounted directly on the MDF, CDF, or SMDF for cross-connect access to the network equipment.
- Protected connector blocks with cross-connect ability shall use the same terminal connection type, where possible, to eliminate the need for multiple wire termination tools.
- The preferred standard block capacity is 100 pair, generally provided with an attached, factory wired distribution cable stub for routing to a cable entrance facility.

Connecting Blocks:

- Connecting blocks, also referred to as terminal blocks or strips, shall provide the cross-connect field and test access capability for office equipment.
- The blocks may exist with a variety of termination connection types, such as solder (discontinued), wire-wrap, and insulation displacement quick clip types (punch-down), and are generally dependent on the framework type.
- Connecting blocks with the same terminal connection type shall be used throughout the office distributing frame network, where possible, to eliminate the need for multiple wire termination tools.
- The preferred standard non-connectorized block capacities are 100 pair and 128 pair to accommodate four equipment cables at 25-pair and four equipment cables at 32-pair, which are most commonly terminated on distributing frames.
- Equipment applications terminating pair counts greater than the preferred standard non-connectorized block capacities shall be considered custom and specific to the application.
- Connectorized blocks are not recommended for voice applications.
- Connectorized blocks may be considered for equipment applications and configurations specifying a requirement for wiring characteristics found in high speed or high speed plus connectorized blocks. However, because distributing frame network hardware has no inherent slack storage capabilities, cables with connectors on both ends require a very accurate measurement and shall be ordered as close to the actual cable length required as possible. Refer to section 6A.4.4 Cable Slack Storage in this publication.
- Although digital loop carrier (DLC) and subscriber loop carrier (SLC) are facility cables and require protection, it is recommended they be terminated on connecting blocks to eliminate protection redundancy, as protection is inherent in the equipment shelf.

Termination Apparatus on Conventional Hardware:

- The preferred connecting block is a single or bifurcated wire wrap front facing block with floating pins, commonly known as the 89-type series.
- Single or bifurcated insulation displacement type pins (punch-down) shall be avoided, to limit the need for multiple termination tools, unless following suite with existing termination apparatus.
- The preferred protected connector block is a single wire wrap block with a protection unit pattern intended for a 5-pin type protection unit.
- The earlier versions of C-50, C-52, or 300 type protected connectors utilize protection carbon block units that are unique to the respective blocks, and are <u>not</u> interchangeable with the recommended 5-pin type protection units. The blocks are restricted from new use, and shall be replaced where possible.
- Earlier versions of conventional frame hardware, drilled for 16 inch wide blocks, may require vertical or horizontal adapter bars to accommodate more recent 8 inch to 9 inch wide block types.

<u>Termination Apparatus on Modular Hardware</u>:

- Modular termination apparatus is generally framework specific.
- Existing frameworks shall follow suit with existing termination apparatus types where possible.
- On the modular COSMIC types, the recommended connecting blocks are the hardware specific 78-type and 112- type connecting blocks, and the recommended protected connector block is the hardware specific 307-type.
- On the modular Augat DF-300 and DF-330, all required termination apparatus are hardware specific Augat-Telzon type blocks.
- A separate Protector frame is required on the COSMIC I/ IA type SMDF's and the Augat DF-300 type SMDF.
- The standard modular protector frame requires the hardware specific 302-type protected connector, whereas the high density modular protector frame requires the hardware specific 308 type protected connector. The 302-type and 308-type blocks are <u>not</u> interchangeable.
- Protector Frame to Distributing Frame strap cabling in DF Networks with a PF-DF arrangement contains hardwired, non-shielded strap cable, and does not meet "shielded circuit" requirements.
  - The exception to this is the Modular COSMIC IIA with an integrated PF, as the cable harness is less than three (3) feet in length.

<u>DF Jumper wire</u>:

- Distributing frame wire is typically a twisted pair of insulated copper conductors.
- Most DF circuits today are terminated as either one (1) pair of wires (leads) consisting of a tip (T) and ring (R) known as a 2-wire (2WR), two (2) pairs of wires consisting of a

transmit tip (T) and ring (R) and a receive tip (T1) and ring (R1) known as a 4-wire (4WR), or a single lead still used with some miscellaneous circuits.

- A 4WR special service circuit, consisting of two (2) pairs or four (4) wires, may utilize a quad jumper wire (two wire pairs twisted together) only when the circuit being terminated does not require separation of the Transmit and Receive path.
- Distributing frame apparatus (connecting and connector blocks) with wire-wrap or quick-clip terminations shall be designed to reliably accept 22- or 24-gauge cross-connect wire.
- 24-gauge wire is generally recommended for all modular frames, all single-sided conventional frames, and small double-sided conventional frames where the ultimate growth will be less than or equal to 20 verticals in length to minimize jumper pileup.
- 22-gauge wire is generally recommended for all large double-sided conventional frames over 20 verticals in length and small double-sided conventional frames where the ultimate growth will be over 20 verticals in length.
- Existing jumper wire colors vary, having been previously associated with the voice switch types. Follow suit with existing frame wire gauge, color, and connection type, where applicable (see table below)
- Jumper wire, which consists of one (1) to four (4) leads, shall be routed within the distributing frame structure, and shall not be routed outside the DF structure on cable rack.
- Jumper cable, which consists of 5 more leads, is generally not present on distributing frames, but if required, may be routed outside of the DF structure on cable rack.

The table below shows the recommended jumper wire colors and apparatus/block termination connection types for new distributing frames, and existing frames undergoing transition or rehabilitation:

TABLE 3.1: Distributing Frame Jumper Wire

Wire Type	Wire gauge	Insulation Color	Service Circuit	Framework type / Block connection type
Single	24 GA	BK (black)	Misc. lead single	Modular / quick-clip, Small Conventional/ wire-wrap
1 Pair-twisted	24 GA	Y/BL (yellow/blue)	POTS	Modular / quick-clip, Small Conventional / wire-wrap
1 Pair-twisted	24 GA	Y/R (yellow/red)	Specials	Modular / quick-clip, Small Conventional / wire-wrap

1 Pair- tight-twist (cat5)	24 GA	V / BL (violet/blue) (violet/green pending)	DSLAM	Modular / quick-clip, Small Conventional / wire-wrap
2 Pair-twisted	24 GA	Y/R (yellow / red) 2 pair	Specials (4WR) , use 2 pair	Modular / quick-clip
Single	22 GA	S (slate)	Misc. lead single	Large Conventional / wire-wrap
1 Pair-twisted	22 GA	W / BL (white/blue)	POTS	Large Conventional / wire-wrap
1 Pair-twisted	22 GA	W/R (white/red)	Specials	Large Conventional / wire-wrap
1 Pair- tight-twist (cat5)	22 GA	V/BL (violet/blue)	DSLAM	Large Conventional / wire-wrap
2 Pair-twisted	22 GA	W/R (yellow/red) 2 pair	Specials (4WR), when transmit-receive separation required	Large Conventional / wire-wrap
2 Pair-twisted quad	22 GA	W/BL/R/G (white/blue/red /green)	Specials (4WR), when transmit-receive separation not required	Large Conventional / wire-wrap

3.2.5 DF Termination Allocation:

- The placement of all required facilities and equipment terminations on "specific DF's" is dependent on the given DF function.
- Typically, a given termination appears on one DF. Facilities and Equipment may be bridged over two or more DF's, temporarily, during a transition. Long term operation with these "multiple appearances" is not recommended.
- Outside Plant local exchange cable (CP) termination allocation is specific to the distributing frame function. They shall appear on the main distributing frame (MDF) or the subscriber main distributing frame (SMDF), but not both.

- All voice switch line equipment (LE or OE) terminations shall be allocated to the main distributing frame (MDF) or the subscriber main distributing frame (SMDF), but not both.
- Switching machine inter-office trunks are no longer terminated on the DF Network, although limited counts of copper trunk cable {TCP}, limited D-type carrier (CXR), and other carrier bank types may still be terminated and active.
- New subscriber loop carrier (SLC) and digital loop carrier (DLC) shall be allocated to the main distributing frame (MDF, CDF, CMDF) or SMDF.
- Existing SLC and DLC, terminated on an intermediate distributing frame (IDF) or a trunk main distributing frame (TMDF) should be transitioned to the main distributing frame where feasible to eliminate tie cables, reduce the length and quantity of cable runs, and shorten the overall distance for circuit provisioning.

3.2.6 DF Tie Pairs:

- Tie pairs, or permanent cable links interconnecting the DF's, shall exist in distributing frame networks containing two or more distributing frames, to establish and maintain interconnection between all facilities and all equipment terminations.
- Distributing frame tie-pair cables consist of two types:
    - Intra-frame ties occur between multiple lineups of the same functional frame unit, as required. The Modular SMDF is the only functional frame inherently designed and approved for intra-tie pair applications, using either direct ties or a separate Tie Pair Distributing Frame (TPDF)
    - Inter-frame ties occur between the main distributing frame (MDF, CDF, CMDF, or SMDF) and extend to all secondary frames (TMDF, CXRDF, IDF, ICDF, or SDDF) as required to ensure total circuit interconnection.

- Distributing Frame Tie-Pair Considerations and Recommendations

    - In general, proliferation of new small tie-pair cables and pair counts shall be avoided, as this complicates engineering, administration, and cable inventory efforts.
    - For Conventional type frameworks, the recommended minimum inter-frame tie cable and pair quantity is 100 pair.
    - For Modular type frameworks, the recommended minimum tie cable and pair quantity is 100 pair for full shelves, or two 50 pair connecting blocks and cables for half shelves.
    - For Modular ESS type framework, tie-pair cable counts vary from the recommended 100 pair. The engineer shall follow suit with the existing hardware and capacity patterns.

- For existing frameworks where the hardware is framework specific, the engineer shall follow suit with the existing tie-pair block hardware type and capacity patterns.
- The entire tie-pair block capacity shall be cabled out, where applicable.
- Partial block cabling shall be avoided, unless specified in an approved configuration, as future cabling to existing blocks presents cable access issues and invites service interruption for existing working circuits. In most instances, the block cabling terminations are not accessible after the initial installation.
- If two or more secondary frames exist in the DF network, and they each contain common termination allocations for transport and transmission equipment, (e.g. multiple D4 Carrier systems, Office Repeaters, etc…), it is recommended that inter-frame ties be provisioned to ensure total circuit interconnection. Sometimes referred to as umbilical ties, these inter-frame ties shall occur between the two affected frames.
- Two distributing frames interconnected by "split-leading" equipment, where separate lead groups from the same equipment are terminated on two different frames shall not be considered a substitute for inter-frame tie-pair cabling, and is not recommended as a cabling method for distributing frame networks.

Shielded Tie Pairs:

- Shielded Tie pairs, or permanent shielded cable links interconnecting two DF's, are sometimes required in distributing frame networks, usually from the main frame (MDF) to the subscriber digital distributing frame (SDDF), if the SDDF has been provisioned with transmission equipment for certain repeater and loop extender applications.
- The recommended minimum inter-frame shielded tie-cable and pair quantity is 50 pair for the transmit cable path and 50 pair for the receive cable path, following the tie pair guidelines set above for the various framework types.
- Applicable guidelines for cable and binder signal separation apply
- Inter-frame shielded tie pair cables shall be installed, as required, between the main distributing frame (MDF, CDF, CMDF, or SMDF) and extended to all secondary frames (CXRDF, IDF, ICDF, or SDDF), if the secondary frame contains repeater or loop extender equipment that has the potential to be provisioned for T-1 powered DS1 (1.5Kb) level circuits, usually accomplished by optioning or carding, the equipment shelf with the applicable T-1 card.
- Inter-frame shielded tie pair cross-connect jumpers are recommended for circuits on the IDF, or shared SDDF, when the repeater or loop extender equipment shelf has been provisioned for DS1 (1.5Kb) level circuits that are T-1 powered, to "shield" the T-1 circuit from the existing voice grade circuits.
- A shared SDDF exists when a portion of the IDF frame hardware is sectioned off for use as an SDDF, usually at one end, and is identified with a separate Frame name. Shielded jumpers for T-1 powered DS1 circuits are recommended.
- A stand alone SDDF is a separate framework, segregated from the voice grade circuits by nature, and usually does not require shielded jumpers.

3.2.7 DF Network Configurations

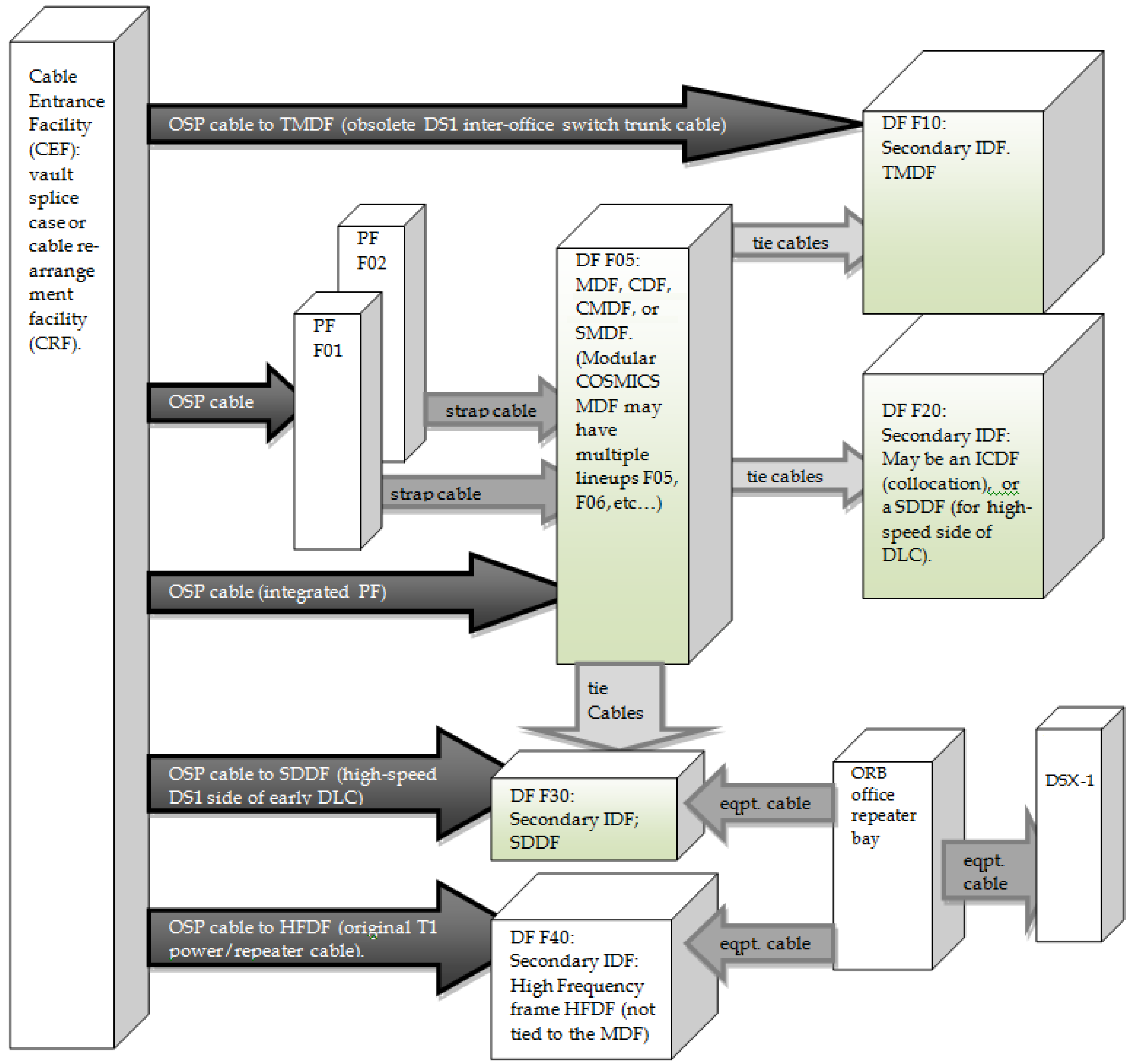
Recommended DF Networks for new offices or network facilities:

- A single combination distributing frame (CDF), where the frame is of conventional hardware, incorporating an integrated protector frame (PF). A subscriber main distributing frame (SMDF), where the frame is of conventional hardware incorporating an integrated protector frame (PF), and a conventional IDF.

Recommendations for DF Networks in existing offices:

- Frames functioning as a CDF MDF, CMDF, IDF, TMDF, CXRDF, and ICDF should be of Conventional hardware, although some non-supported modular hardware versions still remain. In offices with one DF, the frame should be of conventional hardware, and accommodate all current technology and equipment requirements.
- In offices with more than one DF, there should be one primary Main frame (CDF, MDF, CMDF, or SMDF), where the local exchange cable pairs, along with the voice switch lines are terminated.
- Dual appearance of the facility local exchange cable terminations is not recommended.
- Voice lines from all office switches shall terminate on the same Main frame, to avoid unnecessarily fragmented or stranded frames.

FIGURE 3.1 Distributing Frame Network and Tie Pair Illustration:



NOTES:

1. The DF network may vary from one main frame in a small office or network facility to a main frame and various secondary frames in a larger office or network facility.
2. Every frame (distributing and protector frame) requiring inventory in a mechanized system uses an individual 11 (eleven) character frame name to facilitate inventory in the appropriate database for circuit provisioning. The frame name is identified by the 8 (eight) character Common Language Location Identifier (CLLI) code followed by the frame identifier "F" and an assigned two character value (i.e. 01).
3. Equipment on most secondary frames may be consolidated to the main frame, if the main frame is constructed of conventional hardware.

4. A DF network containing a subscriber main distributing frame (SMDF) constructed of modular hardware requires a secondary IDF to accommodate transmission, transport, and miscellaneous equipment. The SMDF supports only local cable, voice lines, and tie pairs.

3.2.8 DF Layout and Assignment Recommendations:

The DF Layout or the pattern in which subsets of terminations appear on a given DF, is usually established when the DF is first built:

DF Layout Alternatives:

- Non-Spread (Block-terminated) Layout, where each type of facility or equipment is terminated on only a few conventional frame verticals and no effort is made to distribute these blocks over different locations on the frame.
- Uniform Spread Layout, where each type of facility or equipment is uniformly spread over the length of the frame, on the conventional frame horizontal or vertical sides, or in Modular frame equipment or facility modules.
- Zone Spread Layout, where the frame is divided into a number of mutually exclusive zones of equal size, and each equipment type is divided equally among the zones, such that all zones have approximately equal number of loop cable pairs.
    - When terminating new equipment on existing conventional frames, an attempt should be made to plan for eventual termination in all existing zones.

DF Assignment Alternatives:

- Preferential Assignment (PA); or the strategy using search algorithms in a mechanized database to minimize the jumper length required to connect a facility block to an equipment block.
    - Modular frame assignments should consist of preferential assignment. Exceptions are the COSMIC Mini, the Augat DF-330, and other modular frames which require manual planning.
- Non-Preferential Assignment or Random Assignment (RA); the strategy followed most commonly when making manual assignments, that of selecting the first available spare equipment provided it meets all other constraints.
    - Conventional frame assignment alternatives may be preferential or non-preferential (random) assignment:

DF Layout and Assignment Guidelines:

Conventional Frames:

- The recommended layout and assignment methods for New Conventional Frames are the Uniformly Spread or Zone Spread Layout – Random Assignment. Uniform Spreading results in additional flexibility and reduces the number of zones required.

It is recommended the existing Frame layout and assignment method be continued where effective and practical, when an existing Conventional Frame requires a growth extension.

- The Horizontal side of the MDF (CDF, CMDF), shelves A to K, shall generally be treated as three assignment areas:
    - Shelf A and B for low production equipment, such as Test access blocks and miscellaneous blocks, where circuits are terminated once and changed infrequently. Use "A" as the last alternative.
    - Shelf C to F for high production equipment, such as Switch Line blocks and Equipment blocks, where circuits are terminated and changed very frequently, if not daily.
    - Shelves G, H, and J, K , for average production equipment, such as DSL, Repeaters, D4, etc, where circuits are terminated and changed frequently, and whose placement require paired block placement.
- On taller Conventional frames, if capacity demands allow, attempts should be made to avoid block placement above the K shelf, other than to cable out the remaining capacity for any previously placed, existing equipment bays, or if frame growth is impeded.

<u>Modular Frames</u>:

- The recommended layout and assignment method for the existing Modular SMDF frameworks is the Zone Spread Layout – Preferential Assignment method. These frameworks are not recommended for new deployment.
- A Modular SMDF Frame Complex requiring intra-frame (cross-aisle) tie pairs shall be provisioned with direct ties or with a separate TPDF (Tie Pair Distributing Frame).
    - <u>Direct Ties</u>: Recommended for Frame Complexes where the "future" frame size is expected to contain no more than two lineups.
    - <u>Separate TPDF:</u> Recommended for Frame Complexes where the "future" frame size is expected to grow more than two lineups.
- Modular SMDF Frames shall be treated as containing two assignment areas:
    - Equipment Modules, which may contain switch lines, and Intra-Frame and Inter-Frame tie pairs.
    - Facilities Modules, which may contain the outside plant cable, and Intra-Frame and Inter-Frame tie pairs.

- Modular Cosmic IIA SMDF frames, with integrated Protector Frames, have an additional protector frame area, on the rear of the Facility Modules.

3.2.9 DF Space and Cabling:

Physical building space and cabling limitations are key factors in developing and maintaining viable Distributing Frame network plans.

Generally recommended DF space and cabling requirements:

- Space shall be allocated for ultimate lineup space, where possible. Cable access shall accommodate anticipated termination spread requirements.
- Cable access shall include turnaround space to accommodate facility and equipment replacements during the life of the DF, where possible.
- DF lineups shall not be bent, jogged, or include irregular sections.
- DF and PF lineups shall, wherever possible, be oriented parallel with the cable entrance facility (CEF), and perpendicular with equipment lineups.
- Distributing frames and associated separate protector frames shall be placed near each other to facilitate strap cabling and related testing, protection, and disconnection activities.
- Frames terminating outside plant cable (combined protection DF and PF) shall be over, or as near to, the CEF as possible to reduce length and complexity of sheathed cable runs, and to facilitate the use of stubbed DF connector apparatus.
- Functionally related lineups shall be consolidated in one area, where possible, particularly the same floor, for more efficient force management, and should also share common aisles to reduce building space requirements.
- The SMDF shall be favored for placement over or near the CEF, for DF networks with separate SMDF's and IDF’s.
- The horizontal side of Conventional Frames shall face equipment lineups.
- DF lineups shall not be placed in column lineups, as this will result in blocked jumper troughs, loss of frame mounting space, and unnecessarily fragmented functional frames.
- Avoid placement where overhead ducts and VIA system (cross-aisle) cable racks leave little clearance for DF cabling.
- Integrated protector frames shall be considered for new distributing frame networks and those undergoing rehabilitation.
- Rolling Ladders, suspended at the frame from a center-aisle track, are sometimes used on one or both sides of tall DF’s. When extending older frames with this arrangement:
  - Ladder tracks may be extended on a case-by-case basis.
  - Attempts shall be made to exclude the distributing frame vertical/ shelf/bay positions above the 8’-0” height from future terminations, to bring the assignable frame space in line with the standard height low-profile frame (usually the K shelf).
  - A-Frame ladders shall be provided in lieu of rolling ladders, where possible.
  - Rolling platform ladders containing wire reels, usually low height, are intended for use with newer low profile frames.

3.3 Manual Digital Signal Cross-Connect (DSX) Systems

Digital Signal Systems may consist of one bay and one shelf or several distinct lineups of bays and shelves.

A Digital Signal Cross-connect (DSX) frame is a centralized termination point for digital equipment at a particular digital signal level or bit-rate. It consists of one or more contiguous DSX bays with all of the required DSX apparatus. DSX lineups interlinked together form the DSX network.

Refer to CenturyLink technical documents and standard configurations for additional information. Standard configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

3.3.1 DSX Systems Planning and Engineering

DSX systems include all of the hardware, planning, engineering, operations, and administration functions. Planning and engineering specifications may include operational procedures and assignment constraints.

DSX systems shall be planned carefully, as they often outlive several generations of facilities and equipment, making service lifetimes of 30 or more years typical.

The DSX system provides a central location for testing, patching, rearranging, and cross-connecting network elements that use a variety of transmission rates, the most common of which are the 1.544 (DS1) and 44.736 (DS3) Mb/s transmission rates. These systems provide a simple, non-intrusive, method of interconnecting digital network elements, using semi-permanent copper cross-connections.

A DSX frame shall have the capability to provide:

- Re-arrangeable connections between any two equipment terminations or appearances.
- Bridged access, whereby equipment can be connected in parallel with a digital signal path.
- Series access, whereby a digital signal path can be split.

DSX frames are planned and engineered much like the DS0 level voice distributing frames, in that they also require zoning and spreading of equipment for successful capacity and jumper management. Section 3.2.8 provides information that may be applied to equipment terminations allocation on the DSX frame lineups.

DSX Planning Considerations:

- Future DSX requirements and frame growth shall be anticipated and appropriate floor space allotted.
- DSX frames shall be added in dedicated, contiguous lineups to effectively utilize cabling, avoid excessive tie-cable connections, and reduce the occurrence of unnecessarily fragmented or stranded DSX bays and shelves and in no cases shall exceed 50 feet in total equipment lineup length

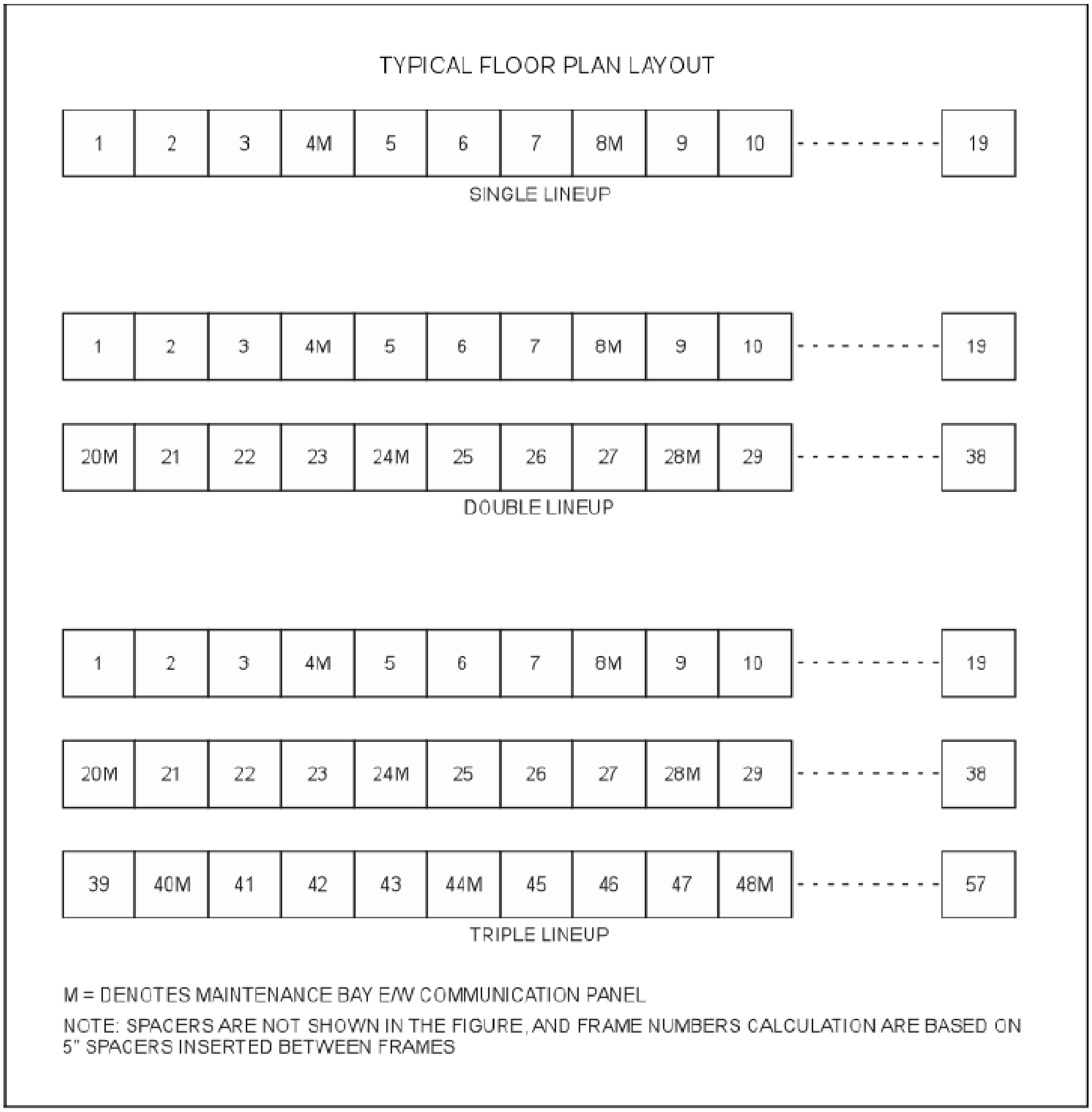
DSX Engineering Considerations:

- All DSX bays shall have upper and lower express troughs for intra-system cable management.
- Express troughs shall be located and sized to avoid impeding the placing, removing, and tracing of cross-connect jumpers. These troughs shall be as large as possible, and are dependent on DSX hardware and bay capacity.
- DSX bays shall allocate at least one panel space at the top of each bay framework for cross-aisle tie panels. .
- Cross-aisle tie pairs, or permanent cable links interconnecting the DSX's, shall exist in DSX frame networks containing two or more frame lineups, to establish and maintain interconnection between all facilities and all equipment terminations.
- Relay rack or bay spacers shall be located on either side of a DSX bay, and between the bay and the end guard in each DSX frame lineup.
- Spacers are sized according to the total bay termination density available in the DSX bay panels, and are dependent on the DSX framework. Spacer width shall remain constant throughout the lineup where feasible.

DSX Lineup Arrangements:

- In DSX lineups, every fourth bay shall be a maintenance bay. Maintenance bays contain space for communication panels, inter-bay panels, cross-aisle panels, writing shelves, and miscellaneous jack panels.
- If a DSX lineup is at or near capacity, the final growth bay shall be dedicated to cross-connect aisle panels, if feasible, to enable connection to a new DSX lineup when required.
- 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.

FIGURE 3.2 DSX Floor Plan Arrangement



<u>Cable Rack Placement:</u>

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

- In new 7' floor supported environments, the cable rack shall 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.

<u>DSX Assignments:</u>

- When assigning locations for DSX panels, the panels should be grouped together by similar technologies (i.e.: FLM, D4, DCS, SLC, ORB) and equally spread across the bays in the DSX lineup(s) where possible to maintain a well-planned cross-connect frame system and minimize long jumpers or patch cords.

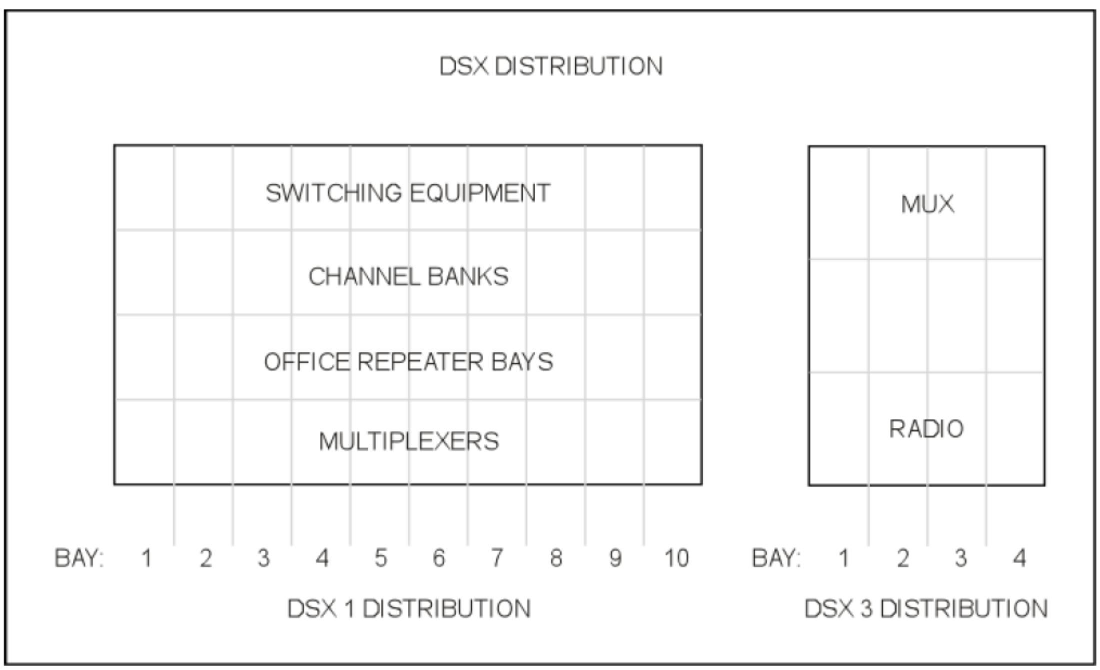
- A record of the DSX module port assignments, including bay, shelf, and ports, should be maintained in an approved inventory system, either manual or mechanized, to allow for circuit order assignment and circuit maintenance..

DSX Terminations:

- DSX terminations shall be zoned and spread to facilitate short jumpers and efficient equipment utilization.
- An analysis of the equipment applications and limitations will permit partitioning of the DSX lineup into one or more functional areas.
- When adding multiple DSX panels, it is recommended the panels be spread across several bays if possible to keep the jumpers as short as possible.
- Equipment types shall be terminated and spread in alternating bays of the lineup or lineups to achieve a uniform distribution of equipment and increase the opportunity for short jumpers.

The following figure below shows generic plans for DSX arrangement layouts:

FIGURE 3.3 Generic DSX Plan



3.3.2 DSX Cross-Connect Jumper Lengths

In order to maintain compatibility between equipment terminated on a DSX network, the network is maintained at an equal level point.

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), and cable lengths (from network element to DSX) are essential. As a rule, jumpers shall be kept as short as possible.

INTRA-SYSTEM JUMPER

- DSX 1
    - Maximum total length of 85 feet includes 24 AWG non-shielded twisted pair wire for jumper and 26 AWG shielded cable for the cross-aisle tie cable.
- DSX 3
    - Maximum total length for cross-aisle tie cable is 50 feet using 735A (26 AWG) coaxial cable, includes 18 feet for 26 AWG coaxial cable jumper.
    - Maximum total length for cross-aisle tie cable is 75 feet using 734A (20 AWG) coaxial cable, includes 27 feet for 20 AWG coaxial cable jumper.

3.3.3 DSX Cable Lengths

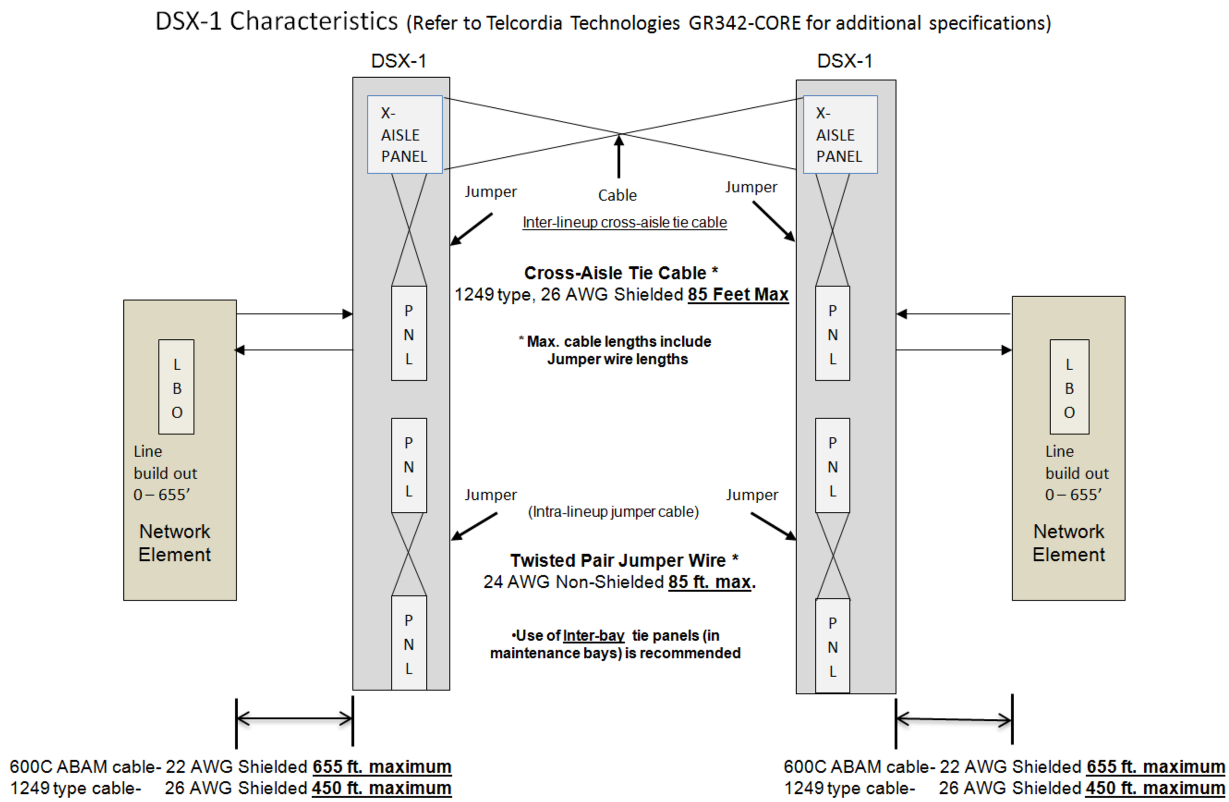
All inter-office cabling between network elements and the DSX have length limitations.

INTER-OFFICE CABLE

- DSX 1
    - Maximum length is up to 450 feet using 26 AWG shielded cable from the network element to the DSX-1 panel.
    - Maximum length is up to 655 feet using 22 AWG shielded cable from the network element to the DSX-1 panel.
- DSX 3
    - Maximum length is up to 200 feet using 26 AWG coaxial cable from the network element to the DSX-3 panel.
    - Maximum length is up to 420 feet using 20 AWG coaxial cable from the network element to the DSX-3 panel.

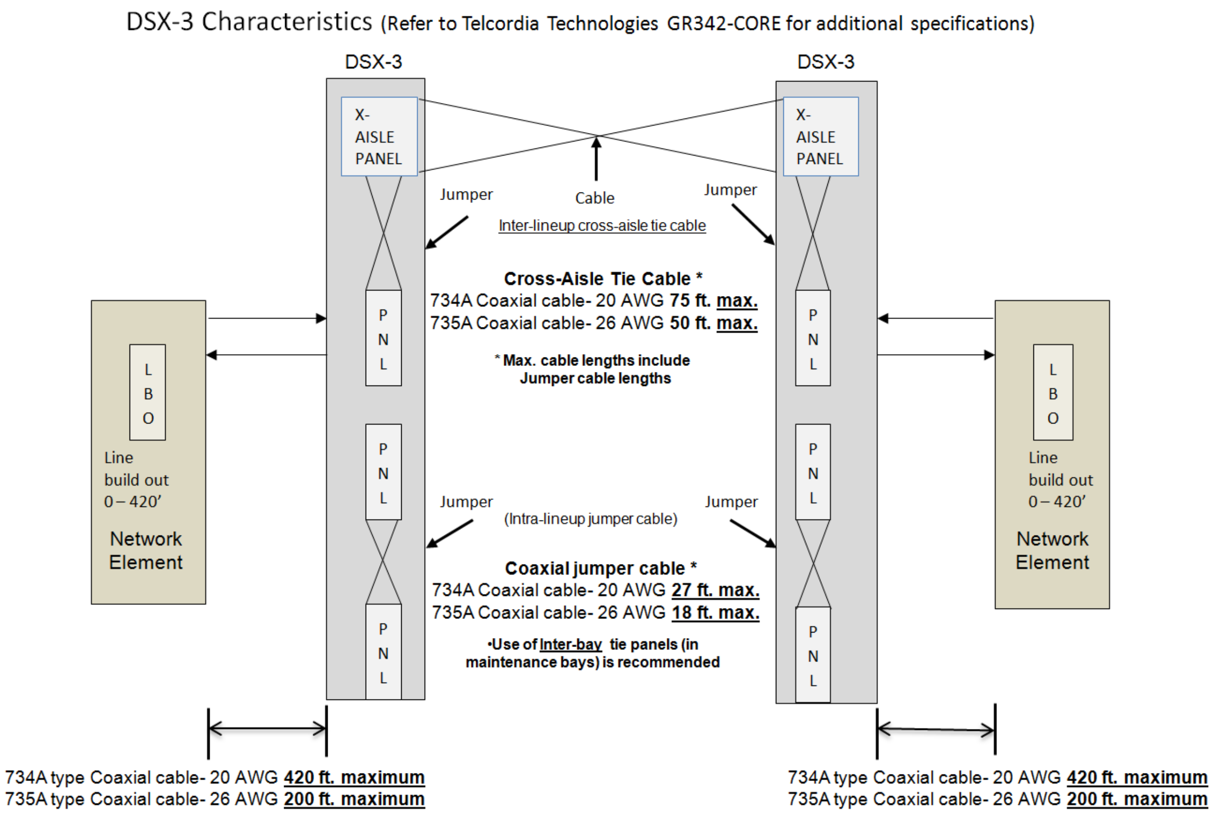
The following is a figure summarizing the lengths for DSX 1 cabling and cross-connect lengths:

FIGURE 3.4 DSX-1 Cable Length and Cross-Connect Summary



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

FIGURE 3.5 DSX-3 Cable Length and Cross-Connect Summary



3.3.4 DSX Cabling Rules

- The cable shield shall be grounded at one end only, usually at the equipment end.
- Input and output digital signal (T & R) leads shall be cabled in separate cables, providing signal separation, unless otherwise noted in specific equipment standard configurations.
- The transmit leads (T) shall terminate on the OUT jacks and the receive leads (R) shall terminate on the IN jacks.
- Shielded cables shall not be run in the same cable rack as power and grounding cables. Cabling for digital equipment is very sensitive to electrical interference.
- Switchboard cables shall not be run in cable rack above equipment that produces a great deal of electrical interference such as electromechanical switching equipment.

3.4 Fiber Facilities

The Fiber Splice Facility (FSF), Fiber Distribution Frame (FDF), fiber cable support systems and fiber management devices 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.

3.4.1 Fiber Splicing Facility (FSF)

- The FSF is the point at which the Outside Plant (OSP) or Indoor/Outdoor (I/O) rated fiber cable is transitioned to low smoke indoor OFNR Riser rated, factory “connectorized” cable.

- All splicing must be protected in a splice tray contained in an approved FSF device such as a splice panel, splice bay, wall mount splice cabinet or splice case approved for use in the network facility environment. Fiber splicing in the overhead cable rack, fiber duct or within a bay framework places the bare fiber at risk and is not an approved method and procedure for any CenturyLink location.

Refer to the Planning and Engineering Guidelines Equipment Configurations for approved product selection.

- The OSP rated fiber cable must be transitioned to low smoke indoor OFNR rated cable within 50 sheathed feet from the OSP cable entering into the network facility from an outside wall to conform to current applicable National Electric Code (NEC) limits and CenturyLink network policy requirements. To support this OSP cable length limitation, an approved FSF device must be placed within the 50 sheathed feet of the OSP cable’s entrance into the network facility through an outside wall. This length limitation includes all rise and run measurements along the cable route to the FSF.

- Only the use of OSP OFNR or OFNP indoor/outdoor rated transition cable will allow extension beyond the 50 foot rule.

NOTE: OFNP Plenum rated cable may be used in place of OFNR rated cable when the cable is intended to be routed in an air supply or return system. Refer to Chapter 10, Section 4.9 for OFNR and OFNP definitions.

- In no case may the OSP fiber cable bypass the FSF unless the cable is configured as Express Fiber and routed directly to a Co-Locator’s caged presence as defined in Technical Publication 77386. In such applications if the cable path to the Co-Locator’s cage measures beyond 50 sheathed feet of the cable entering the network facility, the OSP cable must be of an Indoor/Outdoor fire rating and identified by a continuous yellow tracer on the outer cable sheath.

3.4.1.1 Locating FSF in Network Equipment Environments

- In all cases, a FSF located inside the network facility environment is the first choice for a FSF device.
- Due to the limited space within manhole zero (MH0) and the increasing fiber demands of the network, all splicing activity and FSF components shall be located within the network facility where possible regardless of previous practices. Exception is noted as preference option 3 in the following MH0 should contain a restoration slack loop stored and accessed only in the event of a network facility disaster recovery. Proper planning of structured facilities entering and leaving MH0 is essential to maintain through continuity. Use of MH0 as a Point Of Interface (POI) is not recommended for CenturyLink network fiber architecture when other options are available.

Locating the centralized FSF shall be planned in the following order of preference:

1. Rack mounted and located in the equipment environment and within 50 sheathed feet of the OSP cable entering into the network facility through an outside wall.

2. Splice Case located in the Cable Entrance Facility (CEF), also known as the cable vault, within 50 sheathed feet of the OSP cable entering into the network facility through an outside wall.

    - Additional criteria discussed in section 3.4.1.2 must be met before fusion splicing may occur inside the network facility CEF.

    - If the CEF cannot meet the minimum requirements as defined in section 3.4.1.2, the splice case may be stored within the CEF with a sufficient cable slack loop to allow splicing activity outside the CEF within the network equipment environment.

    - Splice cases used within the network facility (within the cable vault and/or network facility equipment environment) must be fire rated for indoor applications and approved by the appropriate CenturyLink representative responsible for Fiber products.

3. Splice Case located in Manhole Zero (MH0) or subsequent manholes when locating the splice facility within the network facility is not feasible.

- At no time will splice cases be placed on horizontal cable racks or grid type rack. These cable support systems are designed to support distributed cable weight, not the concentrated weight of a fiber splice case. Additionally, placement of splice enclosures on horizontal cable rack or grid type rack will block or inhibit the installation of future cable.

3.4.1.2 Locating FSF in Cable Entrance Facilities – CEF (Cable Vault)

In all cases, a rack mounted FSF located in the network equipment environment is the first choice for an FSF device.

NOTE: Gas seepage in the area of an enclosed cable vault (cable vault surrounded by four walls) can be hazardous to personnel. Equipment fusion splicing requires the use of an ignition source.

CenturyLink permits fusion splicing in CEF's only after all of the following conditions have been met:

- Every effort has been made to locate the FSF within the network equipment environment. This applies even if fusion splicing has been performed previously within the CEF.
- All CEF's shall be equipped with forced ventilation to maintain appropriate oxygen levels.
- All CEF's shall have the appropriate signage and alarming.
- All cable penetrations within the CEF have been properly sealed and fire-stopped.
- Atmospheric testing, including testing for acceptable oxygen and combustible gas levels, must be performed to ensure the absence of potentially hazardous atmospheres.
- Continuous atmospheric monitoring, including oxygen levels and combustible gases, must be performed throughout the fusion splicing activities.
- All CEF's shall be inspected and documented in accordance with CenturyLink Safety and Loss Prevention Program SLPP Section 2.41.
- OSP construction manager must approve of vault splice activity.

3.4.1.3 FSF Selection

Selecting a Fiber Splice Frame (FSF) device is dependent on several factors:

- Size of the Network Facility (current and future)
- NEBS requirements
- Distance from OSP rated cable sheath penetration into the network facility from an outside wall.
- Number of splices required and fiber type (stranded or ribbon fiber)
- Potential for future growth and scalability.

<u>Dedicated Fiber Splice Bays:</u>

- When locating the FSF in the network equipment environment, a network bay dedicated to fiber splice shelves shall be planned and designed for all offices with more than 1008 OSP terminations.
- Dedicated fiber splice bays shall be planned adjacent to one another in a dedicated fiber splice lineup as much as possible. If floor space is limited, FSF bays may be planned in the same lineup as the dedicated fiber distribution bays, but every effort shall be made to segregate the splice bays from the distribution bays.
    - Most dedicated fiber distribution bays are equipped with integrated fiber troughs that allow for inter-bay cabling of fiber cross connects. Placement of dedicated fiber splice frames in the middle of a distribution lineup, or blocking the growth end of a distribution lineup, will disrupt the growth of the integrated fiber troughs and routing of the fiber cross connects.

<u>Combination Fiber Splice/Distribution Bays:</u>

- For smaller network facilities where large fiber volume is unlikely, it is permissible to co-locate the fiber splice in the same bay as the fiber distribution.
- Up to two splice/distribution bays may be placed within a single office.
- If growth demands require additional splice or distribution beyond the capacity of two combination splice/distribution bays, a new dedicated fiber splice bay (possibly in a dedicated splice lineup) shall be planned and designed.
- Combining distribution and splice in a high density fiber distribution framework is not recommended due to maintenance and reliability issues that may result from the high density of terminations per panel.

<u>Combination Fiber Splice/Distribution Panels:</u>

- For smaller network facilities where large fiber volume is unlikely, it is permissible to co-locate the fiber splice and distribution within the same panel designed and approved for such purpose.
- Multiple combination splice/distribution panels may be placed within a single network bay.
- If growth demands require additional space beyond two bays of combination splice/distribution panels, a new dedicated fiber splice bay (possibly in a dedicated splice lineup) shall be planned and designed.
- Combination splice/distribution panels shall not be used for ribbon fiber applications due to the high number of terminations and the pre-terminated fiber type.

Refer to the Planning and Engineering Guidelines equipment configurations for specific approved product selection.

3.4.2 Centralized Fiber Distribution Frame (FDF)

All Network Facilities shall be planned for a designated centralized Fiber Distribution Frame (FDF) location within the equipment environment. In small offices, the FDF may be an individual bay or panel, whereas larger offices will provision for multiple bays and lineups, including future growth requirements.

Those offices with multiple fiber distribution locations shall consolidate to a centralized FDF arrangement as soon as practicable to support optimum network performance. Multiple distribution locations contribute to additional loss to the optical span, create additional points of failure, and increase maintenance challenges.

- Centralized FDF lineups shall be planned for maximum growth wherever possible and in no cases shall exceed 50 feet in total equipment lineup length.
- FDF bays shall be placed contiguously within an FDF lineup.
- FDF growth patterns must be closely watched to insure deployments will have a clear growth route.
- Planning functions shall be done with the ultimate FDF lineup length in mind.
- Floor plans shall be clearly marked, and all planners dealing with the office should be advised of the location.

The FDF shall be established and planned as either a cross-connect or inter-connect arrangement. Both provide a main centralized distribution area.

- The cross-connect FDF’s are well suited for medium to large offices (greater than 1008 total OSP optical terminations) where a centralized location to perform all modifications, circuit re-arrangements, upgrades and maintenance activities, increases maintenance efficiencies and reduces cycle times.

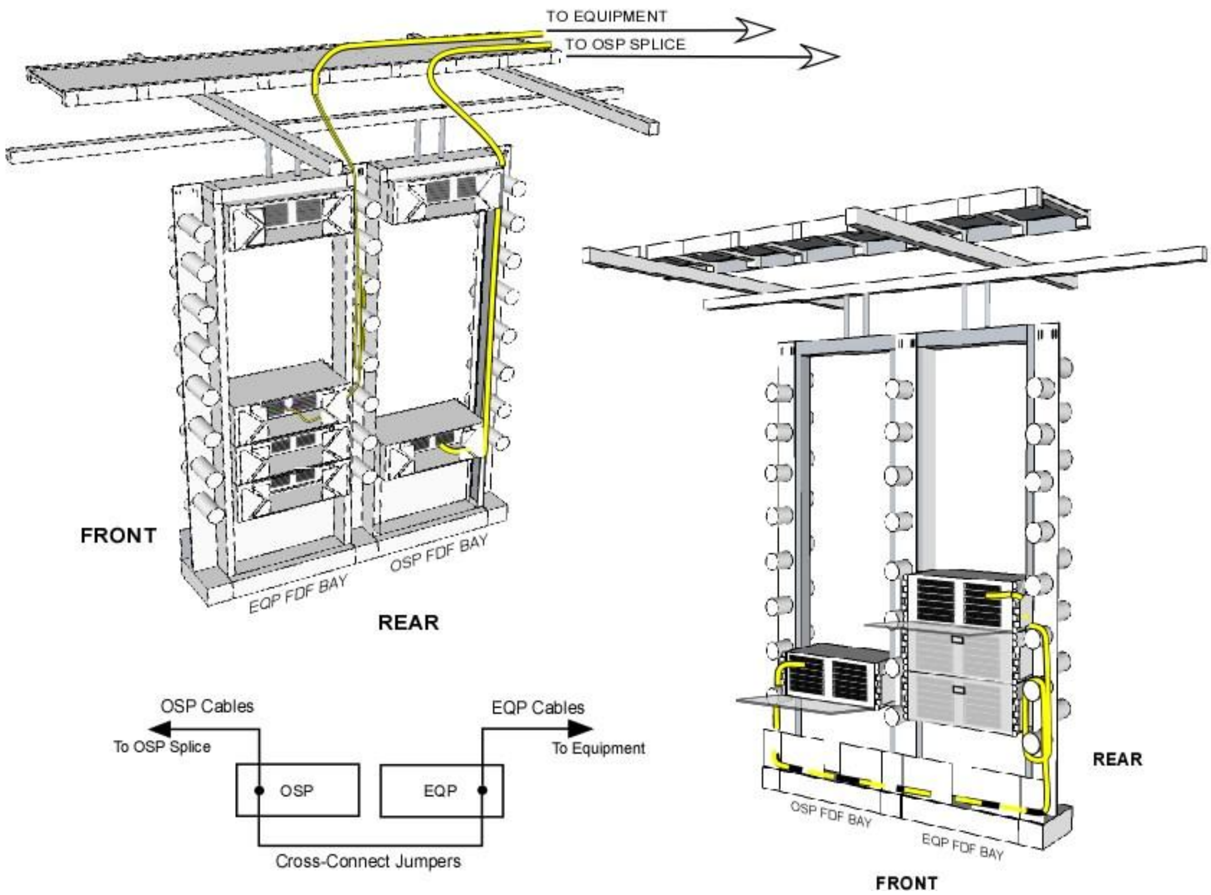
- The inter-connect FDF’s are more practical for smaller network facilities, remote offices, and fiber huts (1008 or less total OSP optical terminations) where space for additional bays or panels is limited.

3.4.2.1 Cross-Connect FDF

In a cross-connect arrangement, the FDF bay and fiber distribution panels are dedicated to either OSP terminations or equipment (EQP) terminations. After the OSP cable is spliced to connectorized indoor rated cable, it is routed and terminated to the rear of a panel dedicated to OSP terminations. Fibers originating from the equipment are routed and terminated to the rear of a panel dedicated for EQP terminations located in the same FDF lineup. A cross-connect jumper is used to complete the connection between OSP and EQP fibers using adapters on the front side of the panels.

The cross-connect FDF design allows the total number of fibers from high density cards or optical patch panels (OPP) placed within the equipment environment to be terminated in a central location where a fiber jumper can quickly be installed to complete the connection and provide service to individual customers on demand.

FIGURE 3.6 Cross-Connect FDF



- Cross-connect FDF arrangements shall be planned for medium to large offices with more than 1008 OSP terminations and space to accommodate multiple adjacent FDF bays in the same lineup.

- Cross-connect FDF arrangements shall dedicate fiber bays for OSP terminations and equipment (EQP) terminations and will be separated by the appropriate fiber management spacer. FDF bays shall be designated as such on the drawing records.

- To maintain a short jumper concept, it is recommended to alternate dedicated OSP fiber bays and EQP fiber bays in the same contiguous lineup.

- All EQP to EQP connections shall be run from the network element (NE) to the centralized FDF for cross-connect. Direct inter-connection between network elements shall be avoided when there is an established centralized cross-connect FDF. Exceptions will be documented in the standard configuration for the given network element device.

- Bays within a centralized cross-connect FDF arrangement shall be labeled as shown in the table below to differentiate the use of the FDF bays within an FDF lineup.

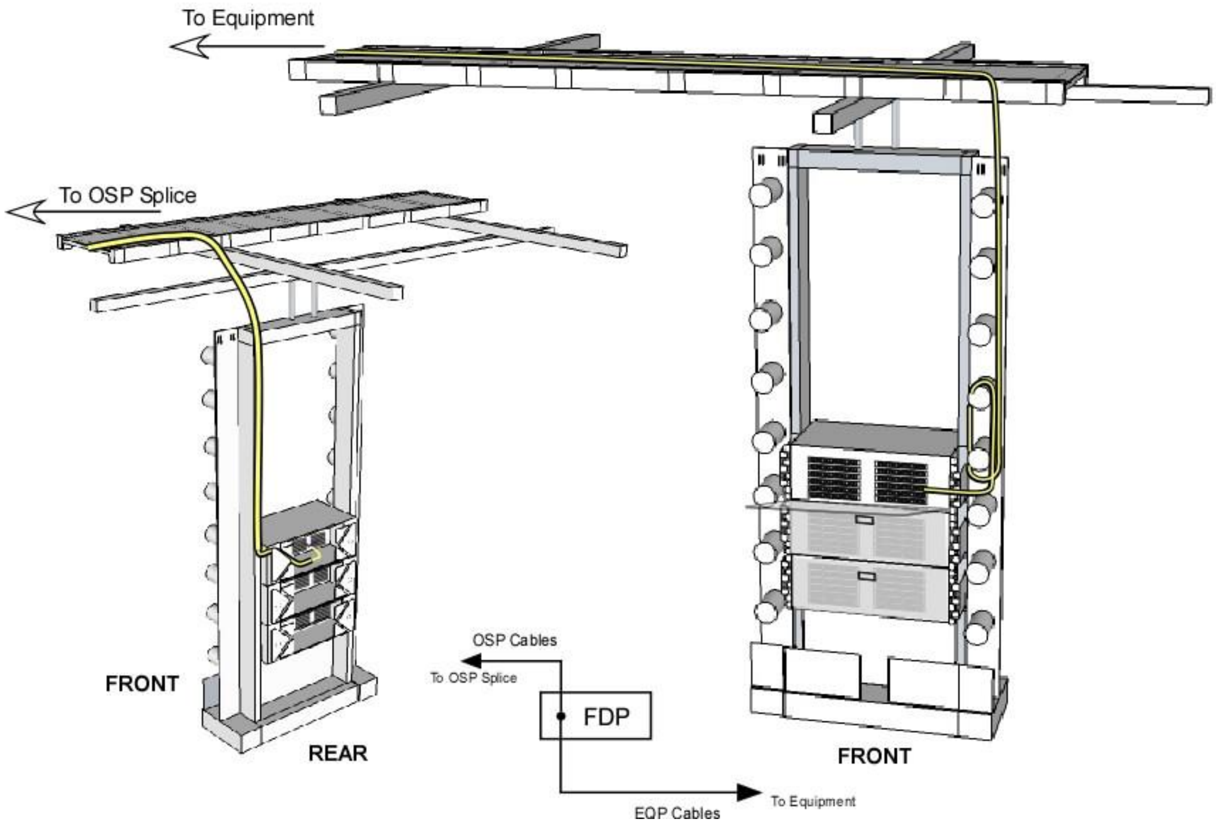
FDF Bay Description	**FDF bays terminating equipment fibers from the network**	**FDF bays terminating OSP fibers from the fiber splice**	**FDF bays containing distribution and splice panels within the same bay**
Label	EQPT	OSP	FDF

- FDF bays shall be placed contiguously within an FDF lineup. Most FDF bays and fiber management spacers are equipped with interconnecting trough systems to provide an easy to follow fiber path to support connections between bays. For this reason, FDF bays within an FDF lineup shall be contiguous and not interrupted by building columns, other non-FDF bays, miscellaneous equipment or office furniture. Any break in a contiguous FDF lineup will result in a new frame name assignment and the use of tie cables between the non-contiguous FDF bays.
- To avoid premature FDF exhaustion and to efficiently manage fiber cabling and fiber jumper lengths, FDF's shall not be utilized to the highest density allowed by the supplier design.
- Panel space at the top of each FDF bay must be reserved and allocated to terminate tie cables only for inter connection to future FDF lineups.

3.4.2.2 Inter-Connect FDF

Inter-connect arrangements allow for a direct connection between OSP and EQP terminations. After the OSP cable is spliced to connectorized indoor rated cable, it is routed and terminated to the rear of a distribution panel. Fibers originating from the equipment are routed and terminated to the front of the same distribution panel completing a direct connection between OSP and EQP.

FIGURE 3.7 Inter-Connect FDF



- Inter-connect arrangements do not allow for pre-termination of future network element (NE) fibers or large volumes of fibers predominant in medium or larger network facilities.

- Inter-connect FDF arrangements shall be limited to small offices that will not grow beyond two bays of fiber terminations (1008 or less OSP terminations). Typically, small offices with low fiber demand have fewer fiber maintenance activities and are usually subject to floor space constraints that are non-conducive to a cross-connect FDF arrangement.

- Any EQP to EQP connections shall be made directly between NE's.
  - Approved fiber management devices must be provisioned within the network element equipment space when engineering direct EQP to EQP inter-connects. All excess cable slack shall be managed within an approved fiber management device and shall not be stored within the overhead cable rack or fiber duct systems. Improperly managed fiber cables may lead to circuit degradation and impact network reliability.

- Inter-connect FDF arrangements can be planned as a single FDF bay dedicated to fiber terminations, a single FDF bay containing a combination of splice and fiber distribution panels, or as a single fiber distribution panel (FDP) that combines splice and terminations within the same panel.

  - Selection of an inter-connect arrangement is dependent on the number of fibers requiring termination and the available space on the equipment floor or within existing framework bays.

- Fiber distribution frame assemblies designed for high density applications shall not be used for inter-connect arrangements. High density FDF designs shall only be utilized to support cross-connect FDF arrangements.

  - High density FDF assemblies typically utilize large base footprint framework and place more demand on floor space requirements. High density frames also require larger cable rack/fiber duct to support the increased volume of fiber cables. Small offices suitable for inter-connect FDF arrangements typically do not have the overhead cable support infrastructure or the floor space to accommodate an assembly of this design.

- Inter-connect FDF bays shall be equipped with a 5 inch inter-bay management panel (IMP) on each side of the FDF bay wherever possible. An IMP is a 5 inch spacer with fiber management dowels attached to the face of the space filler panel.

- Stand alone inter-connect FDP panels shall utilize an approved fiber management device such as a panel or shelf. These fiber management devices shall be installed within the same bay when possible. Use of IMP spacers is also acceptable where space permits.

- FDF bays containing a combination splice and inter-connect FDPs may be planned for offices with 1008 total OSP optical terminations. If more than 1008 OSP terminations are required or forecasted, a dedicated splice facility (FSF) shall be provided.

All excess cable slack storage shall be managed within an approved fiber management device specifically designed for fiber cable storage. Improperly managed fiber cables may lead to micro bends and circuit degradation and impact network reliability.

3.4.3 Fiber Distribution Panels (FDP)

Fiber Distribution Panels (FDP) are termination panels used within an FDF system to provide the connection point and circuit identification for OSP fiber or cross-connect to other EQP fibers.

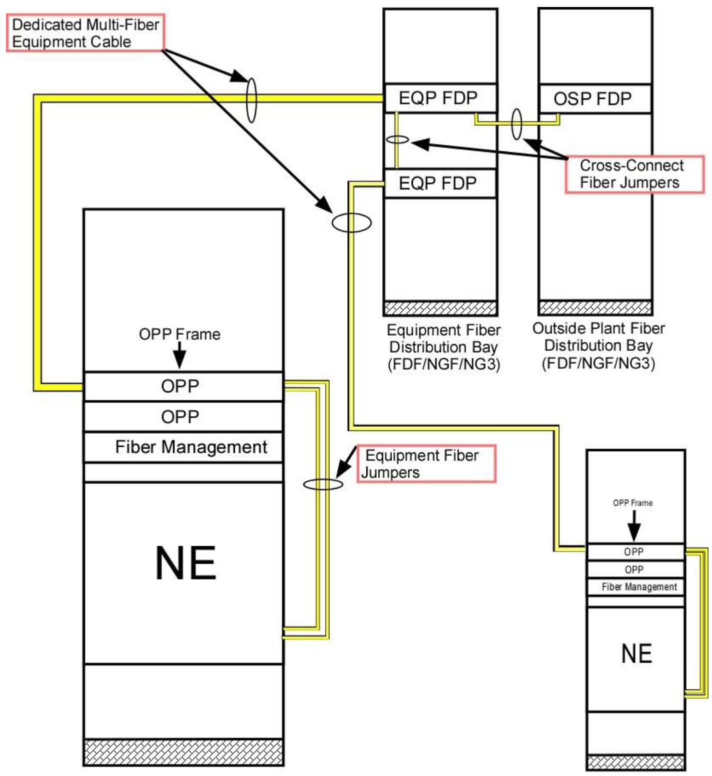
- FDPs shall be placed in bays dedicated to fiber equipment wherever possible.
    - Segregation from electrically cabled equipment is desired to protect fiber cables provisioned for large customers and high bandwidth demands. For applications that must mix FDPs in the same framework or cabinet as copper equipment, every effort must be made to segregate the fiber and copper cabling. This can be achieved by the use of 2x2 vertical slotted fiber duct, IMP spacers, fiber trough, or cable routing on opposite sides of the bay.

3.4.4 Optical Patch Panels (OPP)

Optical Patch Panels are termination panels placed in the network element (NE) equipment environment.

- OPPs may be placed within an equipment bay or cabinet of fiber dense equipment technologies as a means to consolidate fibers routing to a common fiber distribution frame.
- OPPs shall be placed near the top of the equipment bay or cabinet but below the fuse panel whenever possible to avoid congestions or interference with other NE cables.
- Style and type of OPP are typically defined in the Planning and Engineering Guideline configuration document for the given NE equipment where cable access, routing and slack management are fully considered.
    - The OPP is cabled to the centralized FDF lineup using a multi-fiber dedicated equipment cable. Responding to customer demand, fiber jumpers are used to complete the connection between the OPP and optical interface at the equipment. In OPP applications, cycle time and cost are reduced for subsequent circuit turn-ups as orders can be issued via auto flow through provisioning, and cable installation in the overhead cable support system is avoided.

FIGURE 3.8 Optical Patch Panel



- OPPs may be provisioned in offices with an established cross-connect FDF arrangement
    - A dedicated EQP panel is required at the FDF end to provide a means to terminate the multi-fiber dedicated equipment cable originating from the OPP. Inter-connect FDF arrangements generally lack the panel space and fiber management to support the cross-connect jumpers associated with the OPP application.
- All EQP to EQP connections shall be run from the NE to the centralized FDF for cross-connect.
    - Direct inter-connection between NEs shall be avoided when there is an established centralized cross-connect FDF. Cabling between OPPs in different NE bays is not recommended as it increases the TIRKS® CLLI code requirements and the associated billing elements as well as creates maintenance challenges.

- Approved fiber management devices such as IMP type spacers or horizontal storage panels shall always be engineered and installed when OPP's are provisioned within an equipment bay or cabinet.
    - o Equipment manufacturers typically do not design their equipment shelves with adequate fiber management. Therefore, additional fiber management must always be provisioned to support the jumper connection in OPP applications.
- Direct inter-connection between equipment optical interfaces in different bays or cabinets, by-passing the centralized cross-connect FDF is only advised when the equipment is an optical system with a purposefully designed fiber routing path or specifically identified within the standard configuration document for the given equipment.
    - o An optical system in this context is defined as multiple adjacent bays or cabinets with equipment carrying the same network CLLI codes in TIRKS®. To maintain consistency and reliability, the system fiber routing path is designed and documented within the Planning and Engineering Guidelines standard configuration for the given equipment. Bay and cabinet placement must be adjacent. Direct inter-connection between non-adjacent bays in facilities with a centralized cross-connect FDF is not recommended even if the equipment carries the same CLLI.

3.4.5 Fiber Cable Support System

- Within the CenturyLink network facility, there are two main support and routing systems utilized for fiber optic cables:
    - Ladder type cable racks (approved company-wide). Refer to Chapter 6 for engineering requirements.
    - Fire rated duct-type fiber protection system (FPS). Conditionally approved in limited locations. Refer to Chapter 6, Section G for engineering requirements.
- Fiber cable assemblies may be run on approved cable support brackets attached to cable rack stringer or auxiliary framing in specific conditions not capable of placing cable rack or FPS. Support brackets must be placed 6 inches on center or less.
    - Network facility floor surface, exterior to an equipment cabinet is prohibited as a component of fiber optic cable support system, temporary or permanent (except in raised floor environments where fiber is run under the floor. Refer to Chapter 13

Raised Floor Environments for engineering requirements). All new fiber optic cable must be installed using an approved fiber optic cable support system as listed above.

- Wherever physically possible, fiber cables will be segregated from other types of network facility cables (i.e. power and switchboard) to provide the required isolation and protection. Ideally, fiber cable support systems dedicated to fiber optic cable only should be planned.
    - For existing arrangements, where the fiber cable support system must be shared by cables of differing types, every effort must be made to segregate the cable types for all new cable installations to prevent damage. This is best accomplished by routing cables as straight as possible while maintaining minimum bend radius requirements along the cable route path.

- Storage of excess cable slack within the cable support system (e.g. cable rack, grid type rack, or fiber duct) is strictly prohibited.
    - Storage of excess cable length in the cable rack/fiber duct systems prematurely exhausts the support system, creating cable route obstructions, increases the vertical load of the support system, and introduces micro bending and pinched fibers, all of which negatively impact network reliability.
    - Minimize excess slack to decrease the potential combustible material.

- Specific hardware and application information regarding the approved cable support systems are located in the standard configuration documents specific to common systems.

3.4.6 Fiber Management

- Fiber cross-connect systems shall always be engineered with fiber cable storage devices.
    - All excess cable slack storage (multi-fiber cables and/or equipment fiber jumpers) shall be managed within an approved fiber management device specifically designed for fiber cable storage of the cable size being installed.

Fiber cable storage devices can be configured in the vertical space adjacent to a bay frame, such as an IMP spacer (a network spacer equipped with fiber spools mounted on the filler panel) or in the horizontal space within the equipment bay or cabinet.

- Selecting the appropriate storage device is dependent on the available space and ultimate storage capacity required.

- Appropriate fiber storage devices are recommended for specific technology deployment outlined in the standard configuration documentation for that equipment.
- Refer to Chapter 10, section 10.4.8 for additional information related to fiber management.

Contents

FIGURES

4 Power Facilities – Battery/Rectifier (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. 9.4. AC wiring is contained in Technical Publication 77385 sec 1.4.

4.2 Rectifier Plants

A typical power distribution plant is shown in Figure4.2A-1. See Technical Publication 77385 for specifics.

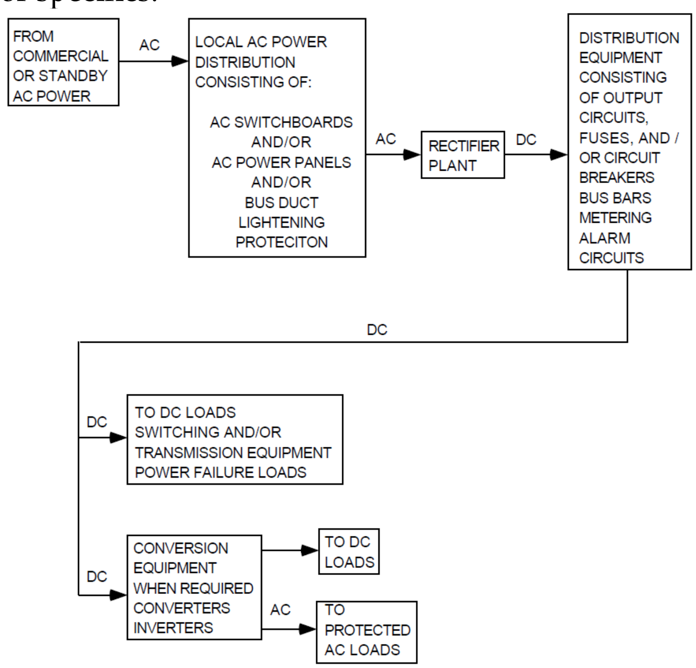


Figure 2-C1-1 Power System

FIGURE 4.1: 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 Centurylink 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 other type that have completed the Centurylink product selection procedure. Bare wire setscrew type connectors are not acceptable for DC connections.

All DC power connections for both supply and return will utilize crimp type copper connections. Connectors for direct battery connections are defined in Section 2.2 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 battery return bus bar will be a two-hole crimp only. Exceptions to the “two-hole” requirement are allowed for battery return bus bars rated at 50amps or less.

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 shall be no longer than 3 ft in length, except for vertical runs in manufacturer's equipment, and shall never be run on a cable rack with switchboard or other power cable. .

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 for 1-1/4" and smaller. 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 in network facilities (Customer Premise, CEV's etc are exempt from requiring dedicated power rack). 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 9.2 for specific requirements for independent feeds to Telecommunication Equipment Loads.

The minimum bending radius of ground conductors shall be 8 inches (12" is preferred). Details for ground conductors can be found in Module 1, Chapter 5 and in Centurylink Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment".

4.3 Charging Equipment (Rectifiers)

For Requirements on Charging Equipment (Rectifiers) 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.

EXHIBITS

5 Network Facility 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 over-current 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/Network Facility Equipment 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 CenturyLink Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environments". 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 CenturyLink 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, CenturyLink Technical Publication 77355 (see Reference Chapter), and this engineering standard. If conflicts occur, the CenturyLink Equipment Engineer should be consulted.

5.2 Integrated Ground Systems

5.2.1 Integrated Ground Plane

The Integrated Ground Plane (also known as the "non-isolated" plane in the PANI system) includes the CO GRD system, which consists of the principal earthing electrode, various supplementary electrodes, the Office Principal Ground Point Bus OPGPB (or MGB in a PANI system), the office vertical equalizer (riser), CO GRD bus bars connected to the riser, or floor ground bars in the PANI system (FGB). 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 not located in an isolated plane. 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 the DC power plant discharge ground (return). Since the CO GRD provides a path in parallel with the discharge ground conductors in older equipment, 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 and Technical Publication 77355, Chapter 5..
- 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 over-current 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 (or PANI MGB) 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 750KCMIL green insulated stranded 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 multi-floor building and a Horizontal Equalizer on every equipment floor requiring earth reference. Bonding and grounding conductors shall be made of copper; CenturyLink prohibits Aluminum grounding wire of all types. Conductors may be wire, bus bar or braided strap. Wire may be stranded or solid, insulated or bare, and shall generally not be smaller than No. 6 AWG or equivalent.

- 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.) Refer to CenturyLink Tech Pub 77355 for additional requirements.

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

5.2.3 Alternating Current Equipment Ground (ACEG)

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 ACEG is commonly referred to as the "green wire ground". The ACEG 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 ACEG must satisfy the NEC and local codes. Local codes are frequently more stringent than the NEC.

2. Specific requirements for the ACEG are shown in the Grounding Engineering Requirements in this chapter and in detail in CenturyLink 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 ACEG 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), 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", “PANI MGB” or “FGB bar”.

- 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 in a non-PANI site is spherical with a maximum radius of three feet.
- The Main Ground Bus (MGB) in the ground window (not to be confused with the Master Ground Bar of the PANI system) 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. 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 in non-PANI sites. 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, 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. 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.

Details of the Isolated Ground Plane are beyond the scope of this standard. Consult CenturyLink Technical Publication 77355, Telcordia GR-295, or the equipment engineer should questions arise.

5.4 Ring Ground System

5.4.1 Exterior Ring Ground

The exterior ring ground establishes a station ground electrode that tends to equalize potentials in the earth surrounding the building (and tower for sites with microwave radio) 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 30 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 (or irreversibly crimp-connected with a connector listed for direct-burial) to the ring at 10 to 20 foot intervals to ensure contact with moist earth. The exterior ring is connected to the interior ring or OPGPB/PANI MGB 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 connected to each metallic tower leg. 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.

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 30 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 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 interior 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 CenturyLink Technical Publication 77355 (see Reference Chapter) or the CenturyLink 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 is separated from the switching system equipment when they are located in a COE area. Operations Support Systems (OSS) is 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 (SRG) system is recommended. In the SRG system all components are effectively bonded together to create a common signal reference ground plane. The SRG system forms a complete equi-potential ground reference point for the raised floor computer equipment. This equi-potential 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 CenturyLink Technical Publication 77355 (see Reference Chapter) or the CenturyLink 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 CenturyLink 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 or copper clad steel rods shall be used. The 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, triangle, or straight line of at least 4 rods per Technical Publication 77355 and section 5.6.
- 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.

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 shall be bonded to the Office Principal Ground Point Bus (OPGPB) as a supplementary electrode.

C. Ground Well

- The diameter of the well caisson shall be at least two inches.
- The depth of the well shall be at least 40 feet and no greater than 250 feet.

5.6.3 Central Office Ground (CO GRD)

The Vertical Equalizer (Riser) shall be an uninterrupted length of 750KCMIL 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 conductors 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 except for chassis grounds and ESD cabinet grounds.

All connections 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.

Risers shall not be enclosed or encircled by any metallic support or metallic conduit without proper bonding at both ends.

5.6.4 Alternating Current Equipment Ground (ACEG)

The design of the ACEG shall satisfy the NEC and any local code that applies. In all cases, an ACEG 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 ACEG even if the applicable code should allow the practice.

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

An appropriately colored (green) ACEG shall always be provided in AC conduits and raceways. (Do not use bare ACEG 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 750KCMIL stranded insulated conductor.

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

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 Further Information

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

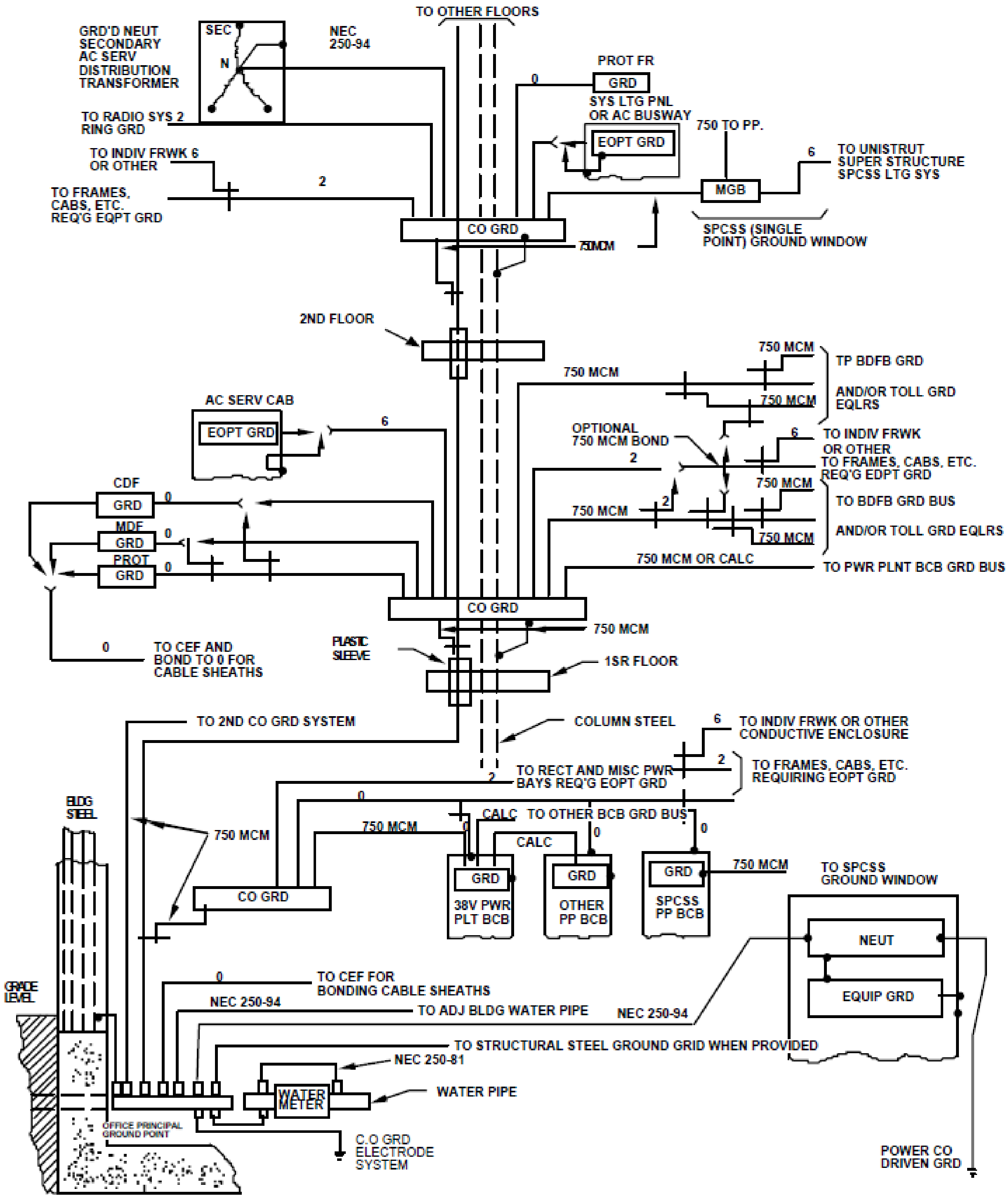


EXHIBIT 2-D-1

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

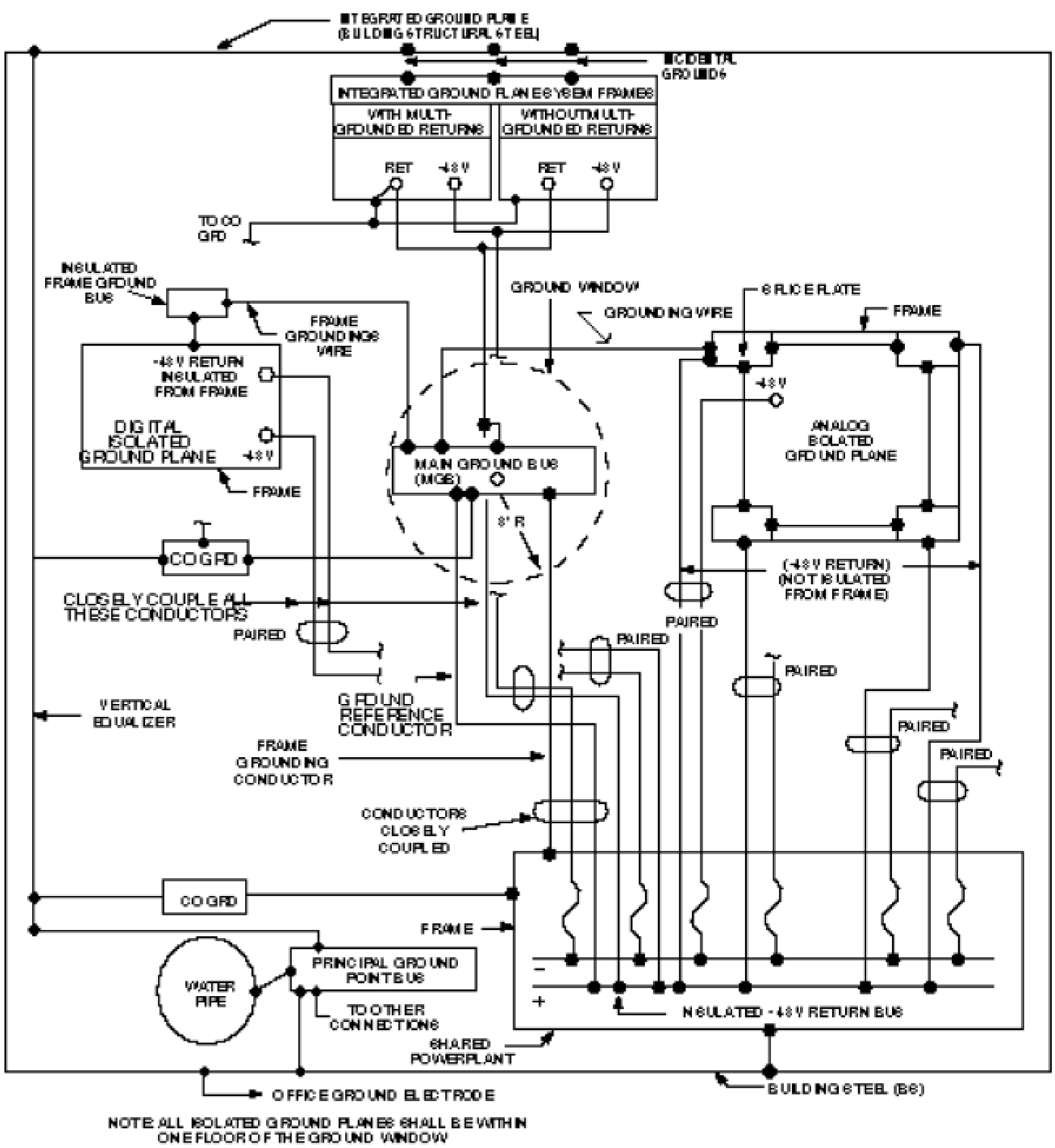


EXHIBIT 2-D-2
2-D-2 GROUNDING FOR INTEGRATED AND ISOLATED GROUND PLANES POWERED FROM A COMMON POWER PLANT

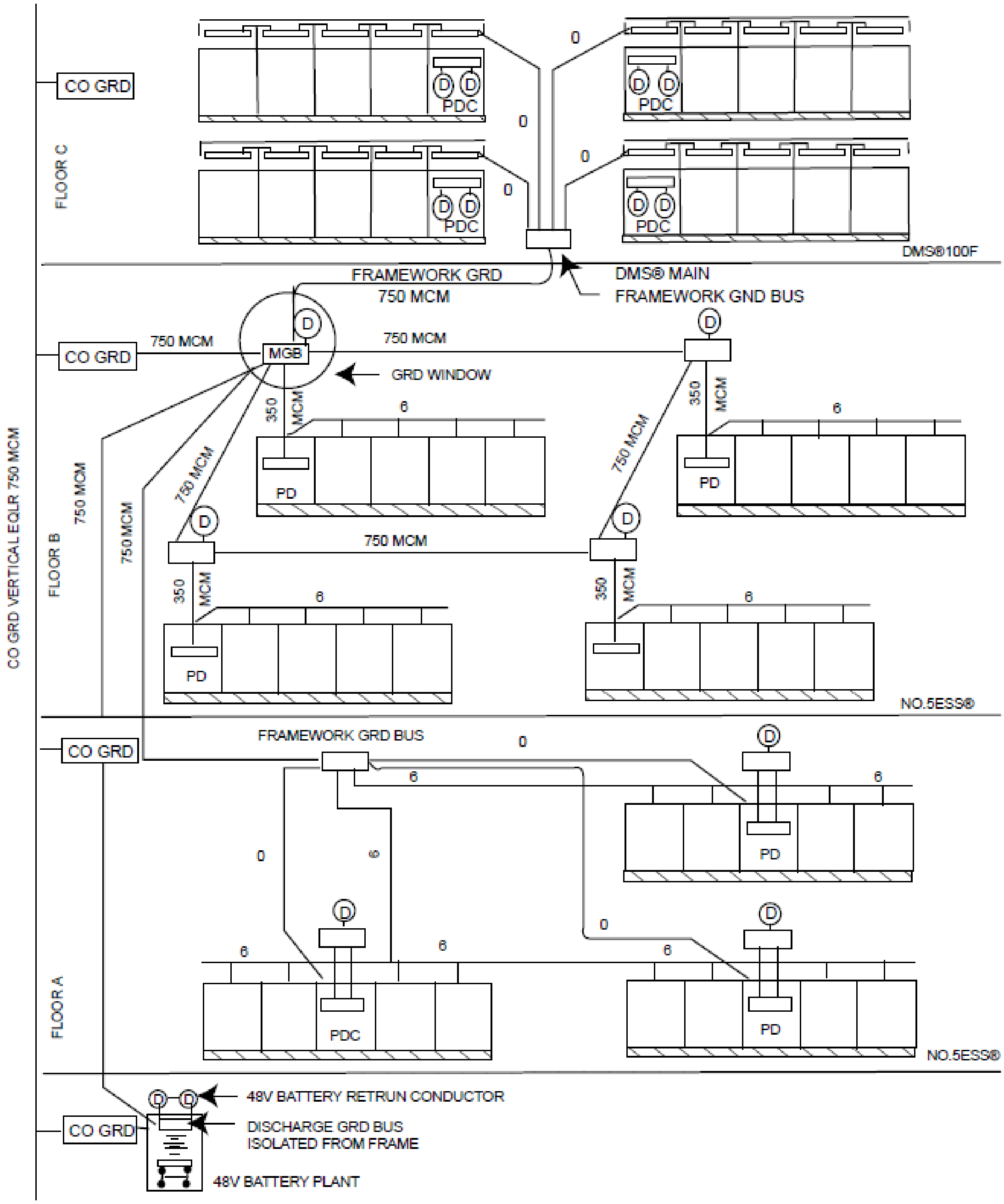
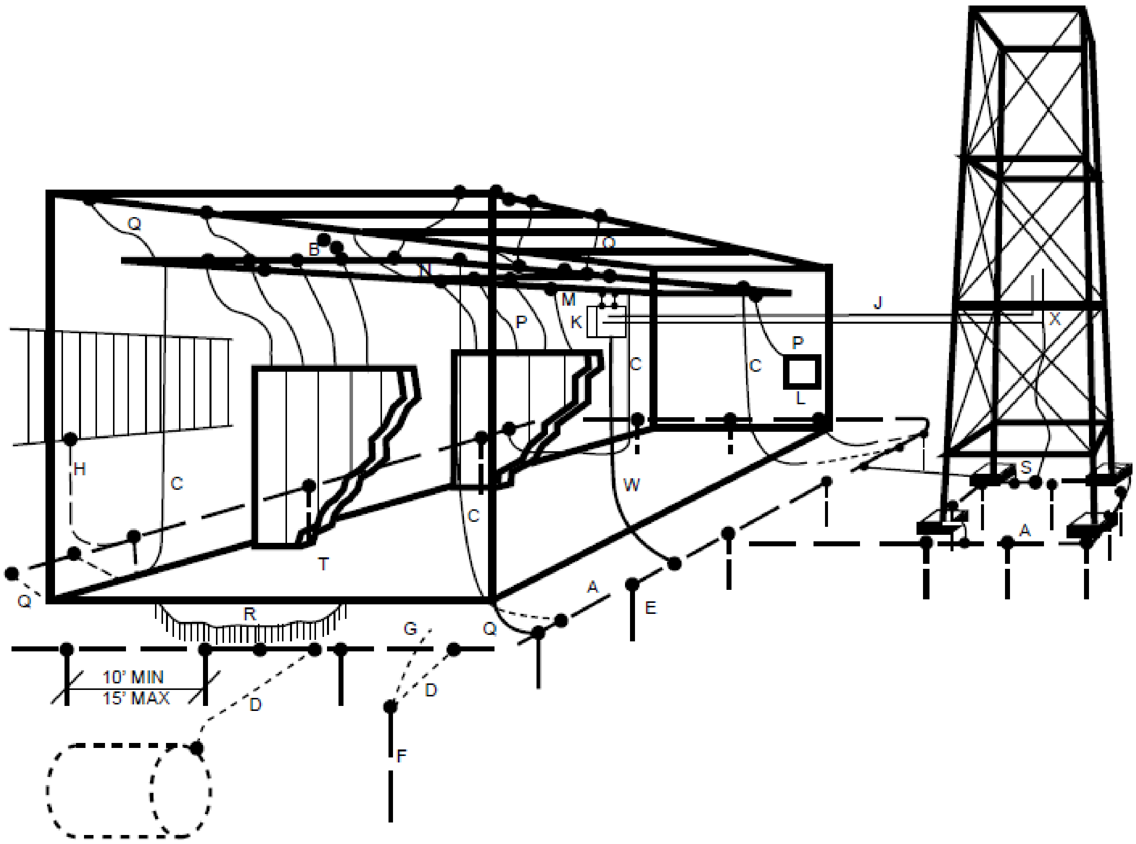


EXHIBIT 2-D-3
2-D-3 MAXIMUM MULTIFLOOR STORED PROGRAM CONTROL SYSTEM (SPCS) GROUND PLANE SPREAD WHEN A SINGLE SPCS DEDICATED POWER PLANT SUPPLIES POWER TO ONE OR MORE SPCS OFFICES



LEGEND

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

EXHIBIT 2-D-4

2-D-4 MICROWAVE GROUND SYSTEM AND PRINCIPLE GROUND BONDS

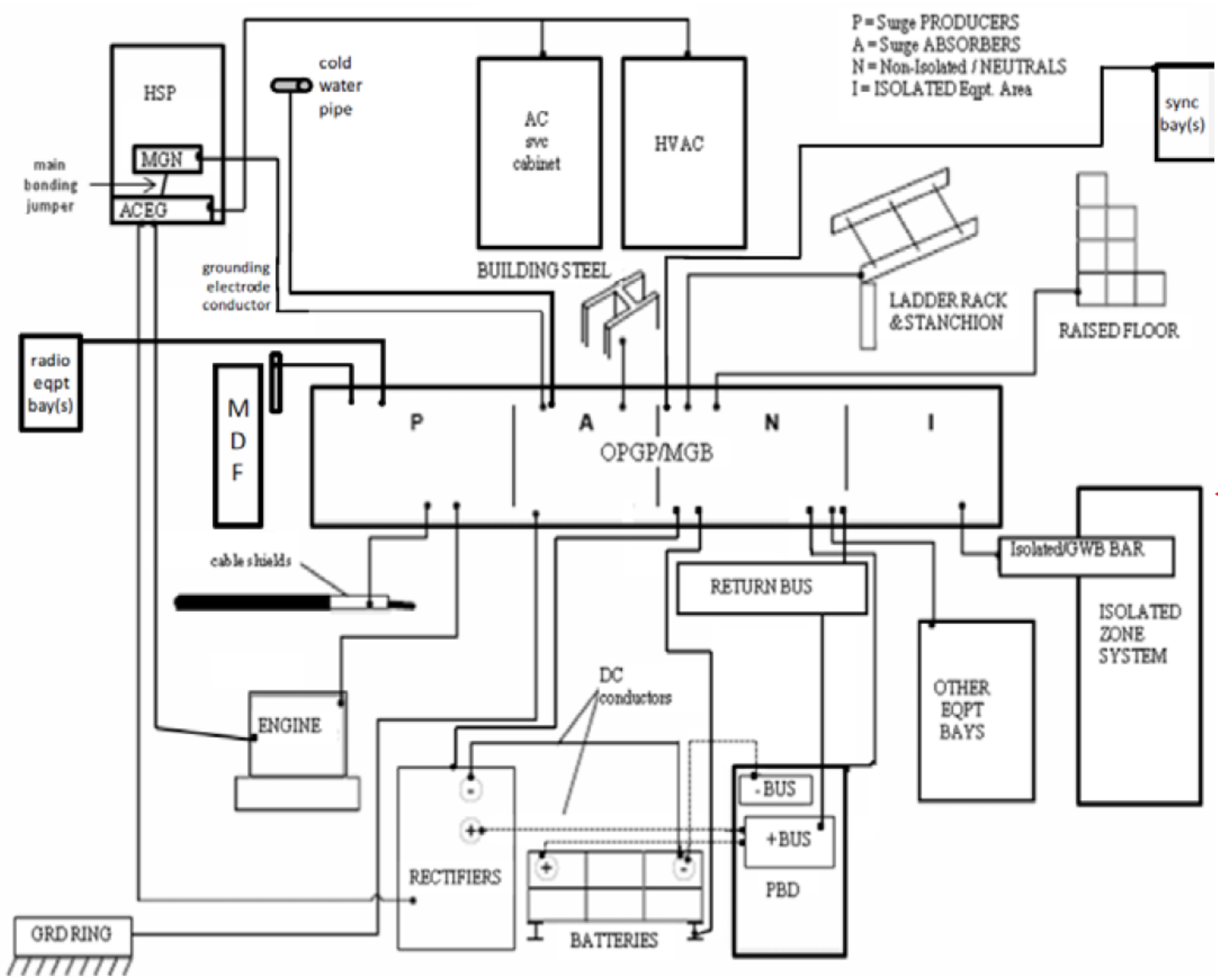


EXHIBIT 2-D-5

2-D-5 PANI EXAMPLE

Contents

EXHIBITS

TABLES

6Cable Rack and Auxiliary Framing

6A. Cable Rack

6A.1 General

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

Any material referenced throughout the chapter refers to currently approved CenturyLink material.

- The information in this chapter is intended to address allowable engineering and installation practices. Practices that are not defined shall be verified with Common Systems Standards prior to engineering or installation.
- Cable rack shall be engineered for telecommunications equipment cabling (switchboard, fiber, and power). Other types of cabling such as AC cabling shall not be intermingled, routed, or supported on racks designated for these uses. Segregated cable rack for other uses shall be reviewed and approved by the CenturyLink representative responsible for common systems standards.
- 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.
- Clamps, bolts, fabrications, etc. shall be assembled per the Exhibits unless prohibited by office conditions and shall be reviewed and approved by the CenturyLink representative responsible for common systems standards..

- Assemblies and components shall be produced by approved manufacturers only. Special components and/or assemblies shall be evaluated and approved following current CenturyLink process.

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

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 CenturyLink representative responsible for the approval of products for common systems may approve the use of other colors of paint.

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

- Plating shall be able to be distinguished from non-plated components. For example, coloring added.
- Where hardware is intended for bonding purposes, refer to CenturyLink Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines" and CenturyLink 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 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 rack is manufacturer discontinued (MD). Environments using bar type cable rack shall be extended using ladder type 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.2.3 Grid Type Rack

Grid type cable rack is manufactured in sections consisting of multiple 1 ½" stringers spaced at 12 inches on center and welded together in specified lengths. Straps consist of round tubes spaced 6 inches apart.

- Environments currently using grid type cable rack may continue to use the grid type cable rack to the logical conclusion of the environment.
- Grid type cable rack shall not be used in any new equipment environments, buildings or floors where grid has not already been established.
- Where feasible, grid type cable rack shall transition to ladder type cable rack.
- The manufacturer's design requirements must be followed for the existing grid system.
- Equipment with high heat dissipation will require additional Real Estate evaluation to provide appropriate cooling support. Refer to Chapter 2, Table 2.1A, and Chapter 2, section 2.2.3 for heat dissipation requirements.
- CenturyLink heat dissipation processes and guidelines must be followed when placing high heat dissipation equipment in the grid type cable rack environment.

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:

SAFE LOADS	
MATERIAL	**POUNDS**
5/8-11 threaded rods	1200

Embedded Ceiling inserts (poured in place)	1200
Beam Clamps	800
5/8 inch expansion anchors	480
3/8″ lag screws for wood (2″ or more in length)	300
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
More than 2 feet 0 inches to 3 feet 0 inches	1500
More than 3 feet 0 inches to 5 feet 0 inches	1000
More than 5 feet 0 inches to 7 feet 0 inches	700
More than 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 be implemented where possible.

Cable shall be supported using approved cable rack except as noted:

- Existing Fiber Duct - Fiber cable only (see chapter 6G)
- Conduit -. Planning and Engineering Guidelines approval may be required.
- Cable Brackets – Primarily used to support ground feeders or fiber cable. Support of other cable types requires Planning and Engineering Guidelines approval.

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:

TABLE 6A.2 CABLE PILE-UP

SECURED CABLE PILE-UP IN TERMS OF SWITCHBOARD

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

UNSECURED 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	12 inches
30 inches	12 inches	9 inches

SECURED CABLE PILE-UP IN TERMS OF POWER CABLE

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

UNSECURED CABLE PILE-UP IN TERMS OF FIBER CABLE

WIDTH OF CABLE RACK	SUPPORTS ON 5 FEET 1 INCH CENTERS	SUPPORTS ON 6 FEET 0 INCH CENTERS
5 inches	5 inches	5 inches
12 inches to 30 inches	7 inches	6 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 unsecured switchboard cable rack for 15 inches to 25 inches may exceed the 12 inch pileup around corners, intersecting cable racks, or transitions from the cable rack.

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 5 inches for 5 inch wide cable rack or 12 inches for 12 inch and wider cable rack.

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 along cable routes spanning horizontal planes shall not exceed 9 inches without additional support.

- Usual lineup, via, and main aisle type cable runs shall be considered as a route. Cable extended from typical cable racking to a bay, DF vertical, or similar location would not be considered a cable route. Spur racks branched from racks to serve single or dual equipment frames or cabinets are not considered a cable route.

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

- At cable rack transitions, the cable rack will be assembled to provide support for the cable at 9 inch intervals as much as possible. Where the cable cannot be directly supported every 9 inches due to bend radius requirements, the cable shall be stitched together at 9 inch intervals using a Chicago stitch or similar securing method.

- 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 may 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 when possible, 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 Acceptable examples: Auxiliary framing, 1 inch steel support pipe, or existing cable rack stringers.

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, shall be secured at the offsets per the standards for securing vertical cable in Technical Publication 77350.

- All cables run on vertical cable racking shall be secured.
- All cable racks that are not horizontal shall be considered vertical. i.e. for cable rack with a change of height level, the vertical transition section of the rack must follow vertical cable rack securing requirements.

Horizontal cable racks not equipped with screen or pan, and cable brackets, require the securing of cable.

- 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 orange (or gray where existing and labeled as "fiber optic cable only") type cable racks or 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 CenturyLink Technical Publication 77350, (see Reference Chapter).
- Cables run on cable brackets, bars, or similar assemblies must be secured.

6A.4.4 Cable Slack Storage

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

- All excess cable slack (multi-fiber cables and/or equipment fiber jumpers) shall be managed within an approved fiber management device specifically designed for fiber cable storage of the cable size being installed.
- Utilizing cable with connectors on one end and stub on the other so cables could be field cut to the appropriate length where possible.
- Utilizing cables with connectors on both ends require a more accurate measurement and shall be ordered based on the minimum size length available from the manufacturer.
- Refer to standard configuration guidelines for additional cable options.
- 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.
- Nuts and bolts not specifically identified in the Exhibits shall be installed so that they will not come in contact with or damage cable. The threaded end of an assembly should be pointed away from cabling.
- Cables shall be run to the inside of cable retaining brackets and shall not remain looped to the outside of a bracket.

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.

- Transitioning from one cable rack to another at points other than at identified cable transition routes is prohibited. For example, cables cannot arbitrarily transition between racks, even when the racks are closer than nine inches to each other.

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

- When cable is routed from cable racks to equipment frames the cables shall transition off lineup cable racks only (cable rack parallel to the rows of equipment frames in the front or rear aisles).

- Cables shall not transition from main aisle or cross-aisle cable racks directly into equipment frames unless breaking off lineup cable racks is prevented by office conditions and no other option is available.

Where cables transition off from 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 or bay extenders.
- Cables shall not be routed from bay to bay without being routed into the overhead cable racking system unless directed by the Standard Configuration documentation.

- Conduit shall not be routed or supported on top of, or "in" cable rack nor will conduit be directly attached to the cable rack stingers where it will interfere with other intersecting cable racks. Exception: Cables that may need to access conduit for further routing outside the cable rack to termination points not in bays or frames. The end of an associated conduit may need to be supported from the top of a cable rack. Example: Alarm leads routed to a building alarm terminal strip.

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.4.7 Running Wire in Conduit

Cables and/or wires may be run in conduit for the purpose of serving locations such as wall mounted terminal panels or Building Terminals, not equipment frames. .

- Conduit shall be extended to the cable rack in the proximity of the location served.
- Conduit used for these terminal panels or Building terminals shall be ended outside of, and within 9 inches of, the cable rack stringers.

6A.5 Engineering Requirements

Cable rack size (width) shall be engineered per equipment requirements and office conditions. Evaluate cable capacities for the areas and lineups to be served

- Cable racks shall be provided in the approved cable rack sizes identified in Table 6A.3. Existing equipment lineups utilizing cable rack sizes other than the standard sizes identified can be transitioned to the new standard size similar to Exhibits 2-E1-21A, 2-E1-31 and 2-E1-32 when feasible.

- Cable rack routes should be planned so that mixed equipment lineups, both present and future, could be accessed by switchboard, power, and fiber racks.
- New cable rack arrangements for cable rack sizes 24 inches and greater shall be engineering using auxiliary framing as the direct cable rack support structure regardless of type (switchboard, power, fiber) or earthquake zone.
- The use of G-clips or C-clips is prohibited for cable rack sizes 24 inches and greater.
- 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 be engineered and installed to accommodate cable bend radius of the largest typical cable at the maximum cable pileup. Refer to TP 77350, Standard Configurations, or manufacturers requirements for bend radius requirements.
- Cable rack shall not be located below the tops of windows, doors, or transoms so as to obstruct their proper operation.
- Parallel cable racks for differing functions (i.e. switchboard and power, power and fiber, etc.) should not be engineered adjacent to each other, at the same level, without adequate cable transition space on either side of the cable rack.
- Cable rack routes should avoid crossing Collocation cages. Note: Collocators must be notified when work (including running cable) is performed above their equipment space.
- Cable racks in main/egress aisles and in 7-foot Low Level environments shall be centered between lineups.
- Cable racks shall be within 1/2 inch of center for initial lineup build-outs.

Horizontal cable rack or troughs (cable routes) shall not be located below the top of equipment bays or frames including bay extenders.

- 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 network facility activities.

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 and cable securing operations. Exceptions:

    1. Cable rack routes with a maximum pileup of less than 12 inches, such as power and fiber racks, may have a minimum clearance to obstructions where it will not impact

ultimate cable pileup or securing operations. Allow 5 inches clearance for securing operations where necessary.

2. Five inch wide cable rack where it is supported with 2-E1-85 type saddle brackets.
3. Standard 12 inch high wall cable holes that will accommodate 10 inches of cable pileup with the cable rack extended through the cable hole.

- 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 may be inverted to gain necessary cabling capacity due to fixed obstructions. Inverted cable racks must be equipped with panning and cable retaining brackets.
- Cable racks 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. Exception: Threaded rods may be spliced where threaded rod studs are cast into the ceiling structure.

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

Cable rack engineered for support purposes other than usual cable support (i.e. switchboard, power, and fiber) may not need to adhere to certain engineering requirements such as pileup and/or cable rack support intervals. For example, air pressure hose support.

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.

TABLE 6A.3 STANDARD CABLE RACK SIZES AND CAPACITY

The upper number on the table below represents the approximate number of switchboard type cables and the lower number the approximate weight in pounds per linear foot.

NUMBERS OF MISCELLANEOUS SWITCHBOARD 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"	4-1/4"	13	26	39	51								
		3	6	8	11								
12"	11-1/4"	34	68	102	135	169	203	237	270	304	338		
		7	14	21	27	34	41	48	54	61	68		
15"	14-1/4"	43	86	129	171	214	257	300	342	385	428	471	513
		9	18	26	35	43	52	60	69	77	86	95	103
20"	19-1/4"	58	116	174	231	289	347	405	462	520	578	636	693
		12	24	35	47	58	70	81	93	104	116	128	139
25"	24-1/4"	73	146	219	291	364	437	510	582	655	728	801	873
		15	30	44	59	73	88	102	117	131	146	161	175
30"	29-1/4"	88	176	264	351	439	527	615	702	790	878		
		18	36	53	71	88	106	123	141	158	176		

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

Reduce the approximate number and weight of cable in the above table by 25 percent when calculating cable capacities for unsecured cable rack.

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.

TABLE 6A.4 STANDARD POWER CABLE RACK SIZES AND CAPACITY

The upper number on the table below represents the approximate number of power type cables and the lower number the approximate weight in pounds per linear foot.

		Power Cable Racks - Maximum Allowable Cable Pile-up												
Cable Diameter (in):		0.225	0.247	0.272	0.327	0.3	0.414	0.482	0.606	0.651	0.756	0.93	1.066	1.267
Cable Weight (lb/ft):		0.037	0.047	0.063	0.093	0.132	0.188	0.278	0.441	0.537	0.808	1.29	1.796	2.629
Width of Rack														
Actual	Cable Space	#14	#12	#10	#8	#6	#4	#2	1/0	2/0	4/0	350MCM	500MCM	750MCM
5"	4-1/4"	481	399	329	227	270	142	104	66	57	42	28	21	15
		18	19	21	22	36	27	29	30	31	34	37	38	40
12"	11-1/4"	1783	1479	1220	844	1003	526	388	245	213	157	104	79	56
		66	70	77	79	133	99	108	109	115	127	135	142	148
15"	14-1/4"	2259	1874	1545	1069	1270	667	492	311	269	200	132	100	71
		84	89	98	100	168	126	137	138	145	162	171	180	187
20"	19-1/4"	3051	2532	2088	1444	1716	901	664	420	364	270	178	135	96
		113	120	132	135	227	170	185	186	196	219	230	243	253
25"	24-1/4"	3844	3189	2630	1820	2162	1135	837	529	459	340	225	171	121
		143	150	166	170	286	214	233	234	247	275	291	308	319
30"	29'1/4"	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 6A.5 STANDARD FIBER CABLE RACK SIZES AND CAPACITY

The upper number on the tables below represents the approximate number of fiber type cables and the lower number the approximate weight in pounds per linear foot.

Fiber Cable Racks - Maximum Allowable Cable Pile-up (Breakout/Fanout Style)

Cable Diameter (in):		0.245	0.245	0.555	0.625	0.76	0.88	0.94	0.37
Cable Weight (lb/ft):		0.015	0.0225	0.085	0.111	0.18	0.291	0.31	0.052
Width of Rack		6 Stranded	12 Stranded	24 Stranded	48 Stranded	72 Stranded	96 Stranded	144 Stranded	72 Ribbon
Actual	Cable Space								
5"	4-1/4"	405	405	79	62	42	31	27	177
		7	10	7	7	8	10	9	10
12"	11-1/4"	1504	1504	293	231	156	116	102	659
		23	34	25	26	29	34	32	35
15"	14-1/4"	1905	1905	371	292	197	147	129	835
		29	43	32	33	36	43	40	44
20"	19-1/4"	2573	2573	501	395	267	199	174	1128
		39	58	43	44	49	58	54	59
25"	24-1/4"	3242	3242	631	498	336	251	220	1421
		49	73	54	56	61	74	69	74
30"	29'1/4"	3910	3910	762	600	406	303	265	1714
		59	88	65	67	74	89	83	90

Fiber Cable Racks - Maximum Allowable Cable Pile-up (1.6 Continuous Style)

Cable Diameter (in):		0.0787	0.0787	0.26	0.33	0.66	0.98	0.98
Cable Weight (lb/ft):		0.0122	0.0182	0.0244	0.0377	0.1478	0.2117	0.3408
Width of Rack		Dual	Quad	6 Stranded	12 Stranded	24 Stranded	48 Stranded	72 Stranded
Actual	Cable Space							
5"	4-1/4"	3933	3933	360	223	55	25	25
		48	72	9	9	9	6	9
12"	11-1/4"	14577	14577	1335	829	207	94	94
		178	266	33	32	31	20	33
15"	14-1/4"	18464	18464	1691	1050	262	119	119
		226	337	42	40	39	26	41
20"	19-1/4"	24943	24943	2285	1418	354	160	160
		305	454	56	54	53	34	55
25"	24-1/4"	31421	31421	2878	1787	446	202	202
		384	572	71	68	66	43	69
30"	29'1/4"	37900	37900	3472	2155	538	244	244
		463	690	85	82	80	52	84

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.

- Some clips and plates tend to distort when nuts are tightened excessively. It is necessary, to prevent excessive distortion, that the tightening of nuts be stopped when perceptible bending is noted.
- 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.

<u>SPLICING CABLE RACK</u>: 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.

<u>CORNER BRACKET</u>: 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.

<u>HORIZONTAL AND VERTICAL OFFSETS</u>: 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 for switchboard or fiber cable and 12 inches or less for power cable in parallel planes shall be made as shown in Exhibit 2-E1-39.

- Transitions to/from fiber duct shall be at the same level (height) where possible.

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. Adjustable clamps shall be bolted as indicated in Exhibits 2-E1-40A and 2-E1-40B. 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 5 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.
- Adjustable offsets per Exhibit 2-E1-40A and 2-E1-40B shall be bolted in all earthquake zones.

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.

SPLIT NUTS: The use of split nuts, and associated split clips, is not approved.

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.

- High or low auxiliary framing structure shall not be supported from cable rack.

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

- Supports exceeding 5 foot centers result in decreased ultimate cable capacity and shall not be engineered and/or installed without consulting Common Systems Standards.
- Each horizontal cable rack section shall have a least one point of support. Junctions (splices, T-intersections, etc.) 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 that does not junction to another cable rack, or attached to the floor, wall, etc.
- Vertical cable racks that are supported on each end do not require additional support in the vertical section. Cable racks are considered vertical when they are at a 90 degree angle to the floor.

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 junction 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.
- Cable rack shall not be supported more than 20-inches above an auxiliary framing grid or another cable rack. Exhibits similar to 2-E1-62T, 62U, 66, 82, 83, 84.
- The portion of a cable rack from the last support to the free end shall not be used for ironwork support.

<u>SUPPORT FROM OTHER CABLE RACKS</u>: Ladder and bar-type cable rack shall be supported from other cable rack per Exhibits 2-E1-17C, 18A, 19A, 27, 54, 54F, and 97.

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

<u>AUXILIARY FRAMING SUPPORT</u>: 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 J-bolted at each end of the run. J-Bolts should be provided on both stringers at each support. At a minimum one J-bolt is required at intermediate supports on alternate sides of the rack.

<u>THREADED ROD SUPPORT</u>: Ladder and bar-type cable rack shall be supported from threaded rods per Exhibits 2-E1-39, 66, 66C, 67, 74, 76, 77, 77C, 81 through 87, and 96.

- Cable racking supported by means of threaded rods shall be a maximum of 20 inches above auxiliary framing. (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.
- Threaded rod support 2-E1-76 shall not be used in heavy earthquake zones.
- C-CLIP SUPPORT: C-Clips shall be engineered in place of G-Clips for applicable support assemblies. G-Clips may be used for arrangements as identified below:
- G-Clips can be used when re-supporting rack with existing assemblies, relocating assemblies, or as necessary.
- C-Clips shall be installed at cable rack cross strap locations. If the cable rack or support location cannot be adjusted then G-Clips shall be used at cross strap locations.
- If both G-Clips and C-Clips would be used at a single support location, the C-Clips will be used on the cable rack providing the structural support. Example: use C-Clips on the lower cable rack when another cable rack is stilted above it.
- C-Clips shall be represented on Drawings by amending a "C" to the end of the Exhibit number used to identify the engineered assembly. For example, if G-Clips would normally be represented by Exhibit 2-E1-81, then C-Clips would be represented by "81C"

WALL BRACKET SUPPORT:

Ladder and bar-type cable rack, no greater than 12 inches in width, may be supported along walls using brackets per Exhibit 2-E1-91.

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

Ladder type cable rack may be supported vertically to walls with brackets per Exhibit 2-E2-97.

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 engineered when required and shall be located at a maximum of 20 feet intervals where not dictated by specific cable rack system arrangements or CenturyLink Standard Configuration documents.

- Cross-aisle cable rack shall be provided as to not interfere with the cabling entering or existing framework or cabinets below the cross-aisle racks. This may require smaller cross aisle racks to avoid this interference.
- High density cabling areas, such as distributing frames and DSX, should have cross-aisle cable rack at approximately 10 feet intervals.
- Cross-aisle cable racks shall only be placed for the first tier cable rack (usually switchboard). To avoid blocking of cable rack routes, cross-aisle racks shall not be installed for the additional tier racks when secondary tier cable racking varies or alternates between equipment lineups (i.e. power and fiber).

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.
- Cross-aisle cable rack, five feet or less, may be supported using only T-intersection details per Exhibit 2-E1-27 or 2-E5-12G.

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 rack runs more than 2 feet below auxiliary framing or a ceiling and over 20 feet long shall be braced sidewise and endwise 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 side 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-E1-88 and 89.

Hanger rods supporting second tier continuous horizontal cable rack runs stilted above auxiliary framing do not require bracing.

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 (when used with copper/power cable) with a maximum of 18 inch intervals.

Cable brackets or horns shall be mounted at approximately 6 inch intervals (when used with fiber cable) with a maximum of 9 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.
- Power cables, ground feeders, and fiber cables shall not be run together on the same cable brackets.
- Different cable types shall not be mixed on the same cable brackets. i.e. SWBD and power, SWBD and fiber, etc.
- 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

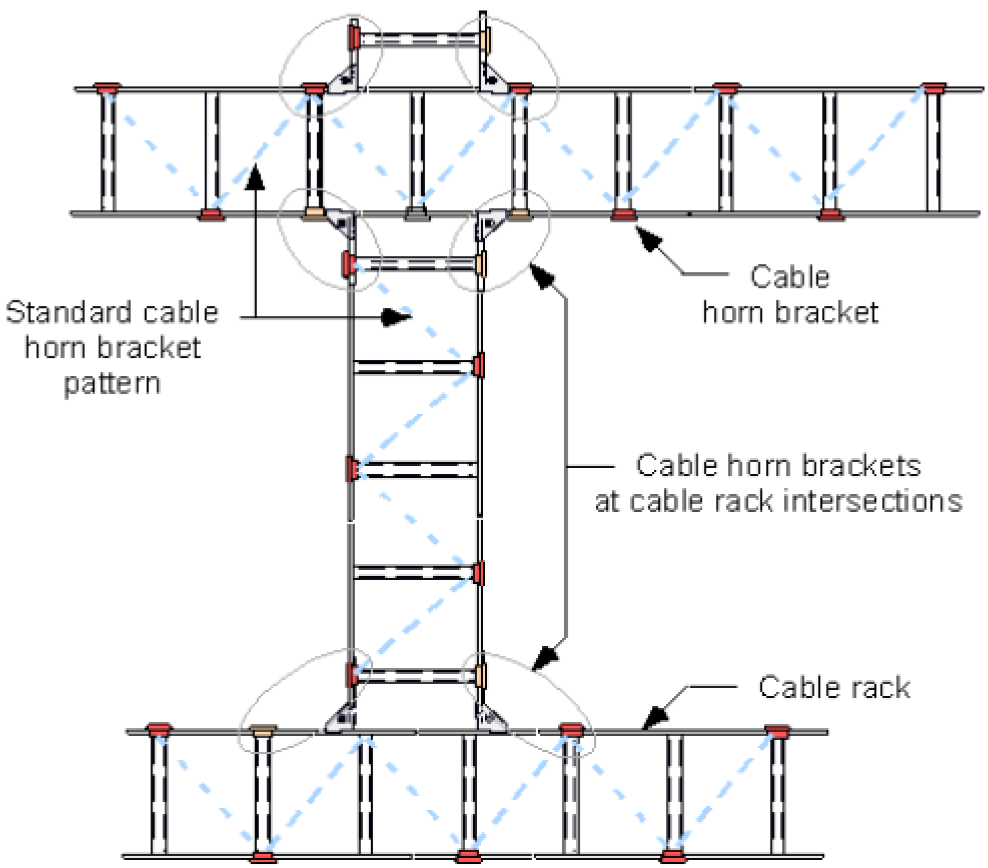
Panned or screened racks with cable retaining brackets are generally intended for high volume cabling routes which allow for free running of cables and limited securing.

Screen or Pan

- "Screen" generally applies to a metal plate supported to the underside of cable rack with clips (existing environments only).
- "Pan" generally applies to a plastic or metal plate placed on top of a cable rack.
- 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 engineered 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.

Cable Retaining Brackets (Cable Horns)

- "Brackets", when used with screen or pan, generally applies to cable retaining type brackets.
- Exhibit 2-E1-93 illustrates several types of discontinued cable retaining brackets Exhibit 2-E1-93A illustrates current typical cable brackets
- Compartment type cable brackets are restricted use. Contact Common Systems Standards for approval prior to installation.
- Cable retaining brackets are required on all cable rack, with unsecured cables, that do not include a compartmentalized cable way system.
- Secured type cable retaining brackets, per Exhibit 2-E1-93A, shall be engineered where possible.
- Cable retaining brackets shall be located on alternate straps of the cable racks.
- Install cable horns in a zigzag pattern similar to the following illustration. Cable horns shall be on approximately 18 inch centers on one side of the rack. Brackets should straddle the cable rack strap. Additional cable horns shall be located at cable rack intersections, turns, etc. as needed.



- 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.
- Cable retaining brackets, where cable must be secured, shall be installed with the cable retaining bar to the inside of the cable rack stringer (side) and the cable retaining clamp to the outside of the stringer. See Exhibit 2-E1-93A.
- Cable retaining brackets shall not be installed on cable transitions (waterfalls) as the cables on this portion of a cable rack must be secured.
- 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.

The following cable retaining bracket heights are available per Exhibit 2-E1-93A.

- <u>5 inch high</u>: Approved for use on all 5 inch wide cable racks. Maximum pileup on these racks is 5inches. These can also be used on wider cable racks where there is less than 8 inches clearance above the rack and cable pileup cannot exceed 5 inches.
- <u>8 inch high:</u> Default cable horn bracket size. Use on main aisle or lineup cable rack where the cable pileup should not exceed 8". Cable rack kits that include cable horns and pan include the 8" cable horns.
- <u>12 inch high:</u> Use on cable rack where the cable pileup would most likely exceed 8inches. This will occur on most main aisle cable racks in medium to large CO's and cable racks in high cable volume areas such as DSX lineups, Distributing Frames, and some via racking.
- Lineups approaching the 50 foot maximum length may also require 12 inch horns based on the type of equipment deployed.
- High volume cable routes though lineup cable racking normally using 8 inch horns will also need to be evaluated for the 12 inch horns.

6A.6 Power Cables and Racking

It is the intent of these requirements that 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 (350KCMIL) 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 (2/0) 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.

POWER ONLY CABLE RACK: Cable rack engineered and/or installed for segregated power runs shall be solid stringer type only.

- Existing channel type cable rack is acceptable for running power cable.
- Power cable rack shall be supported utilizing auxiliary framing as illustrated per Exhibits 2-E1-65 and 77B.
- Power cable racks shall be sized based on required capacity and in no case shall exceed 25 inches in width. Additional auxiliary framing support structure may be required when power cable rack sizes greater than 20 inches are utilized.

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.

6A.7 Fiber Only Cable Rack

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

All fiber shall be run on separate, segregated cable rack or supported on brackets below existing cable rack.

- Fiber cables are prohibited on switchboard or power cable rack no matter what size fiber cable.

- Fiber cables may be run on fiber protection system (FPS) if segregated fiber cable rack is not feasible. Refer to Technical Publication 77351, Chapter 6, unit G for engineering requirements associated with the Fiber Protection System.
- A Letter of Deviation shall not be accepted allowing fiber cables to be placed in the same cable rack as switchboard or power cables.

- Fiber cable 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.

<u>FIBER ONLY CABLE RACK</u>:

GRAY FIBER CABLE RACK: Gray fiber cable rack is allowed in the following conditions:

- Existing equipment lineups only in which the gray fiber cable rack may be extended to the end of the equipment lineup.
- Gray fiber cable rack must not be equipped with pan or screen to allow fiber cables to remain visible at all times.
- Gray fiber cable rack must be labeled as “Fiber Optic Cable Only” on the outside of each stringer every five feet.

ORANGE FIBER CABLE RACK: Orange fiber cable rack is the approved cable rack dedicated for fiber optic cables and may be equipped with brackets and the approved fire rated pan. The bright coloring eliminates the requirement for stenciling or labeling necessary on gray cable racks.

- All existing equipment lineups with established orange fiber cable rack.
- All new equipment lineups.
- May be equipped with pan and brackets for all horizontal cable rack run. When not equipped with pan and brackets, the fiber cables shall be tied to the cable rack cross bars using the approved securing method.

- Existing channel type cable rack is acceptable for running fiber cable.
- Fiber cable racks shall be sized based on required capacity and in no case shall exceed 25 inches in width as the equipment lineup rack and 30 inches in width as the main aisle rack.
- Fiber cable rack sized less than 24 inches may be supported utilizing C-clips as illustrated per Exhibits 2-E1-66A, 66 and 66C.
- Fiber cable rack sized 24 inches and greater shall be supported utilizing auxiliary framing as illustrated per Exhibits 2-E1-65 and 77B.
- All bend radii must be preserved. Corner brackets on each horizontal turn and 90 degree turns for vertical drops will be engineered, installed and reflected on the drawing records.

- Fiber cable rack shall adhere to a minimum 12 inch clearance above the top of the cable rack to the bottom of any obstruction to accommodate cable pileup and cable securing operations with the following exceptions:
  - Cable rack routes with a maximum pileup of less than 12 inches, such as power and fiber racks, may have a minimum clearance to obstructions where it will not impact ultimate cable pileup or securing operations. Allow 5 inches clearance for securing operations where necessary.
  - Five inch wide cable rack where it is supported with 2-E1-85 type saddle brackets.
  - Standard 12 inch high wall cable holes that will accommodate 10 inches of cable pileup with the cable rack extended through the cable hole.

Main fiber 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.
- Fiber 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. Fiber cable rack turns are available in a variety of widths.

Extended vertical runs of fiber 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.

<u>SECURING FIBER CABLE</u>:

Fiber cables shall be secured appropriately based on the following requirements and requirements outlined in the CenturyLink Installation Standard 77350.

- Cable ties to secure fiber optic cables are prohibited for any application
  - Lacing cord used with fiber sheeting is the preferred securing method which allow for maximum use of allotted cable space.
  - Plastic cable ties degrade, become brittle, and break over time. Sharp edges may damage cable jacketing and places the fibers at risk for damage.
- At the bottom of vertical cable racks that carry fiber 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 fiber cables.
- Fiber cables of all sizes must be secured for all transitions and vertical routes, wrapping with fiber sheeting where it is tied with cord within the overhead cable support system.
- Fiber cables of all sizes must be secured to every 4th cross strap in horizontal applications and to every cross strap in vertical applications on non-panned and bracketed cable rack.

- Fiber cables may be run unsecured on orange, panned and bracketed ladder rack only. Similar size cables should be loosely bundled with fiber sheeting and lacing cord
- Running single and dual fiber cables on un-panned ladder rack is not approved.
  - Increase optical attenuation is introduced to circuits when single and dual fiber cables less than 2.0mm outer diameter are routed and secured to ladder rack cross straps
    - Placement of new dedicated fiber cable rack equipped with approved fire rated pan shall be considered as a first choice.
    - Fiber duct attached to the cable rack stringer or cable support brackets may be considered.
      - Care must be taken to consider the entire route when selecting the fiber duct support options so as to not obstruct existing cable rack or force a change of level.
      - Solid fiber duct is required for all horizontal applications.
    - As a last result, singles and duals may be run on existing un-panned ladder rack that cannot be retro-fitted with the approved fire rated pan or new dedicated fiber cable rack shall not be added.

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

6A.8 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.

6A.9 Cable Holes and Firestopping

6A.9.1 Cable Holes

- The recommended method of fire/smoke stopping is accomplished with approved intumescent and endothermic materials identified by CenturyLink Standard Configuration documents and Fire Life and Safety Practices.

- All reference to a cable hole or firestopping in this document are associated for use with network cabling only.

- Locations of cable holes shall be coordinated between Network Engineering and CenturyLink Real Estate through the approved process. Cable holes shall be provided by CenturyLink Real Estate.

- Cable holes used during the course of any CenturyLink project shall be modified as necessary to meet the current level of standards outlined in this section.

- The Engineering Judgement from the firestopping manufacturer shall be followed when modifying existing or establishing new unique or non-standard cable holes.

- Firestopping assemblies shall comply with the manufacturer's UL listed drawings.

- 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 and tagged per CenturyLink Technical Publication requirements.

- Cable holes shall be defined as the following:

    - 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.

CABLE HOLE CAPACITIES: Firestop material manufacturer requirements always include maximum limits on cable hole fill for the firestop material warranty to be valid. Cable hole capacities shall be limited per manufacturer requirements based on the individual manufacturer's UL listed drawings.

- "F" ratings, as defined by UL, is the amount of time a fire stopping assembly can endure extended fire before it is breached (fire gets through). "F" ratings must meet or exceed the existing rating of the wall or floor.
- "T" rating, as defined by UL, is the amount of time a fire stopping assembly can resist the passage of heat through a fire stopping system. "T" ratings must meet or exceed the minimum rating of the floor.

6A.9.1A Cable Hole - Floors

CABLE HOLE ANGLE IRON OR CHANNEL FRAME: Cable holes shall be curbed with a welded structural steel angle or channel frame and drilled to accept a cover and bolting material. Curbine shall be capable of supporting vertical cable racking and load.

- Cable hole curb shall be positioned as shown in firestop manufacturer UL listed drawings.

Joints between the cable hole curbing and the floor shall be made functionally air and water tight by filling with the firestop manufacturer's product requirements.

CABLE RACK SUPPORT:

- Cable rack shall be supported at floor cable holes per Exhibits 2-E1-13A, 13B, 13C, 13D and 13E.
- The addition of U-channel per Exhibit 2-E1-13E is requested through CenturyLink Real Estate.

CABLE HOLE COVERS:

- Floor and wall covers shall be secured to the sheathing or fascia with 1/4-20 fasteners and 1-1/4 inch fender washers. Covers shall be cut to fit as closely as practical to fit around the cable bundle per firestop manufacturer requirements.
- Where possible, cable hole safety steel covers shall be cut to allow a straight cable path through the cable hole. Appropriate modifications to the intumescent sheets are required when routing cables through the cable hole to closely match the profile and adhere to the maximum gap allowed in the manufacturer approved UL listed drawing.

WELDED STRUCTURAL STEEL ANGLE OR CHANNEL FRAMES:

- Cable holes shall be provided with a welded structural steel angle or channel frame at floor penetrations for the attachment of cable hole, covers, firestop materials.
- Must be equipped with a minimum collard depth of 3 inches.

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.

- Top floor opening covers shall be required and shall be a minimum of 10 gauge steel.

6A.9.1B Cable Hole - Walls

An approved manufacturer's UL listed drawing shall be applied for firestopping of occupied wall cable openings for all types of fire rated walls and partitions.

FASCIA ANGLES:

- Cable holes shall be provided with fascia angles at wall penetrations for the attachment of cable hole, covers and firestop materials.
- The addition of fascia angles is requested through CenturyLink Real Estate.
- Fascia angles shall be tapped to accept a minimum of 1/4-20 type threaded fasteners.
- Fascia angles or other components of a wall cable hole shall not be used for cable rack attachment or support.

6A.9.2 Firestopping

- Firestopping shall be installed by an approved contractor whom is trained by the appropriate firestop system manufacturer.

- All references to firestopping in this document are associated for use with network cabling only.

- All firestopping material must be provided by the same firestop manufacturer within a single cable hole. Different firestop manufacturer's product cannot be mixed within the same cable hole.

- A primary firestopping manufacturer shall be established for each facility where possible and going forward all new cable holes shall utilize that primary firestopping manufacturer.

All cable holes or slots, whether occupied or unoccupied, in a fire rated wall or floor will be sealed with approved firestop materials.

- Enclosed cable distribution systems, including fiber protection systems and conduit, shall be terminated no less than 3 inches prior to where it passes through a floor or wall cable hole penetration. 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 must be applied according to firestop system manufacturer's UL listed drawing for the appropriate "F" rating.
- Refer to CenturyLink Technical Publication 77350 and the manufacturer's UL listed drawings for proper installation of firestop material and managing of cables through the cable hole.

CABLE HOLE CAPACITY: Cable holes shall not be filled beyond the approved capacity on the UL listed drawing or Engineering Judgement to allow for firestop to operate effectively.

- Cable holes nearing or surpassing capacity will be brought to the attention of the CenturyLink Engineering representative immediately.

CABLE SLEEVE: Cable hole sleeves shall use a high temperature material 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.

- Traditional Cable Holes - 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 a minimum of three inches 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 material. 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.9.3 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 CenturyLink 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 CenturyLink Technical Publication 77350". Labels shall also provide fields for the following entries:
    1. Project Number
    2. Vendor/Organization
    3. Date Closed
    4. UL Listed Fire Assembly Number or Engineering Judgement (EJ) number.
    5. Responsible Party Contact Information.

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 CenturyLink Technical Publication 77350". Labels shall also provide fields for the following entries:
    1. Project Number.
    2. Vendor/Organization
    3. Date Closed
    4. UL Listed Fire Assembly Number or Engineering Judgement (EJ) number.
    5. Responsible Party Contact Information

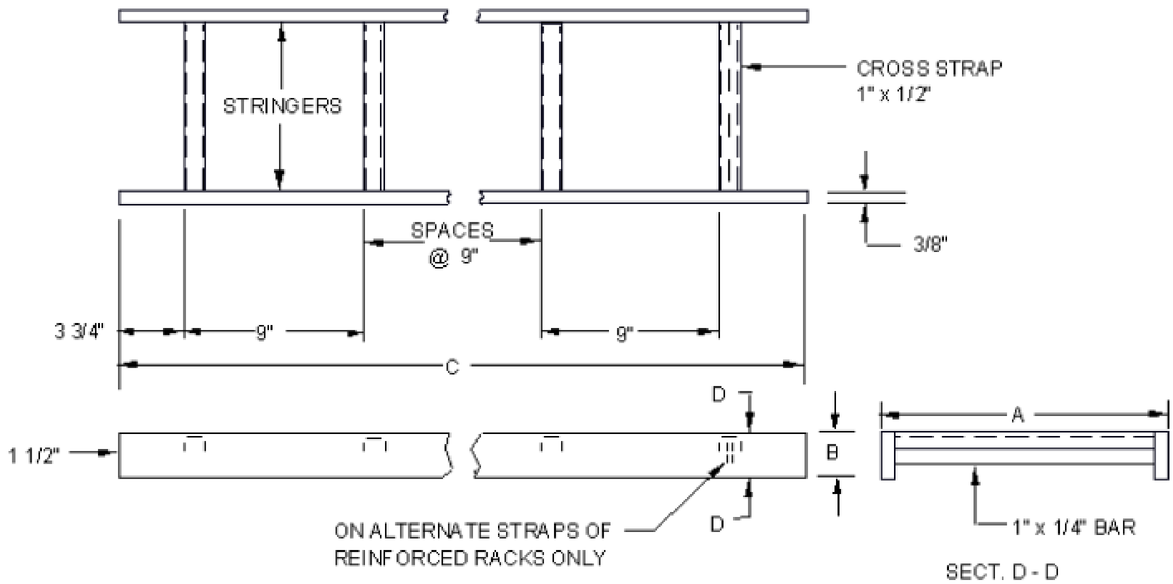


TABLE OF DIMENSIONS

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

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

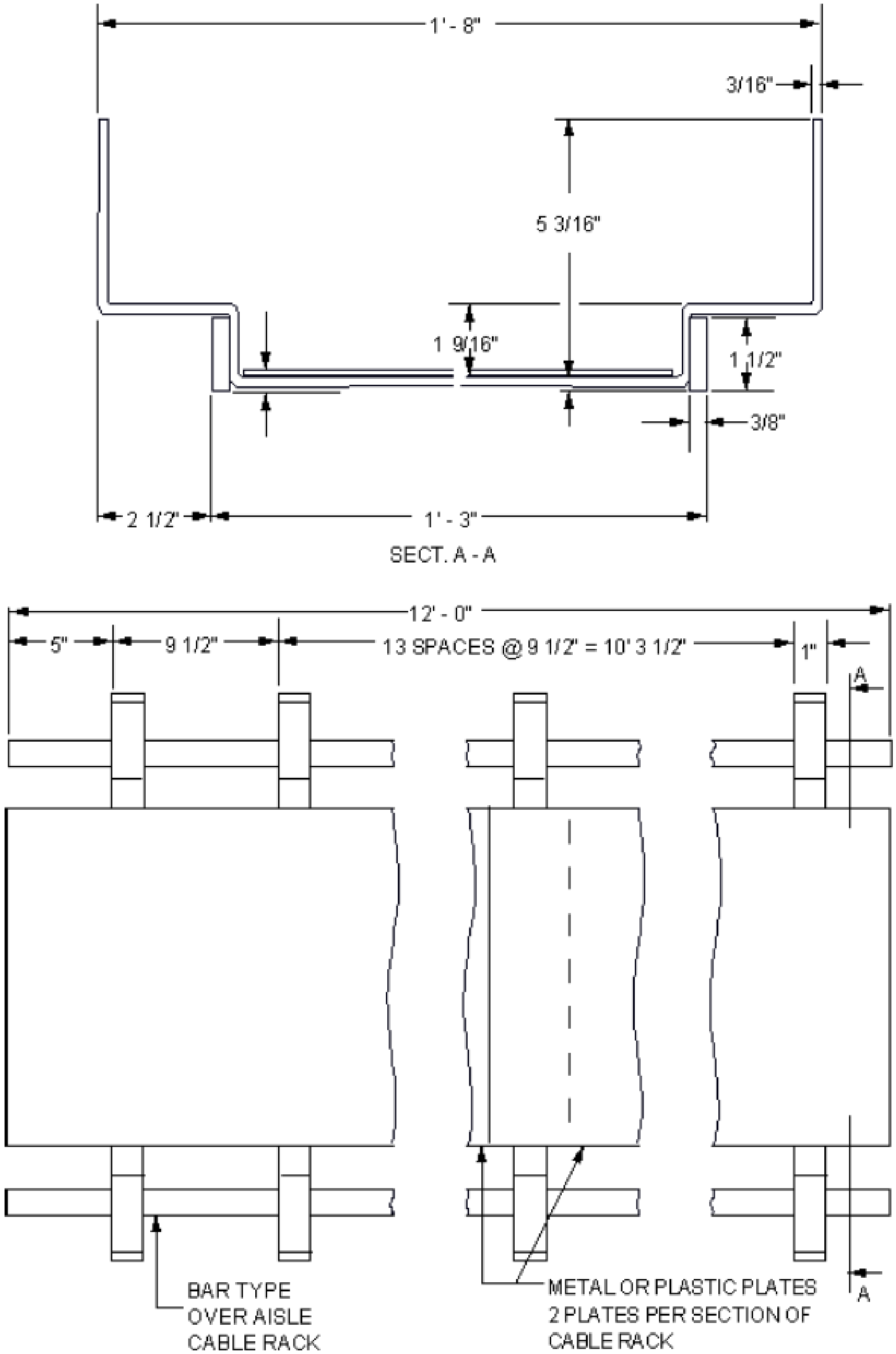
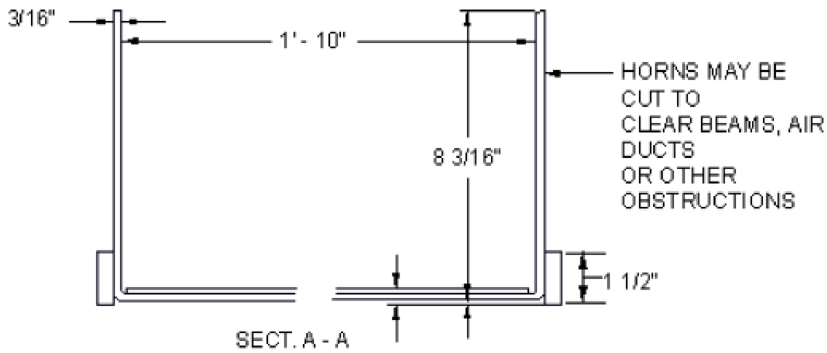
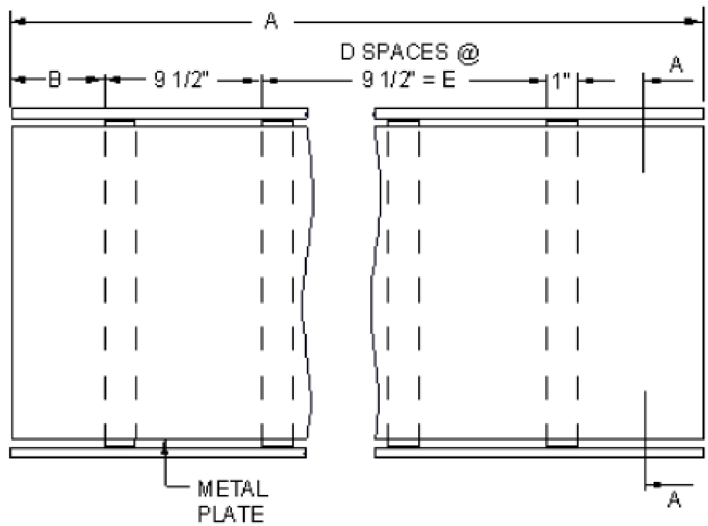


EXHIBIT 2-E1-1D (A&M)

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





DIMENSIONS				WIRING AISLE C TO C	NOTE
A	B	D	E		
5' - 4 7/8"	3 7/16"	5	3' - 11 1/2"	6' - 8"	1
4' - 10 7/8"	5 3/16"	4	3' - 2"	6' - 2"	
4' - 8 3/4"	4 1/8"			6' - 0"	
4' - 11 3/4"	5 5/8"			6' - 8"	2
4' - 5 3/4"	2 5/8"			6' - 2"	
4' - 3 3/4"	1 5/8"			6' - 0"	
1' - 5 1/8"	3 5/16"	0	0"	6' - 2"	3
2' - 3 7/8"	3 15/16"	1	9 1/2"		
12' - 0"	5"	13	10' - 3 1/2"		4

NOTES:

1. CROSS-AISLE CABLE RACK AT THE SAME LEVEL AS THE BAR-TYPE OVER-AISLE CABLE RACK.
2. CROSS-AISLE CABLE RACK 2" ABOVE THE BAR-TYPE OVER-AISLE CABLE RACK.
3. CROSS-AISLE CABLE RACK 2" ABOVE THE BAR-TYPE OVER-FRAME CABLE RACK-BULB ANGLE FRAMES-10 INCH GUARDRAILS.
4. 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)

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

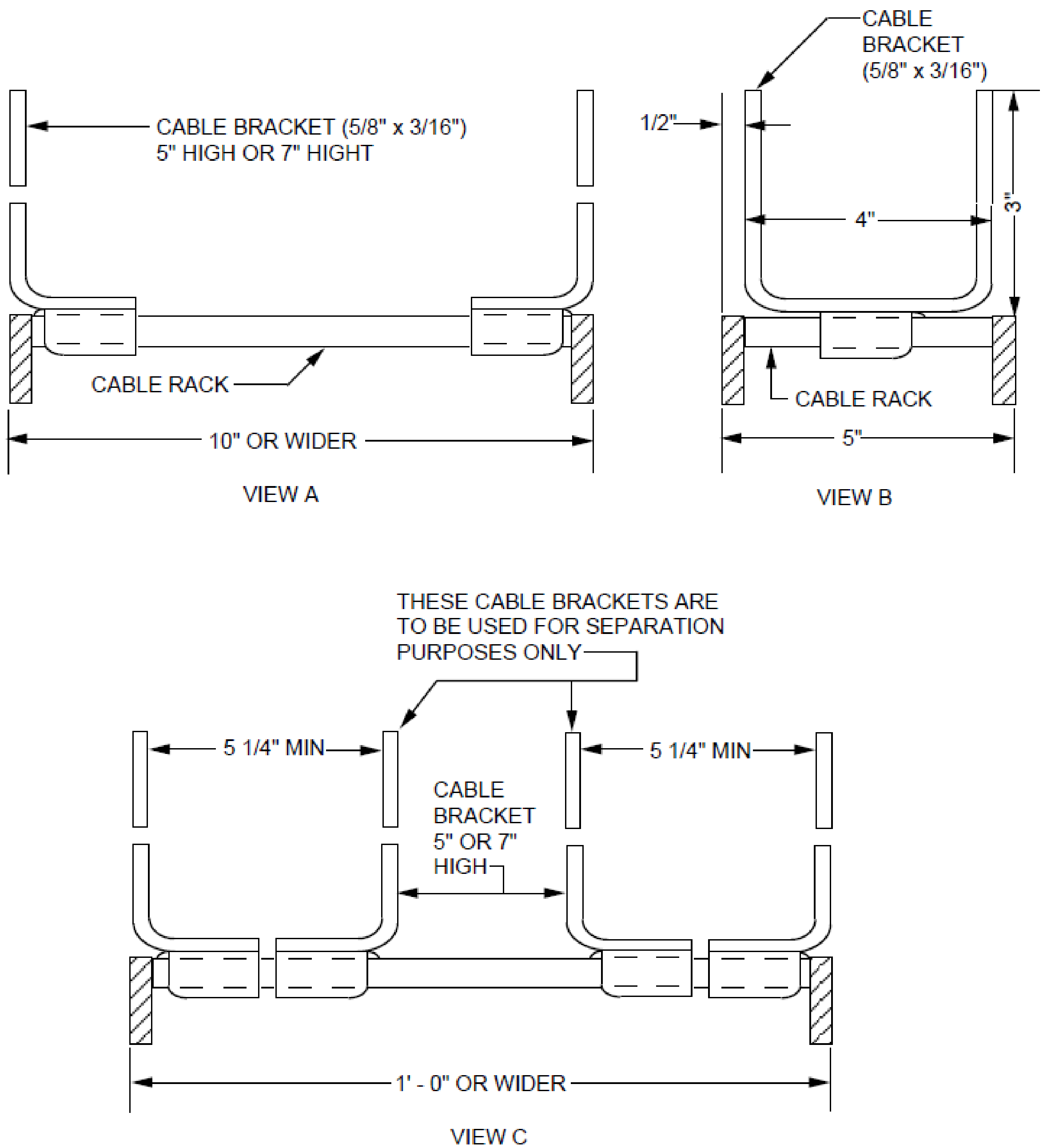


EXHIBIT 2-E1-1F

2-E1-1F MOUNTING SNAP-ON CABLE BRACKETS ON LADDER-TYPE CABLE RACKS

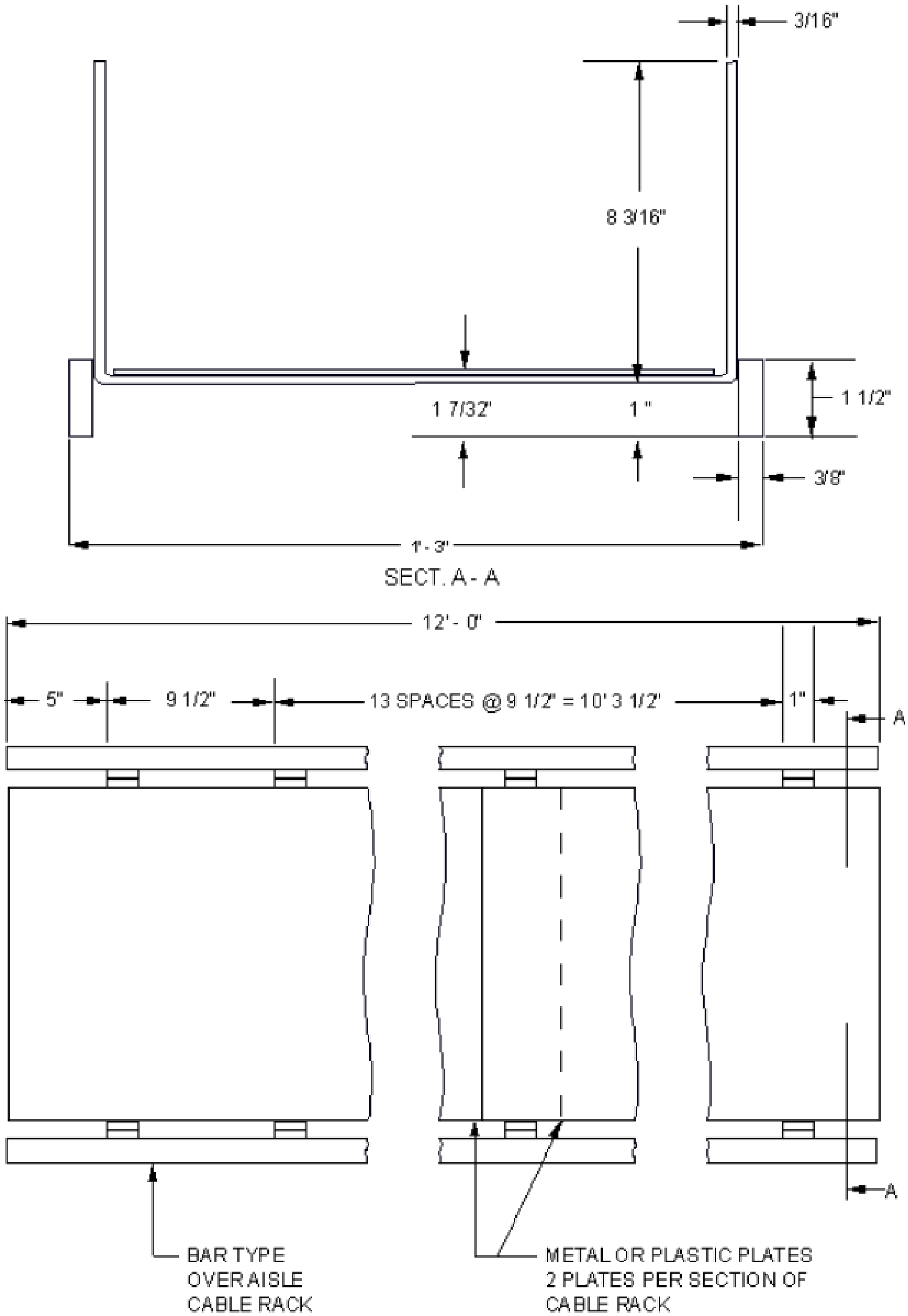
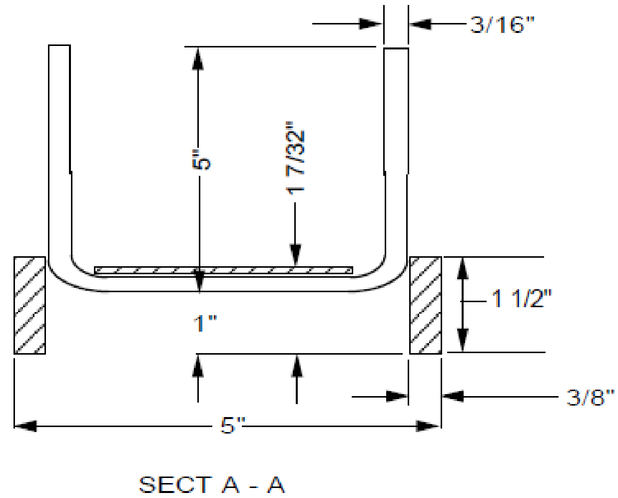


EXHIBIT 2-E1-1G (A&M)

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



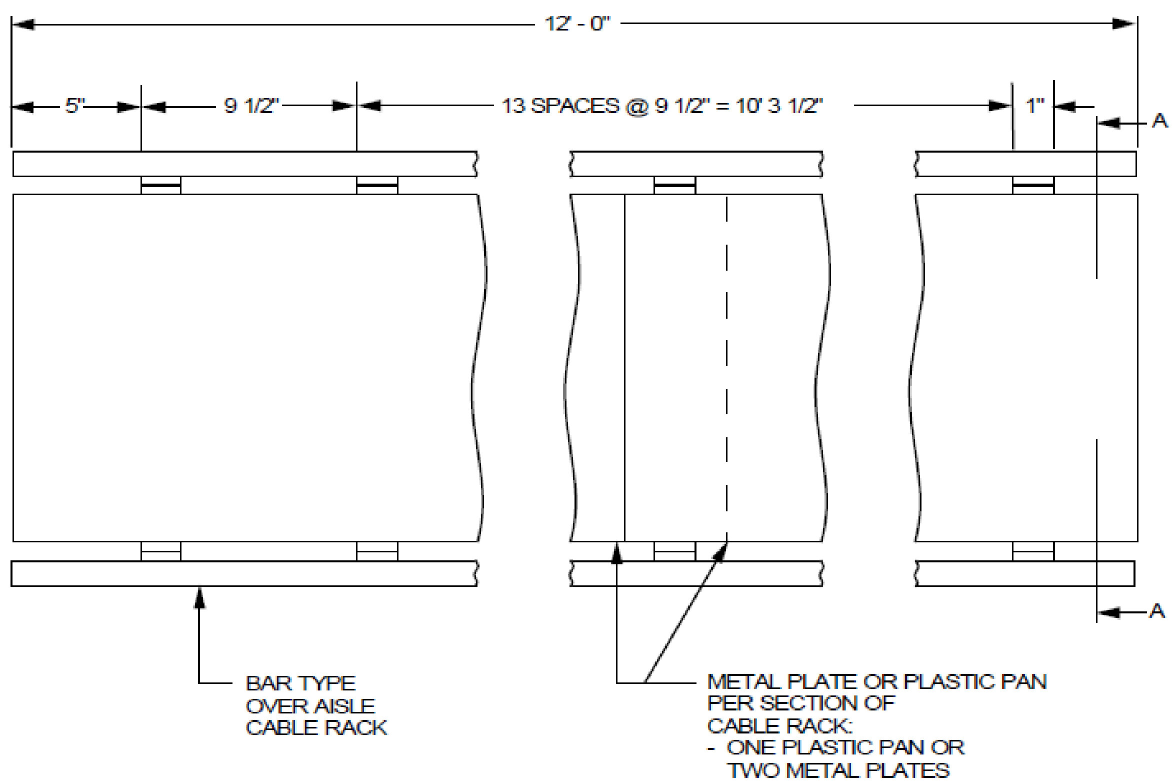


EXHIBIT 2-E1-1H (A&M)

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

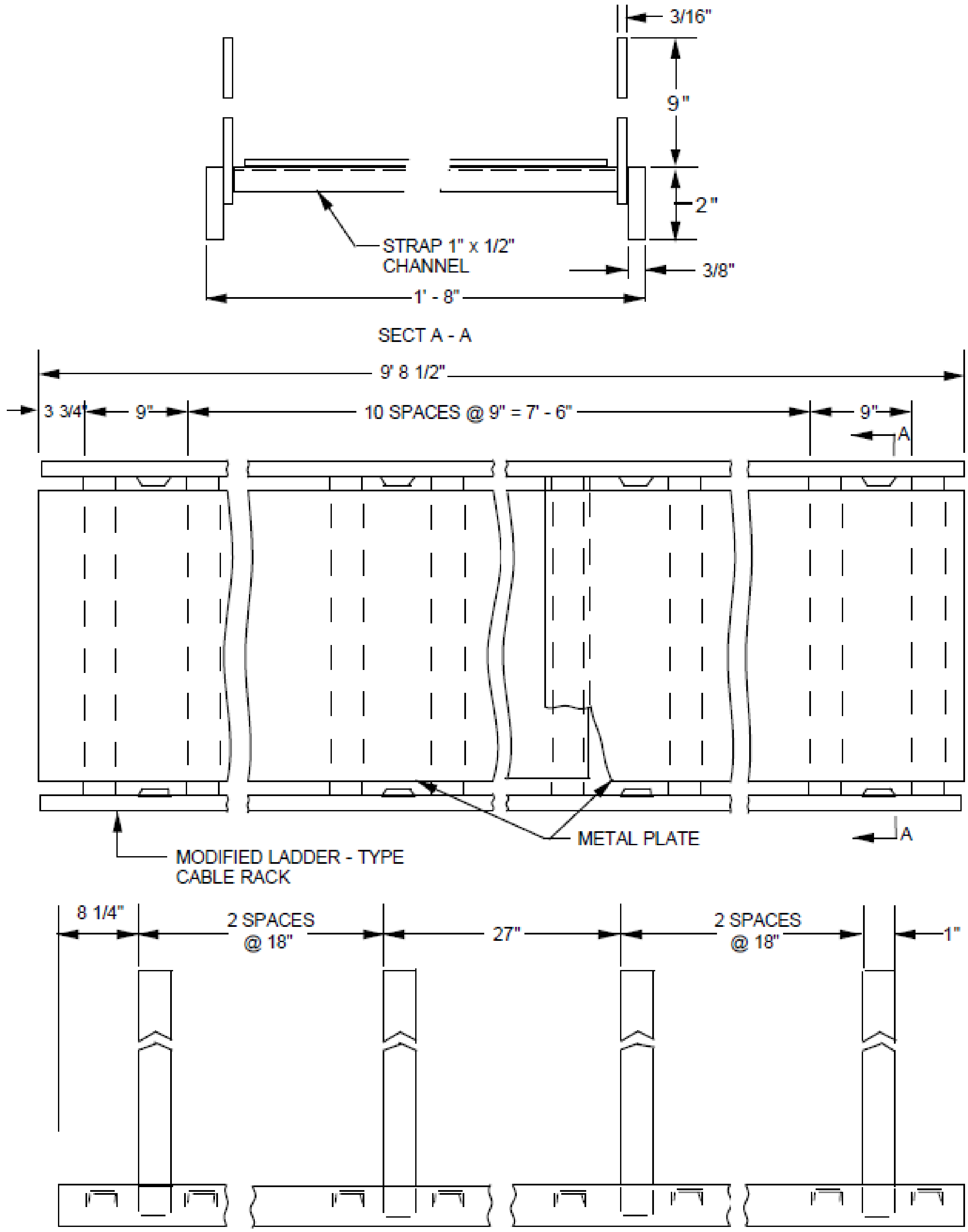


EXHIBIT 2-E1-1J

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

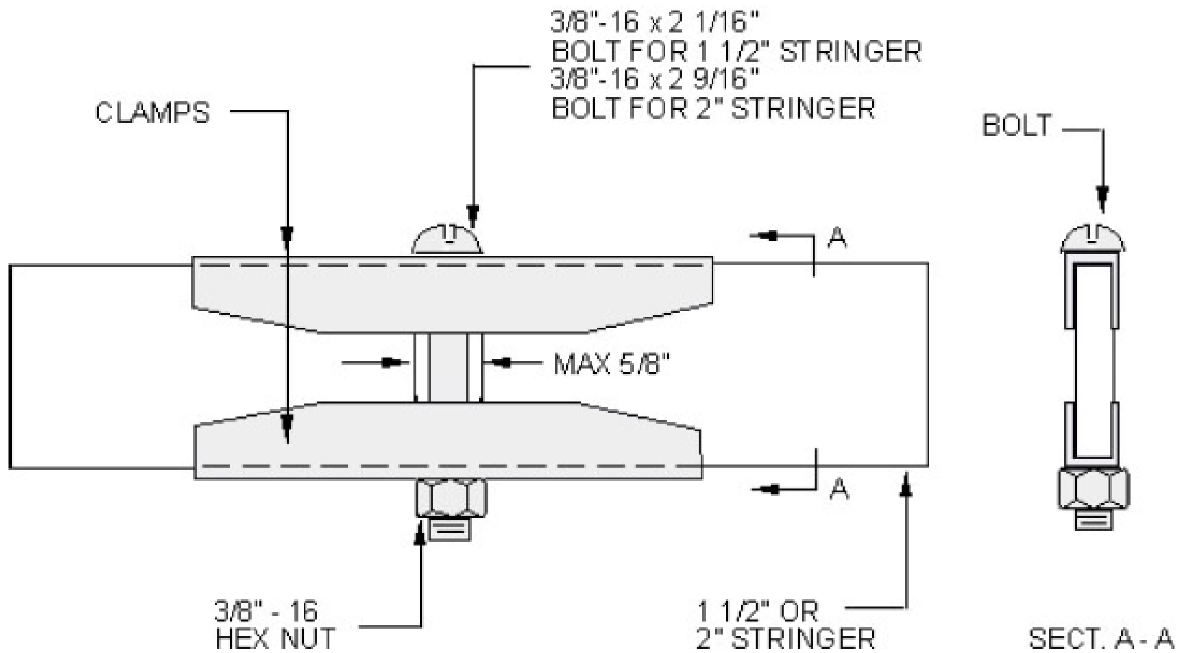


EXHIBIT 2-E1-2

STRAIGHT CLAMP FOR STRINGER OF SAME WIDTH

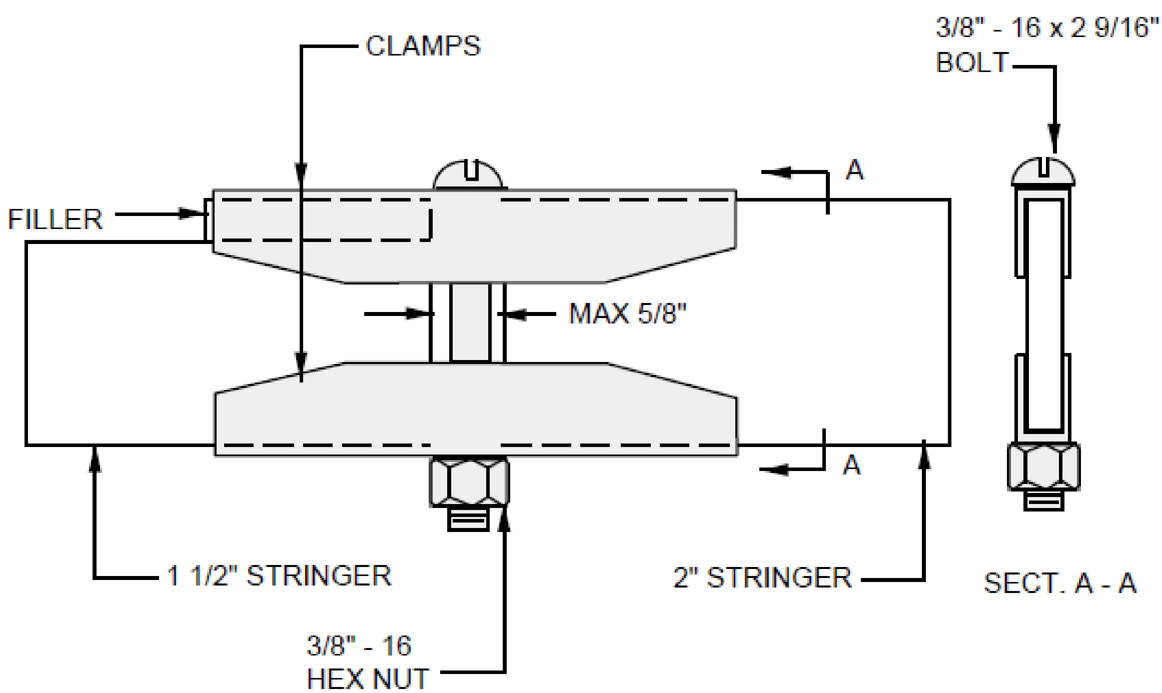


EXHIBIT 2-E1-3

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

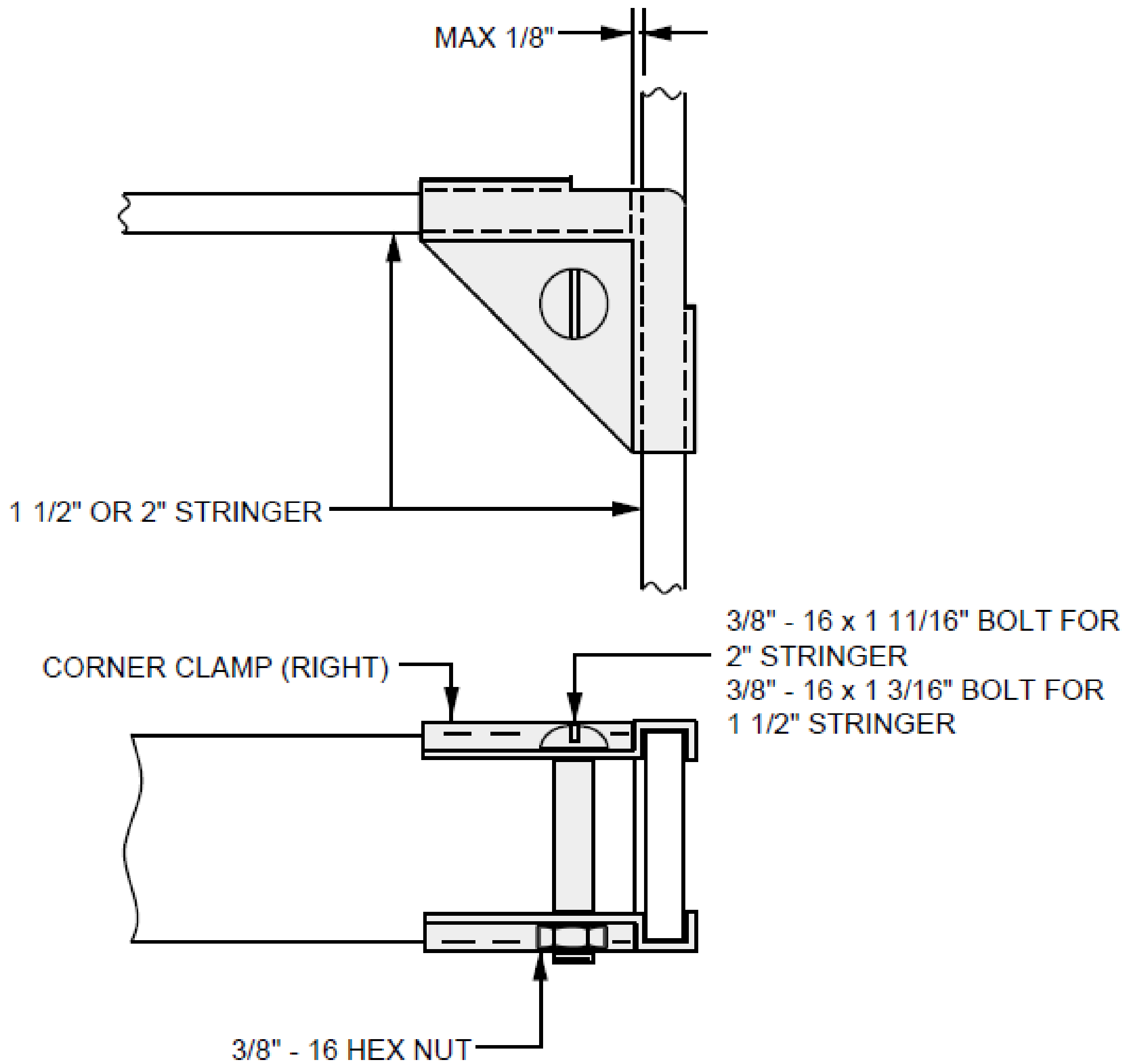


EXHIBIT 2-E1-4

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

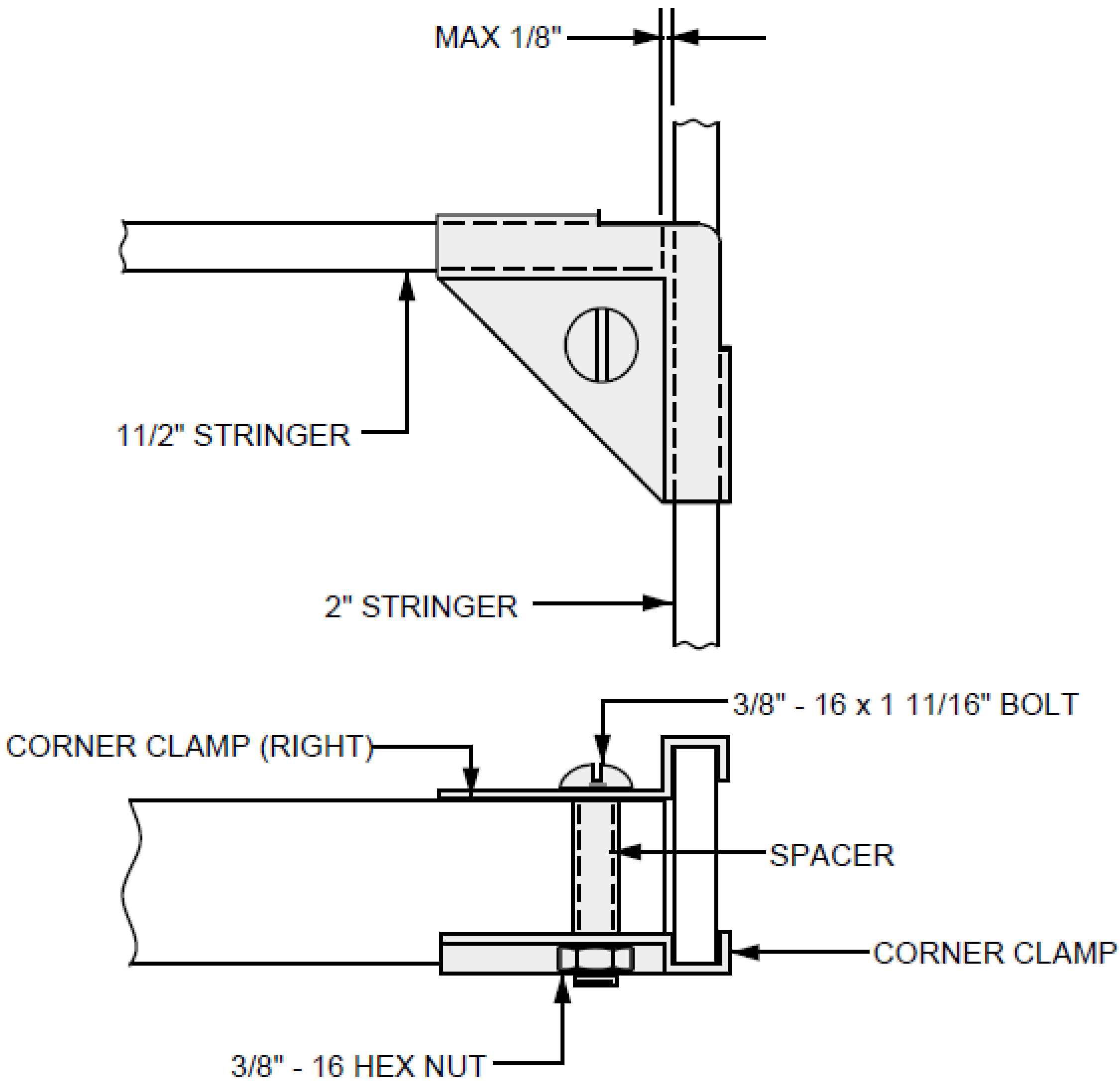


EXHIBIT 2-E1-5

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

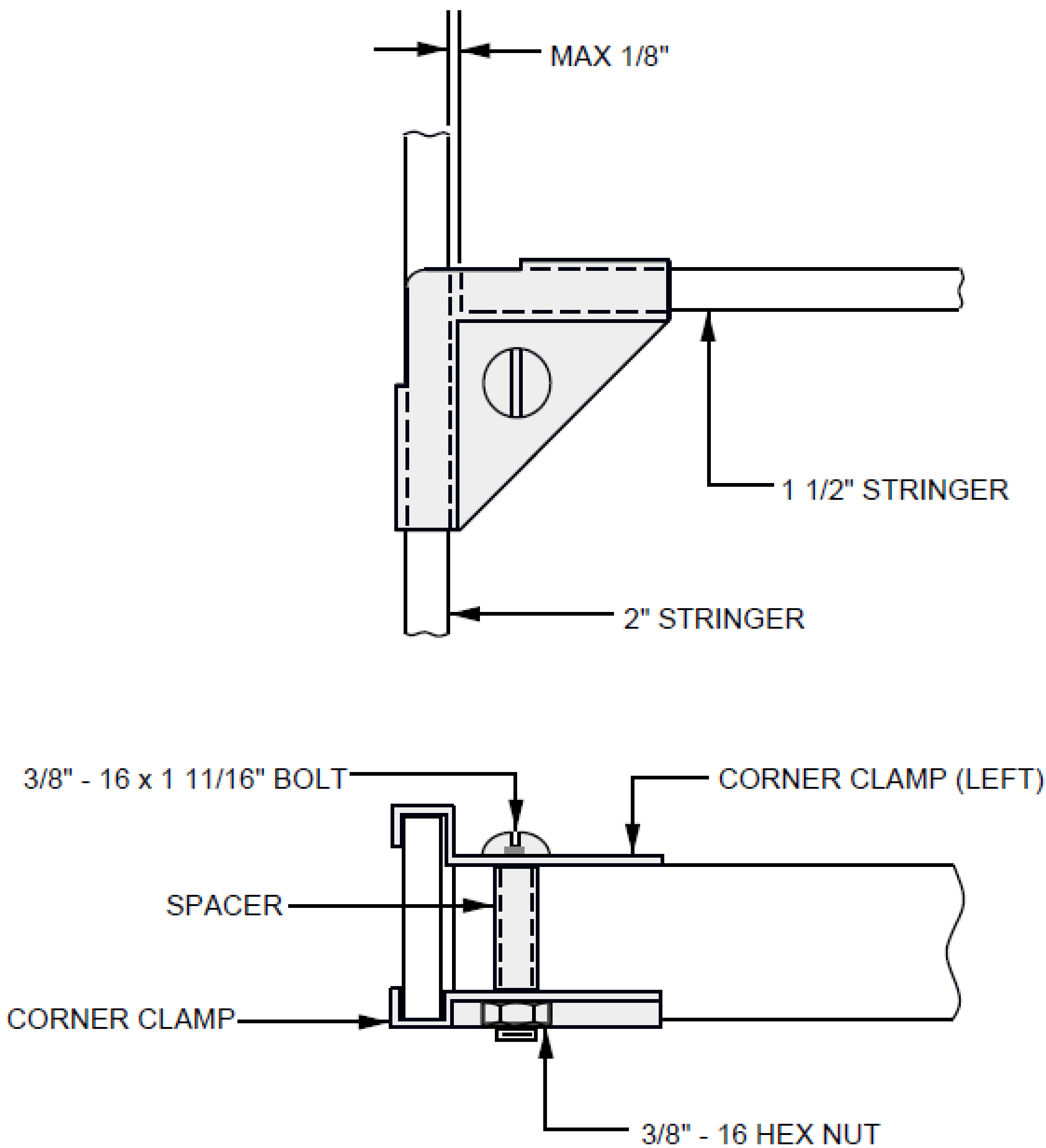
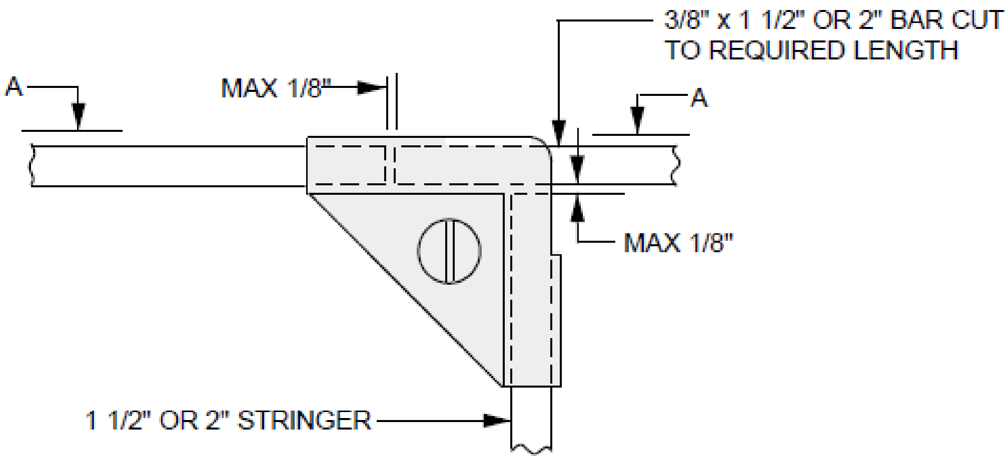
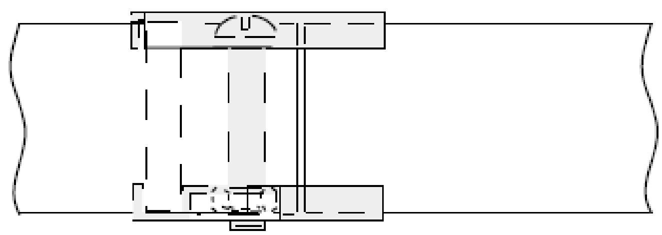


EXHIBIT 2-E1-6

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





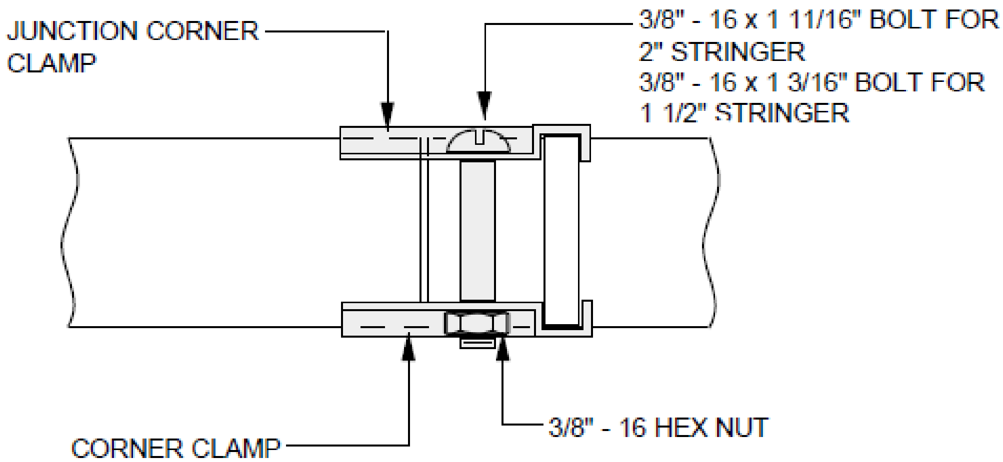


EXHIBIT2-E1-7 (DISCONTINUED)

2-E1-7 (DISCONTINUED) JUNCTION CORNER CLAMP FOR STRINGERS OF SAME WIDTH-LEFT

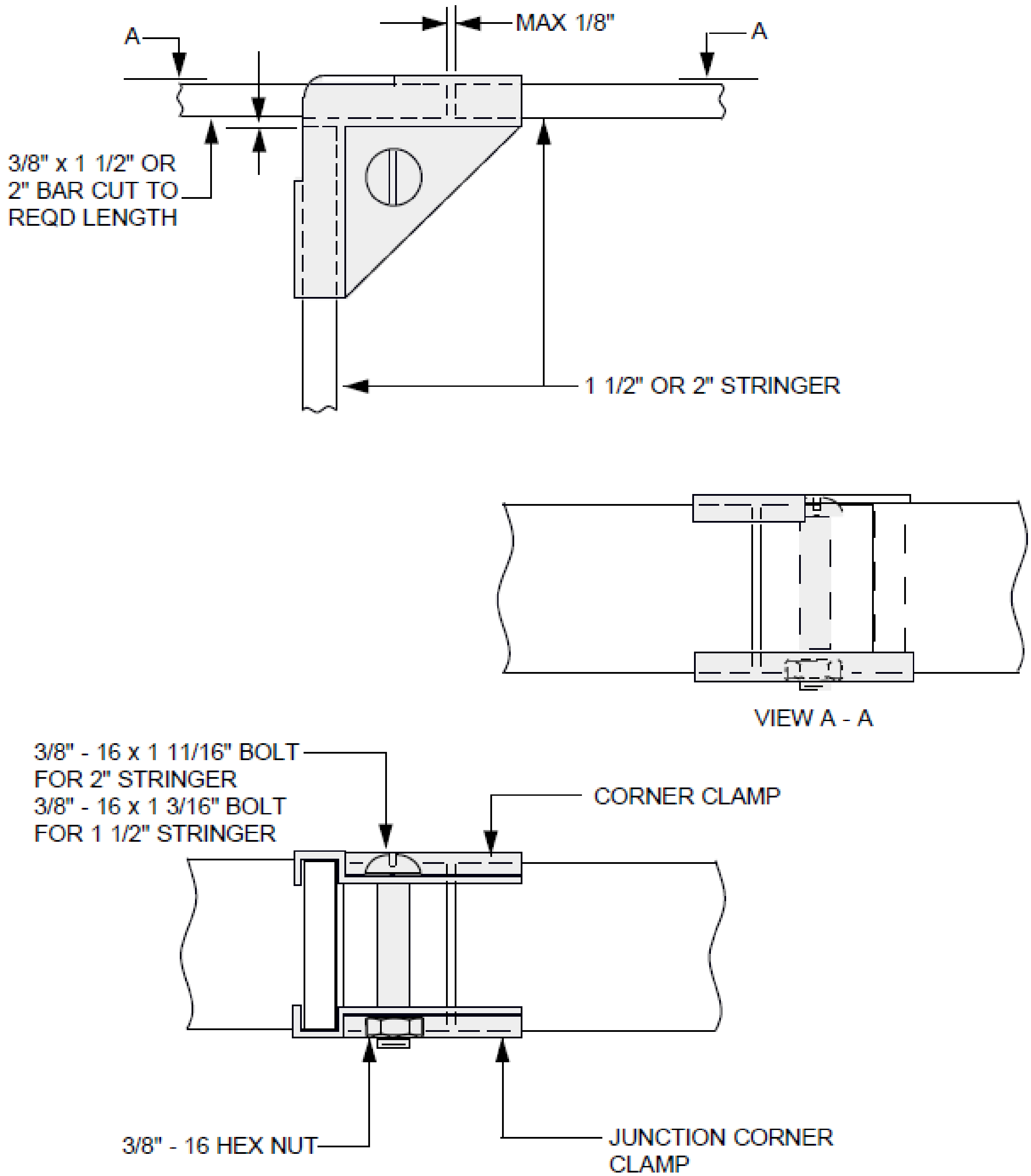


EXHIBIT 2-E1-8 (DISCONTINUED)

2-E1-8 (DISCONTINUED) JUNCTION CORNER CLAMP FOR STRINGERS OF SAME WIDTH-RIGHT

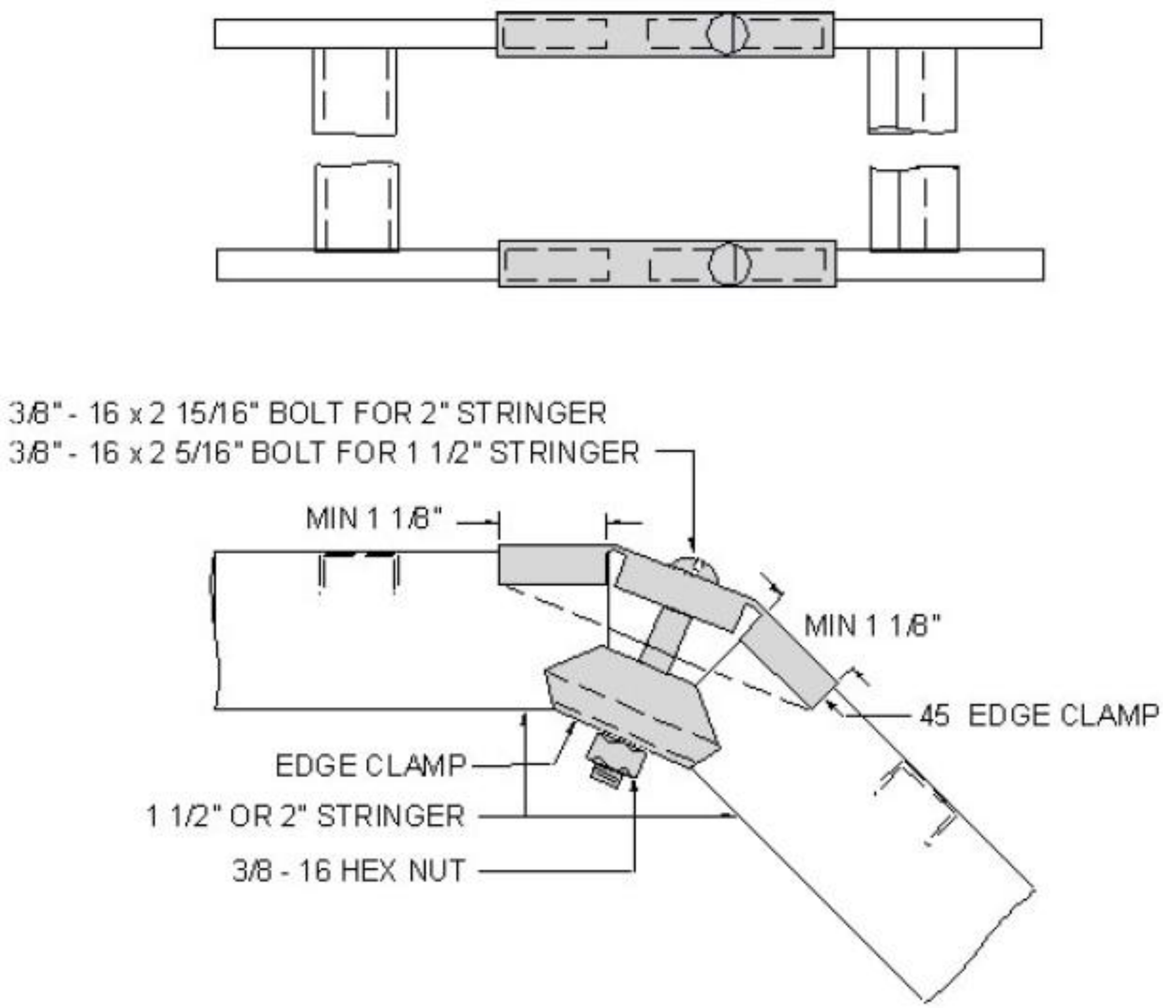
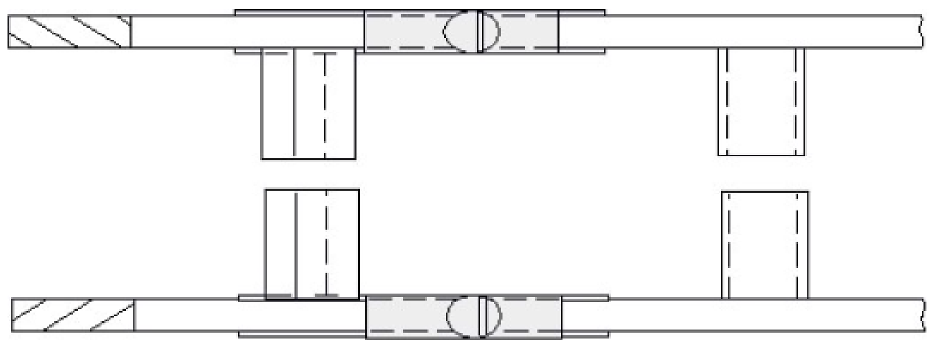


EXHIBIT 2-E1-9

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



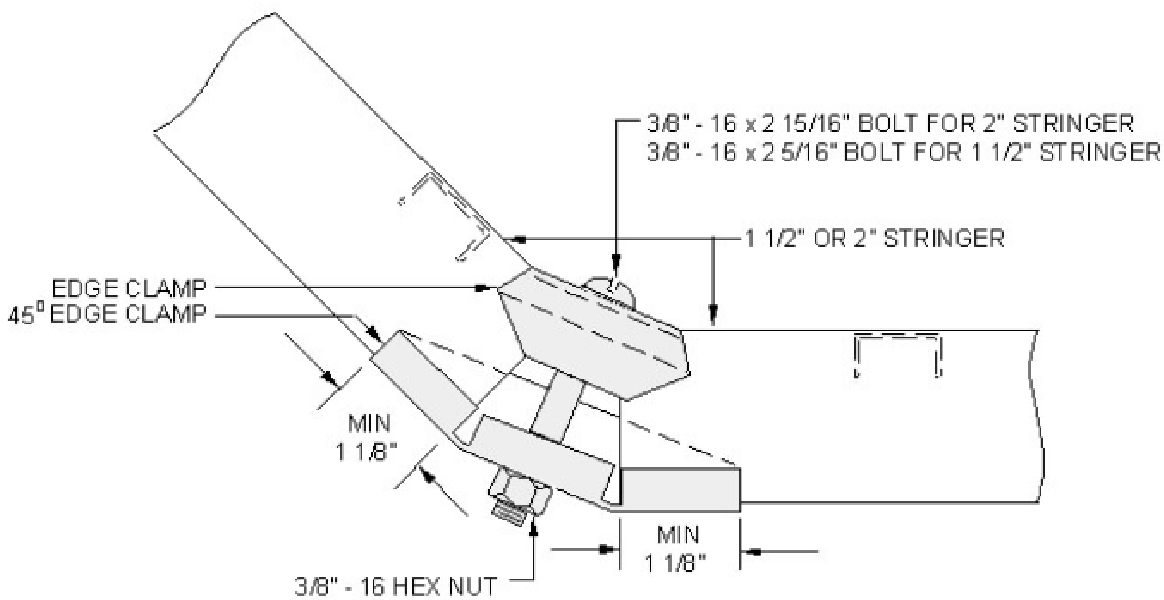
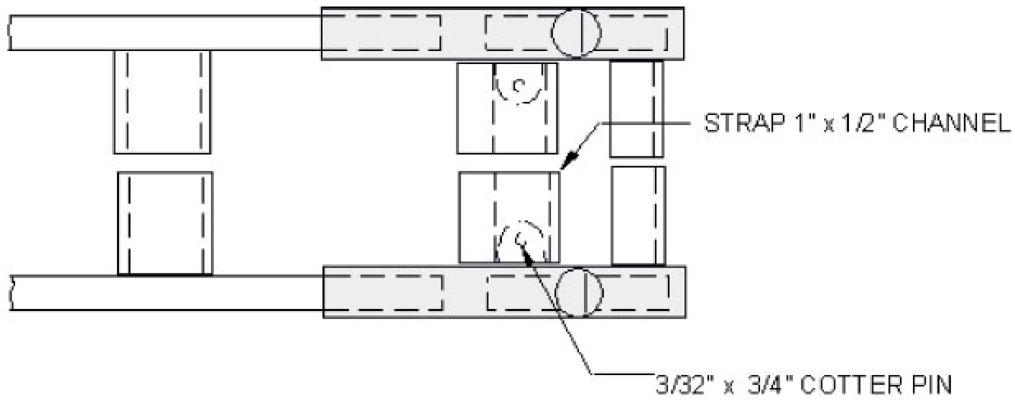


EXHIBIT 2-E1-10

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



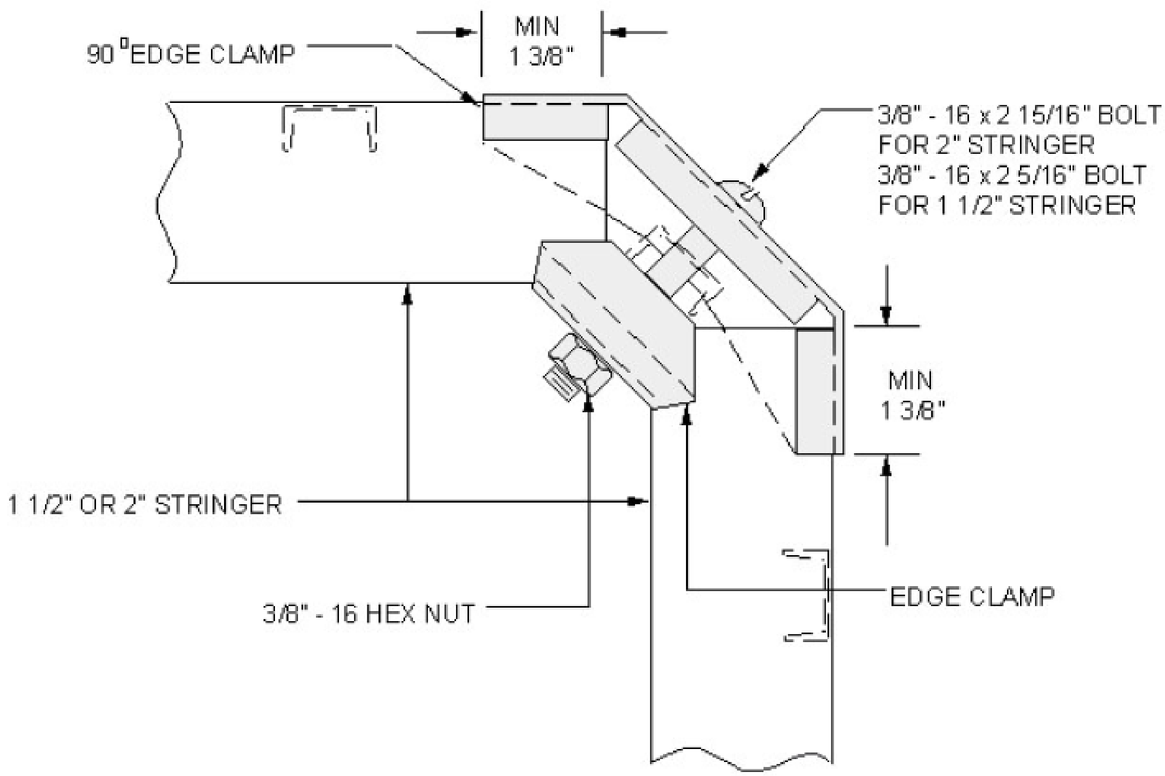
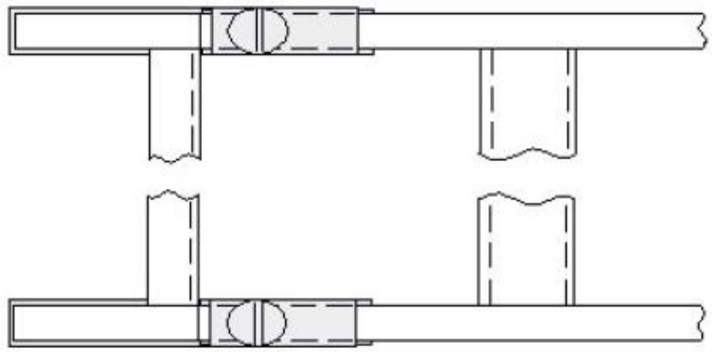


EXHIBIT 2-E1-11

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



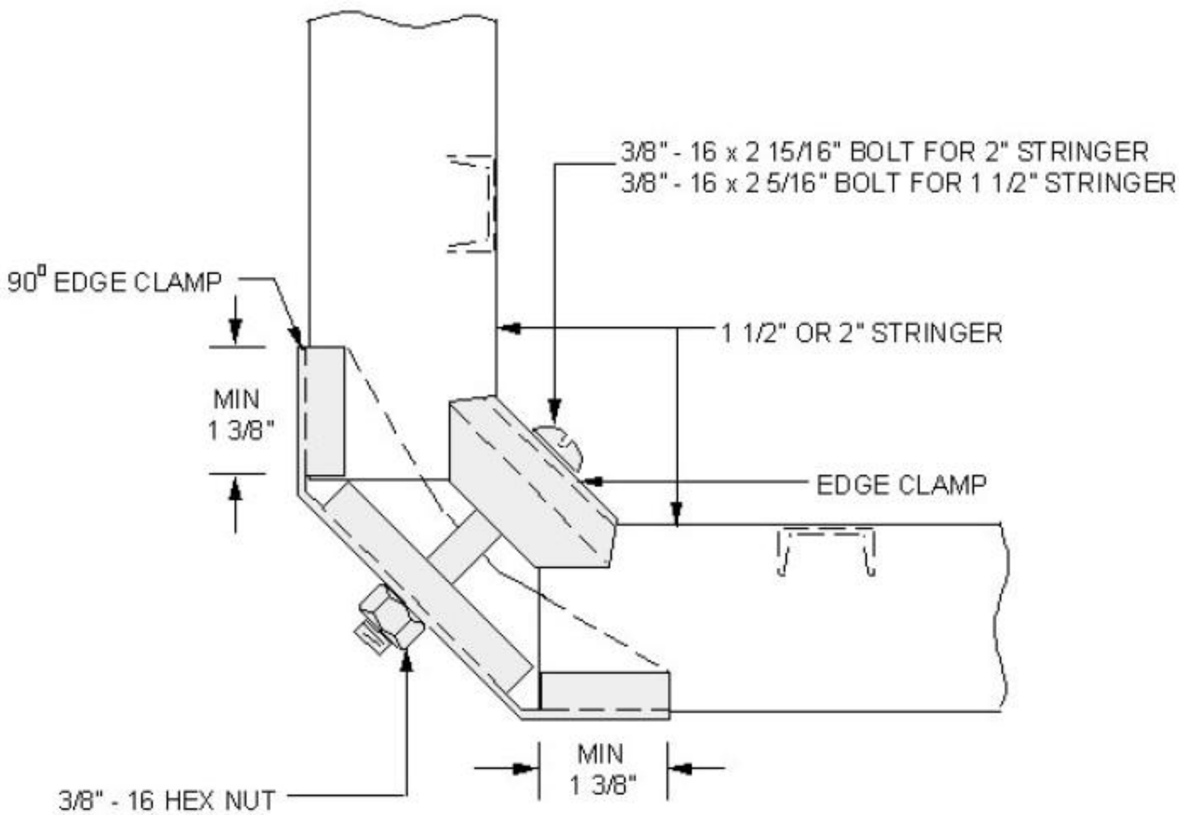


EXHIBIT 2-E1-12

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

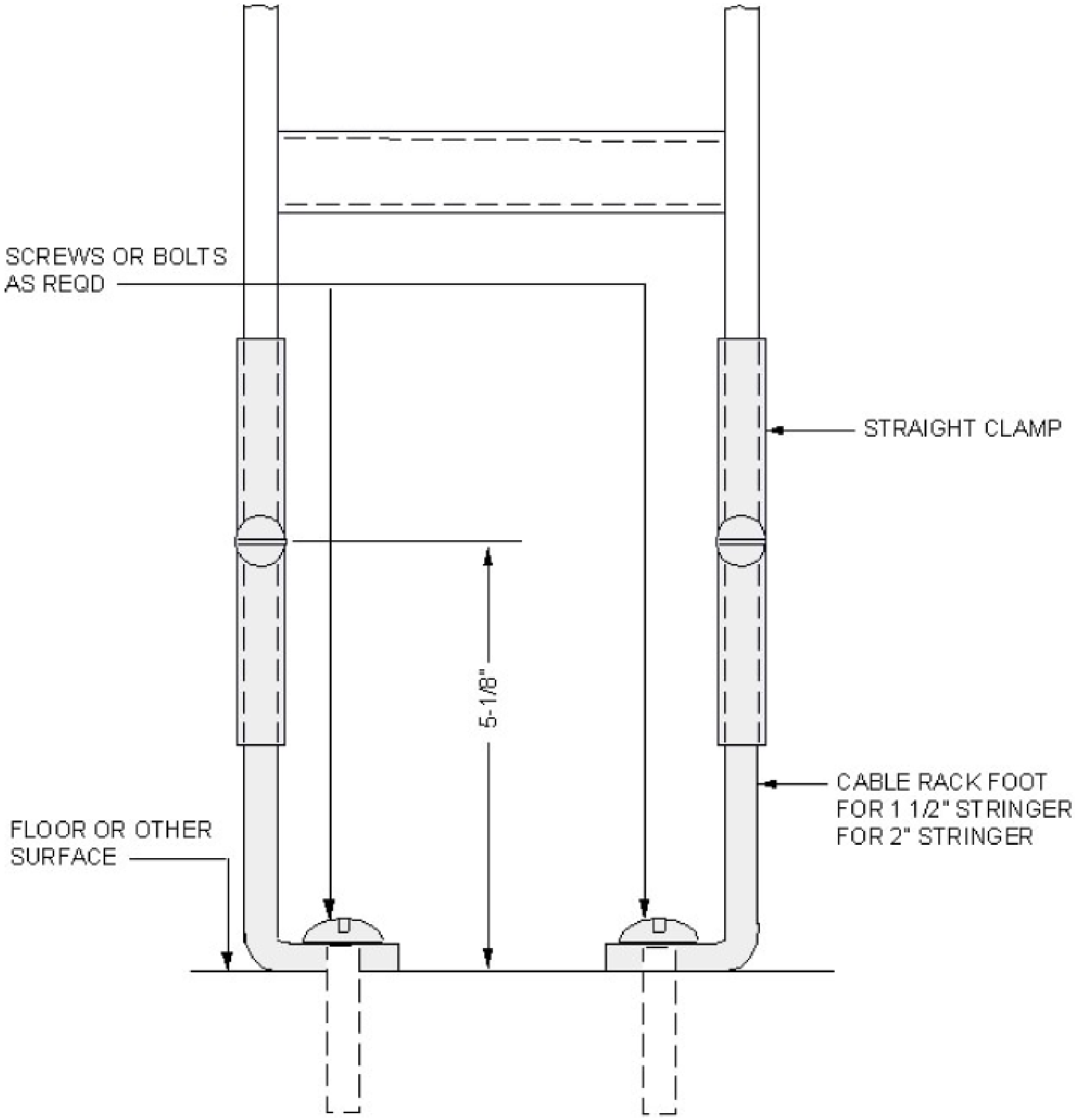
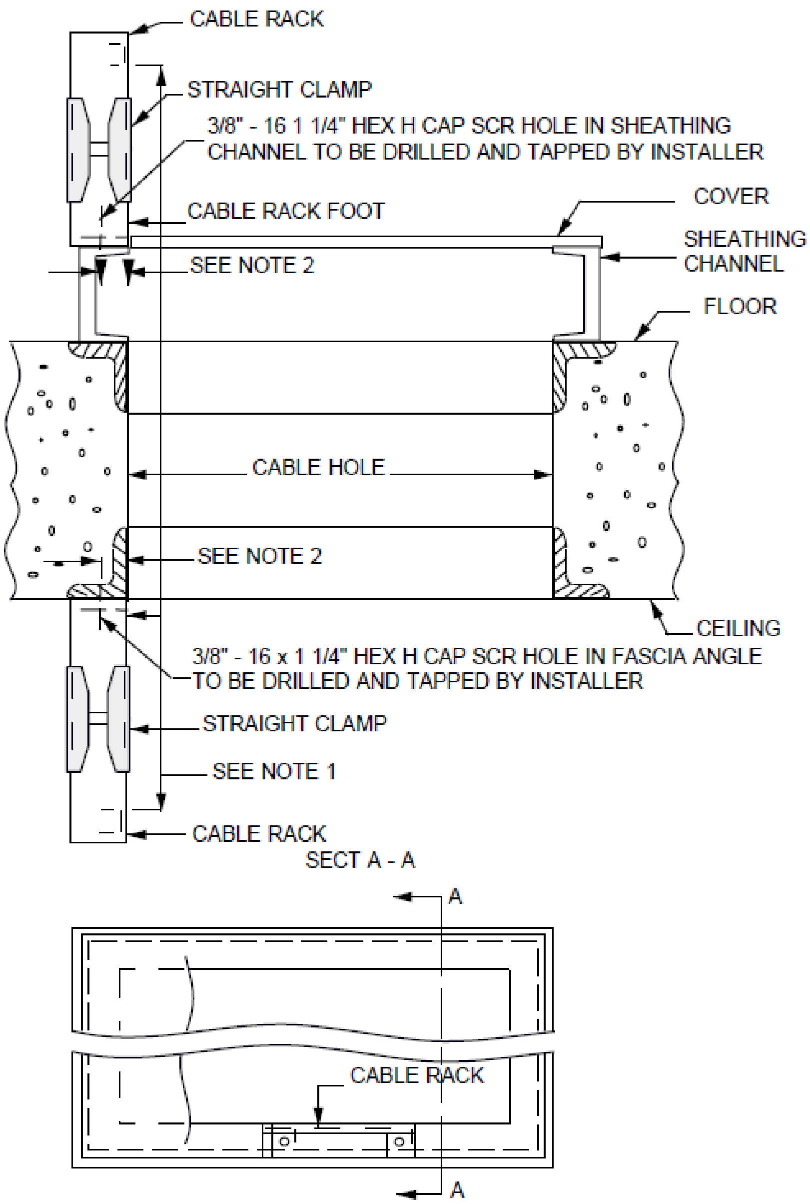


EXHIBIT 2-E1-13

2-E1-13 SECURING END OF VERTICAL RACK

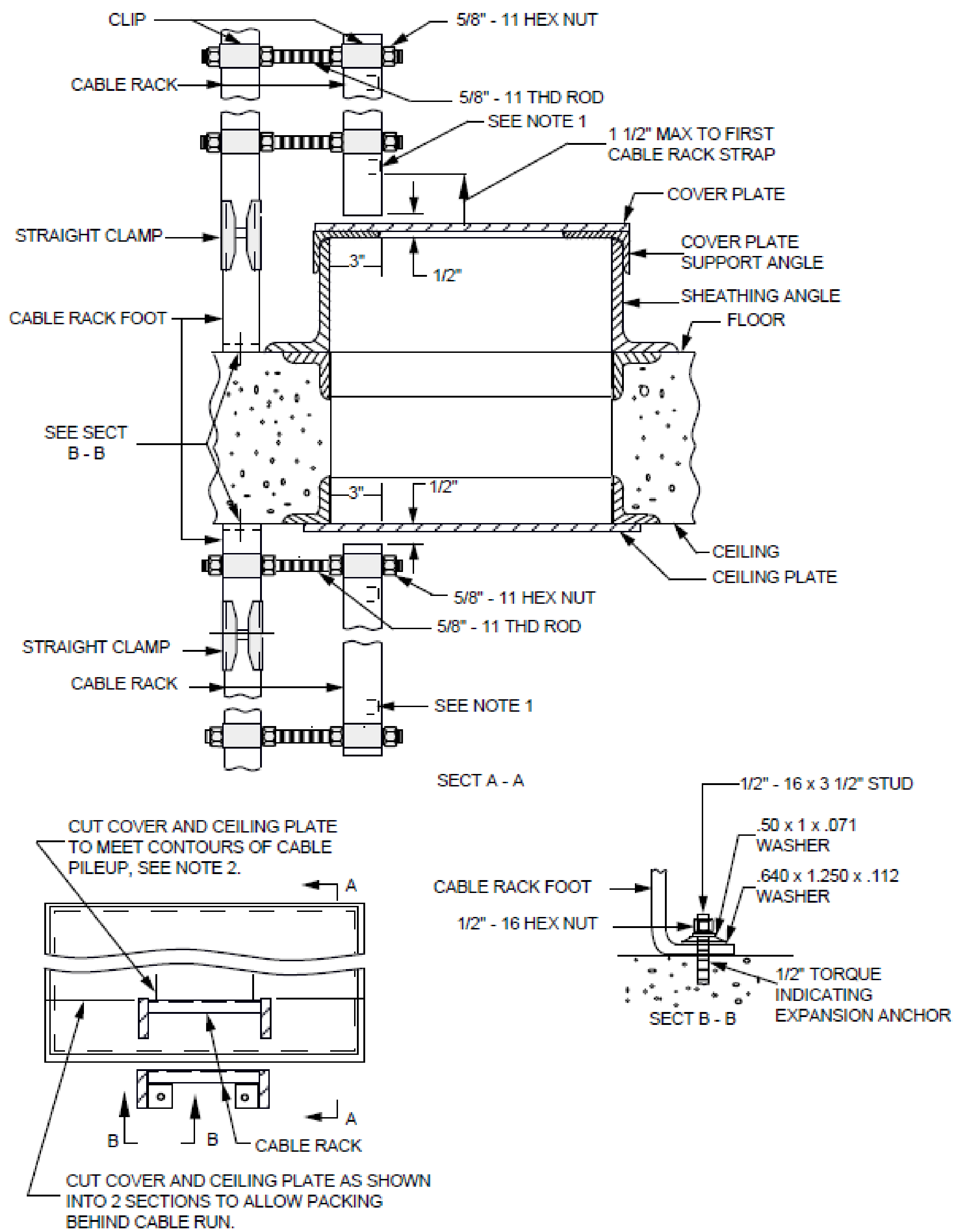


NOTES:

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

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

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

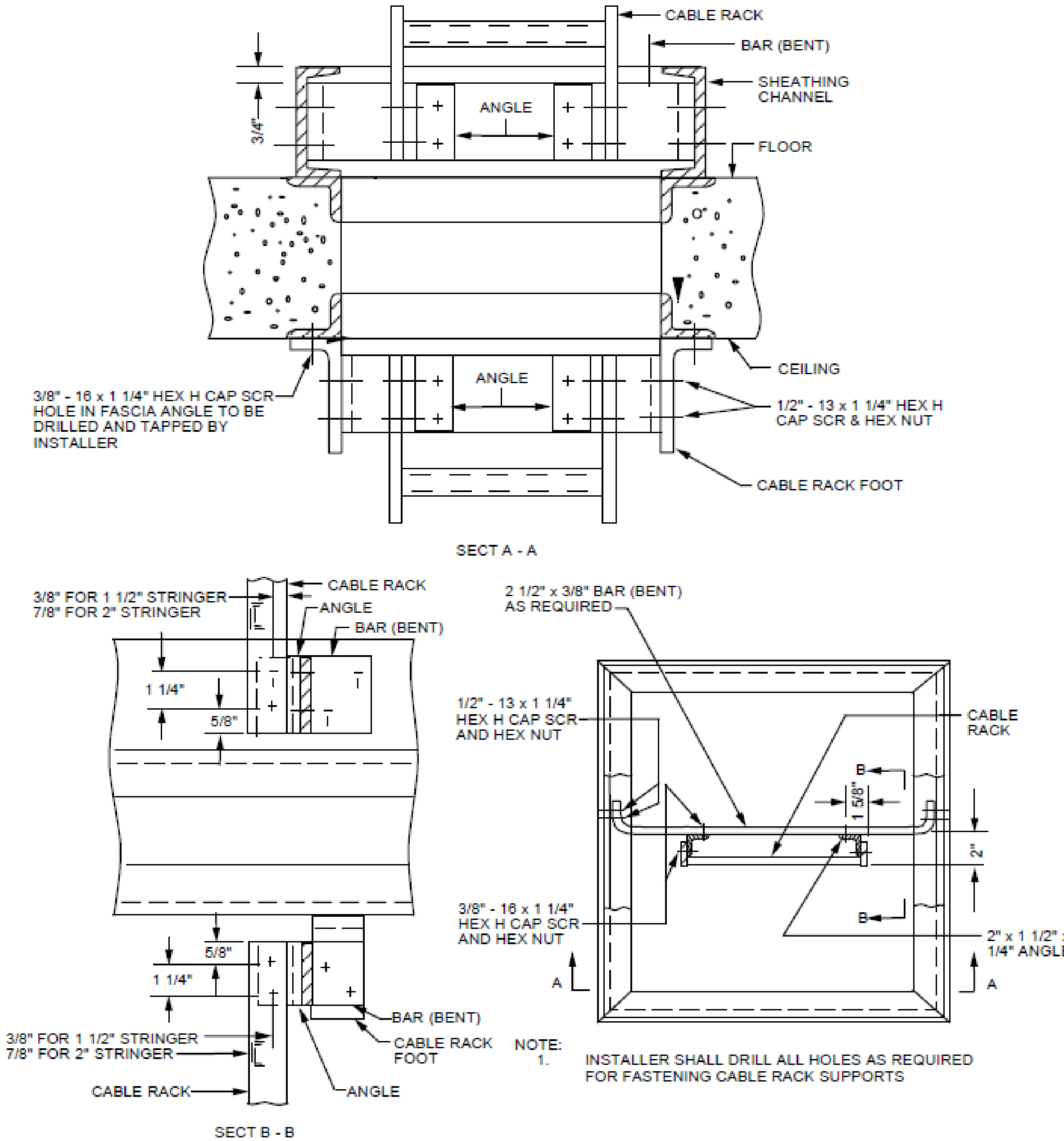
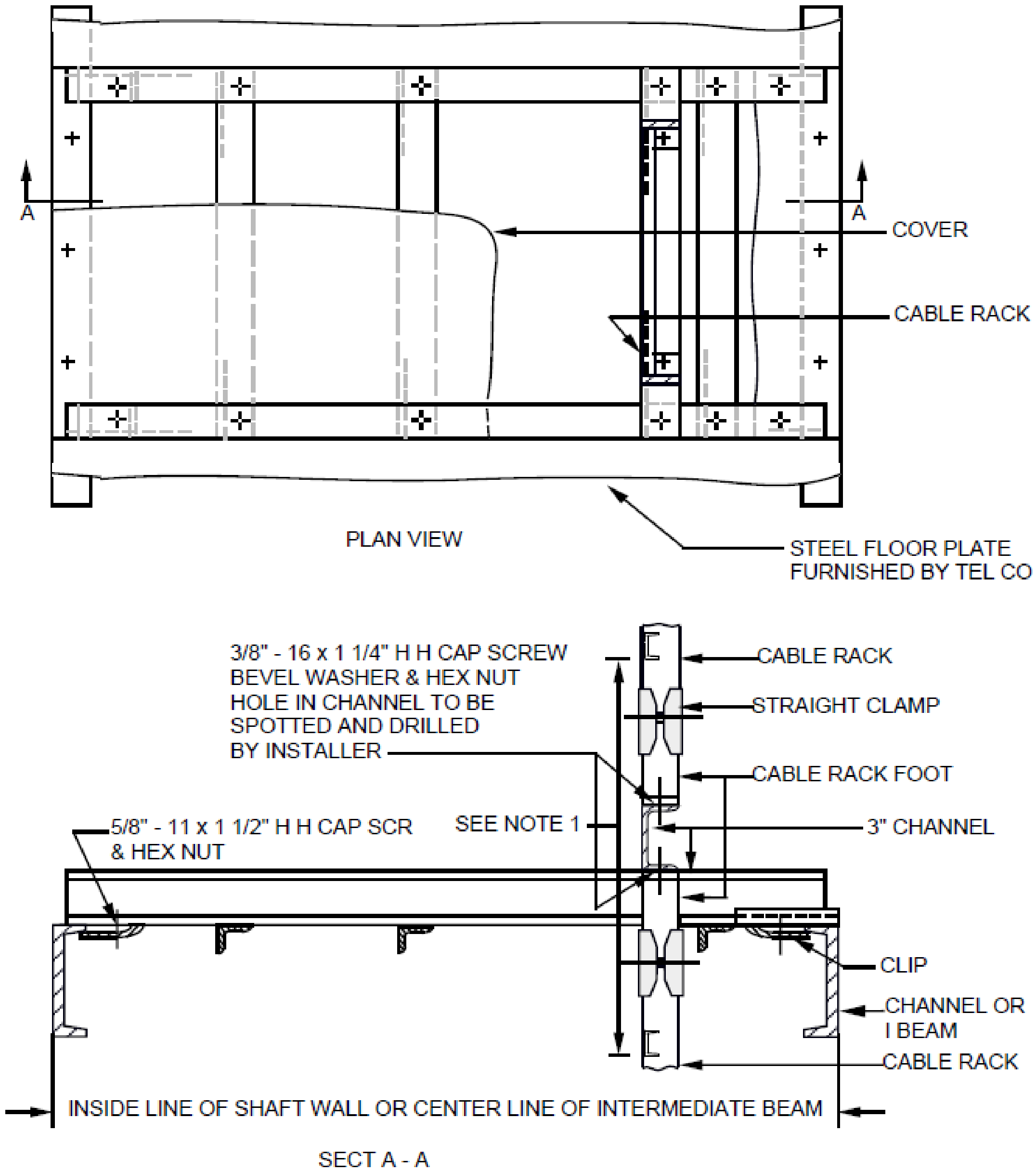


EXHIBIT 2-E1-13C

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

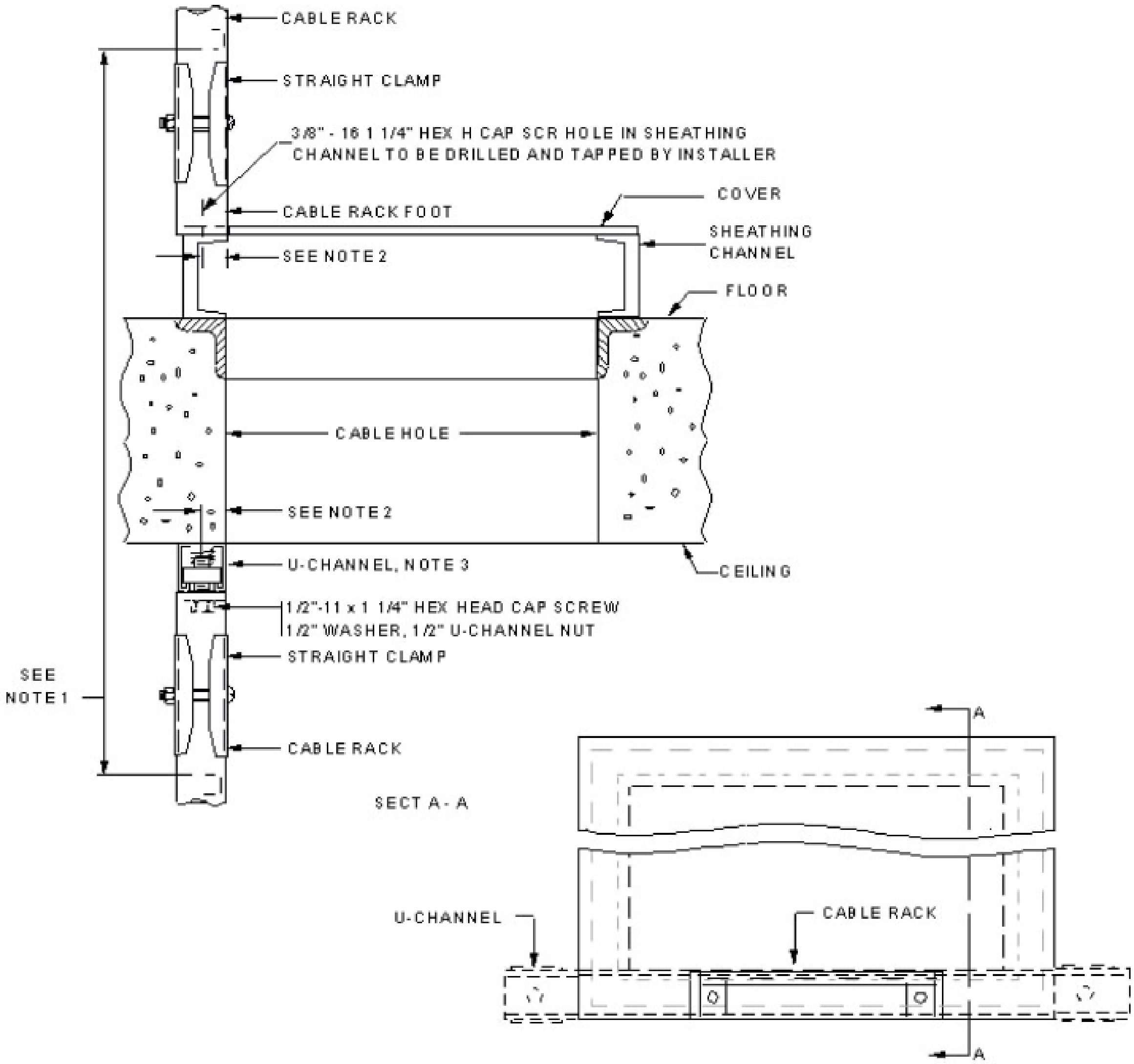


NOTE:

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

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



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.
3. U-CHANNEL SHALL BE FLUSH WITH INNER EDGE OF THE CABLE HOLE AT THE CEILING.

EXHIBIT 2-E1-13E

2-E1-13E TYPICAL SUPPORT OF CABLE RACK TO CEILING AT CABLE HOLE USING U-CHANNEL

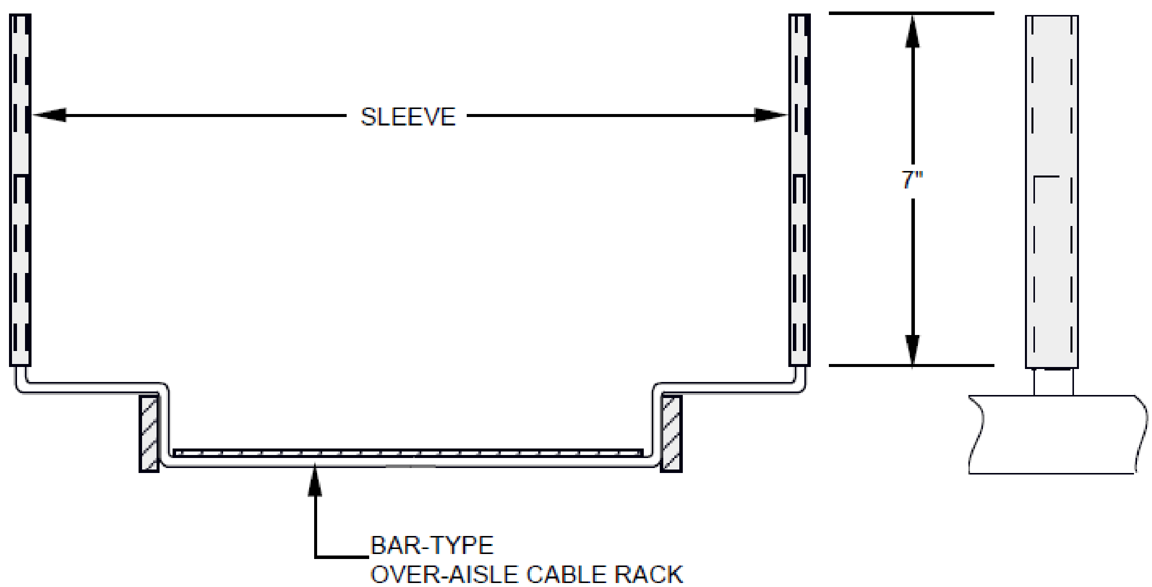
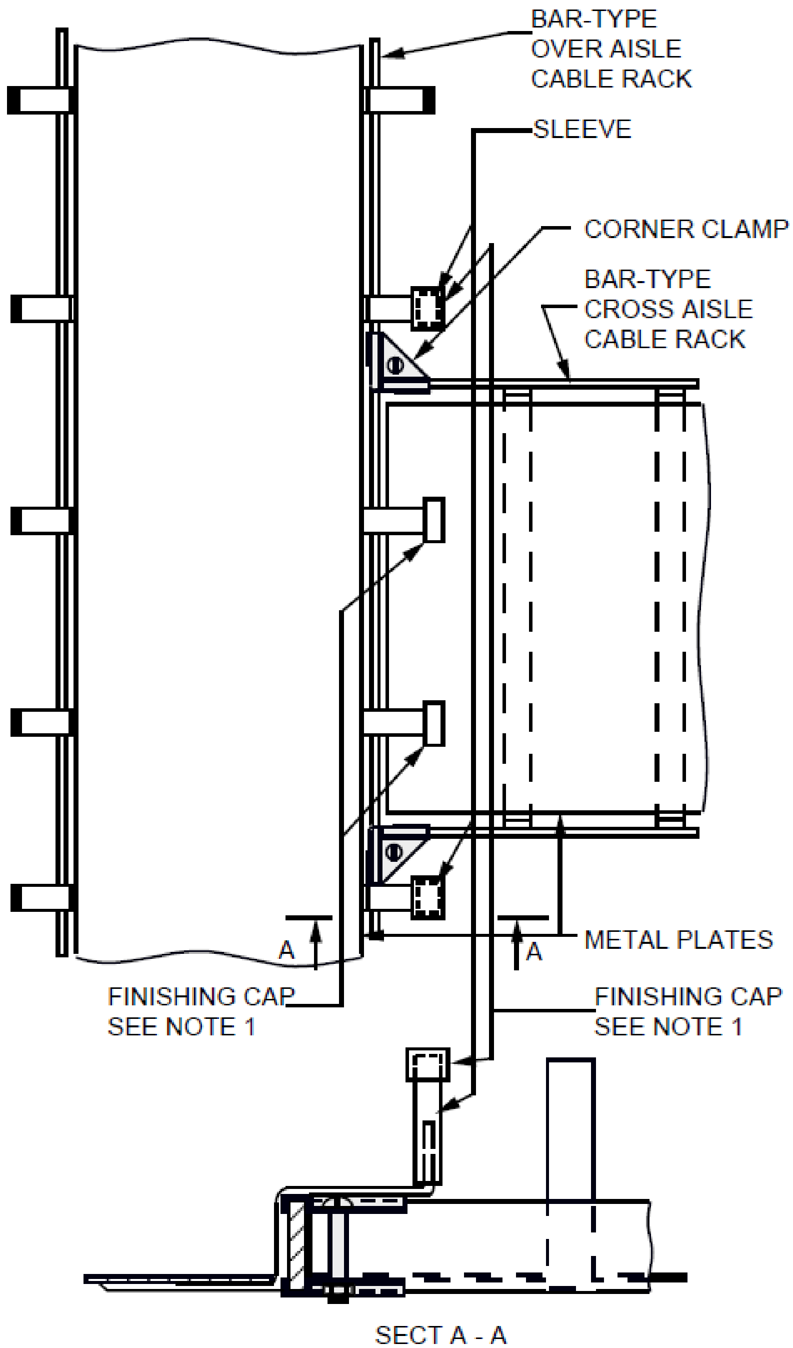


EXHIBIT 2-E1-16A (MD)

2-E1-16A (MD) EXTENSIONS FOR BAR-TYPE OVER-AISLE CABLE RACK

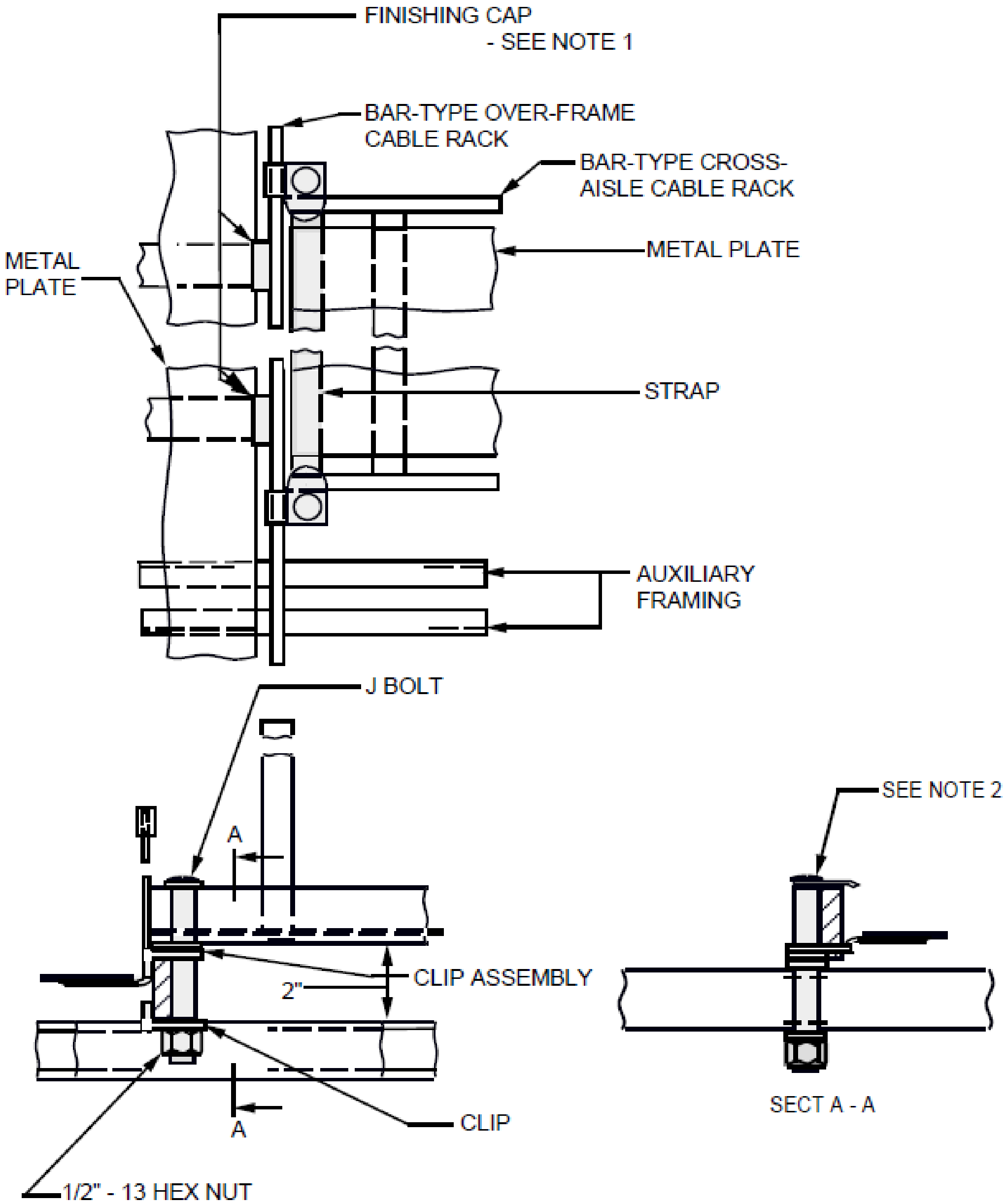


NOTE:

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)

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

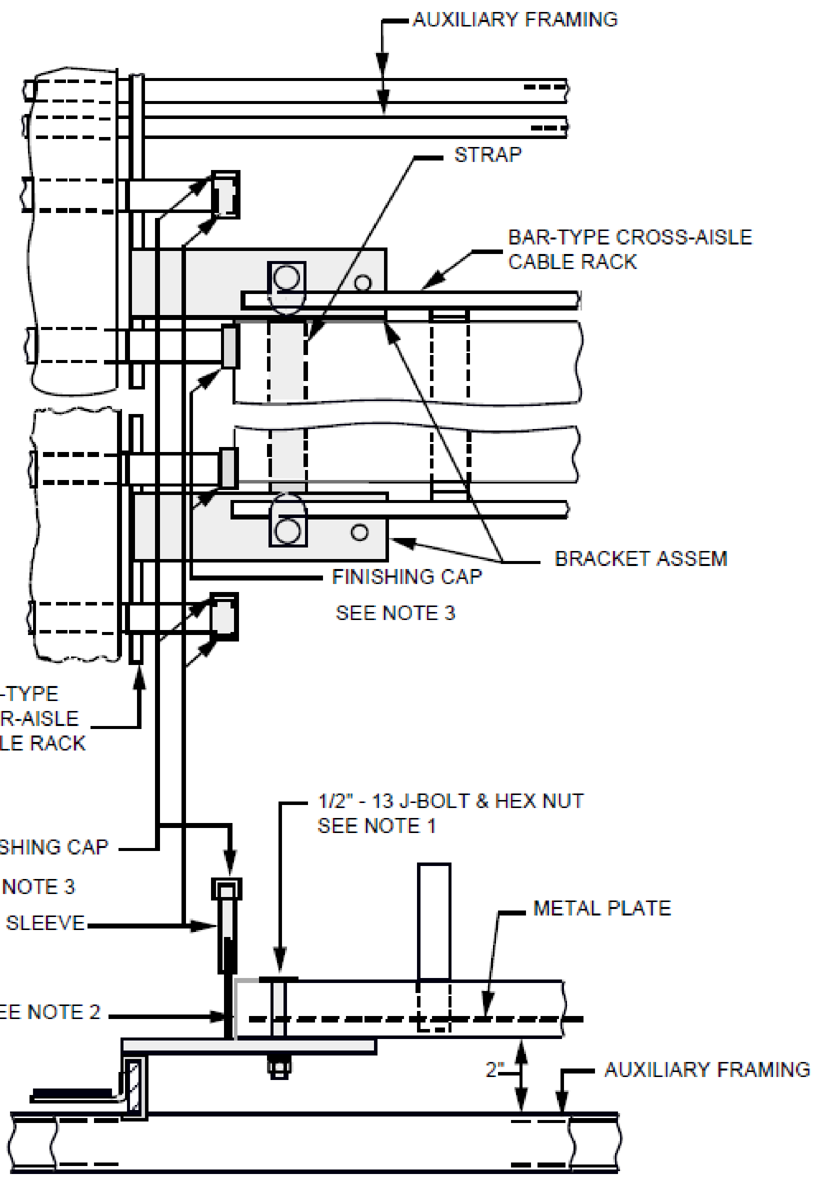


NOTES:

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)

2-E1-17H 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

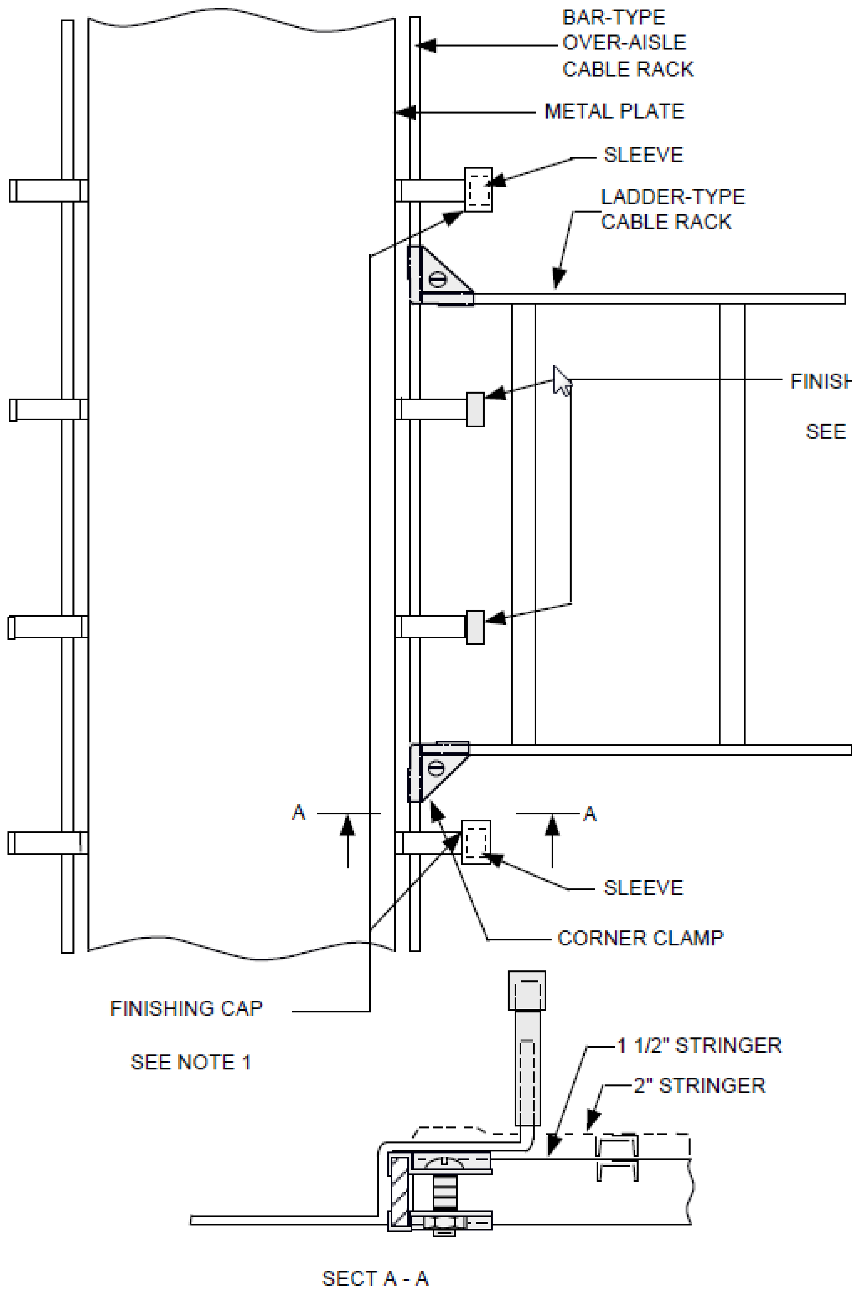


NOTES:

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)

2-E1-17J 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.

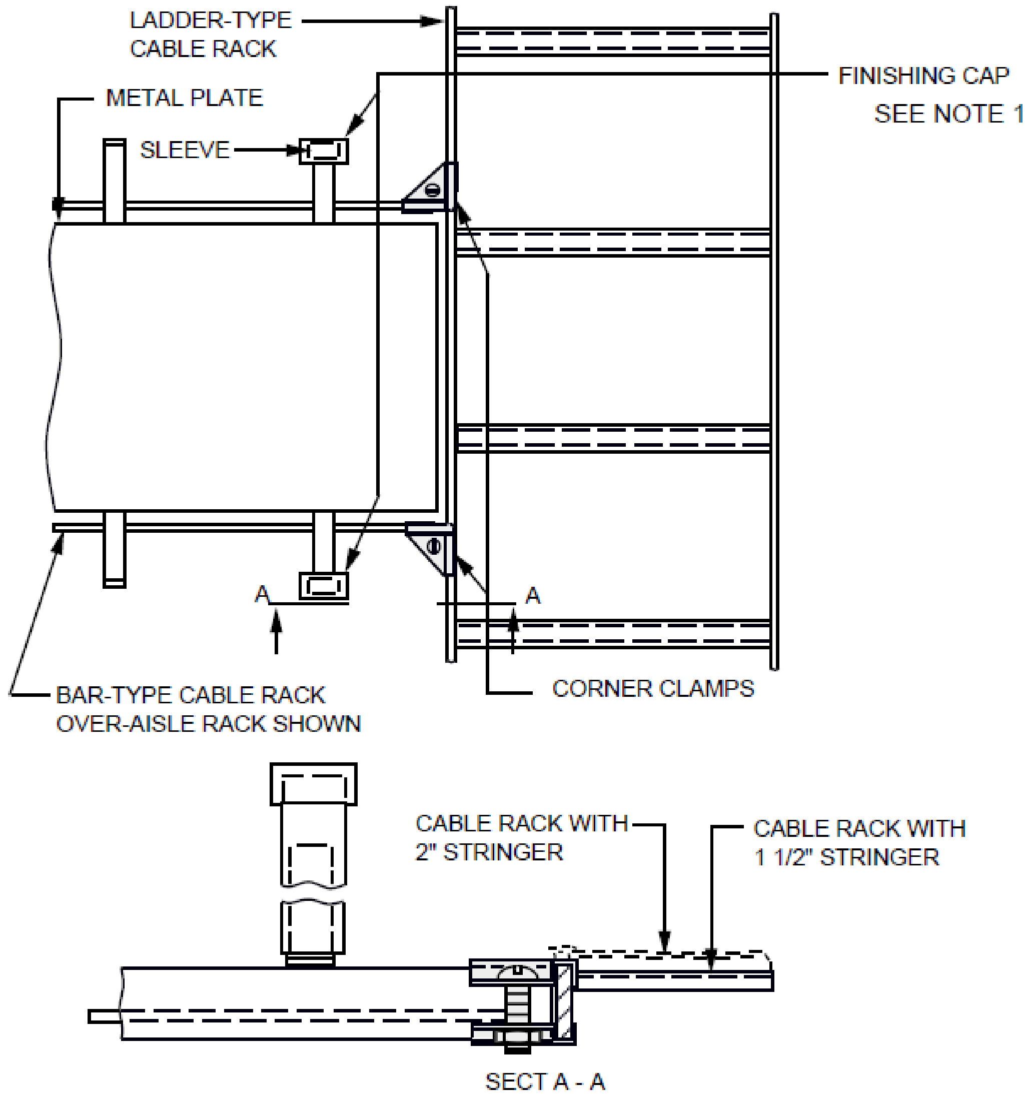


NOTE:

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

2-E1-18A 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

2-E1-19A T-INTERSECTION LADDER-TYPE TO BAR-TYPE CABLE RACK

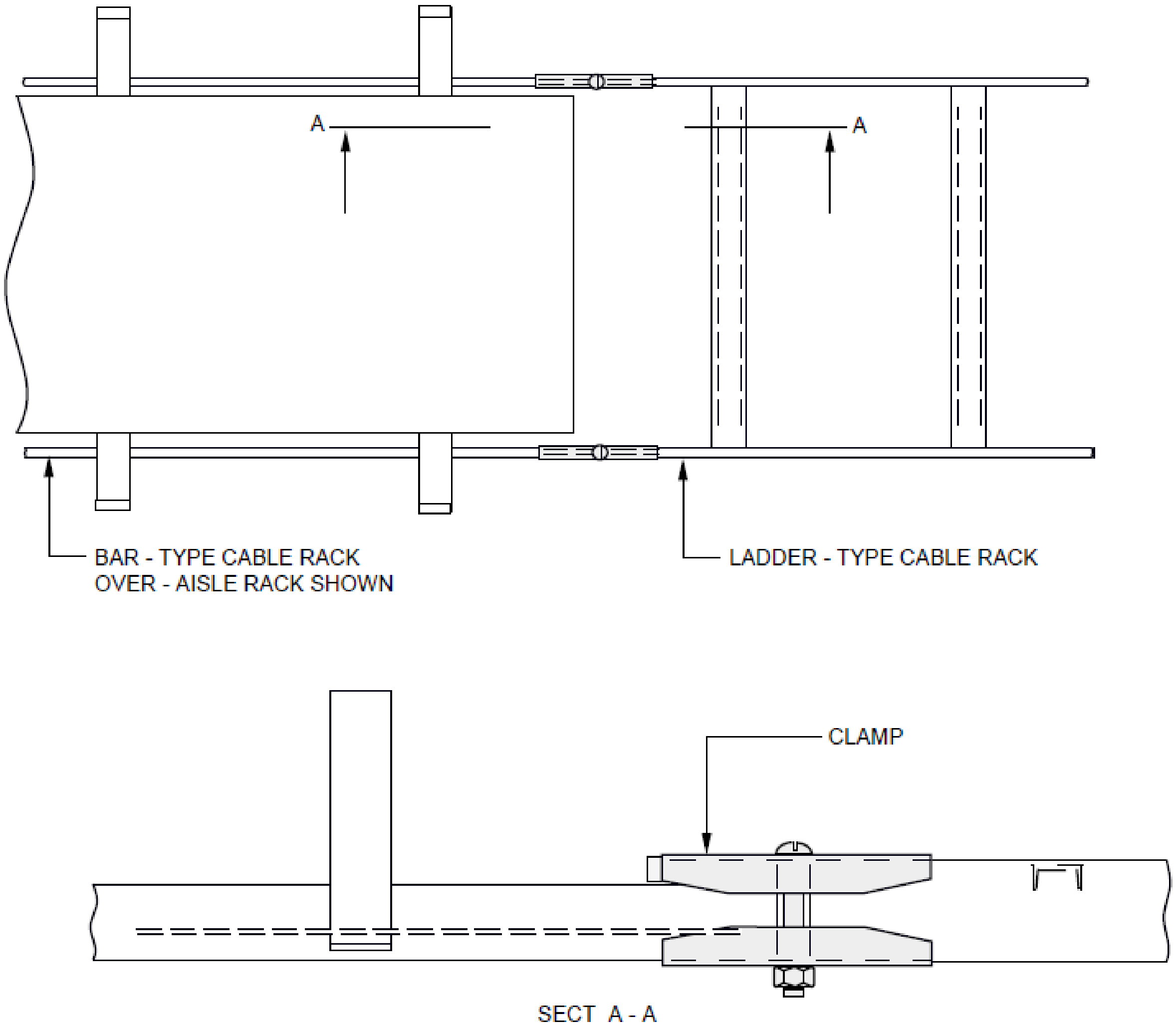


EXHIBIT 2-E1-20A

2-E1-20A JOINING BAR-TYPE TO LADDER-TYPE CABLE RACK OF THE SAME WIDTH.

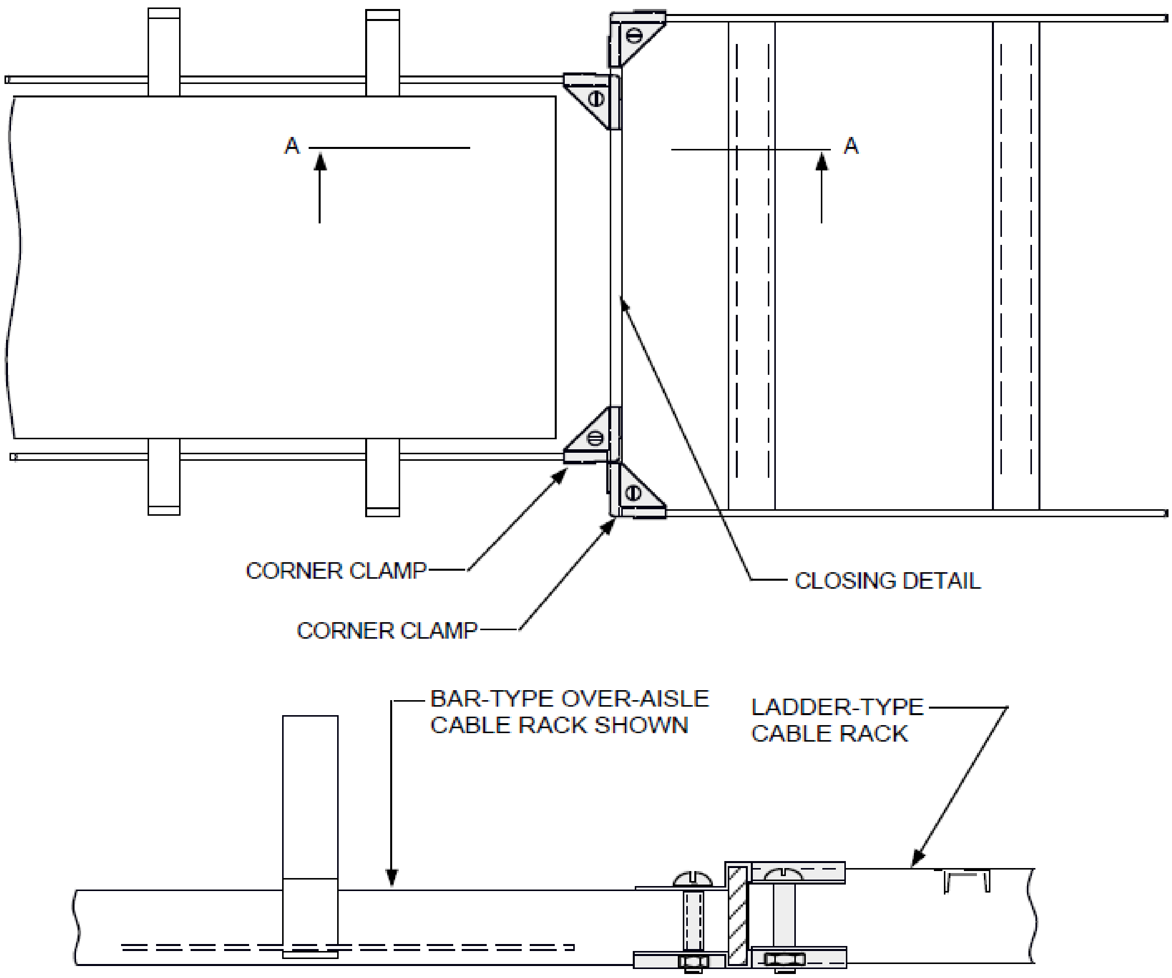


EXHIBIT 2-E1-21A

2-E1-21A JOINING CABLE RACK OF VARYING WIDTH AND STRINGER SIZE.

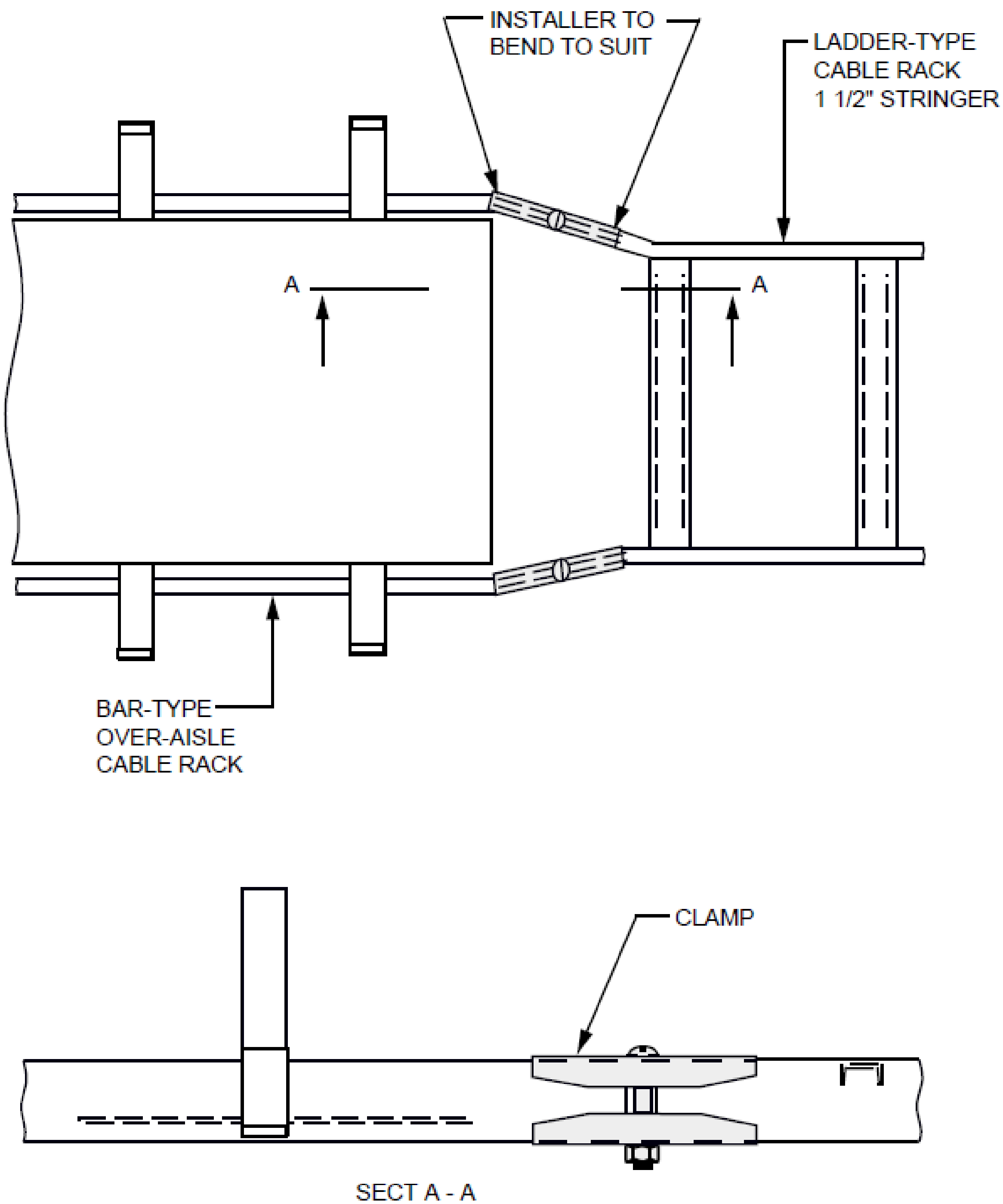


EXHIBIT 2-E1 22A (DISCONTINUED)

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

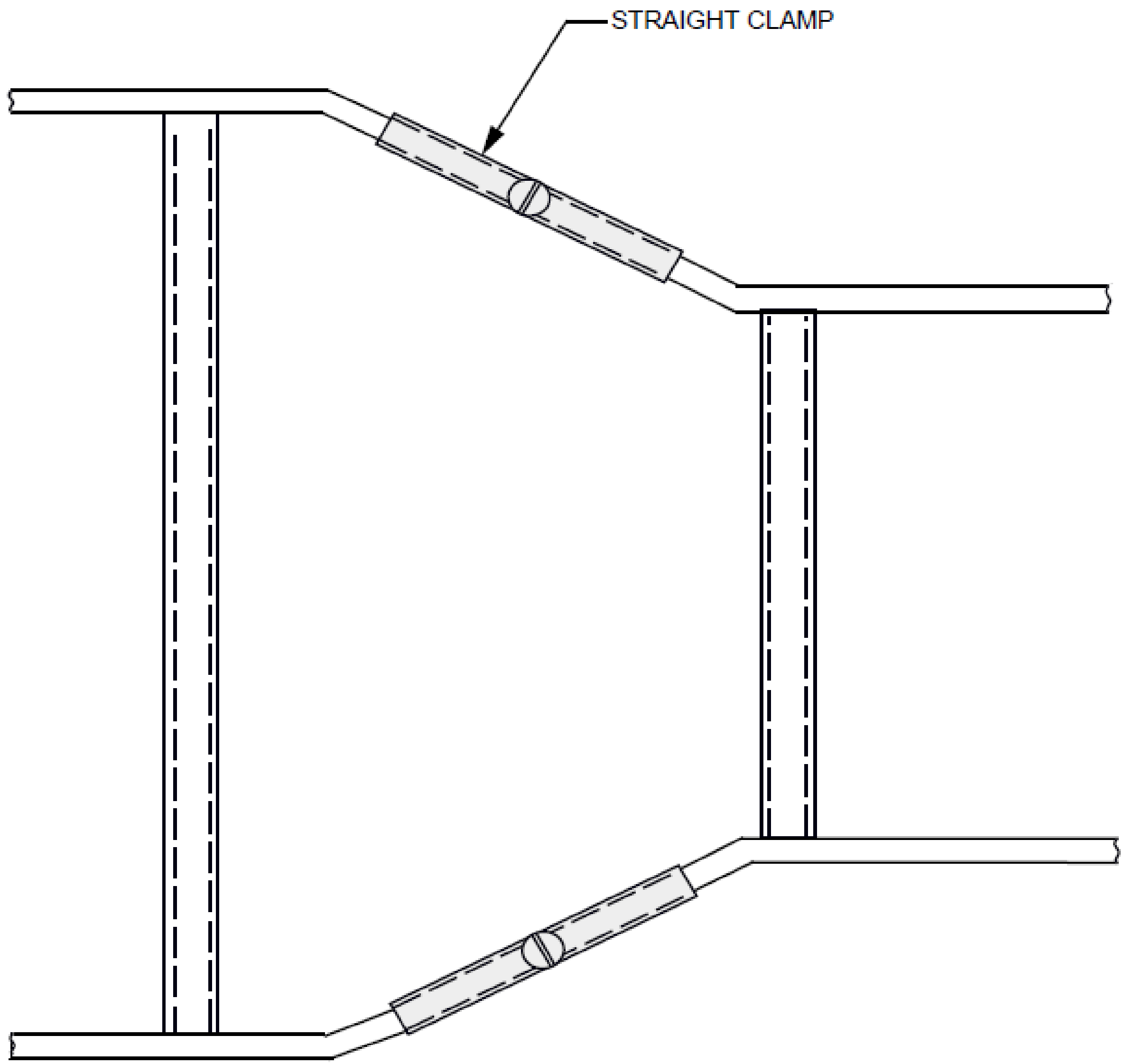


EXHIBIT 2-E1-23 (DISCONTINUED)

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.

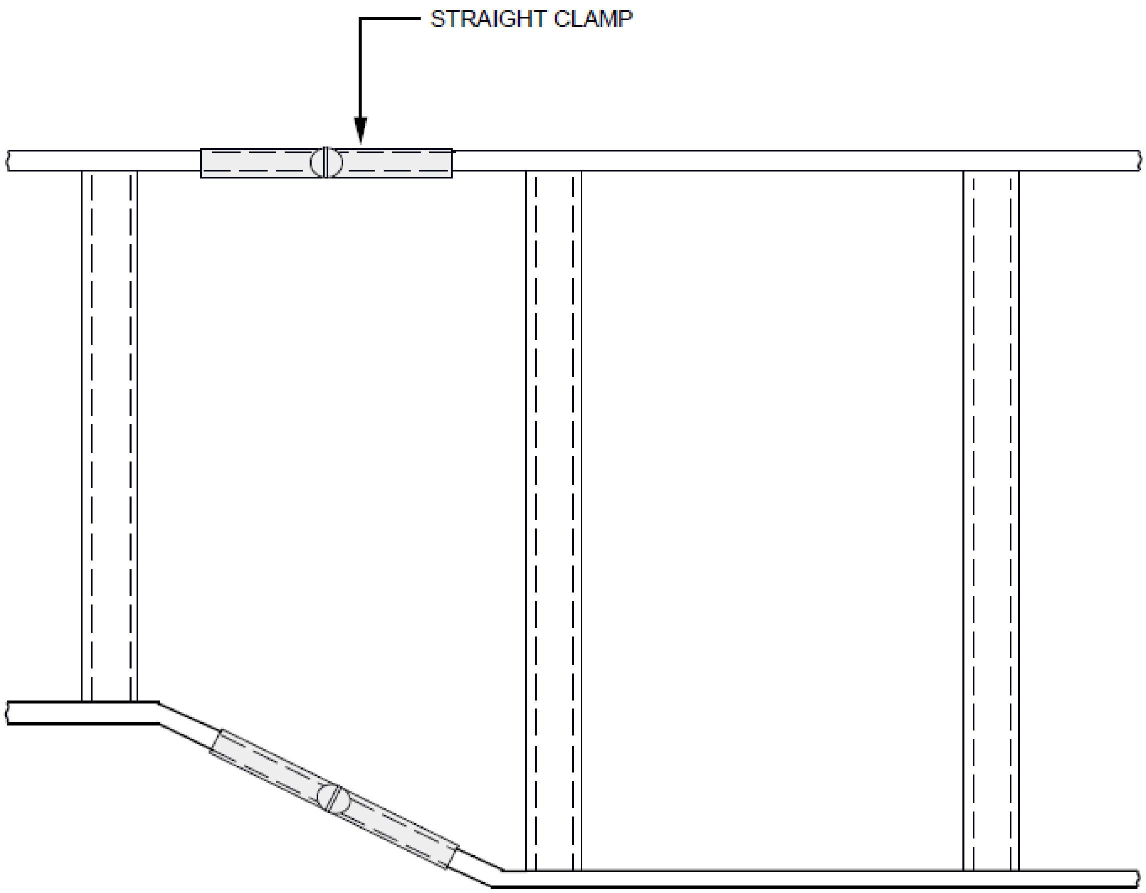


EXHIBIT 2-E1-24 (DISCONTINUED)

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

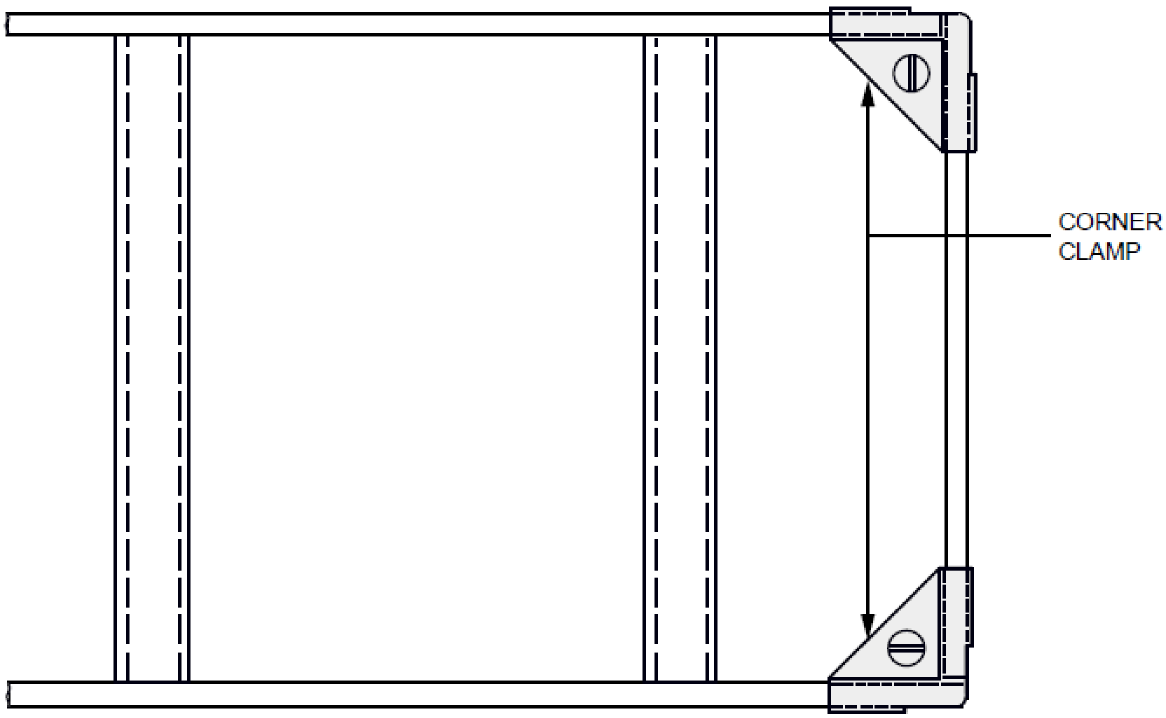


EXHIBIT 2-E1-25

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

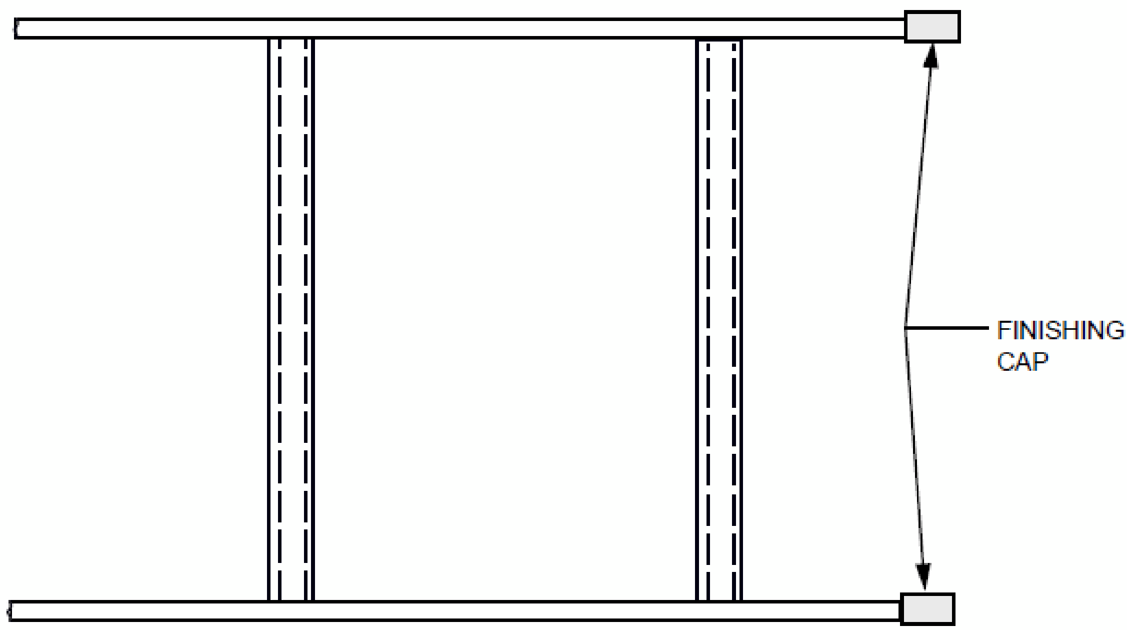


EXHIBIT 2-E1-25C

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

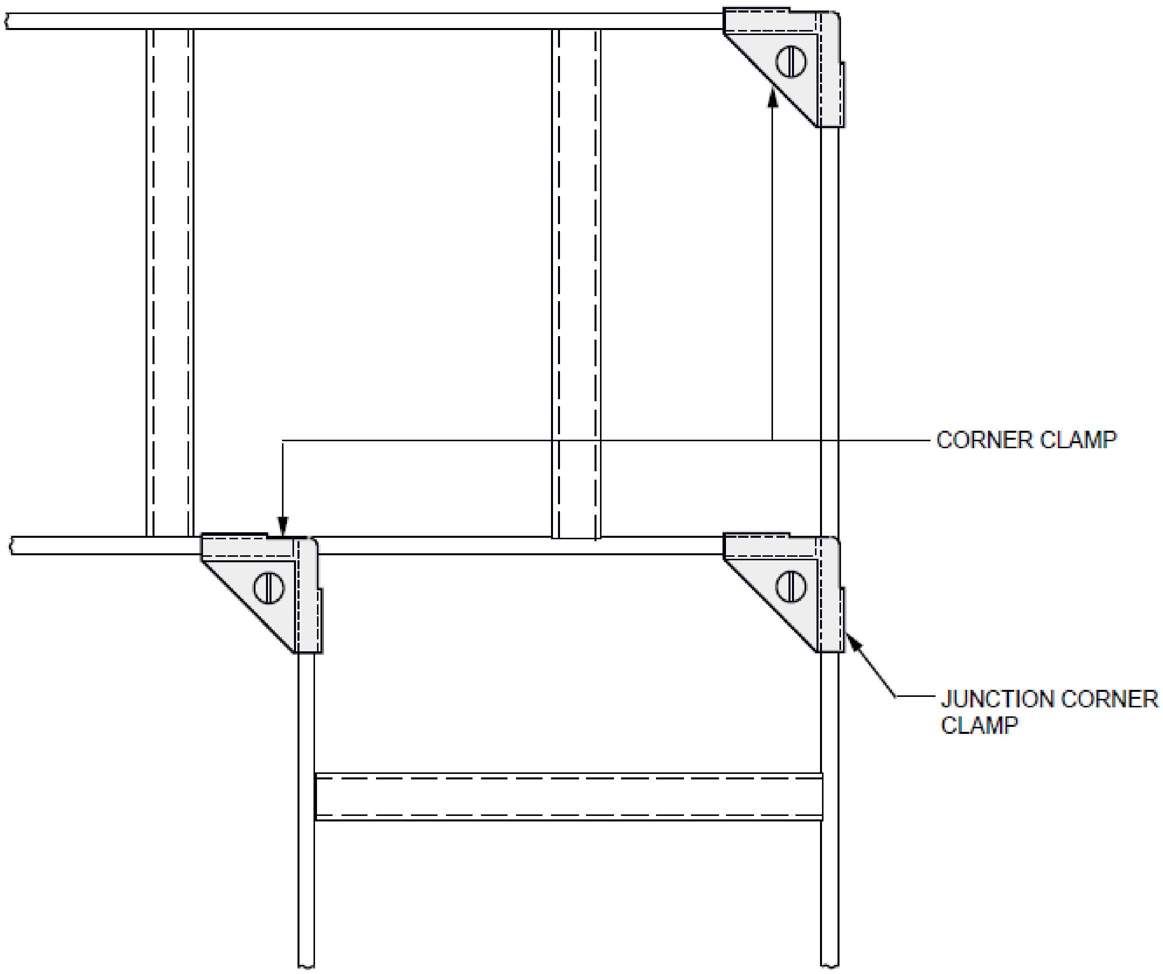


EXHIBIT 2-E1-26

2-E1-26 90 DEGREE TURN IN SAME PLANE

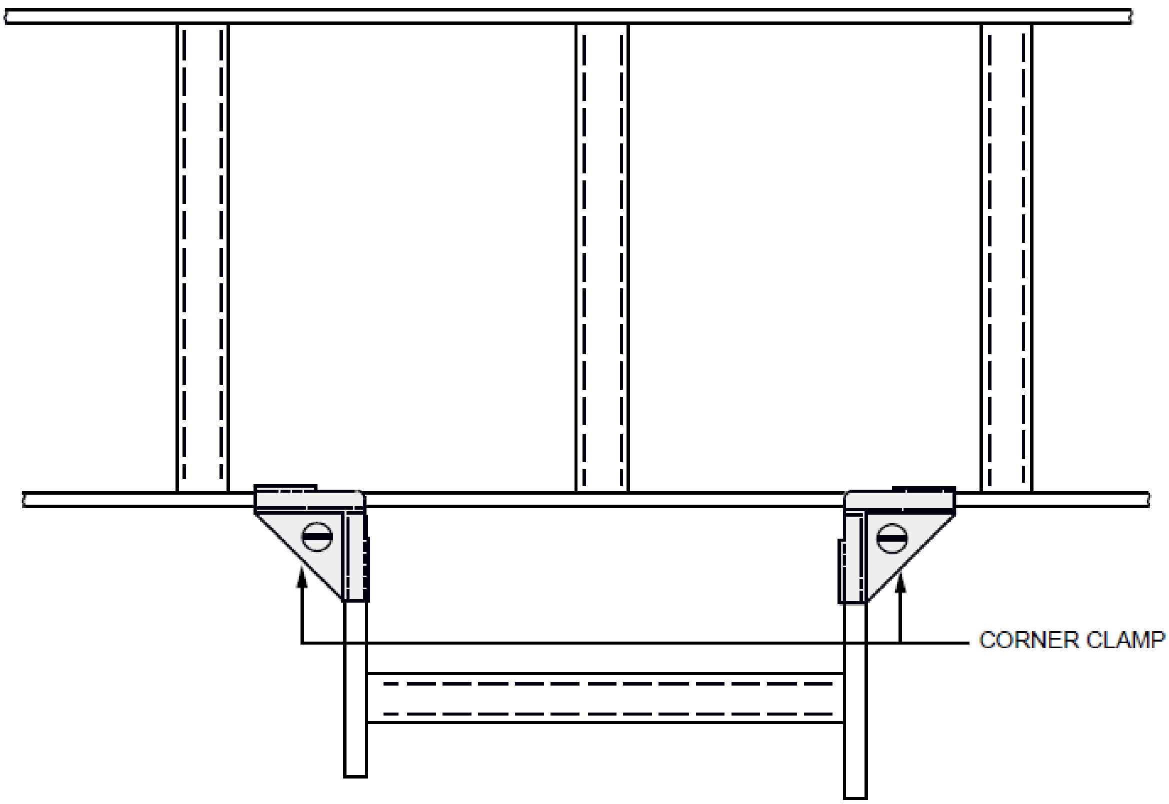
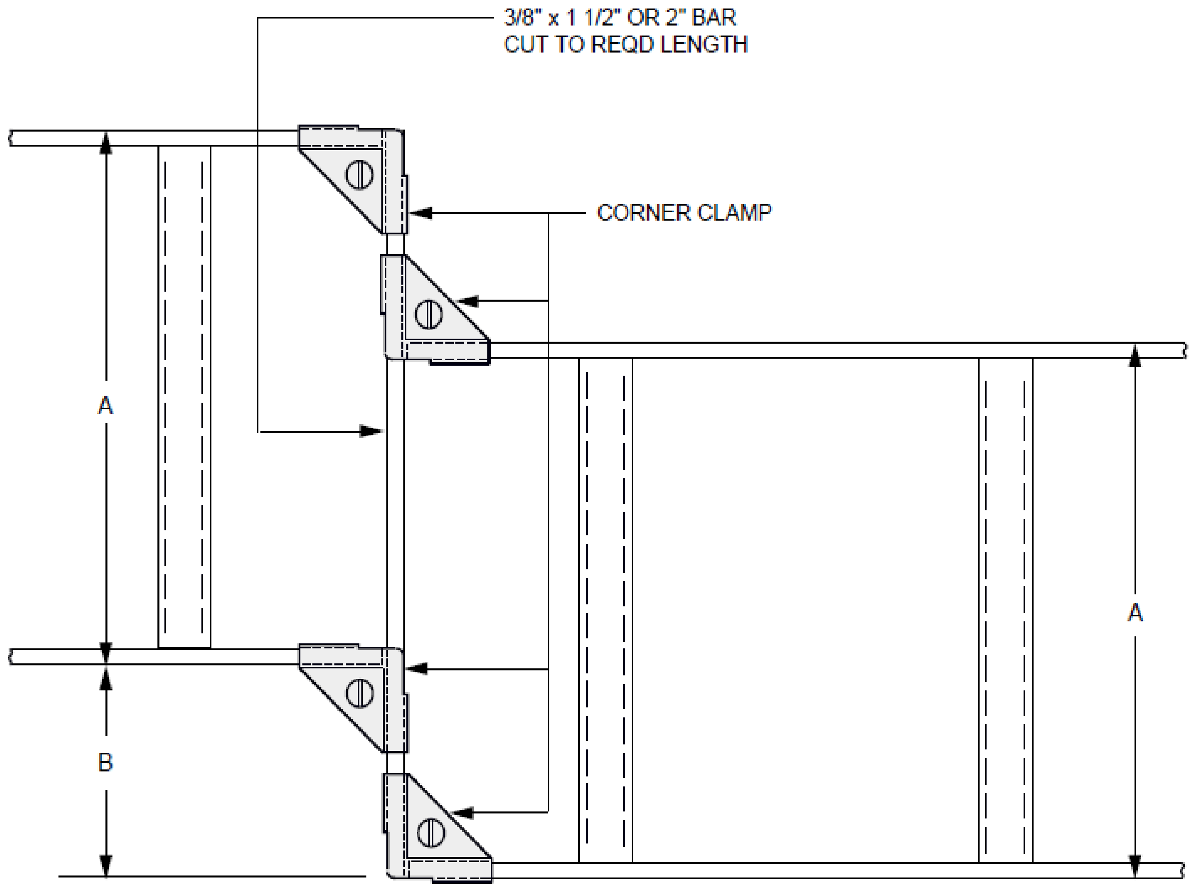


EXHIBIT 2-E1-27
2-E1-27 T-INTERSECTION



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

EXHIBIT 2-E1-28

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

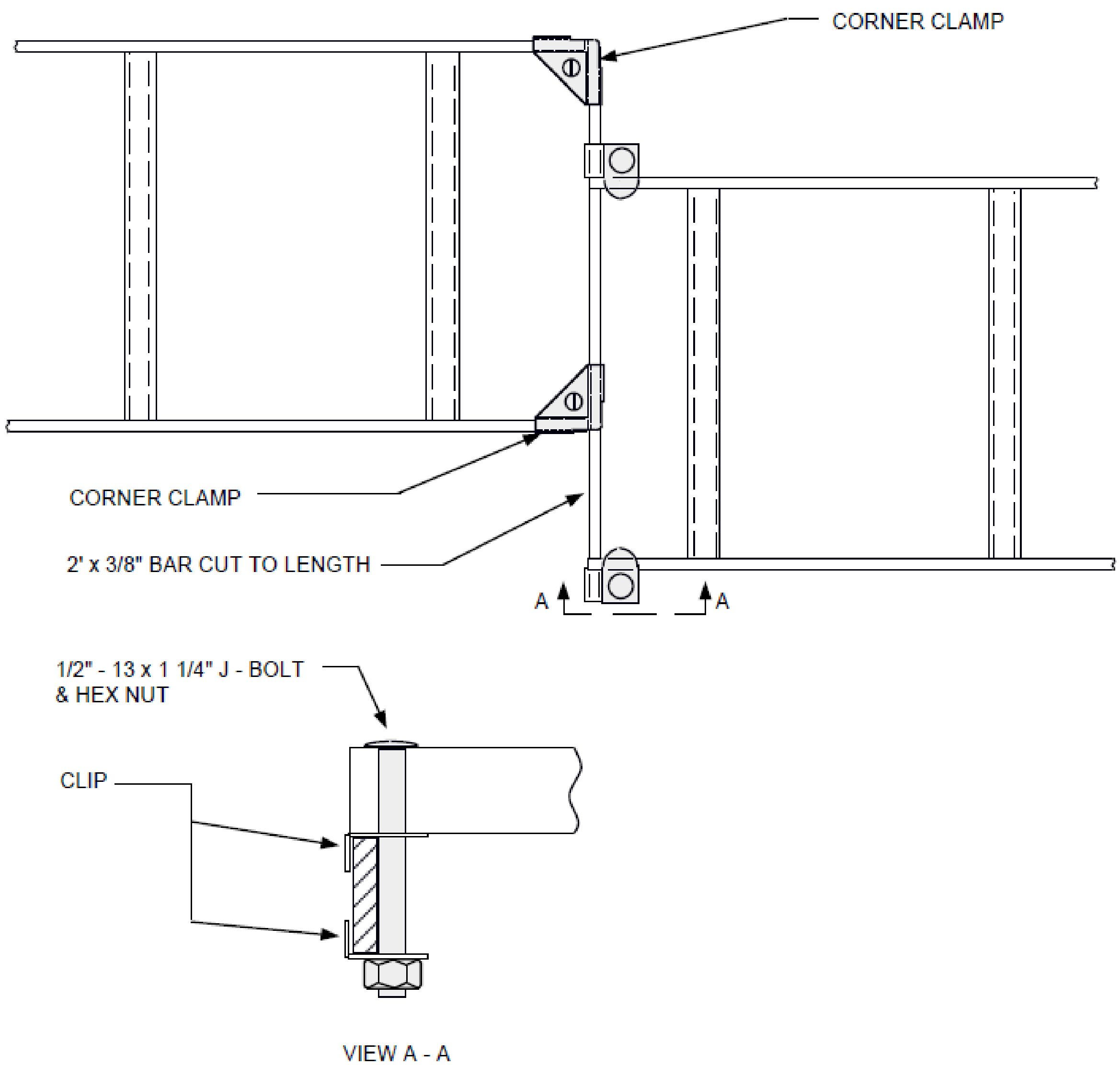


EXHIBIT 2-E1-28A

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

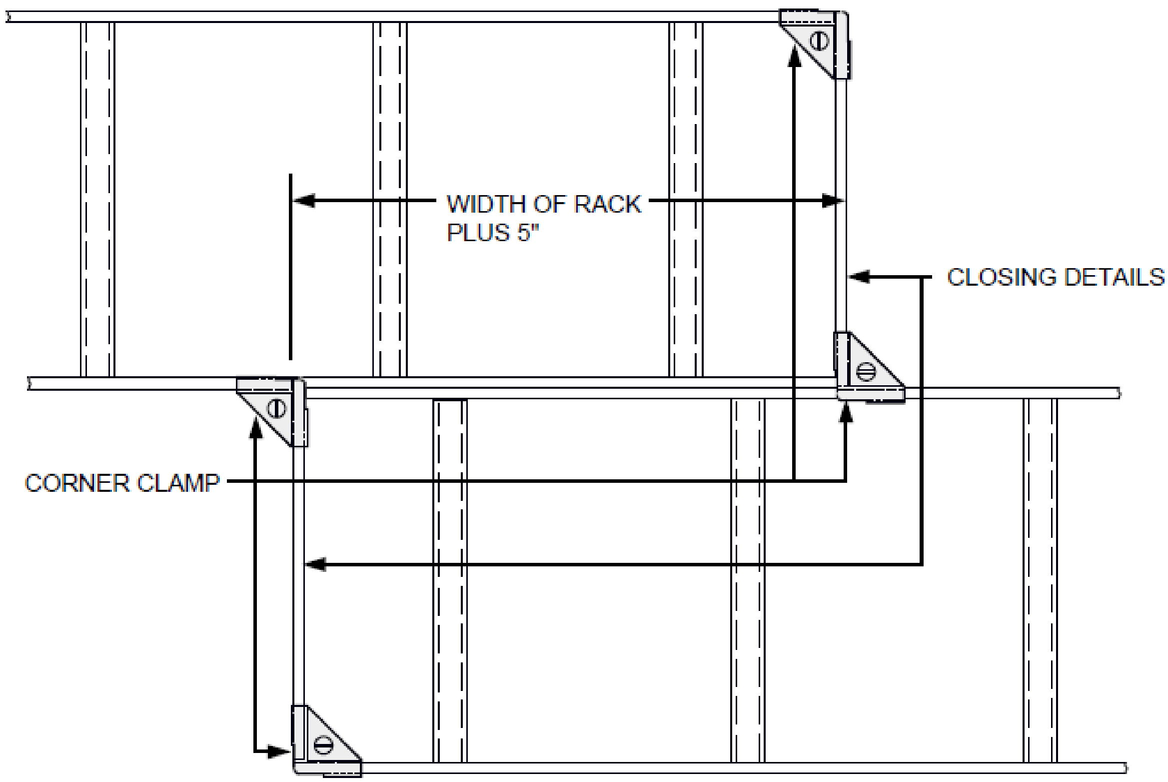


EXHIBIT 2-E1-29

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

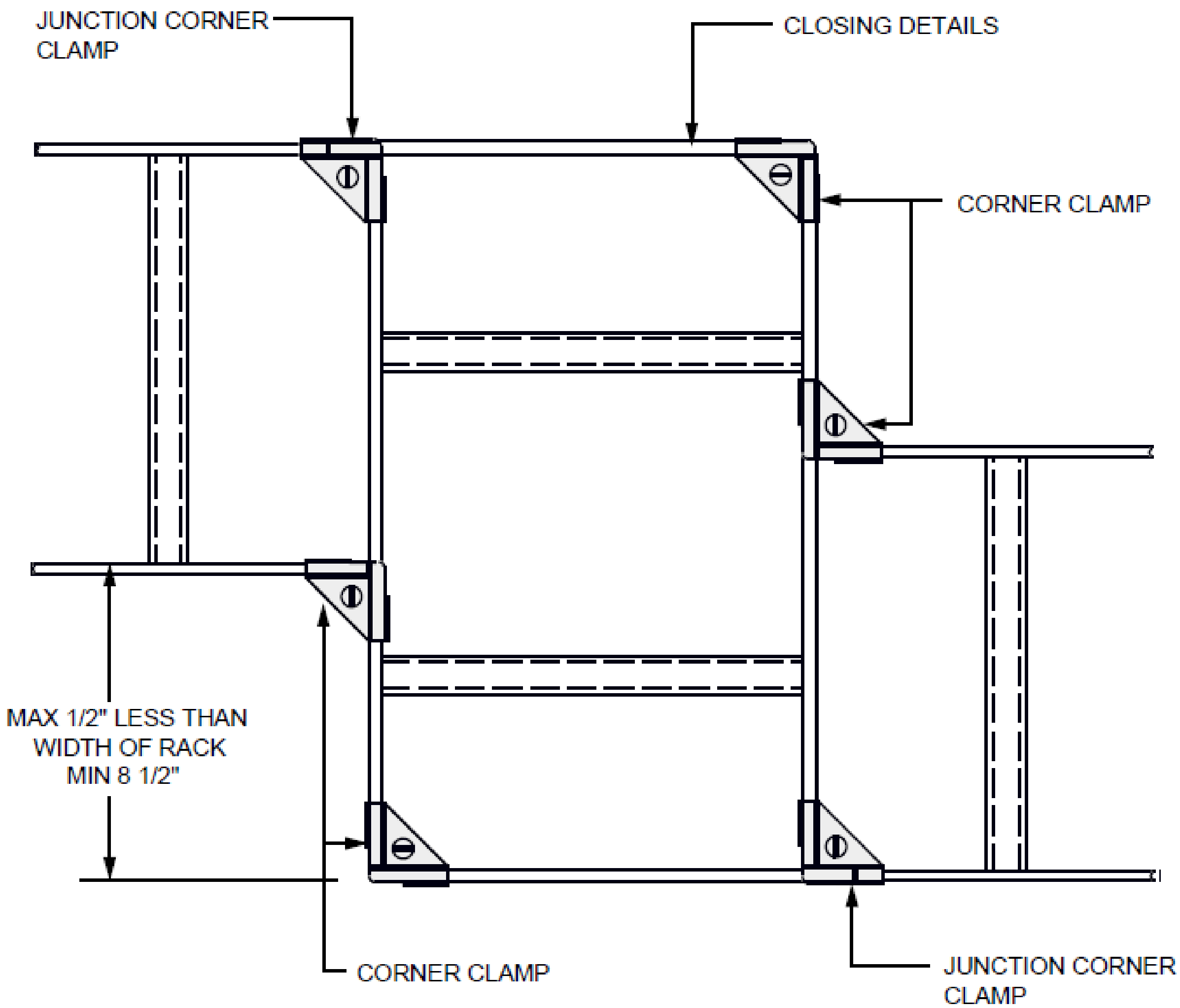


EXHIBIT 2-E1-30

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

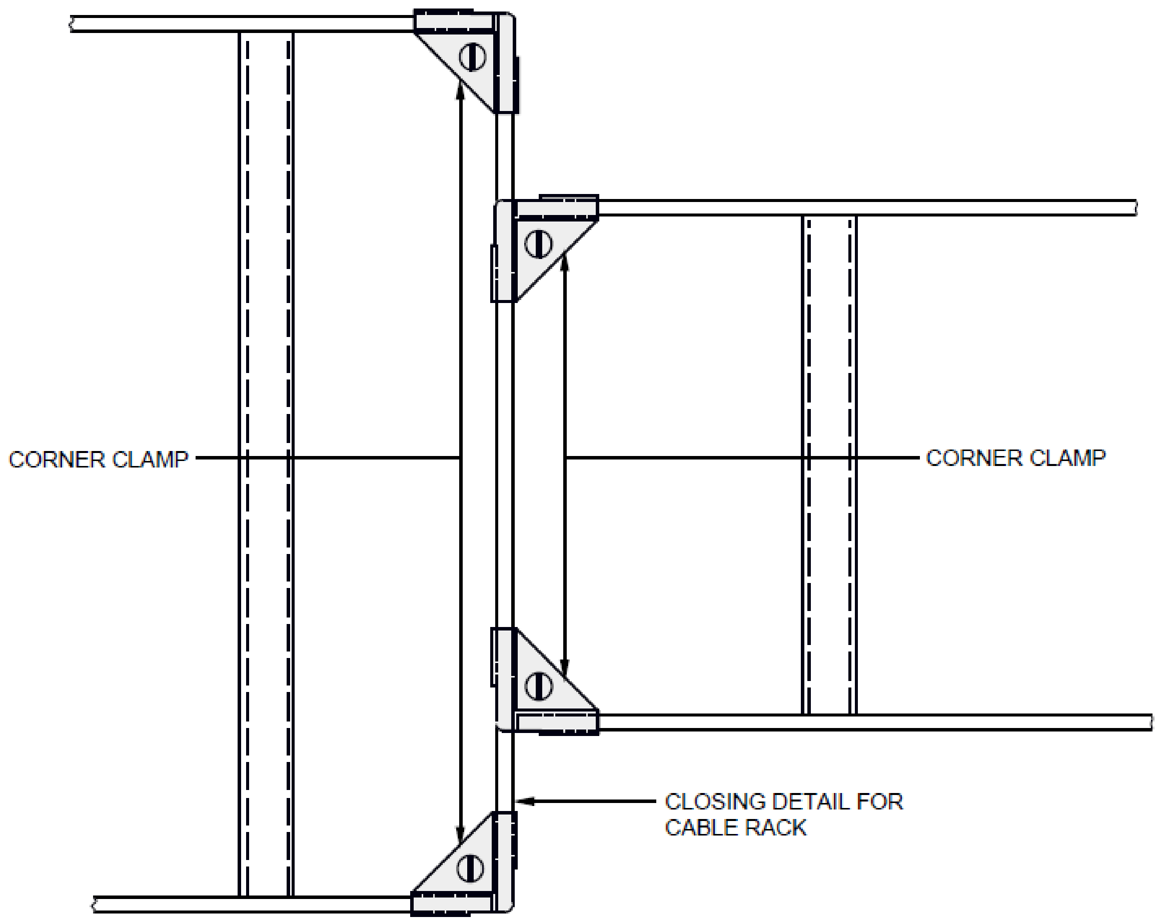


EXHIBIT 2-E1-31

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

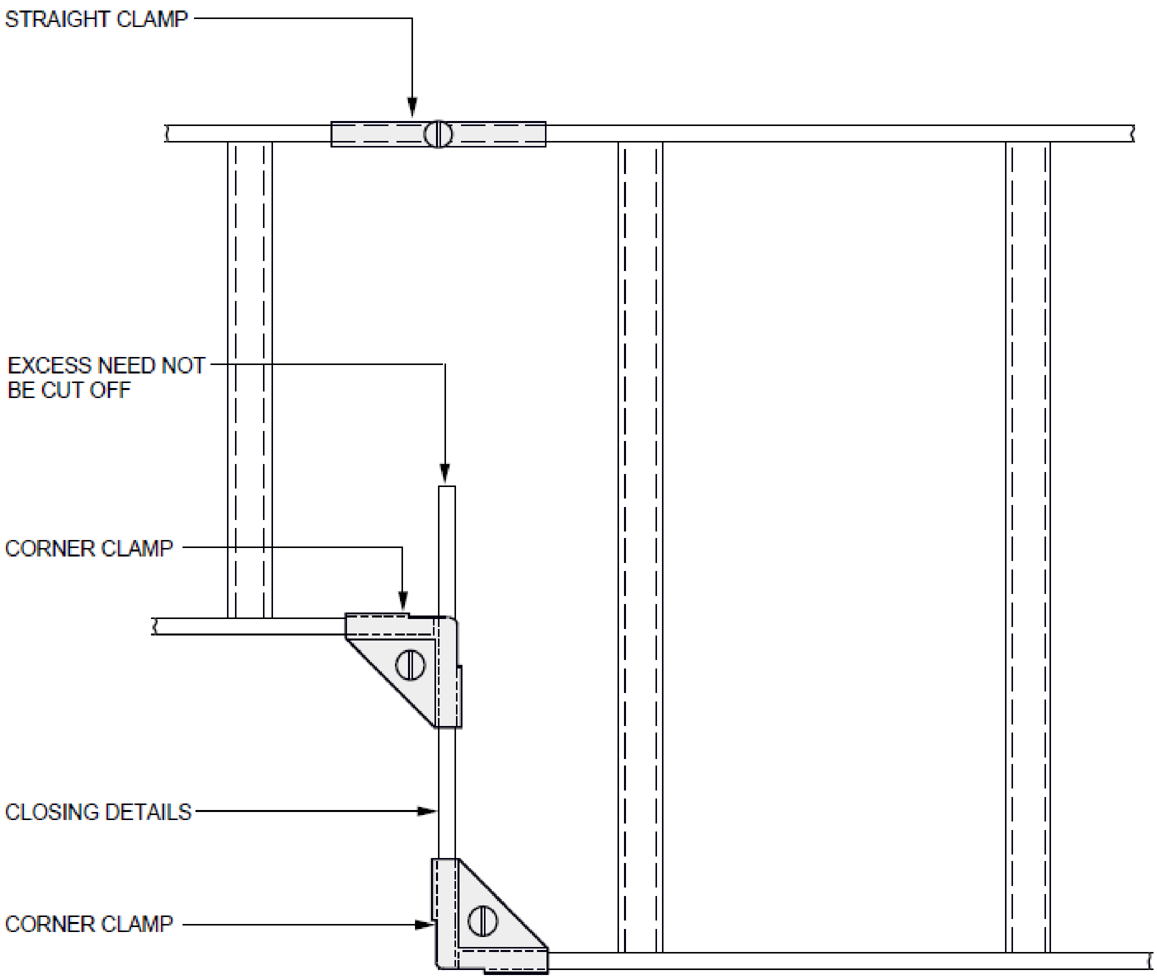


EXHIBIT 2-E1-32

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

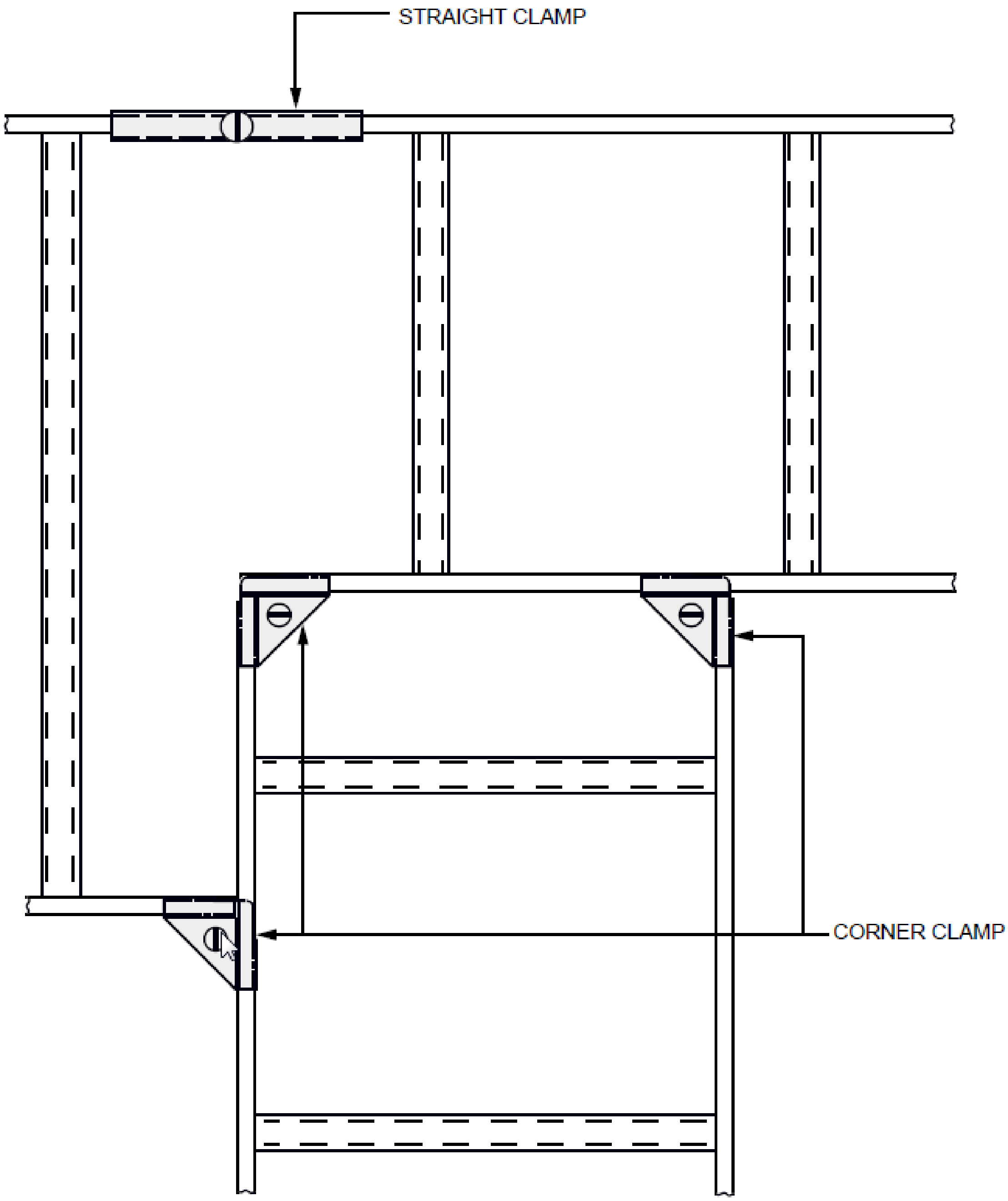
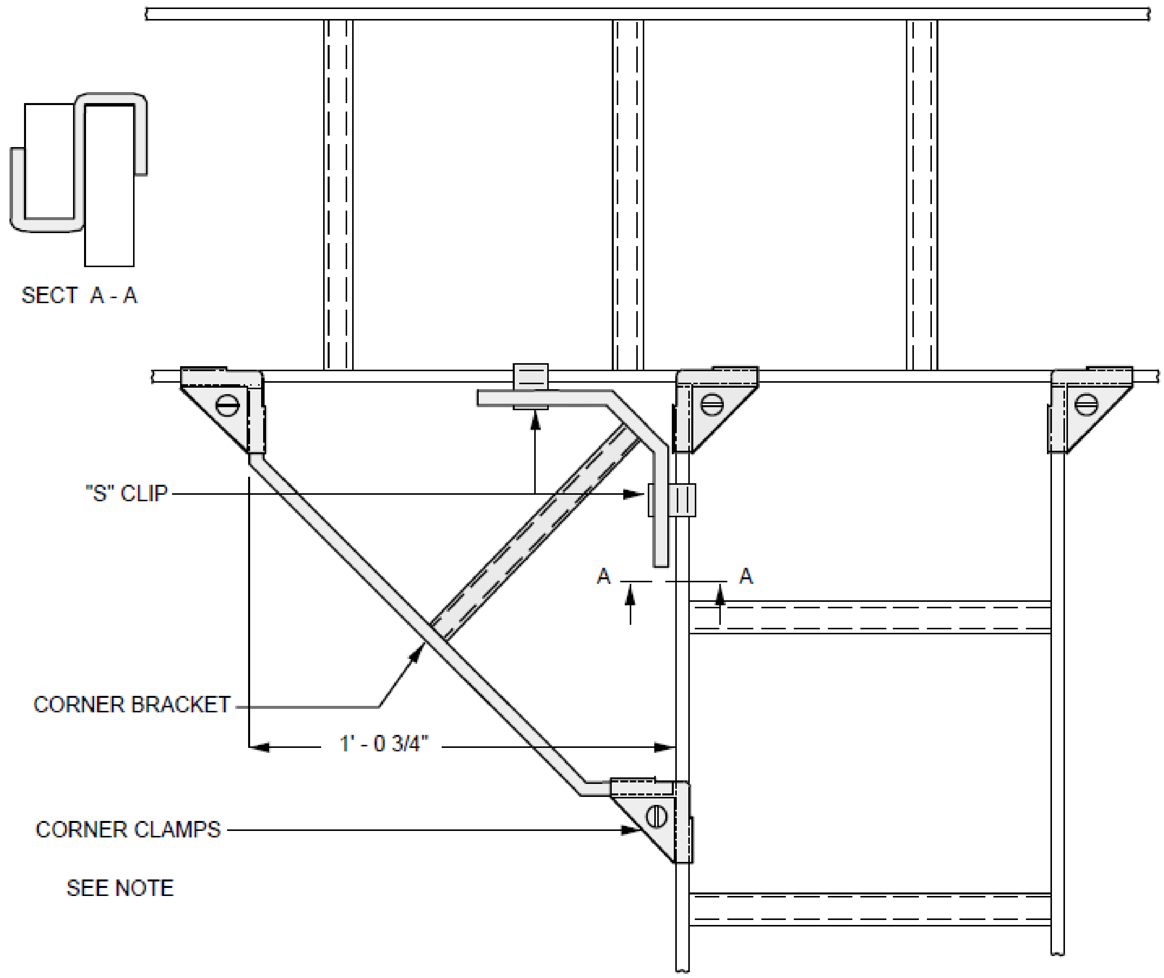


EXHIBIT 2-E1-33

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

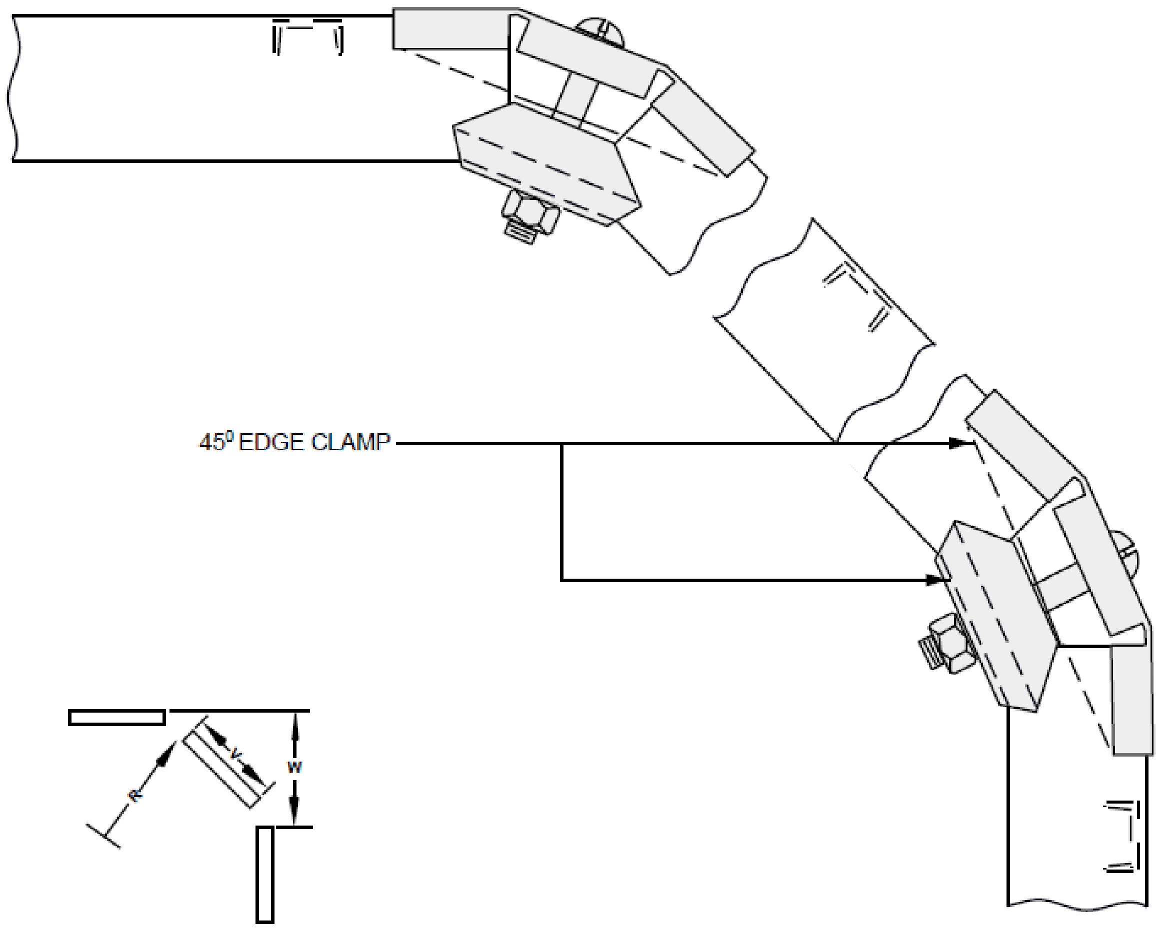


NOTE:

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

EXHIBIT 2-E1-34

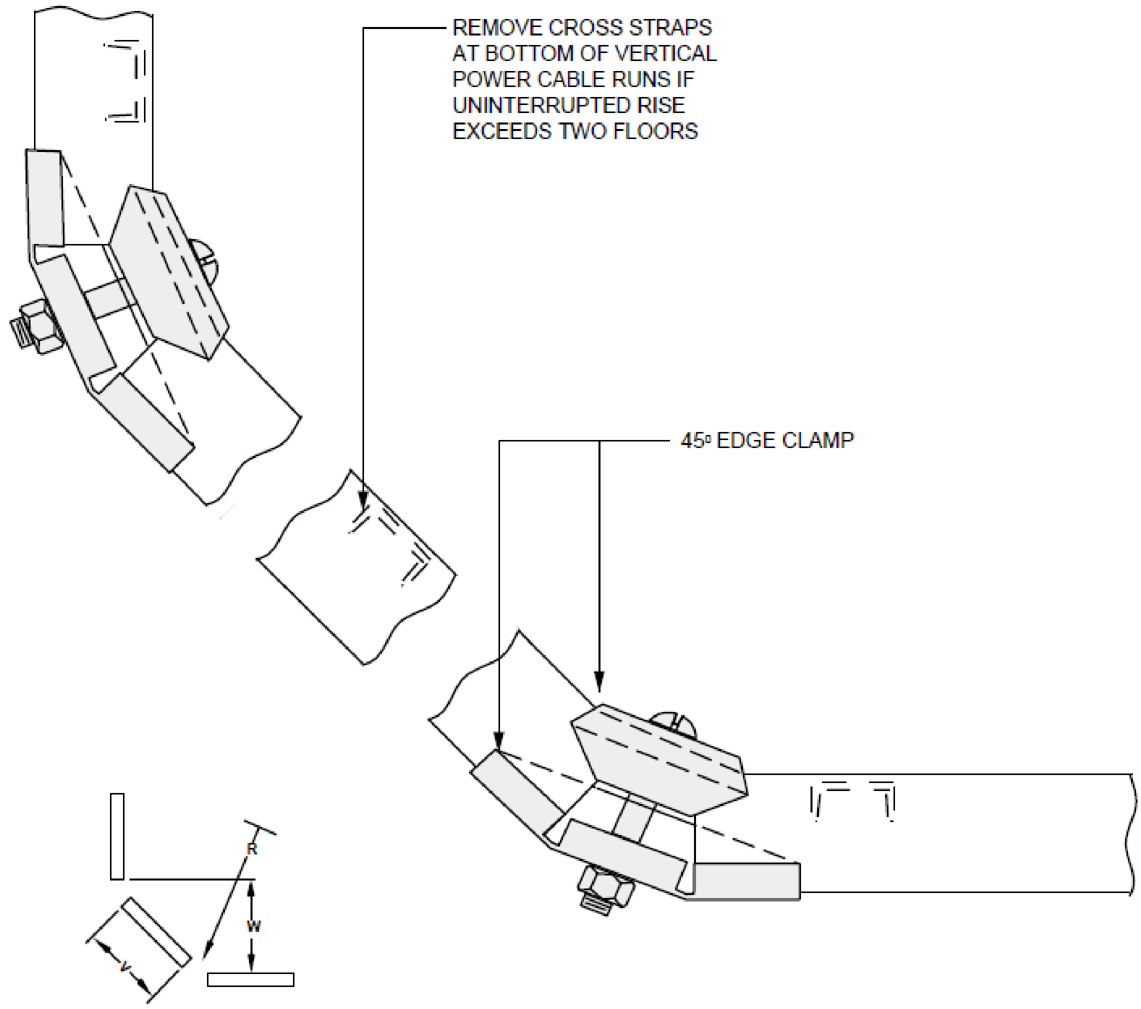
2-E1-34 CORNER BRACKET AT TURN OF INTERSECTION



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

EXHIBIT 2-E1-35

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

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

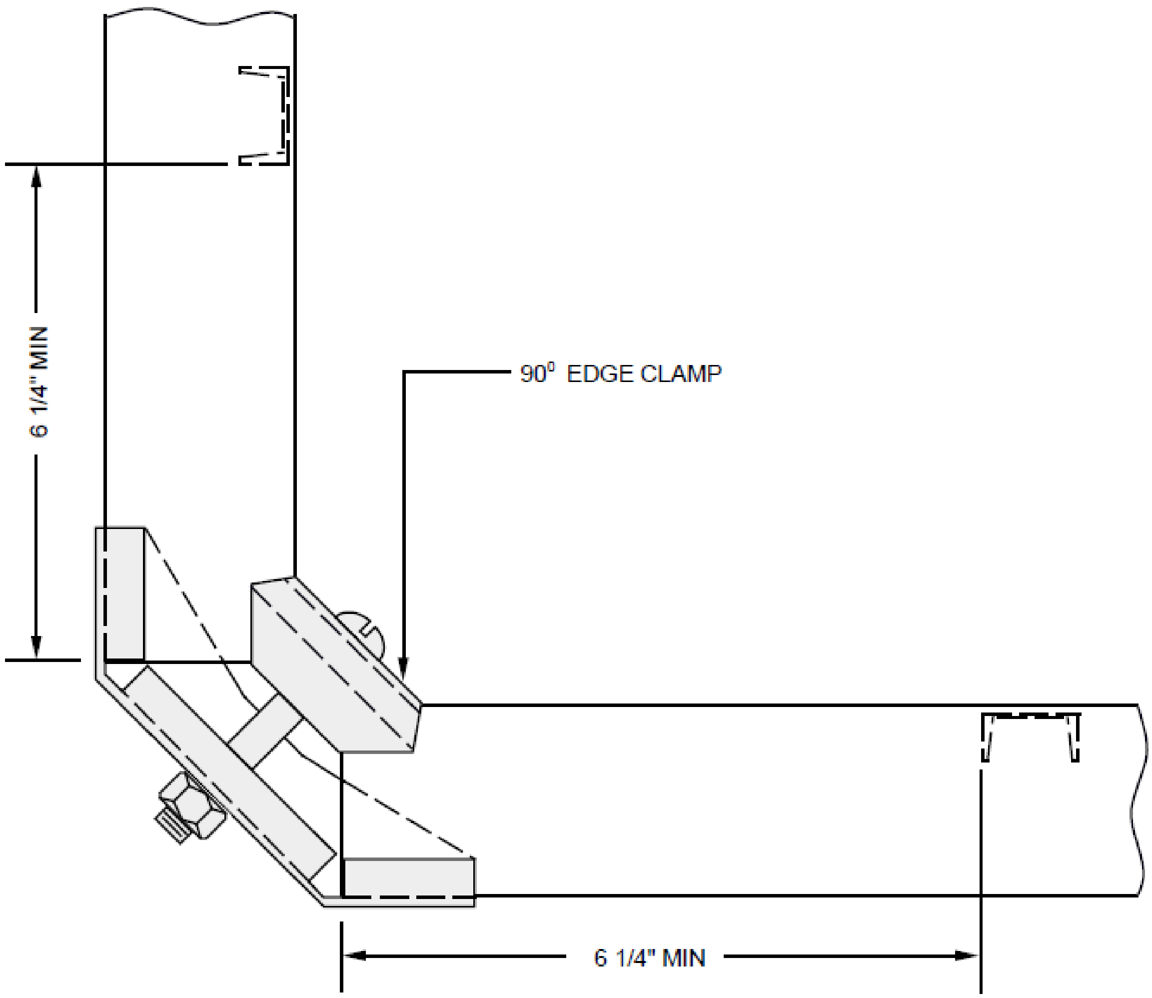


EXHIBIT 2-E1-37

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

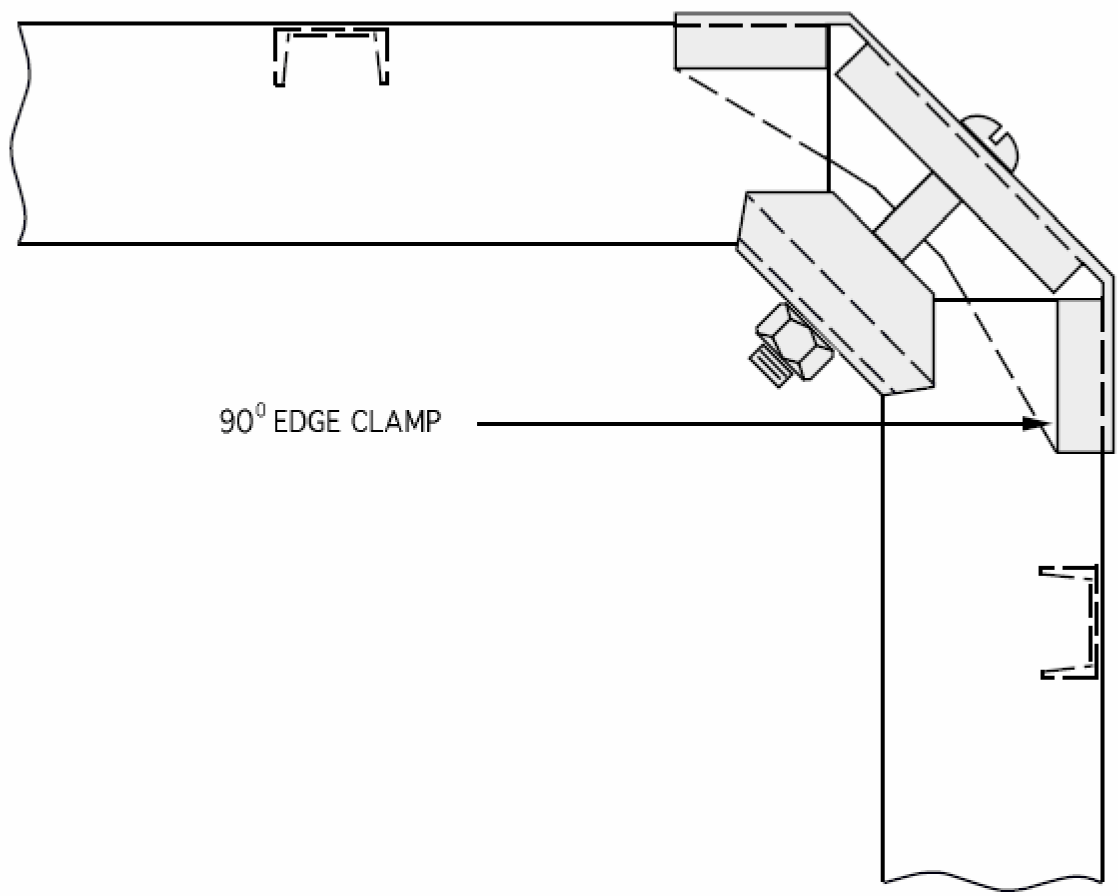


EXHIBIT 2-E1-38

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

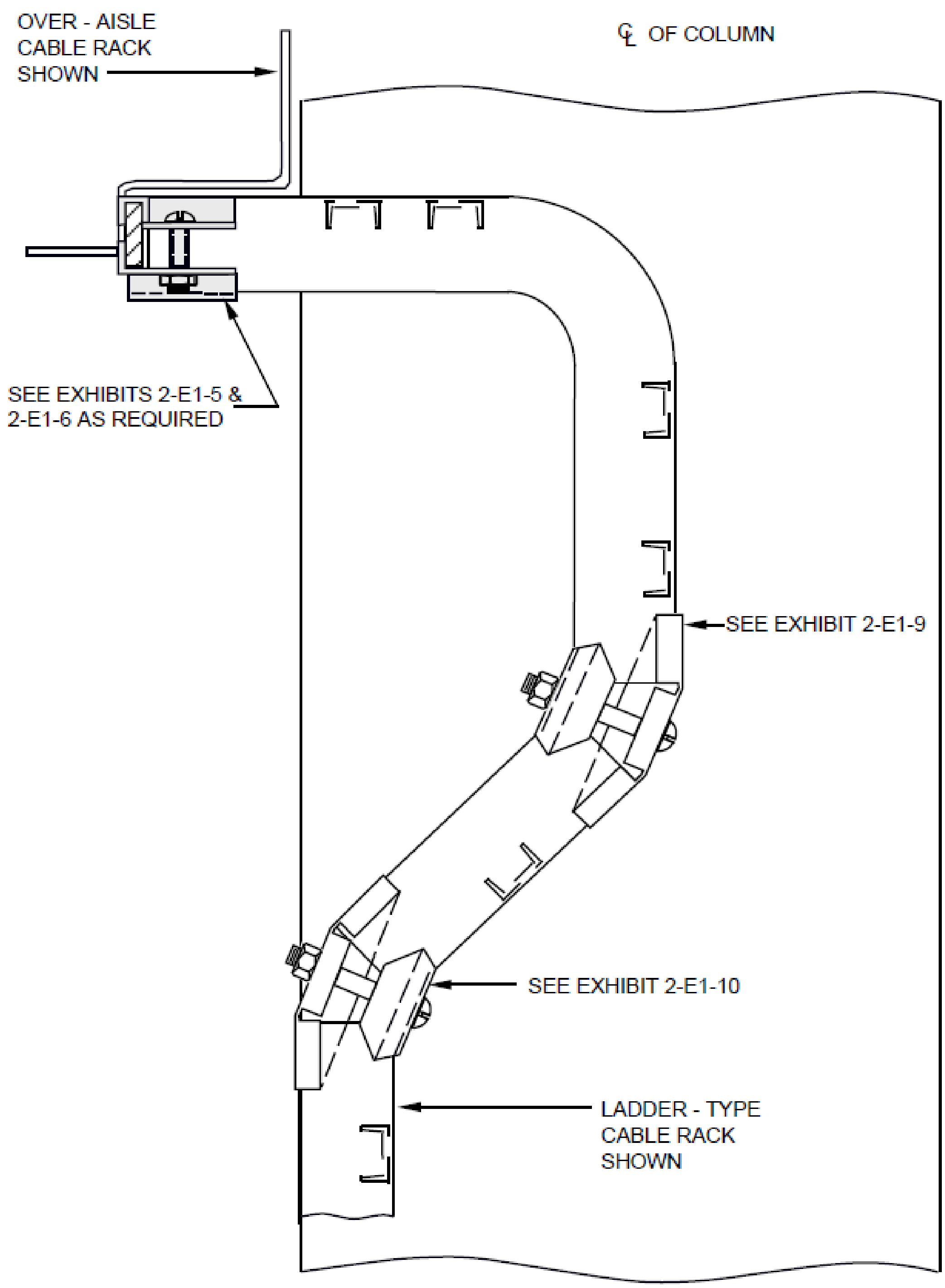


EXHIBIT 2-E1-38H

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.

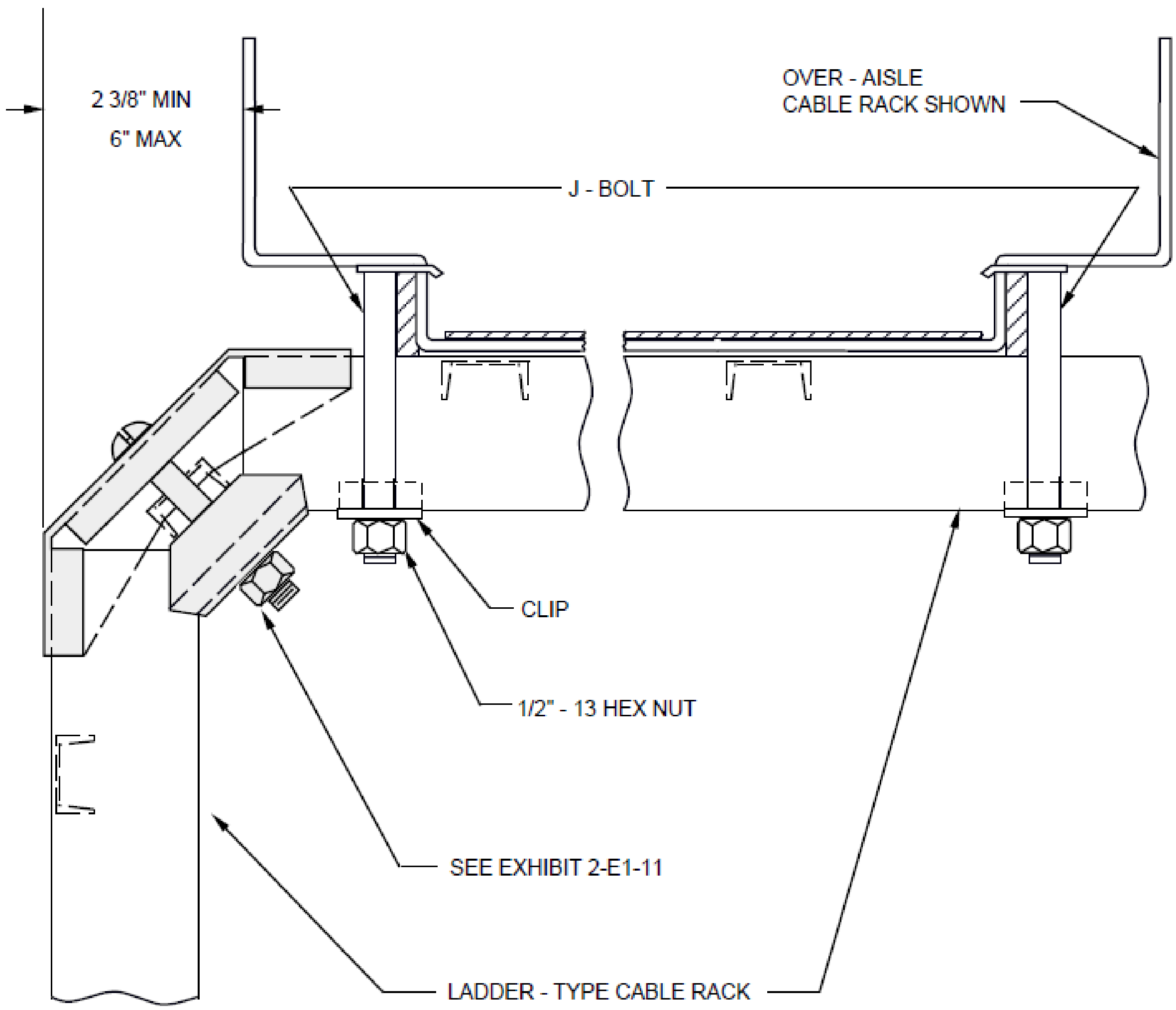
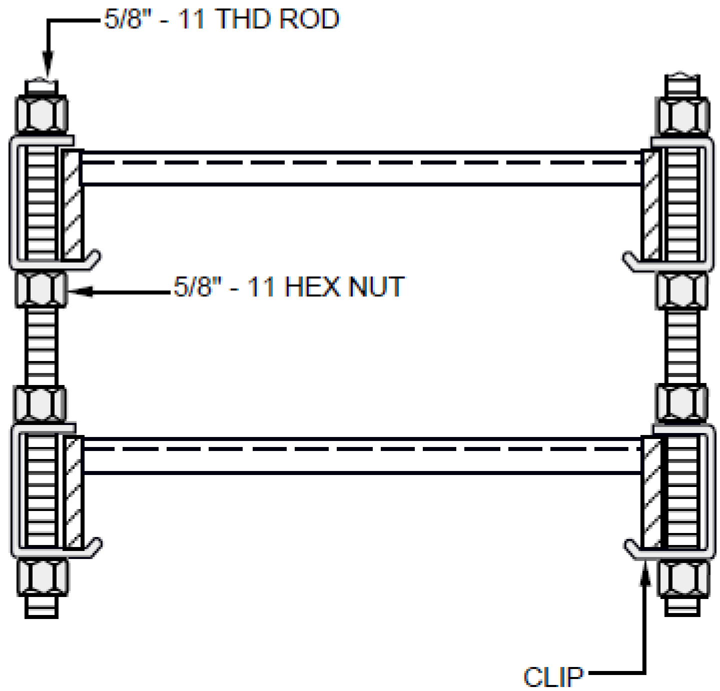
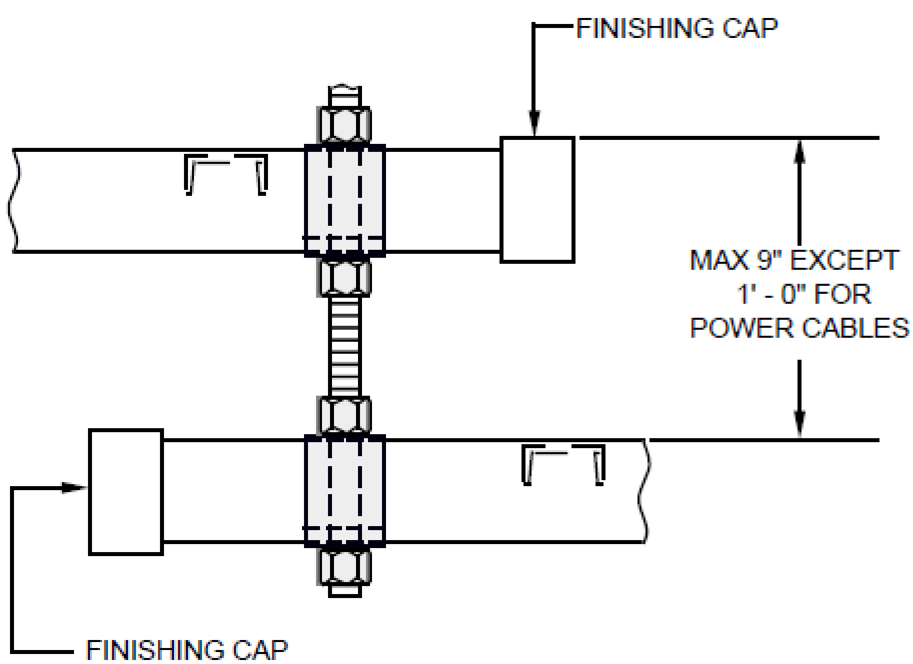


EXHIBIT 2-E1-38J (A&M)
2-E1-38J (A&M) VERTICAL LADDER-TYPE CABLE RACK DROPPING OFF THE SIDE OF BAR-TYPE CABLE RACK 90 DEGREE LARGE OUTSIDE RADIUS TURN.

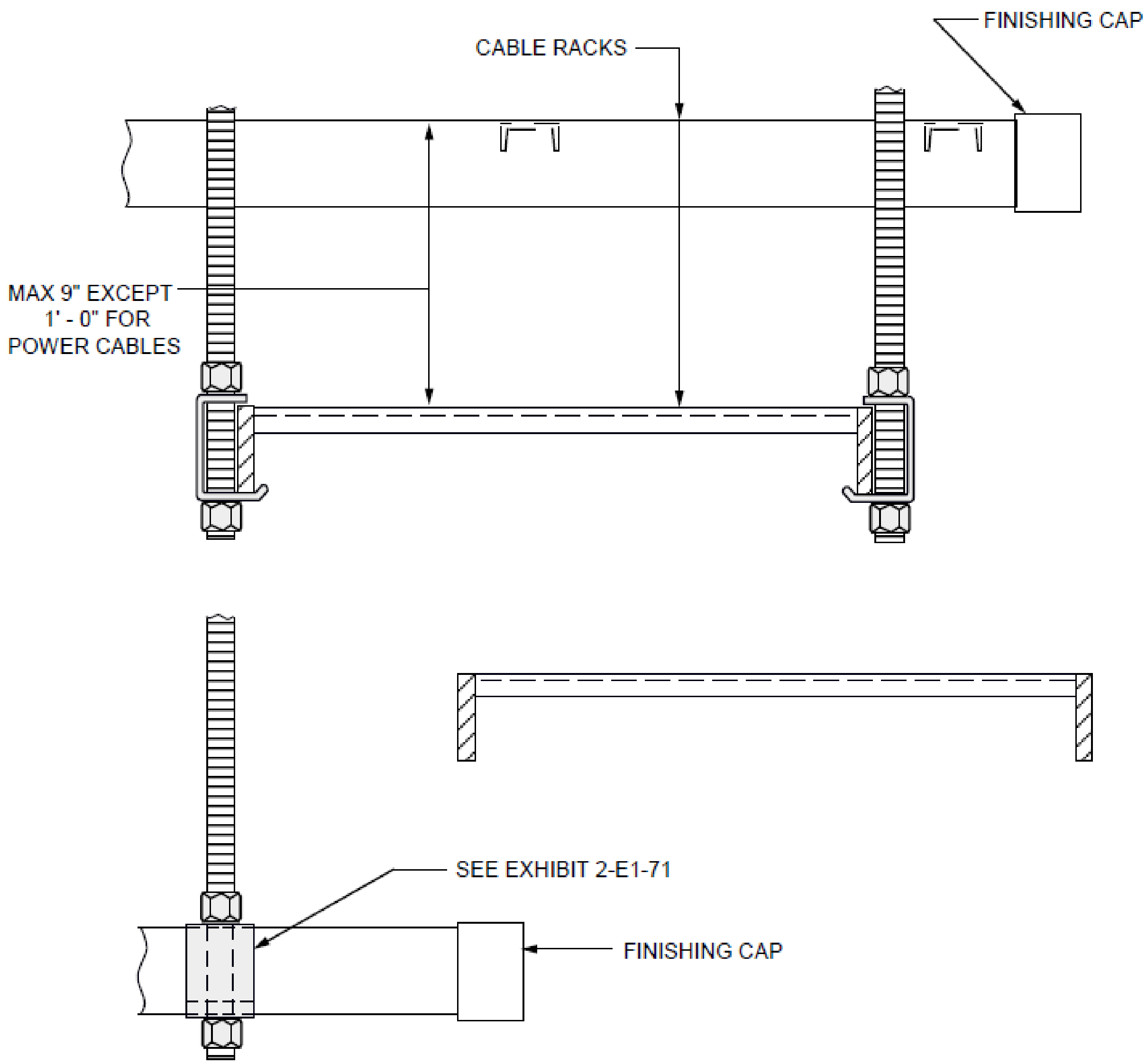




VIEW A

EXHIBIT 2-E1-39

2-E1-39 SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS

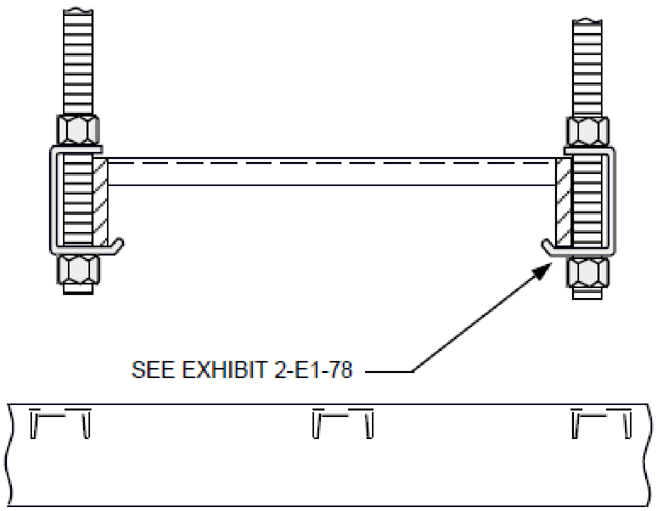


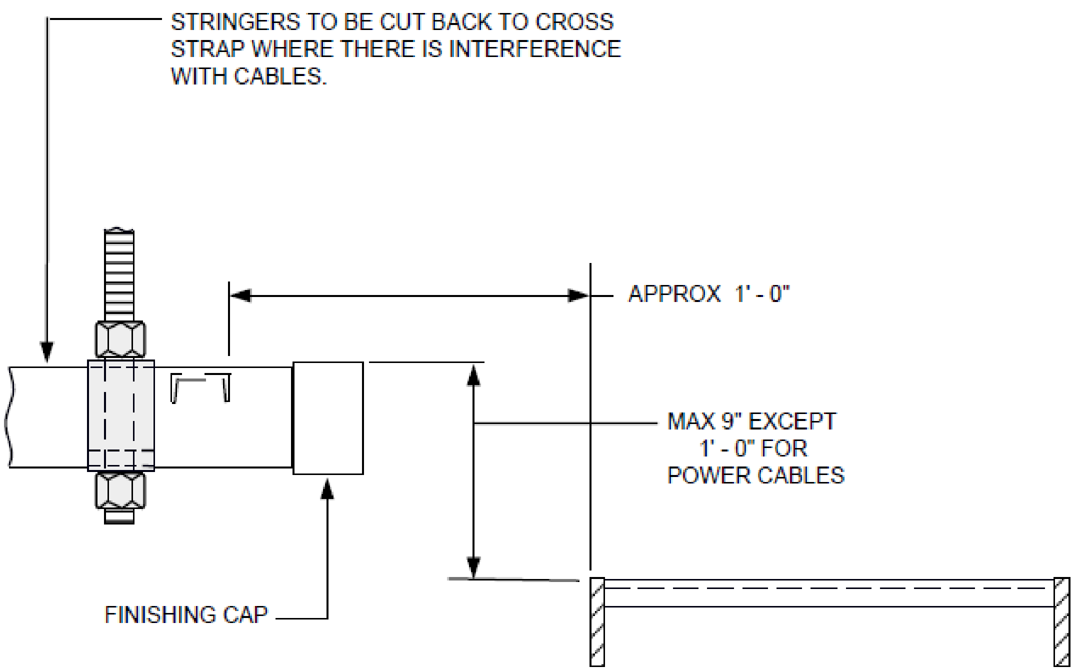
VIEW B

NOTE: THIS EXHIBIT IS FOR ILLUSTRATING CABLE RACK ORIENTATION. SUPPORT ARRANGEMENTS MAY VARY ACCORDING TO OFFICE CONDITIONS.

EXHIBIT 2-E1-39

2-E1-39 SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS



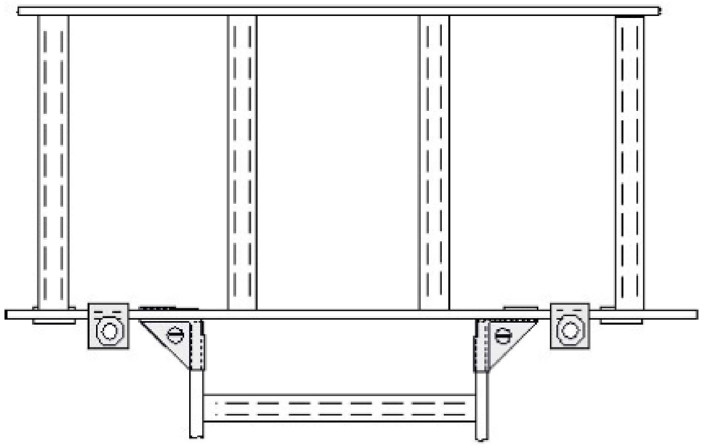


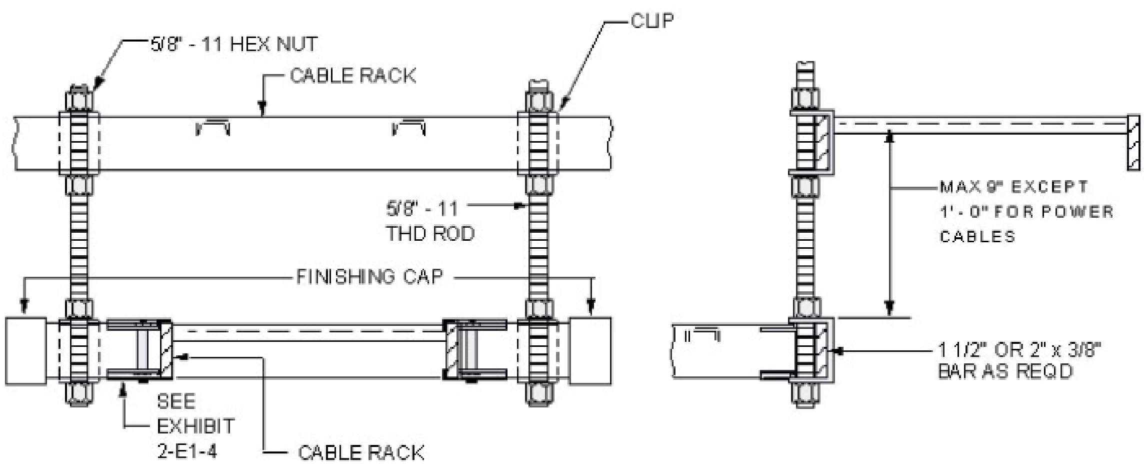
VIEW C

NOTE: THIS EXHIBIT IS FOR ILLUSTRATING CABLE RACK ORIENTATION. SUPPORT ARRANGEMENTS MAY VARY ACCORDING TO OFFICE CONDITIONS.

EXHIBIT 2-E1-39

2-E1-39 SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS



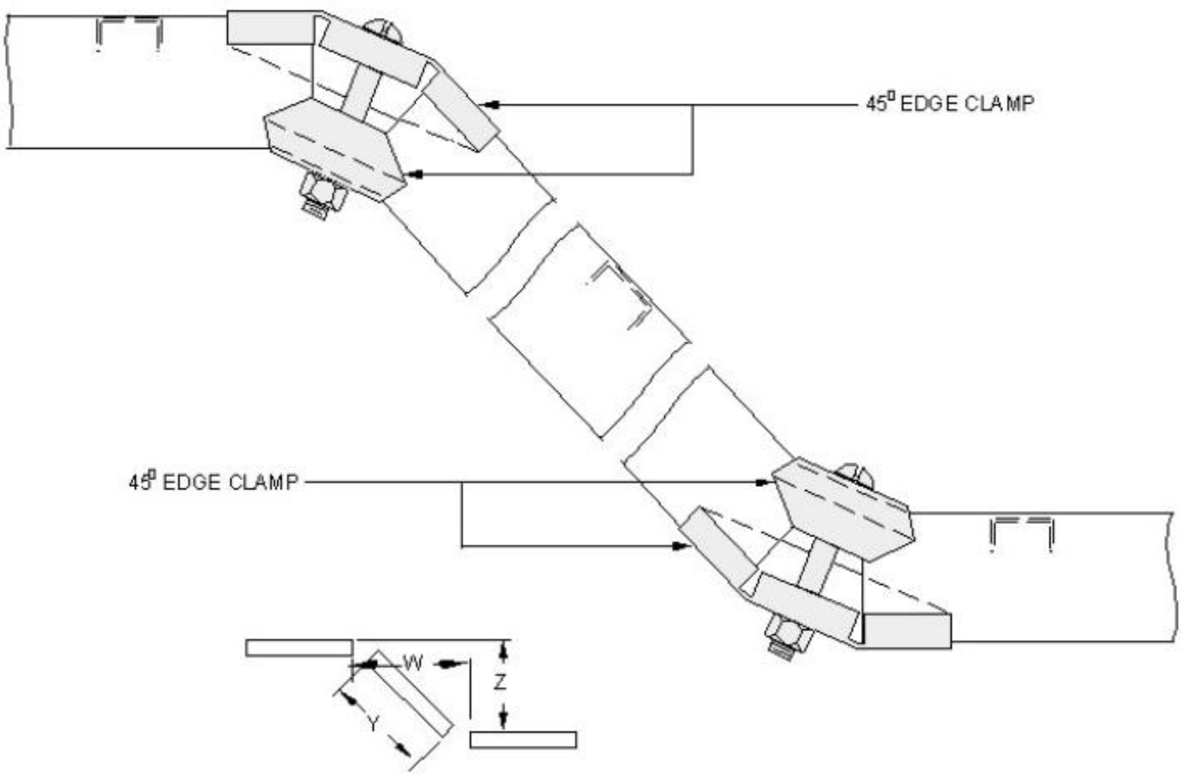


VIEW D

NOTE: THIS EXHIBIT IS FOR ILLUSTRATING CABLE RACK ORIENTATION. SUPPORT ARRANGEMENTS MAY VARY ACCORDING TO OFFICE CONDITIONS.

EXHIBIT 2-E1-39

2-E1-39 SMALL VERTICAL OFFSETS IN HORIZONTAL RACKS

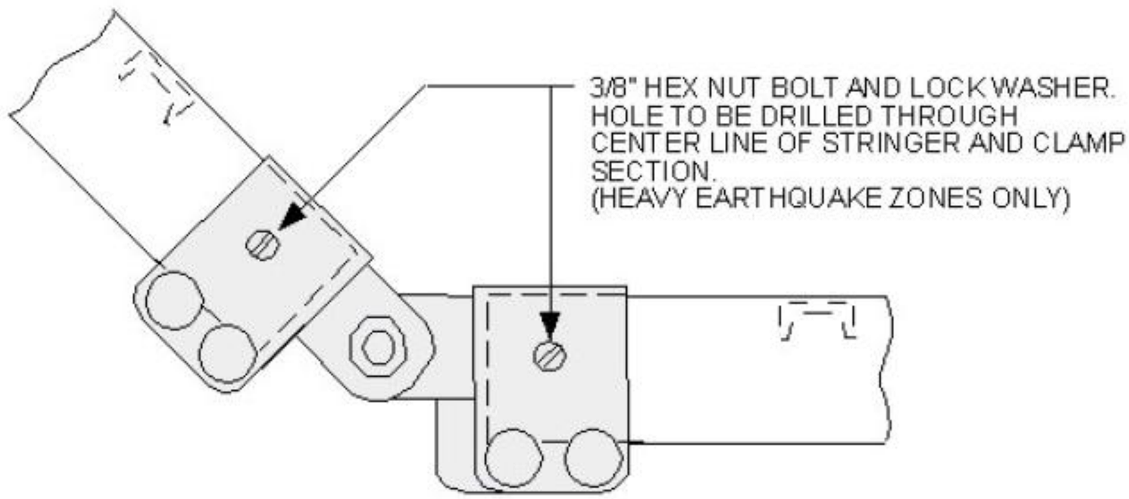


Z	Y	W
10"	1'-0-3/4"	11-1/4"
11"	1'-2-1/4"	1'-0-1/4"
1'-0"	1'-3-5/8"	1'-1-1/4"
1'-1"	1'-5"	1'-2-1/4"
1'-2"	1'-6-1/2"	1'-3-1/4"
1'-3"	1'-7-3/8"	1'-4-1/4"
1'-4"	1'-9-1/4"	1'-5-1/4"
1'-5"	1'-10-5/8"	1'-6-1/4"
1'-6"	2'-0-1/2"	1'-7-1/4"
1'-7"	2'-1-1/2"	1'-8-1/4"
1'-8"	2'-3"	1'-9-1/4"
1'-9"	2'-4-3/8"	1'-10-1/4"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

NOTE: THE TRANSITON LEVEL CHANGE (Z) IS LIMITED TO A MAXIMUM OF THREE FEET

EXHIBIT 2-E1-40
2-E1-40 OFFSET GREATER THAN 9 INCHES IN PARALLEL PLANES USING 45 DEGREE EDGE CLAMPS-LADDER-TYPE CABLE RACKS



NOTE: THIS TRANSITON LEVEL CHANGEIS LIMITED TO A MAXIMUM OF THREE FEET

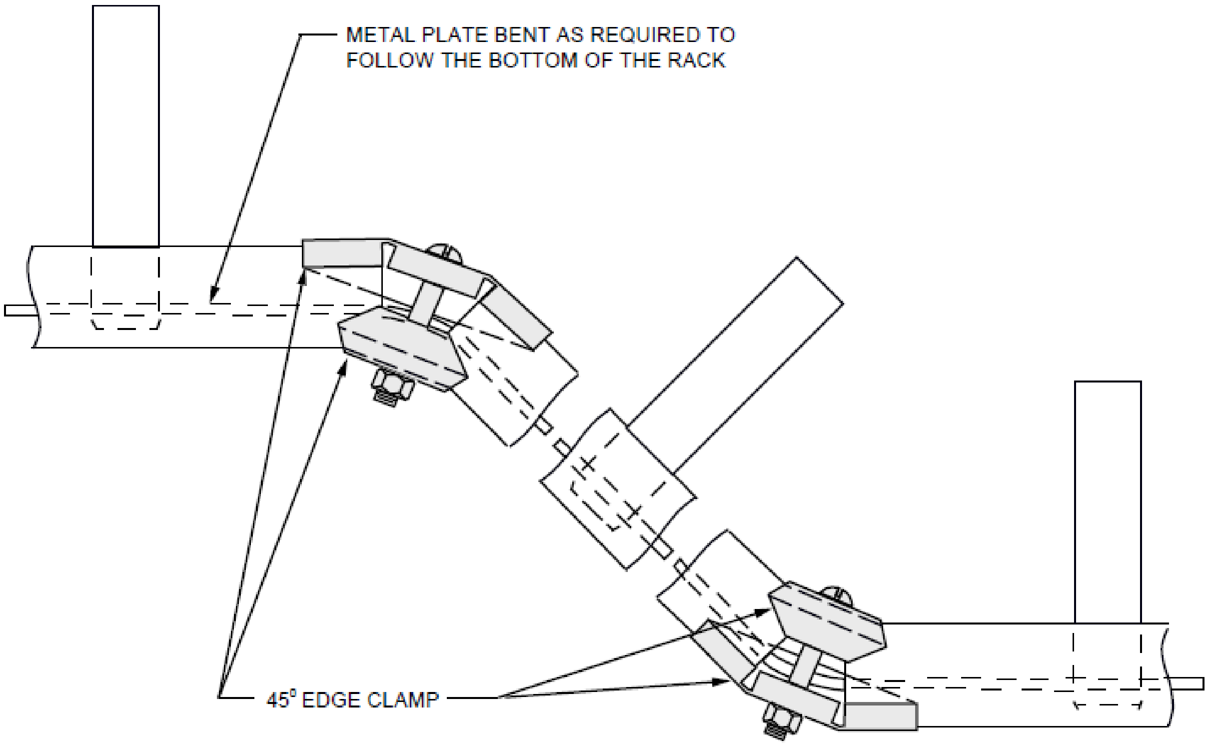
2-E1-40A

2-E1-40A ADJUSTABLE CABLE RACK SPLICE

NOTE: THIS TRANSITON LEVEL CHANGE IS LIMITED TO A MAXIMUM OF THREE FEET

2-E1-40B

2-E1-40B ADJUSTABLE CABLE RACK SPLICE, RIGHT ANGLE



NOTE: THIS TRANSITON LEVEL CHANGE IS LIMITED TO A MAXIMUM OF THREE FEET

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

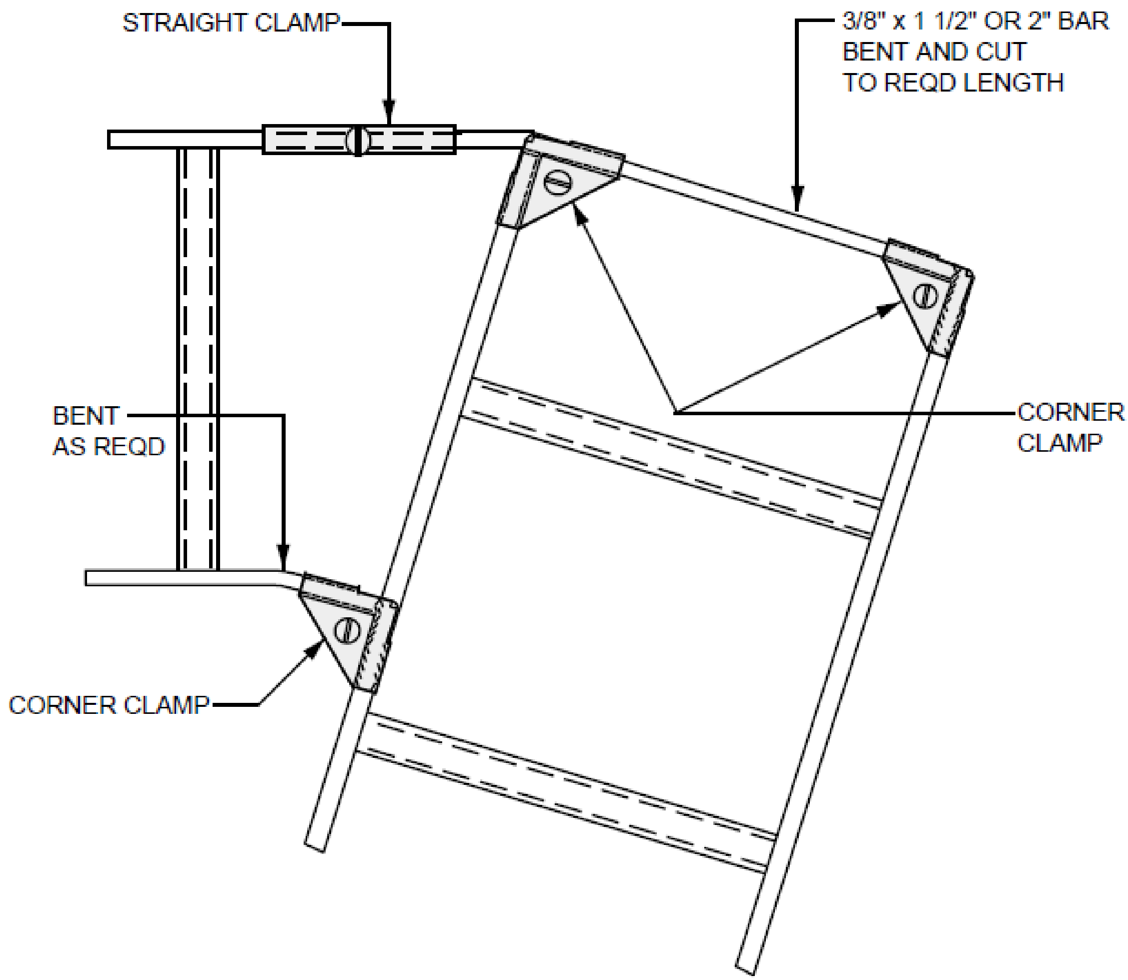


EXHIBIT 2-E1-41

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

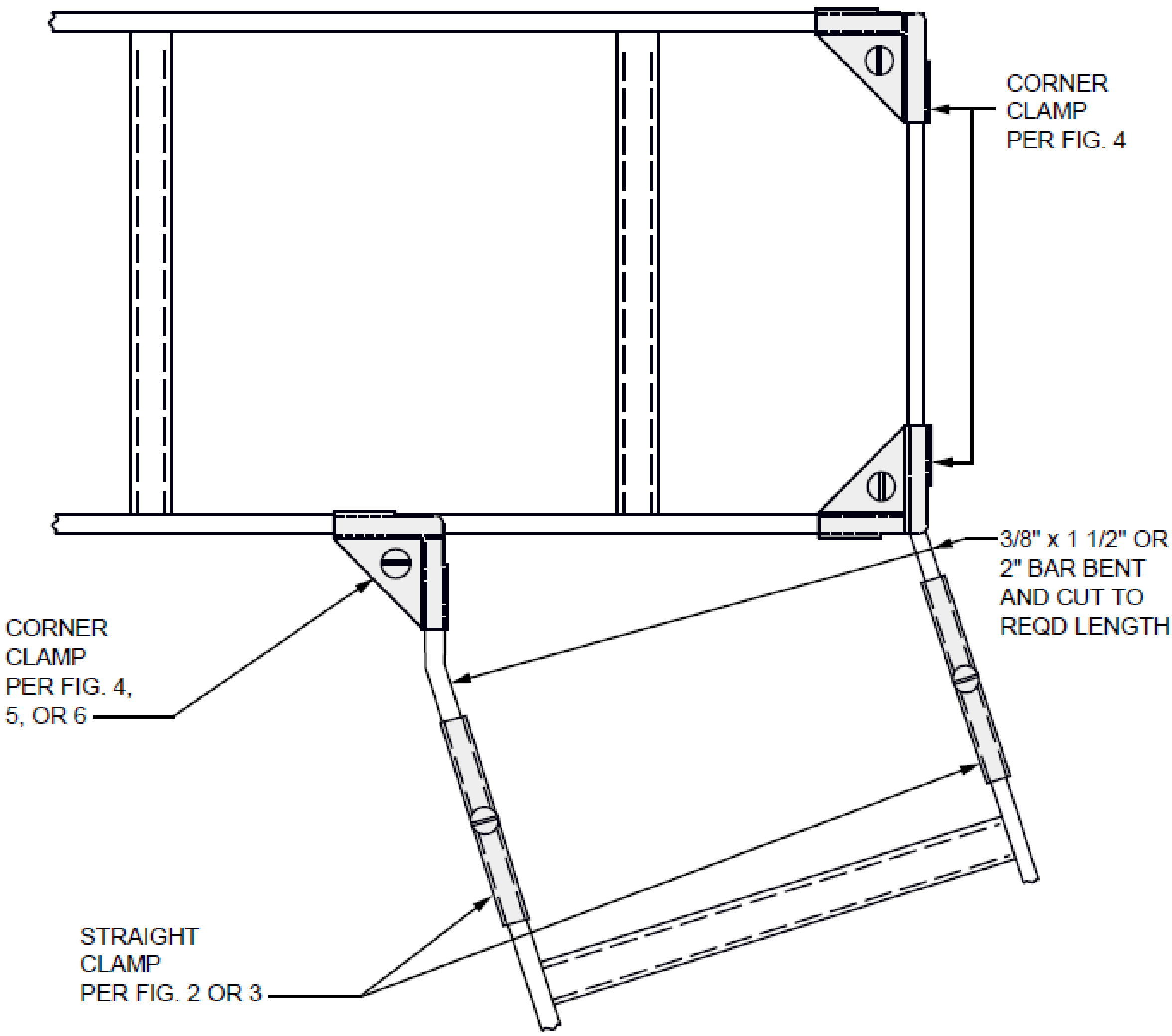


EXHIBIT 2-E1-42

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

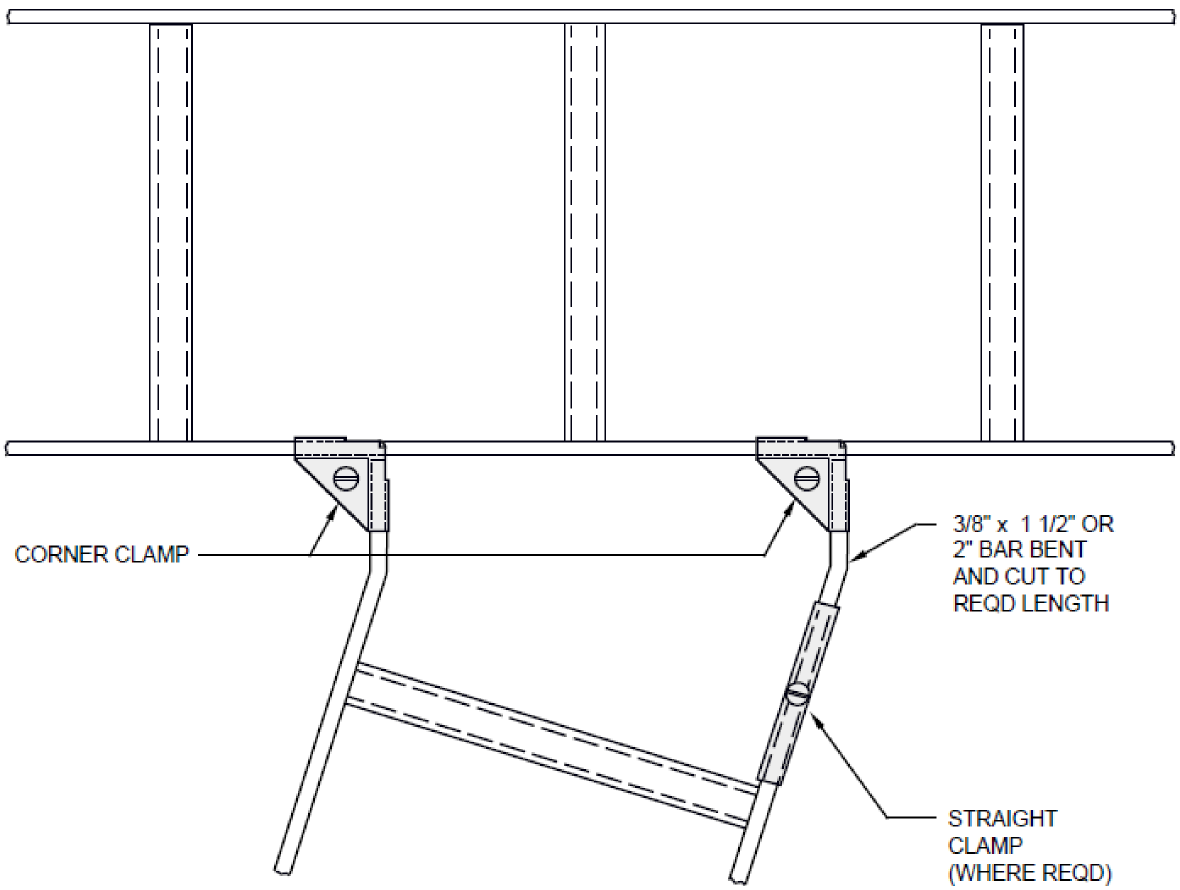
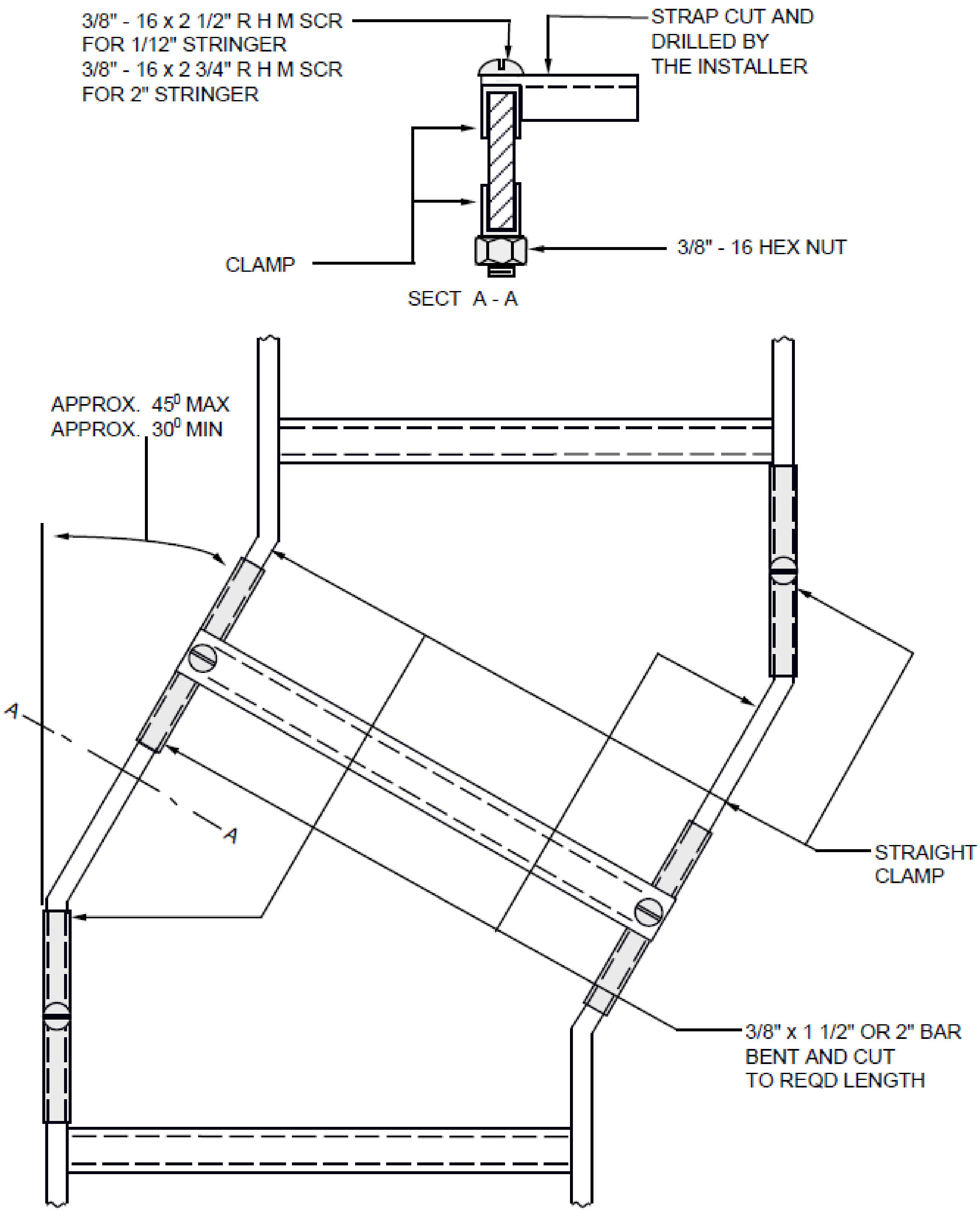


EXHIBIT 2-E1-43

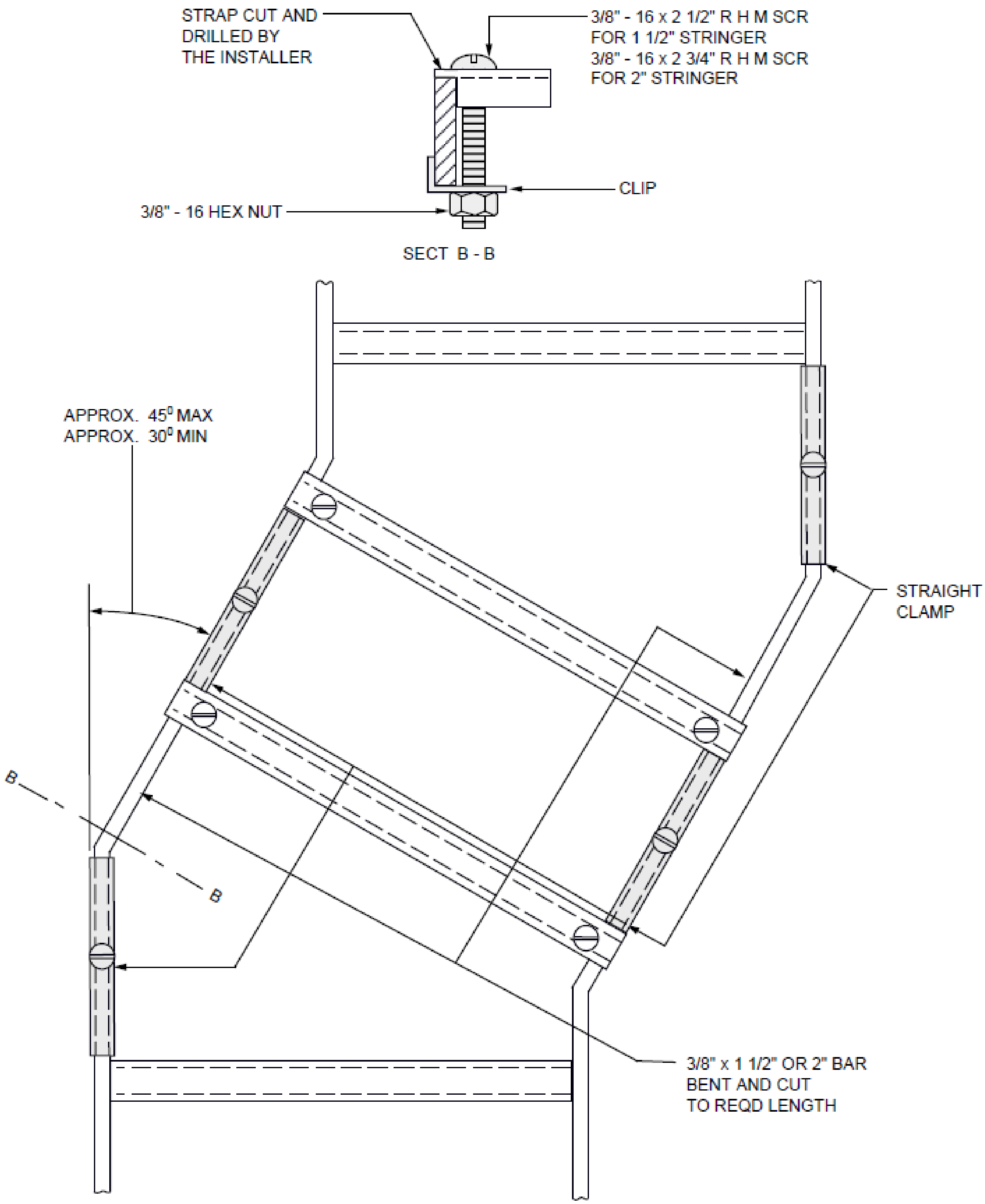
2-E1-43 ACUTE-OR-OBTUSE-ANGLE TURN IN SAME PLANE



ONE STRAP IN OFFSET
(A)

EXHIBIT 2-E1-52

2-E1-52 OFFSETS IN EXPOSED VERTICAL CABLE RACKS

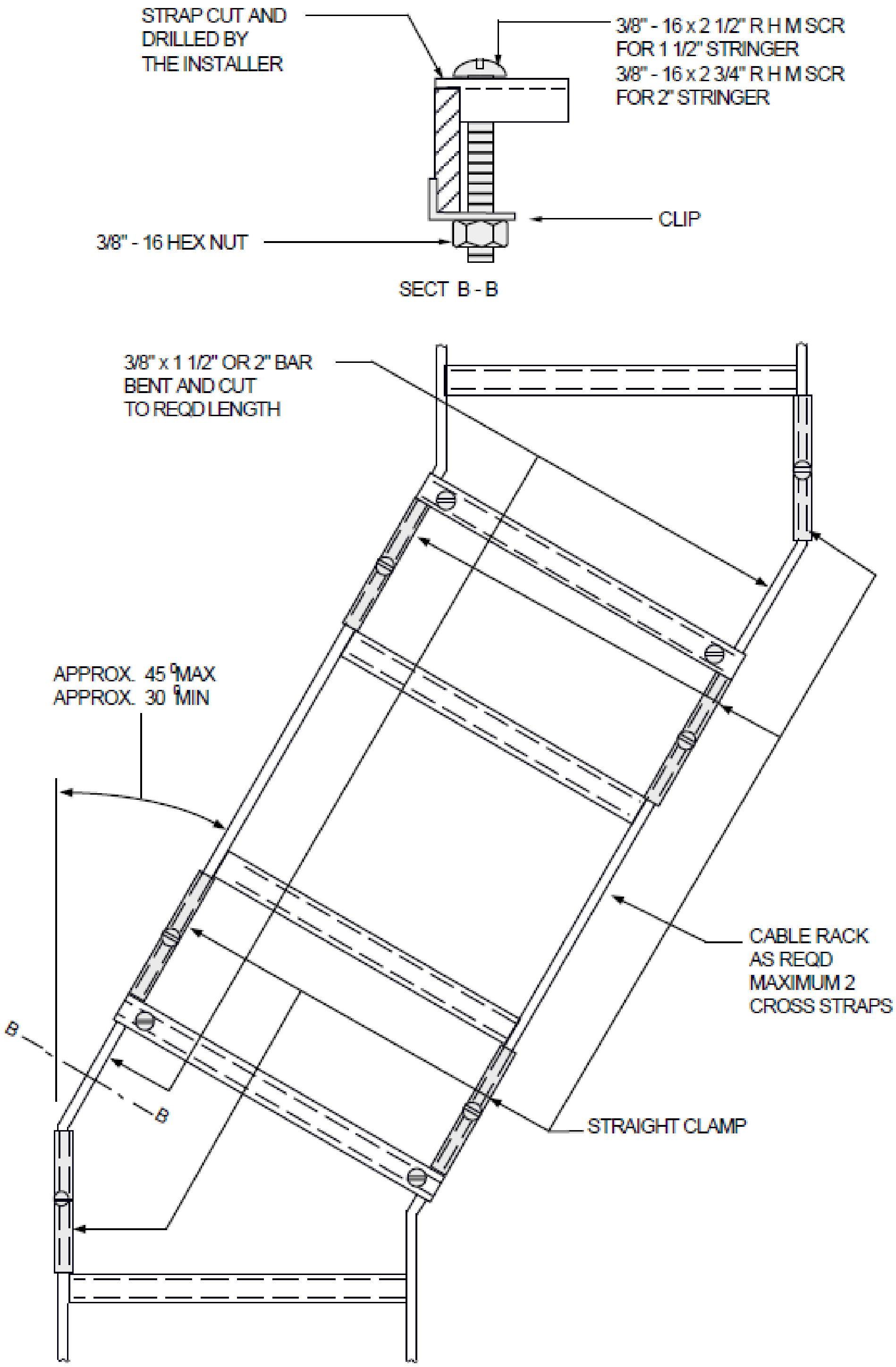


TWO STRAPS IN OFFSET

(B)

EXHIBIT 2-E1-52

2-E1-52 OFFSETS IN EXPOSED VERTICAL CABLE RACKS

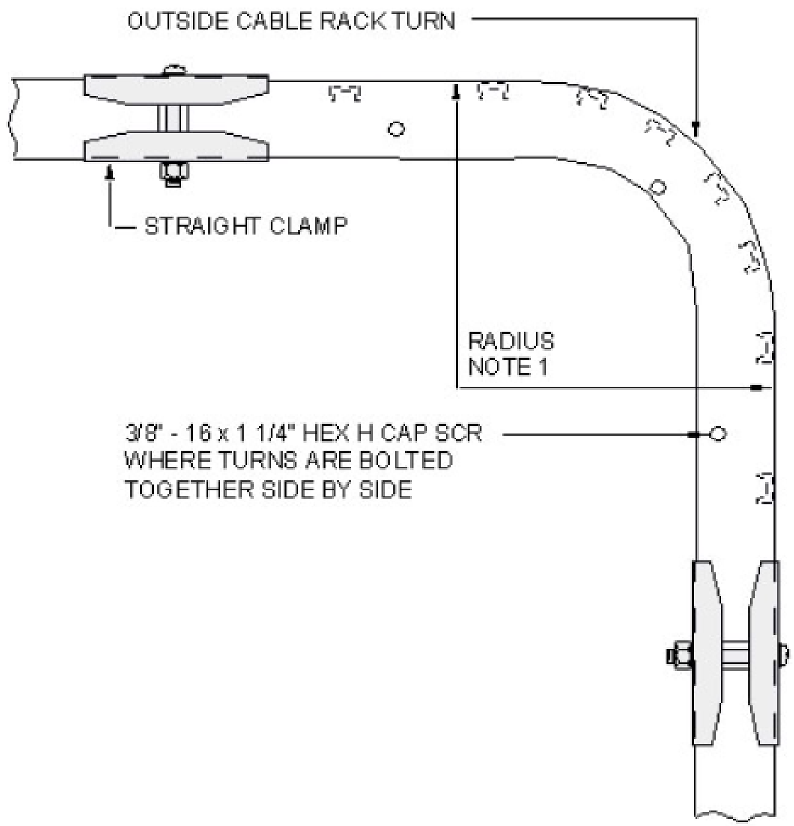


THREE OR FOUR STRAPS IN OFFSET

(C)

EXHIBIT 2-E1-52

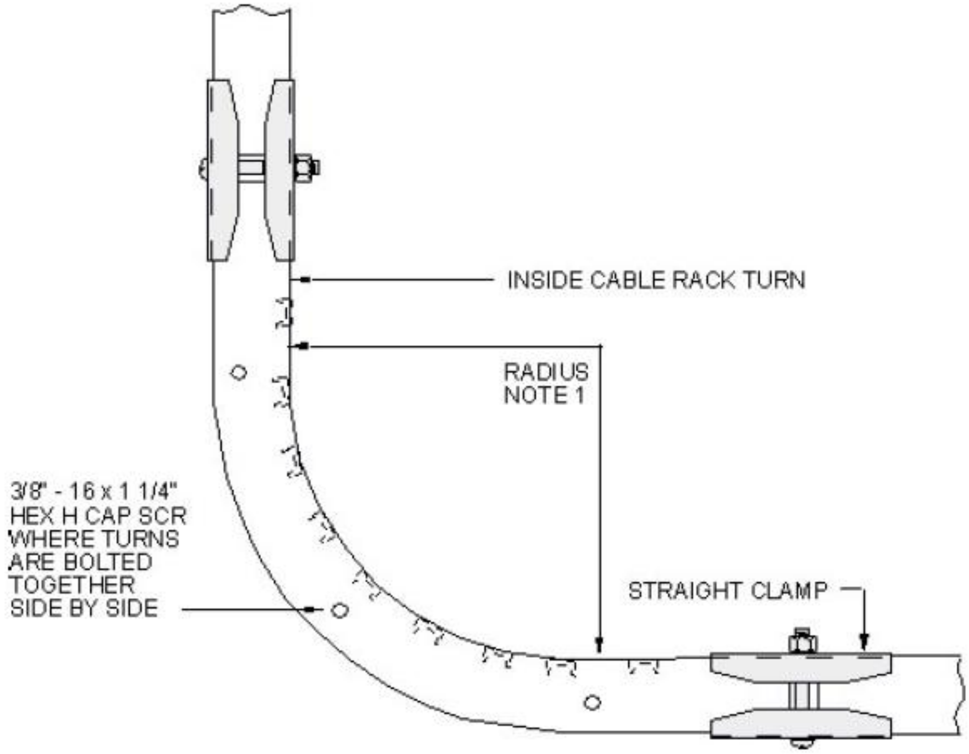
2-E1-52 OFFSETS IN EXPOSED VERTICAL CABLE RACKS



NOTE 1: MINIMUM TURN BEND RADIUS IDENTIFIED AS REQUIRED TO MEET MINIMUM CABLE BEND RADIS AT MAXIMUM CABLE PILEUP

EXHIBIT 2-E1-53

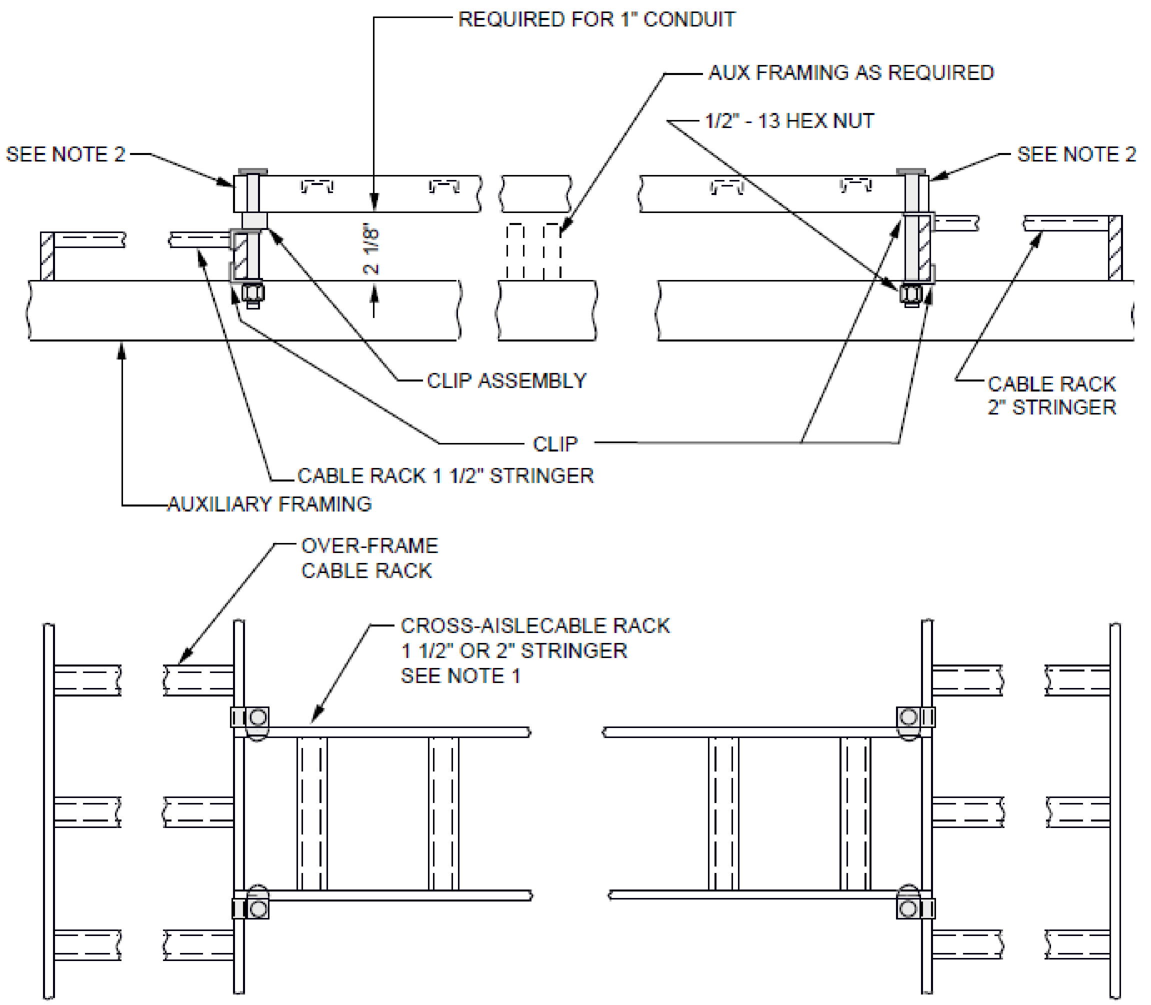
2-E1-53 OUTSIDE CABLE RACK TURN FOR POWER OR FIBER CABLE RUNS



NOTE 1: MINIMUM TURN BEND RADIUS IDENTIFIED AS REQUIRED TO MEET MINIMUM CABLE BEND RADIS AT MAXIMUM CABLE PILEUP

EXHIBIT 2-E1-53A

2-E1-53A INSIDE CABLE RACK TURN FOR POWER OR FIBER 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

2-E1-54 CROSS-AISLE CABLE RACKS RUN NONCONTINUOUSLY OVER-AISLES AT HIGHER LEVEL THAN OVER-FRAME RACKS INTERSECTION

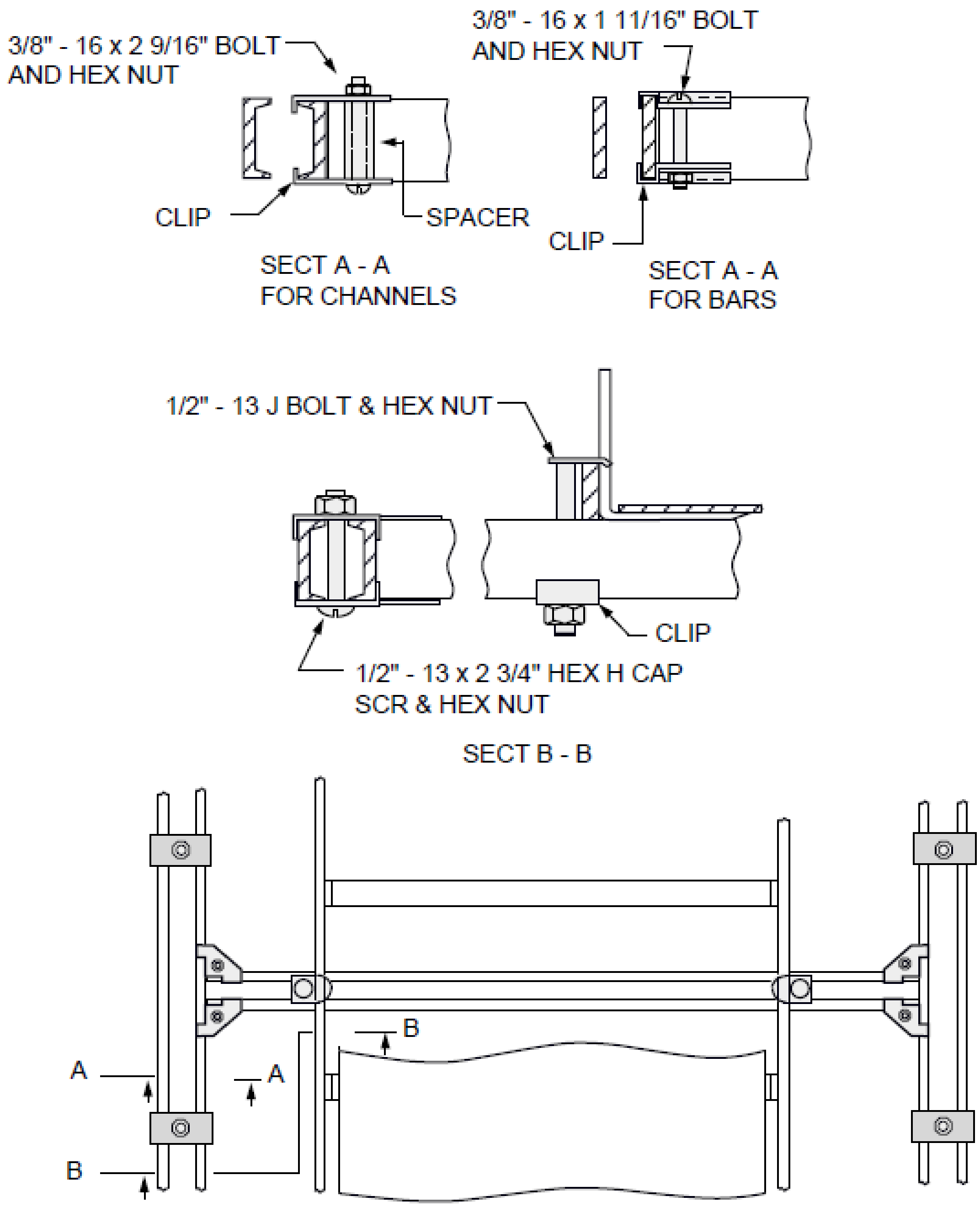
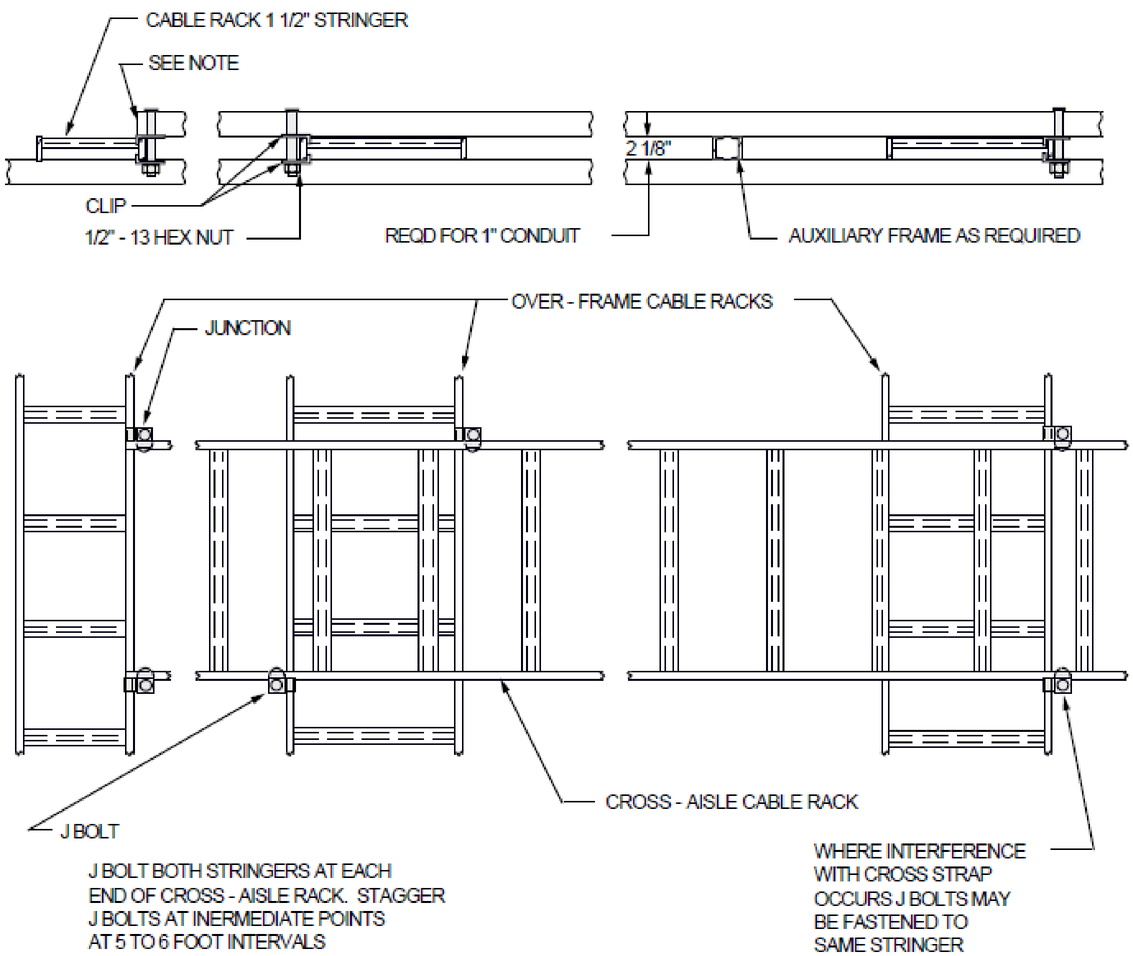


EXHIBIT 2-E1-54E (A&M)

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

CROSS AISLE ILLUSTRATED AT HIGHER LEVEL THAN LINEUP RACK

EXHIBIT 2-E1-54F

2-E1-54F CROSS-AISLE CABLE RACKS RUN CONTINUOUSLY OVER AISLE AT HIGHER OR LOWER LEVEL THAN LINEUP RACKS

ASSEMBLY	STANDARD LENGTH
THREE BRACKET	2' - 1 1/2"
TWO BRACKET	1' - 0"

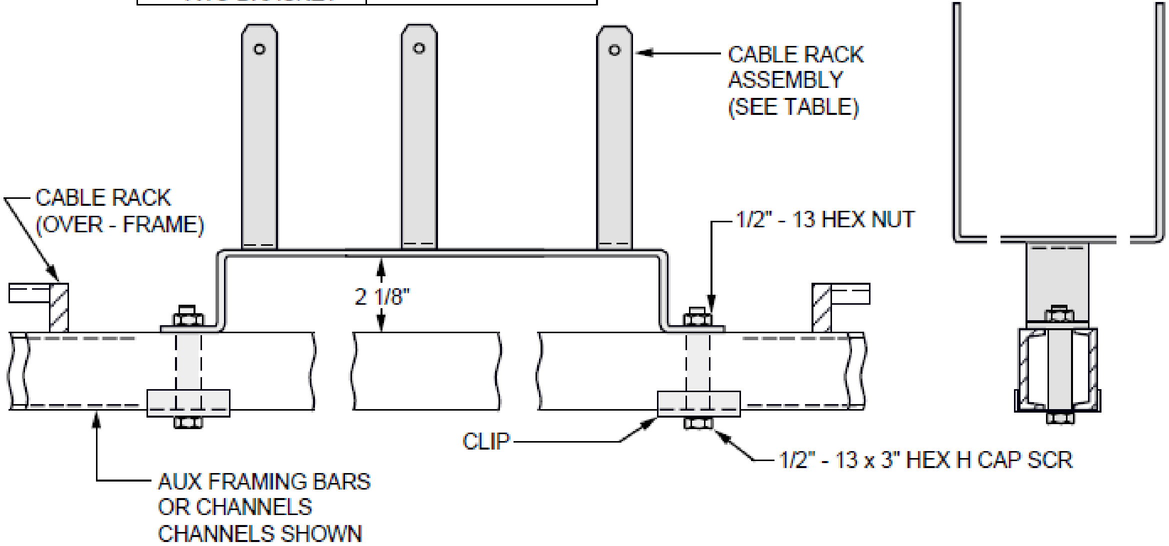


EXHIBIT 2-E1-55 (DISCONTINUED)

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

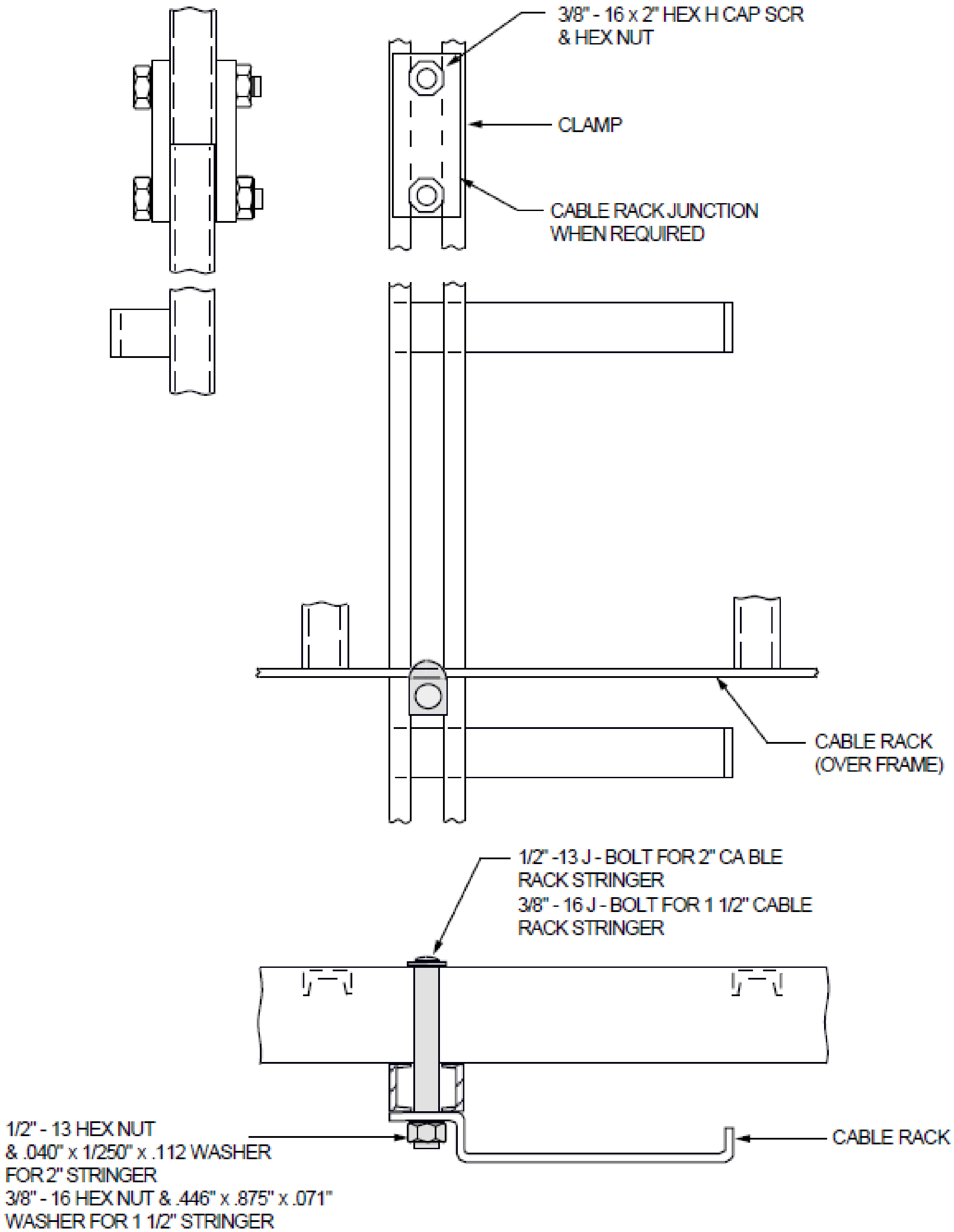


EXHIBIT 2-E1-56 (DISCONTINUED)
2-E1-56 (DISCONTINUED) CABLE RACK FOR POWER CABLES WITHOUT MAIN-AISLE OR END-AISLE CABLE RACK (REPLACED BY EXHIBIT 2-E1-56B)

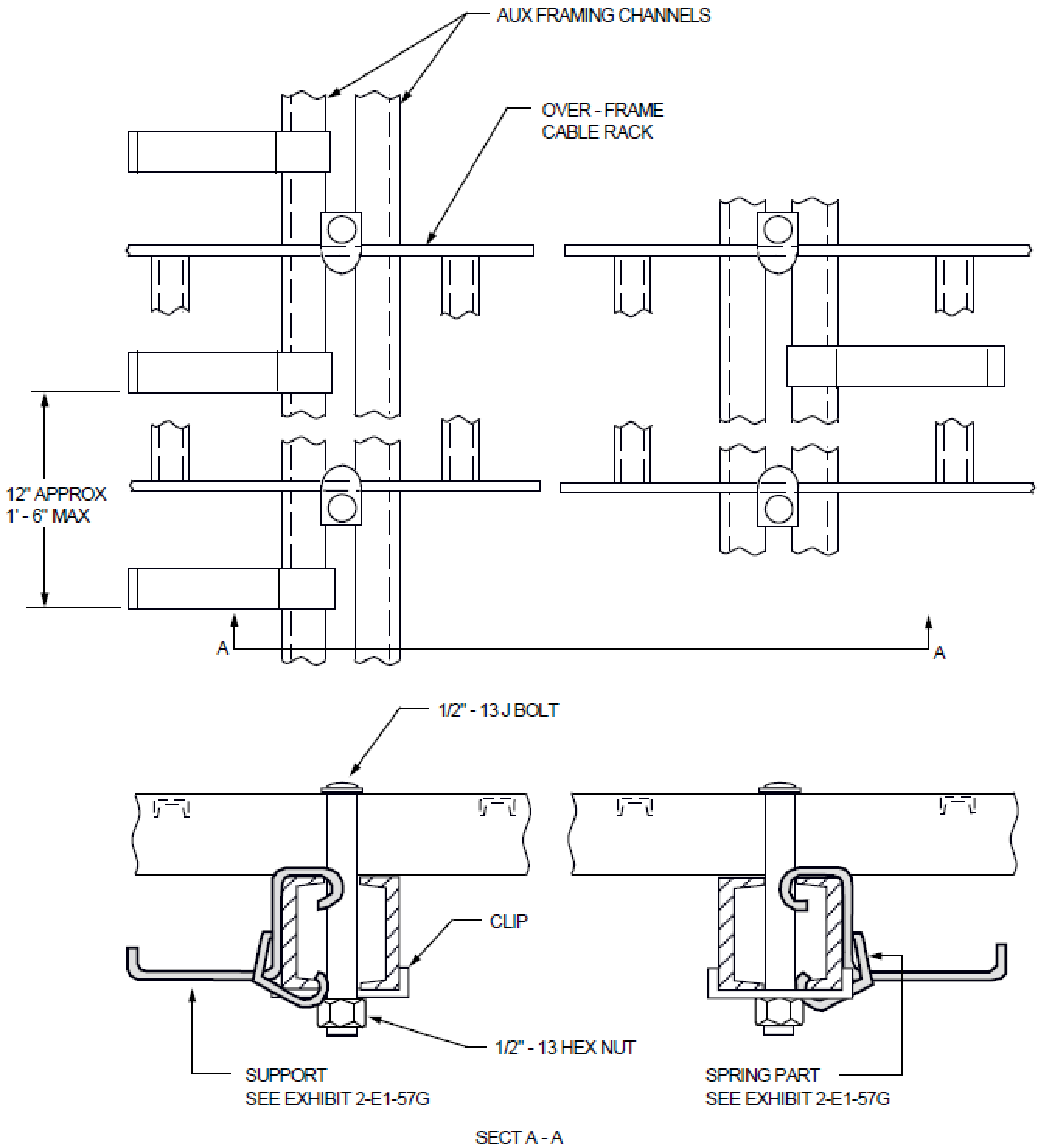
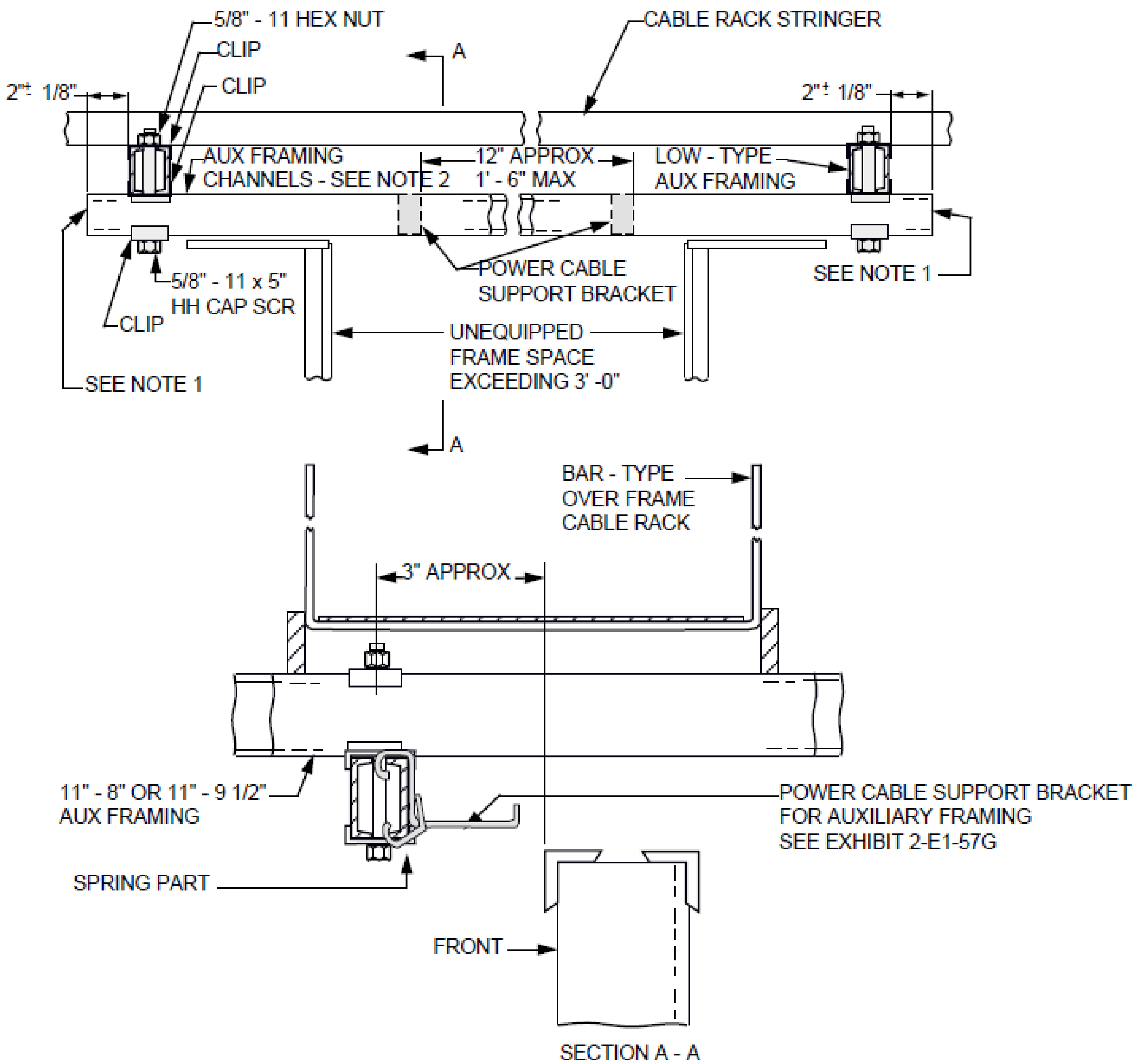


EXHIBIT 2-E1-56B

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)

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

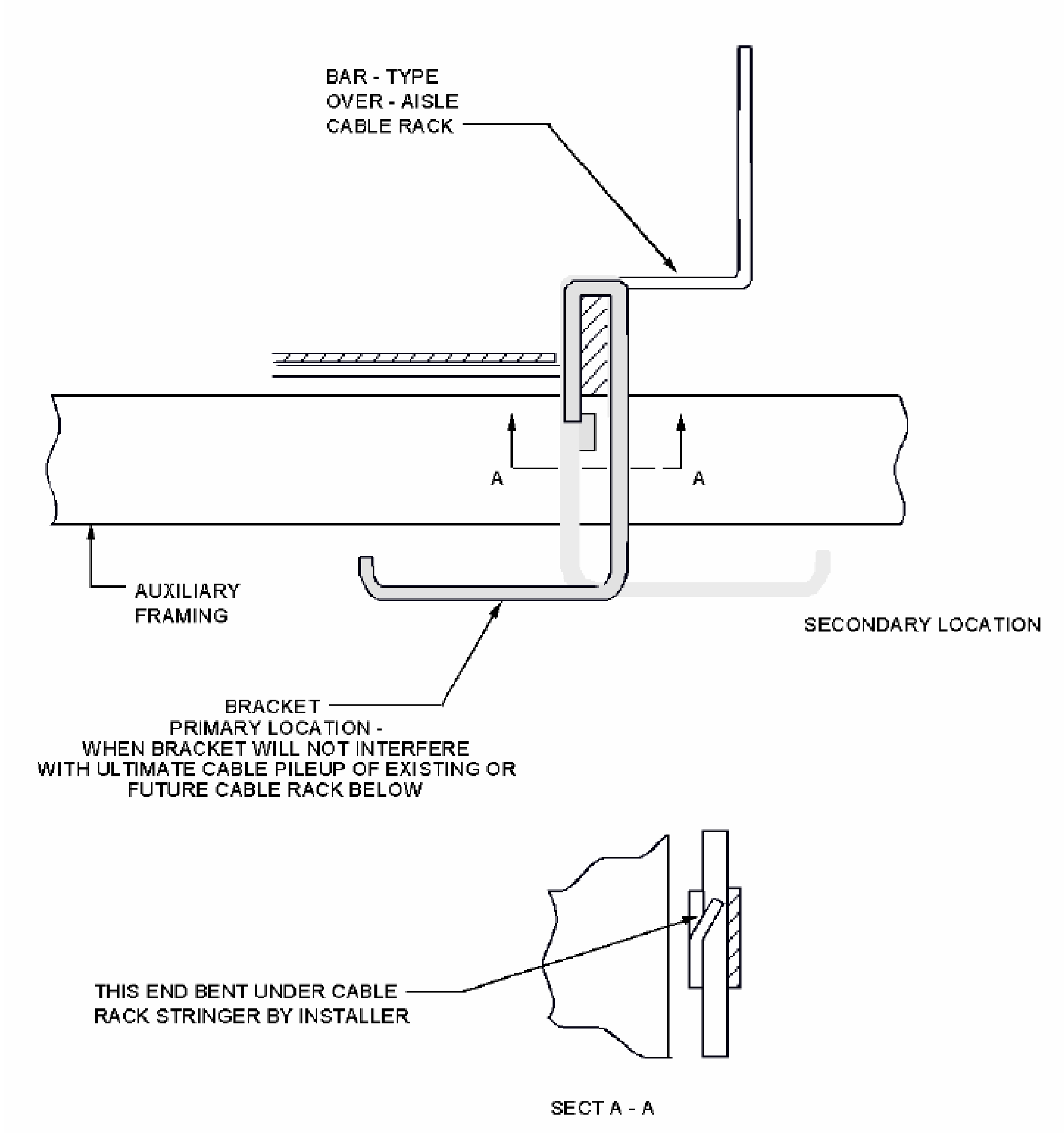


EXHIBIT 2-E1-57E (A&M)

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

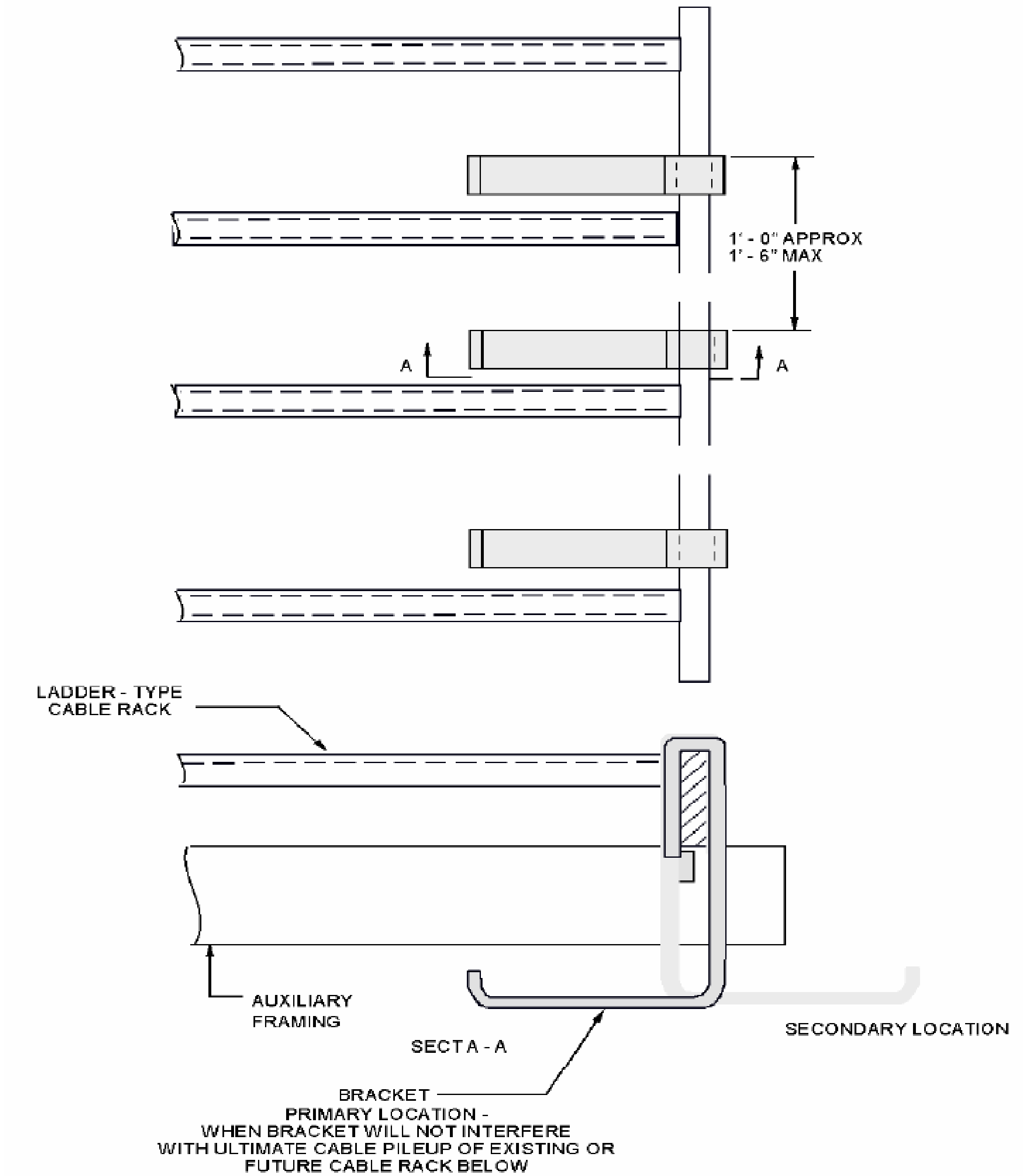
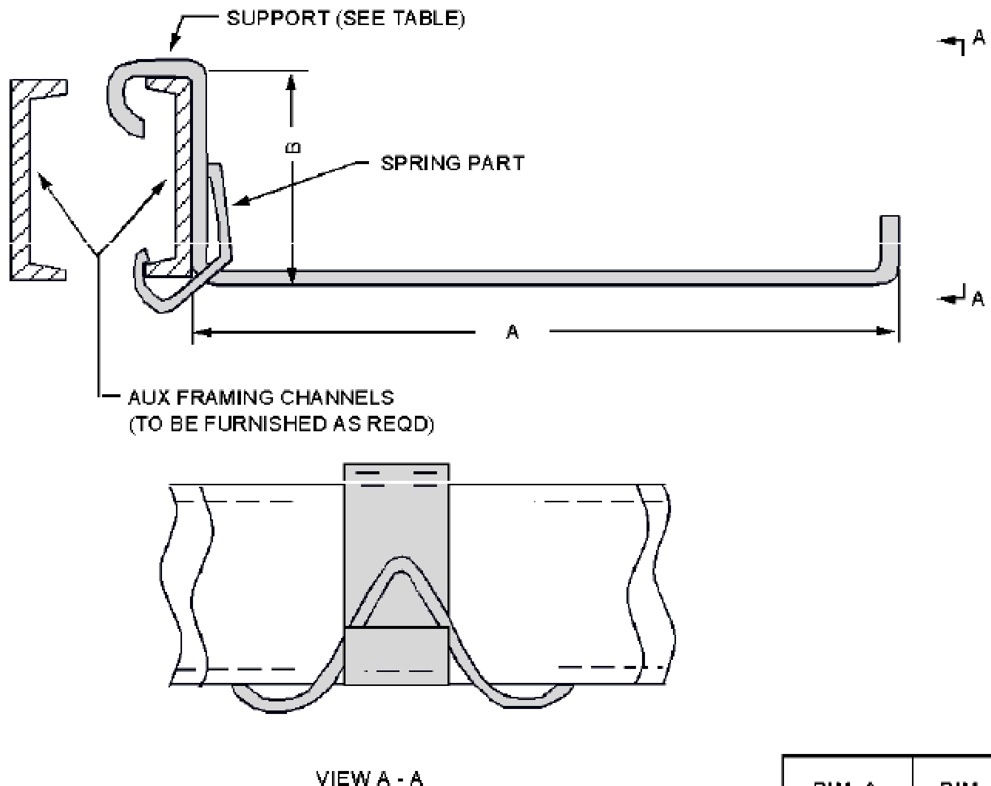


EXHIBIT 2-E1-57F

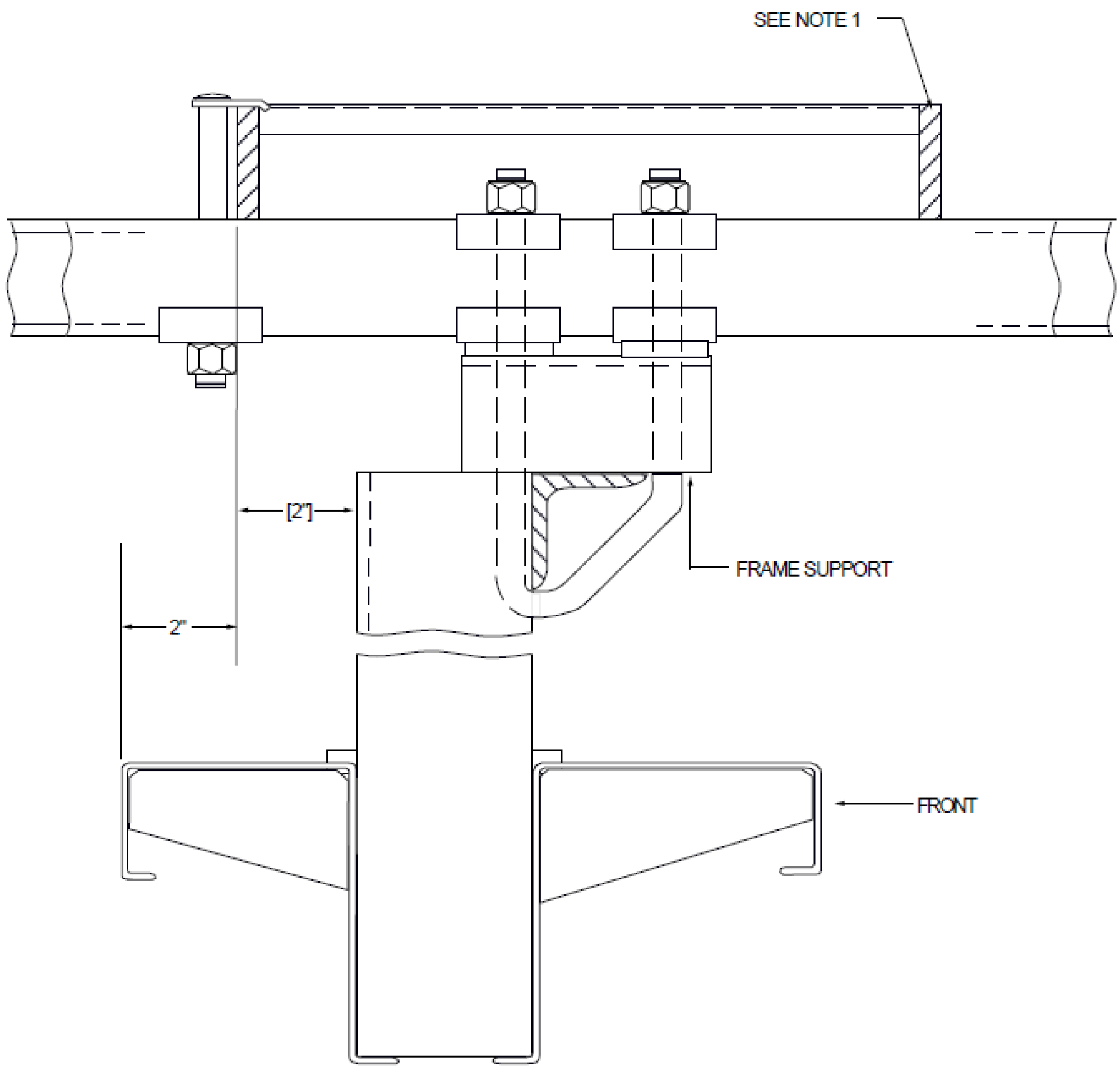
2-E1-57F POWER CABLE BRACKET ATTACHED TO LADDER-TYPE CABLE RACK



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

EXHIBIT 2-E1-57G

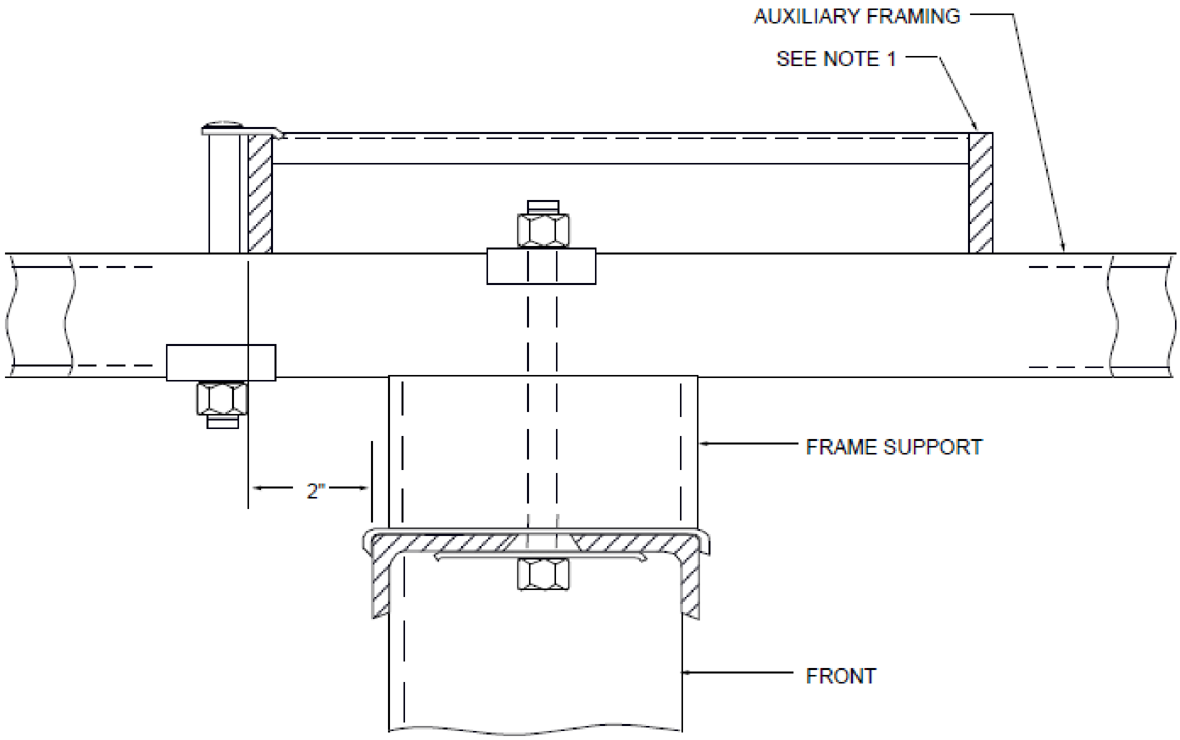
2-E1-57G POWER CABLE SUPPORT BRACKET ATTACHED TO AUXILIARY FRAMING WITH RETAINING SPRING



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-E1-62G (A&M)

2-E1-62G (A&M) LOCATION OF LADDER-TYPE CABLE RACK OVER CHANNEL-TYPE RELAY RACK-STEP-BY-STEP SYSTEMS



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)

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

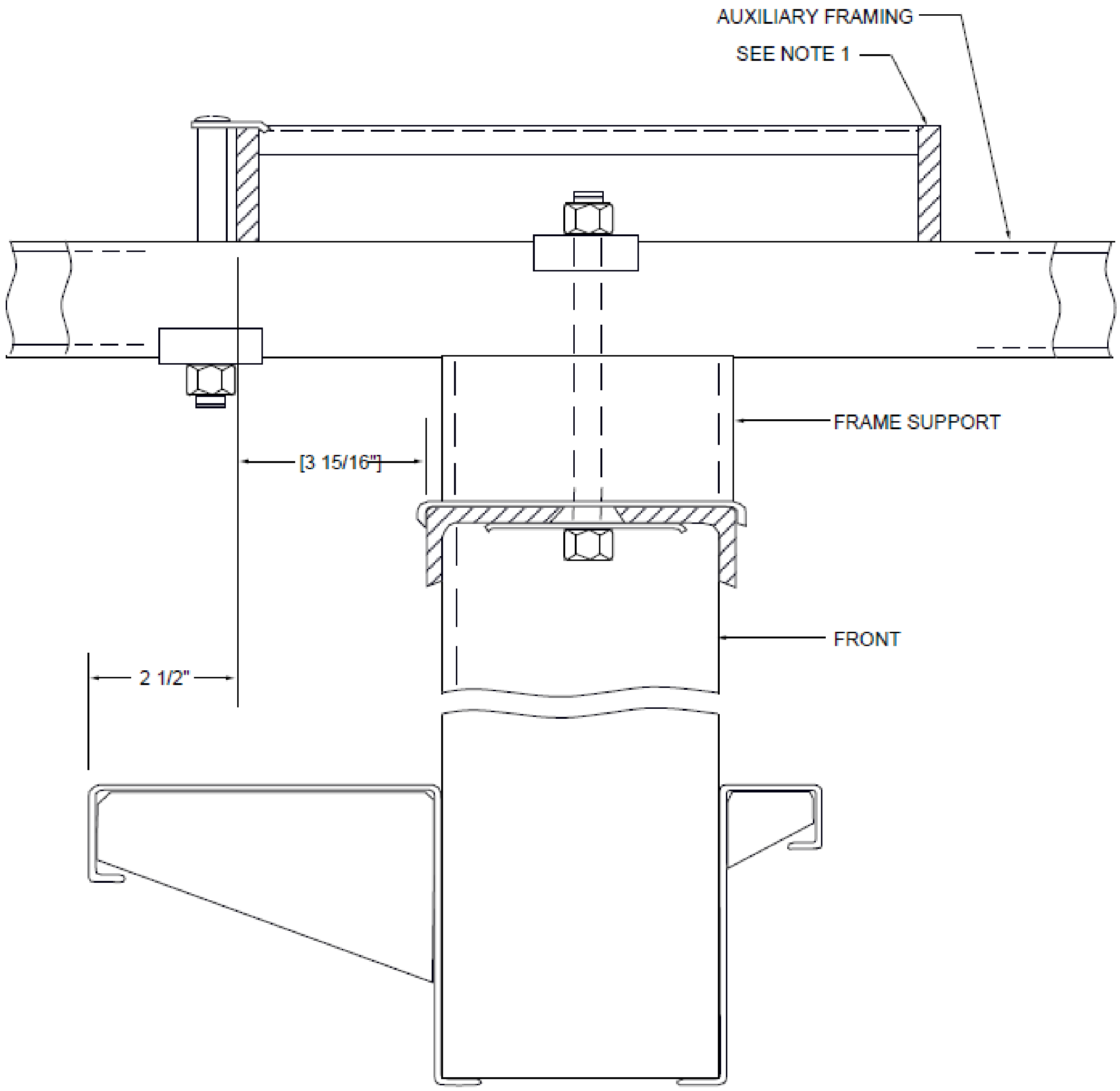


EXHIBIT 2-E1-62J (A&M)

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

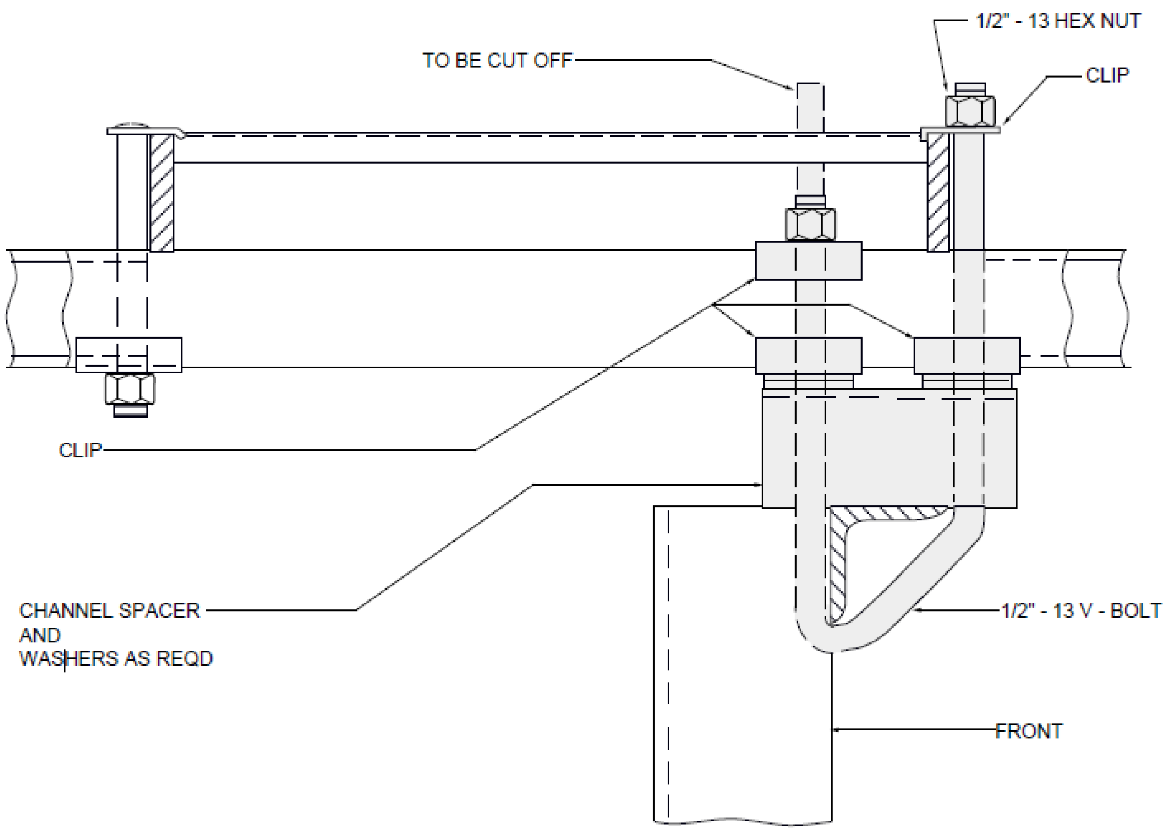
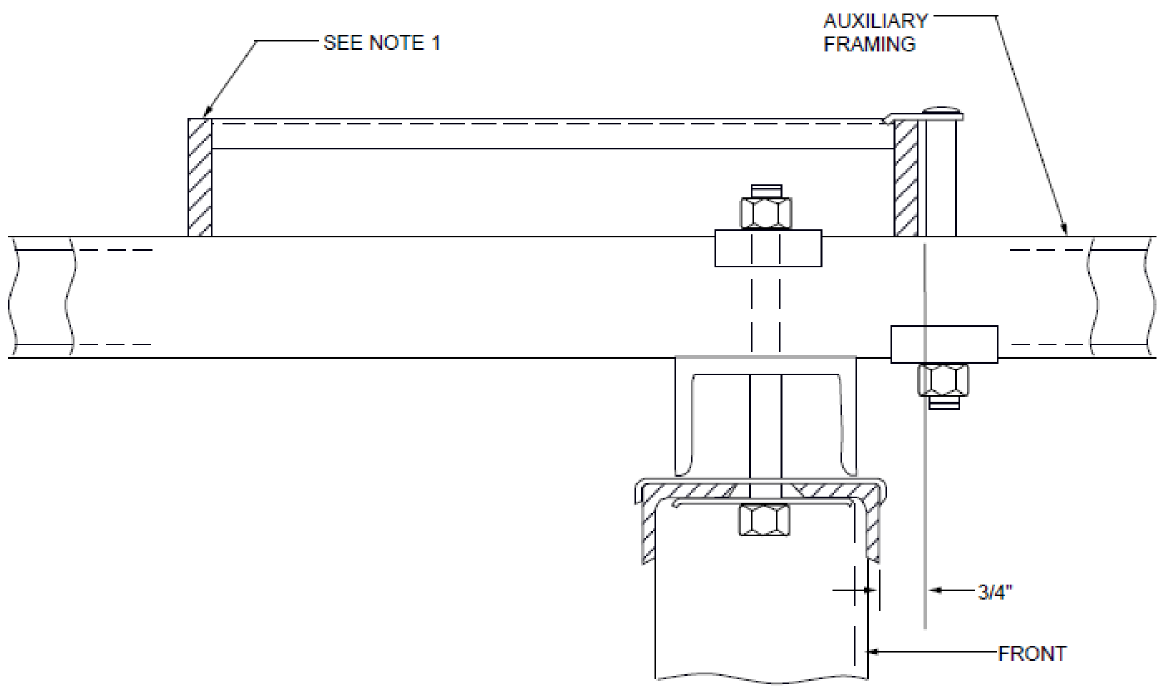


EXHIBIT 2-E1-62K

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)

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

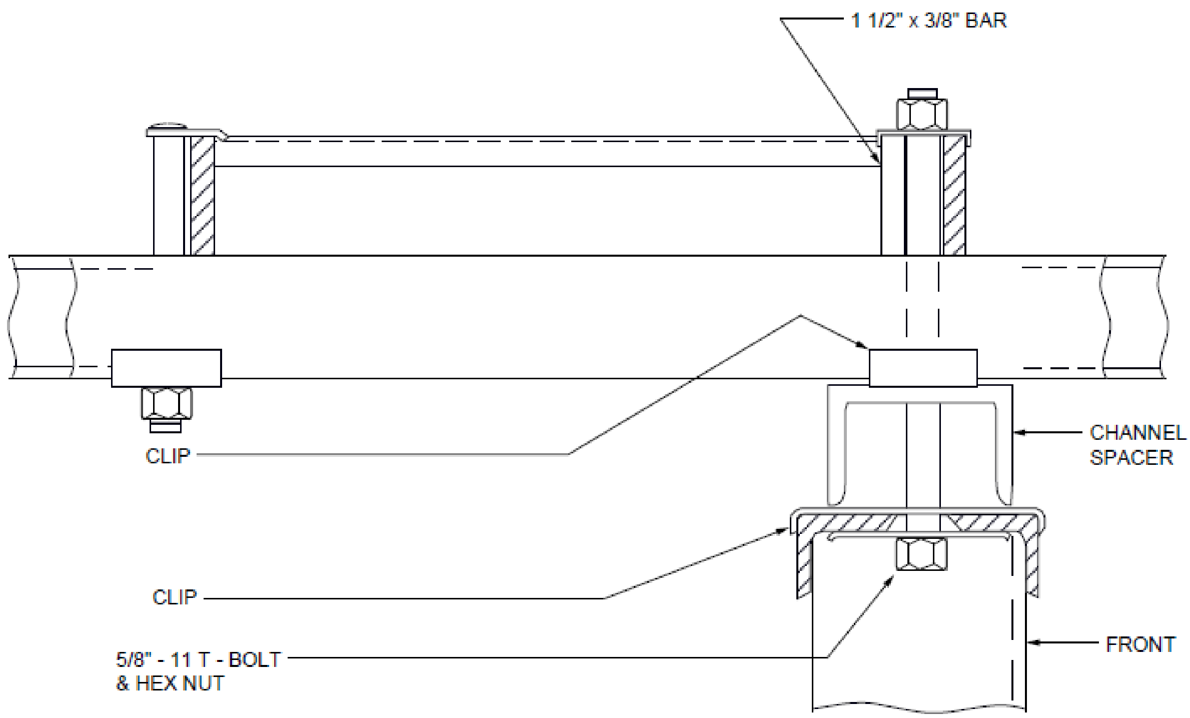


EXHIBIT 2-E1-62M (A&M)

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

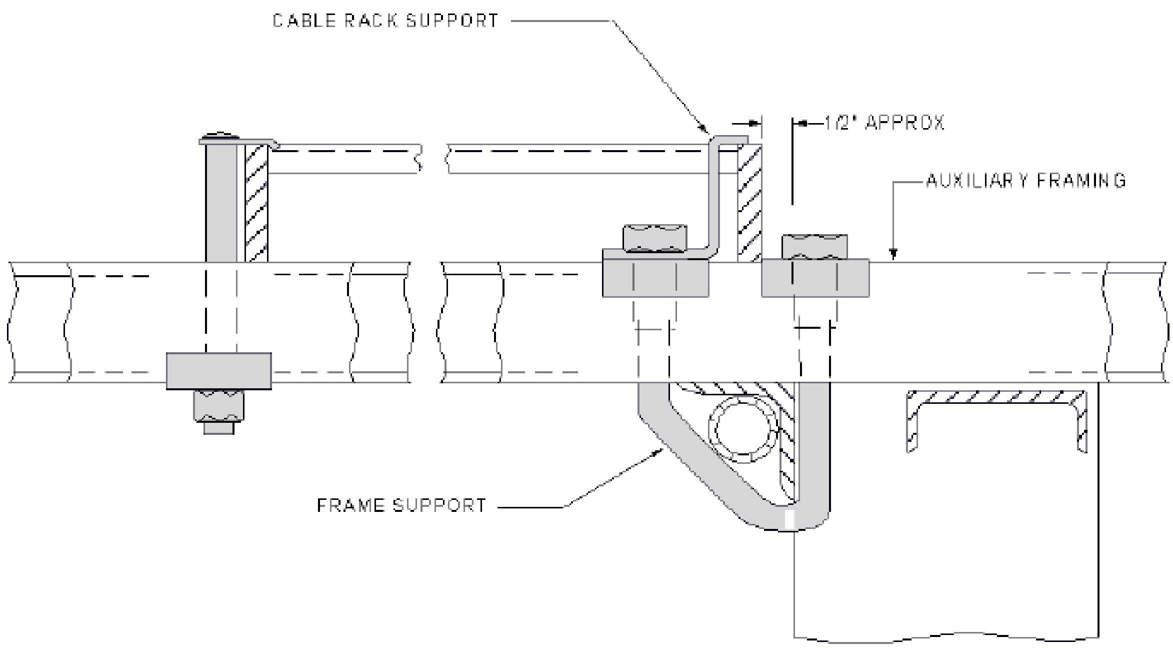


EXHIBIT 2-E1-62N

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

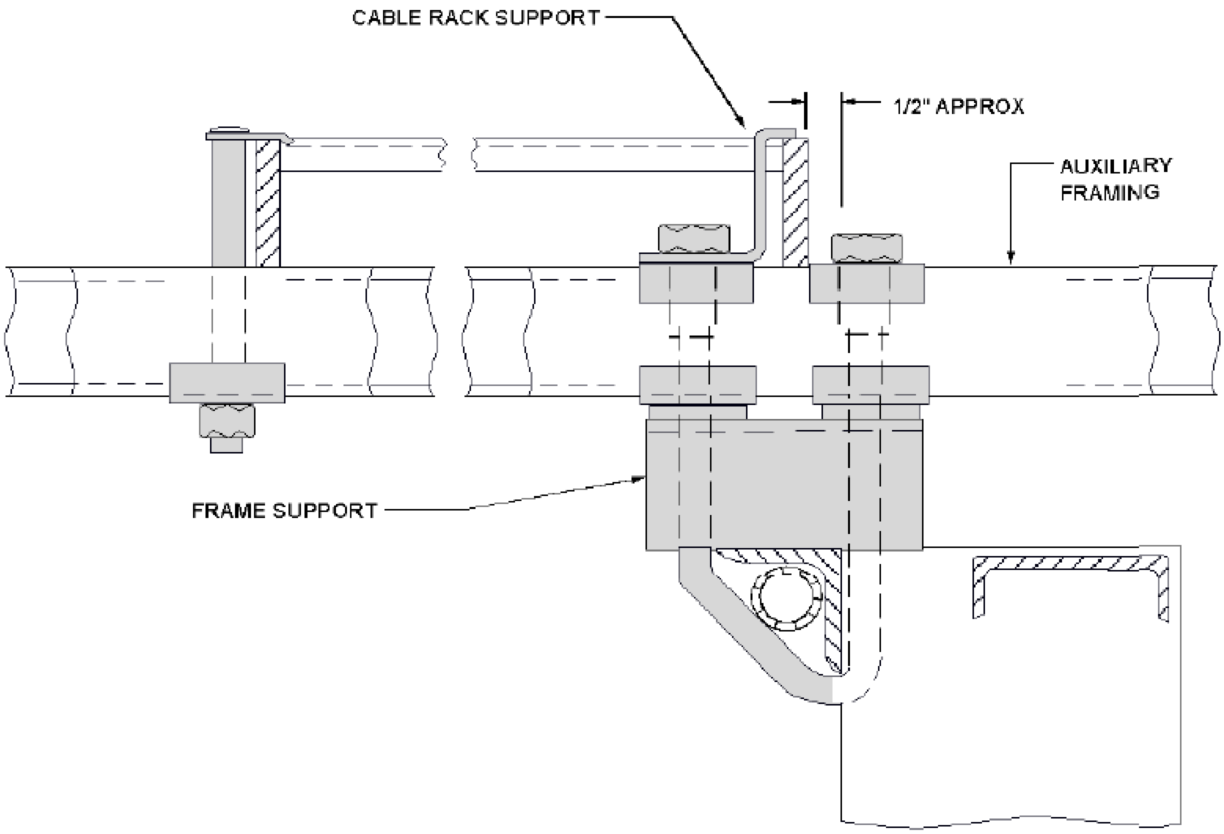
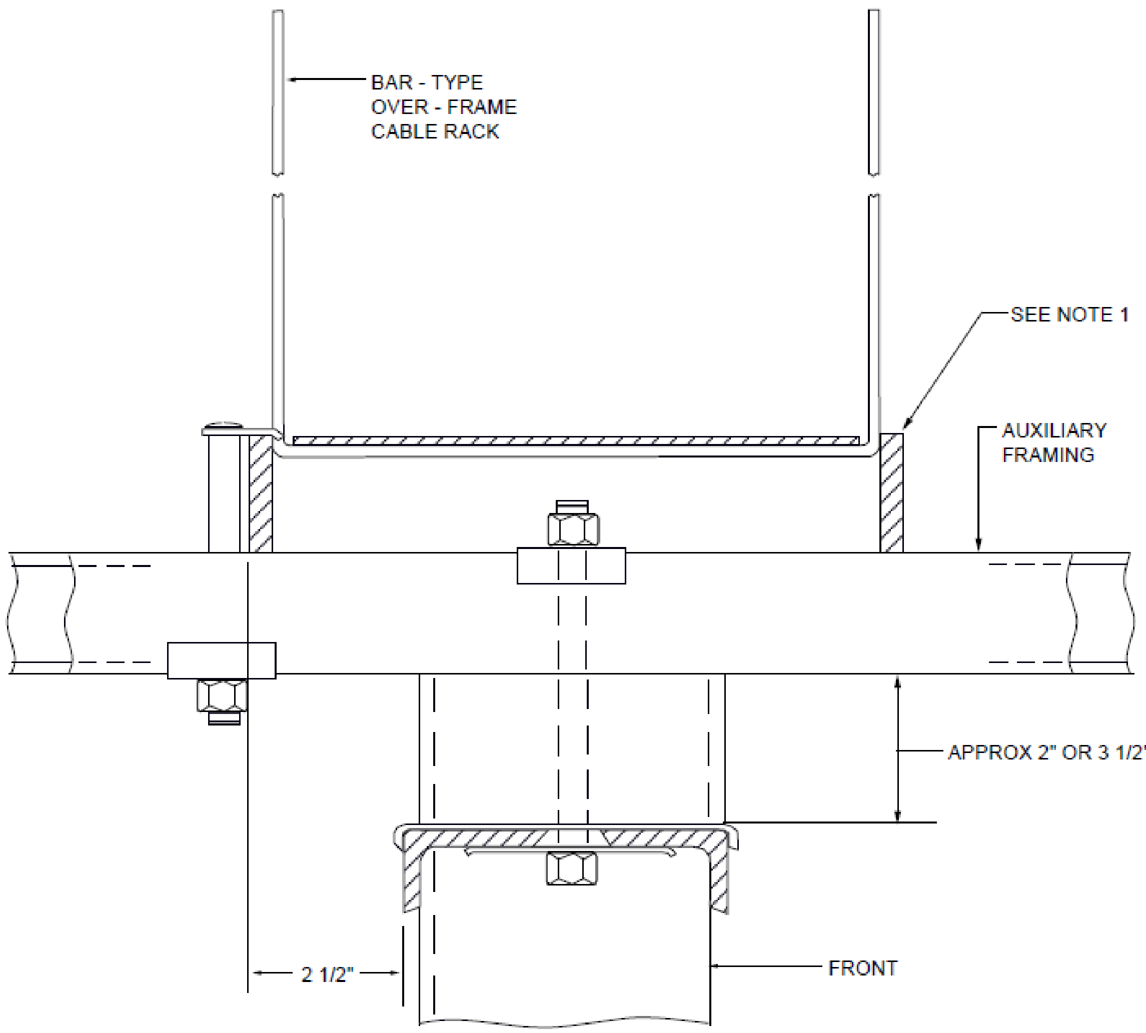


EXHIBIT 2-E1-62P

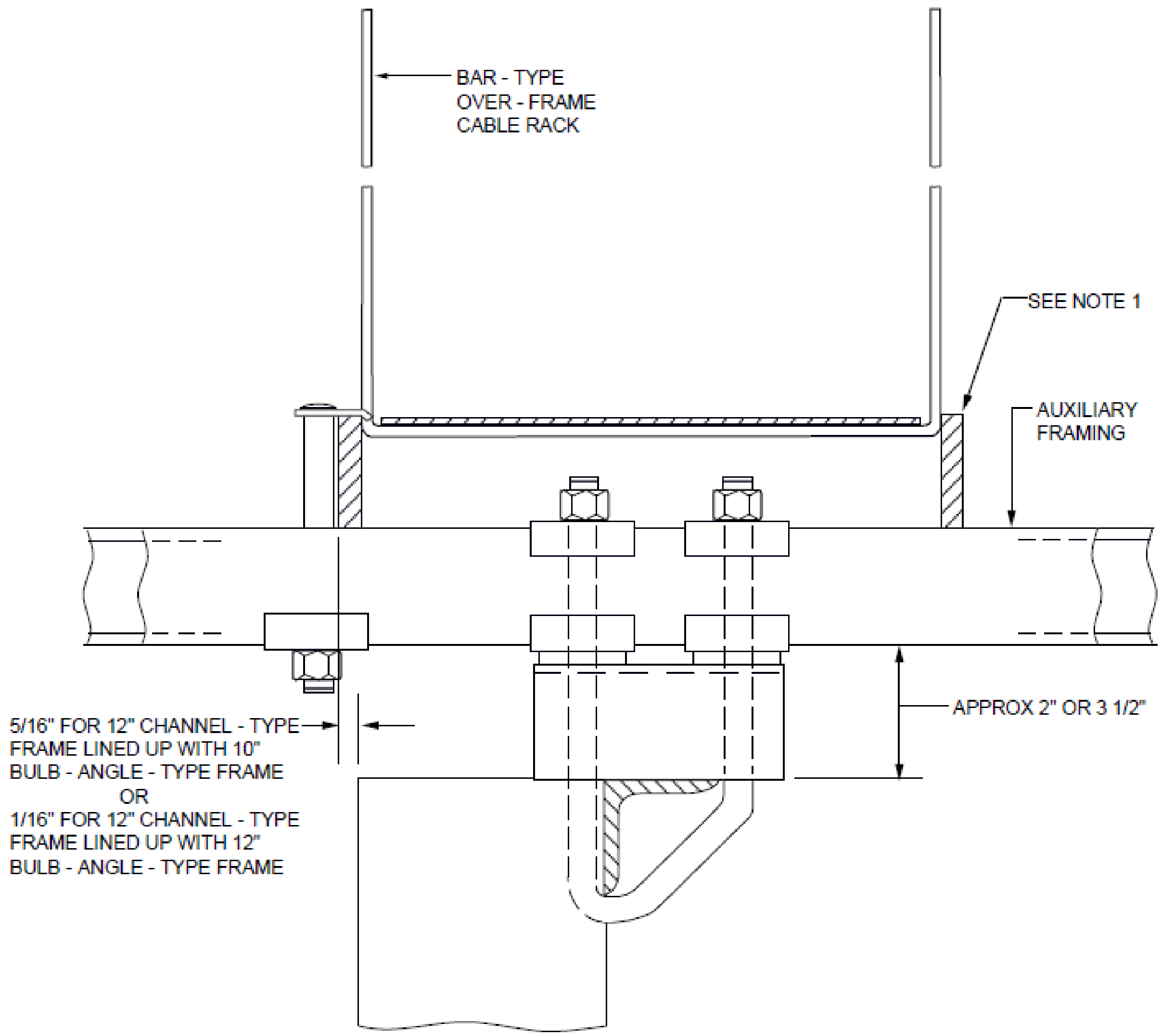
2-E1-62P LADDER-TYPE CABLE RACK OVER CABLE DUCT-TYPE FRAMES 11 FOOT 8 INCH



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)

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)

2-E1-62R LOCATION OF BAR-TYPE OVER-FRAME CABLE RACK OVER CHANNEL-TYPE FRAMES-COMBINED OFFICES

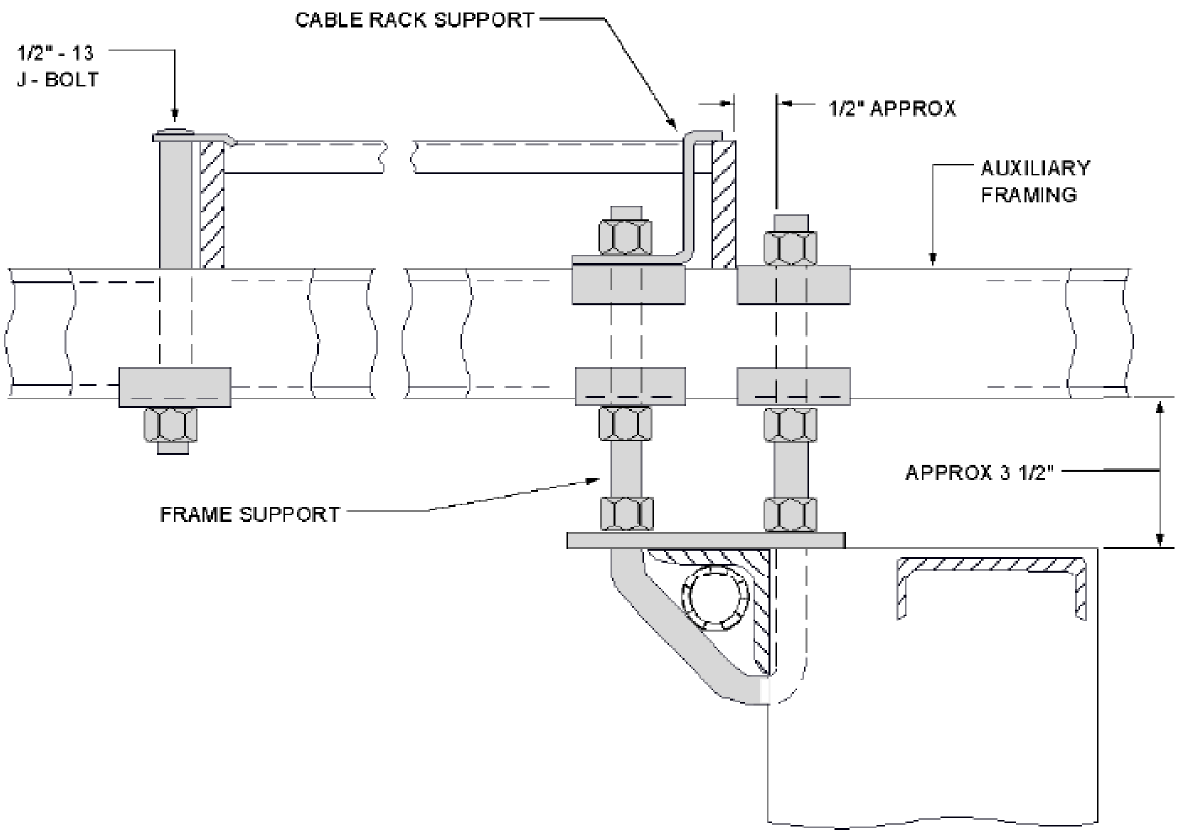


EXHIBIT 2-E1-62S

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

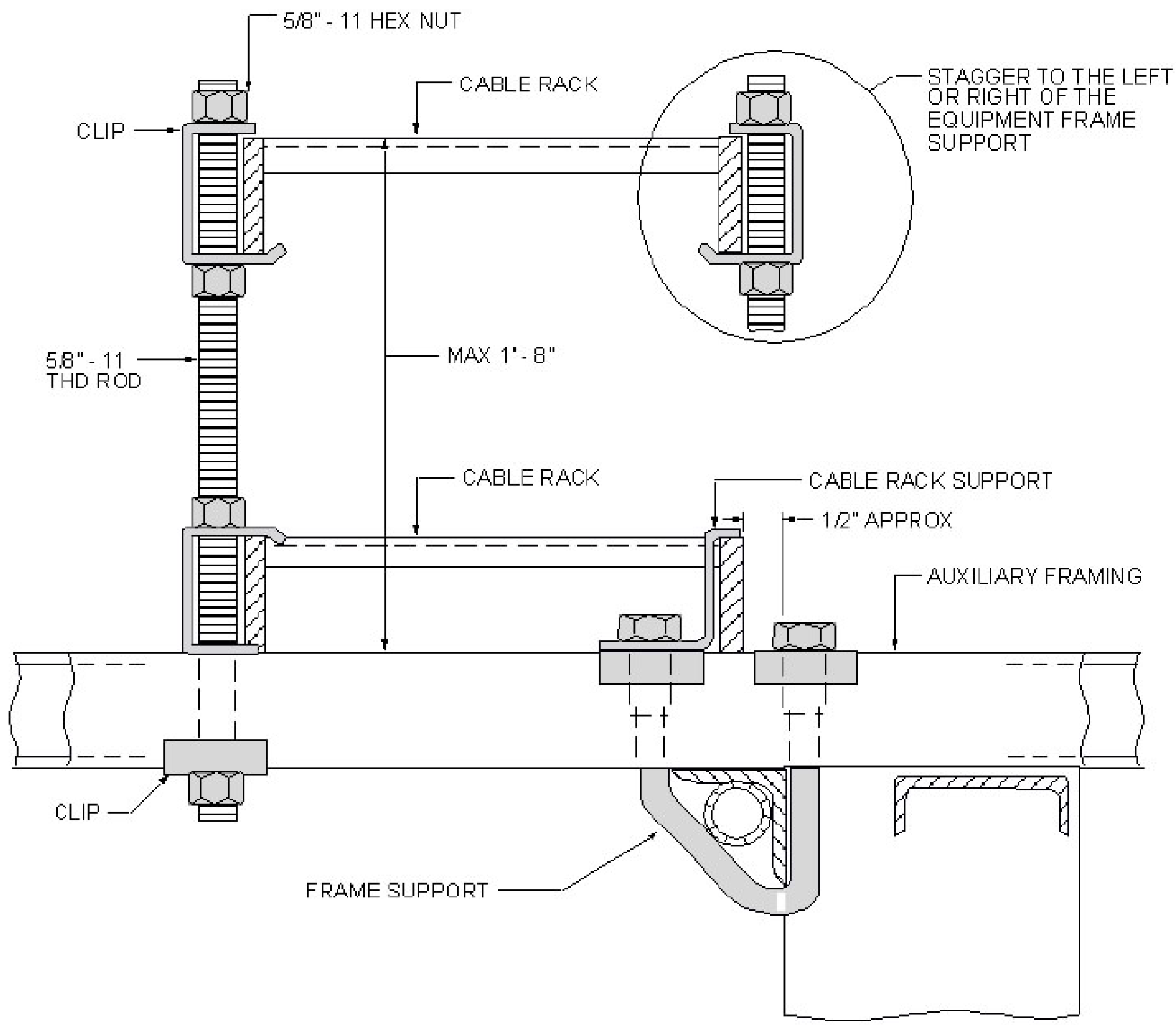


EXHIBIT 2-E1-62T (A&M)

2-E1-62T (A&M) MULTILEVEL CABLE RACK SUPPORT OVER DUCT-TYPE FRAMES-11 FOOT 6 INCH FRAMING

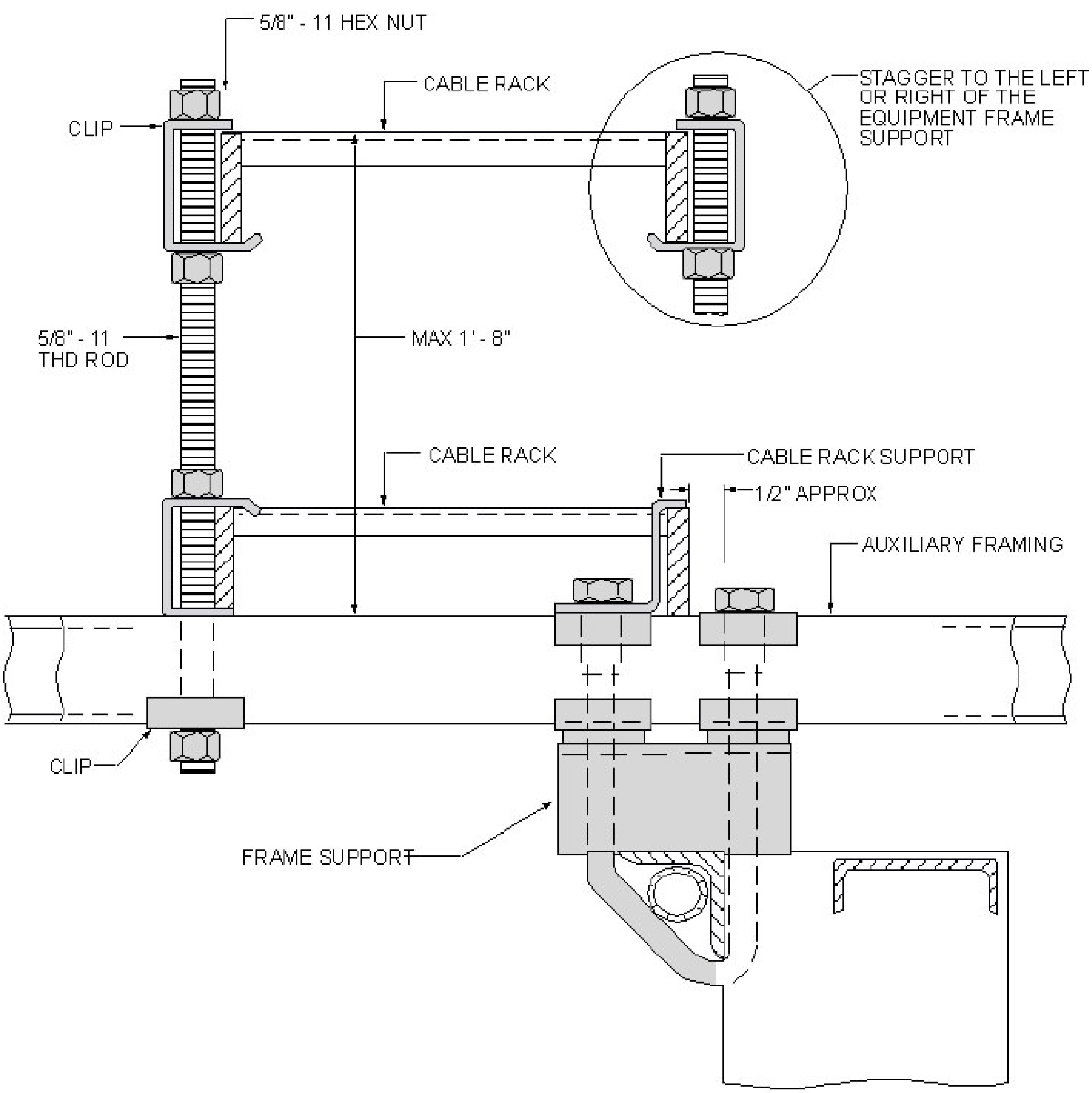


EXHIBIT 2-E1-62U (A&M)

2-E1-62U (A&M) MULTILEVEL CABLE RACK SUPPORT OVER DUCT-TYPE FRAMES-11 FOOT 8 INCH FRAMING

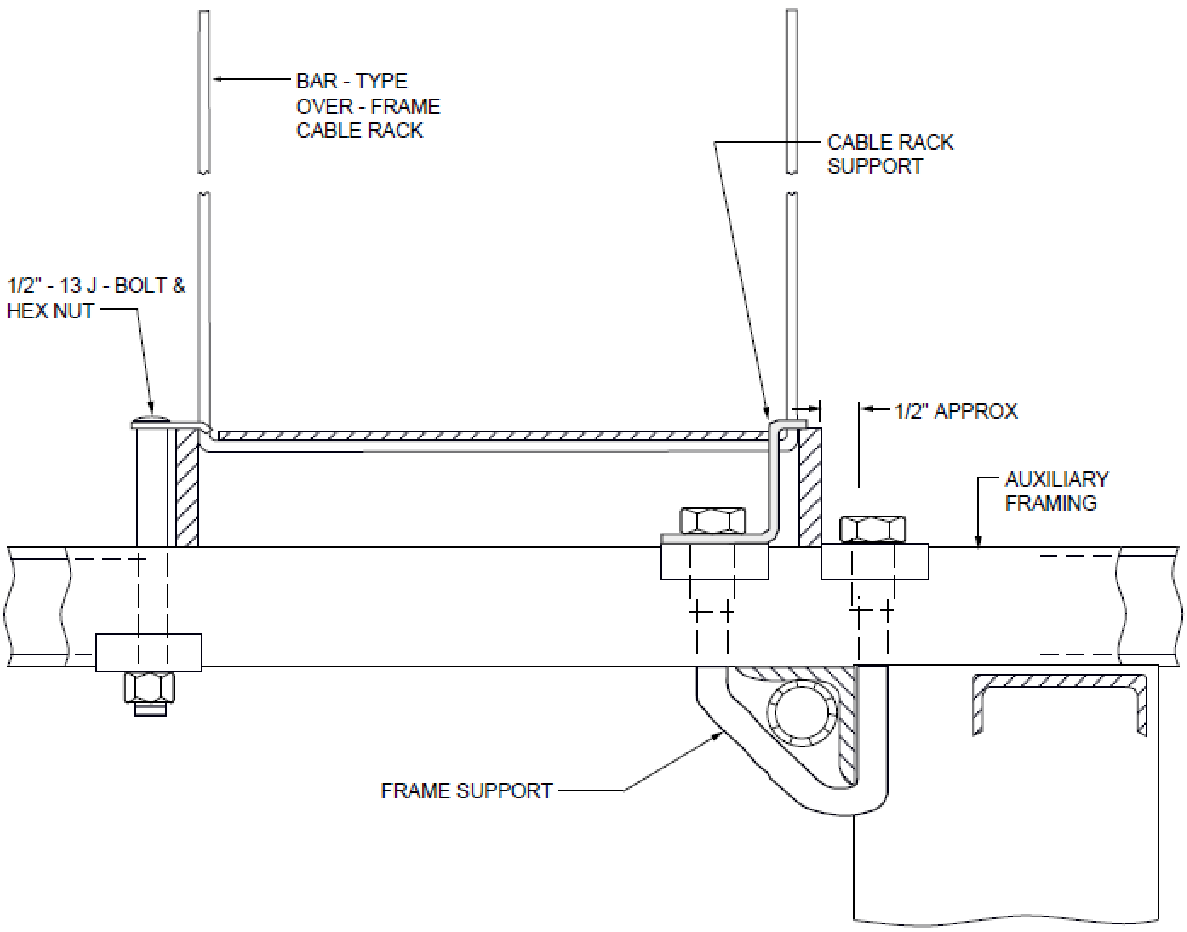


EXHIBIT 2-E1-62V (A&M)

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

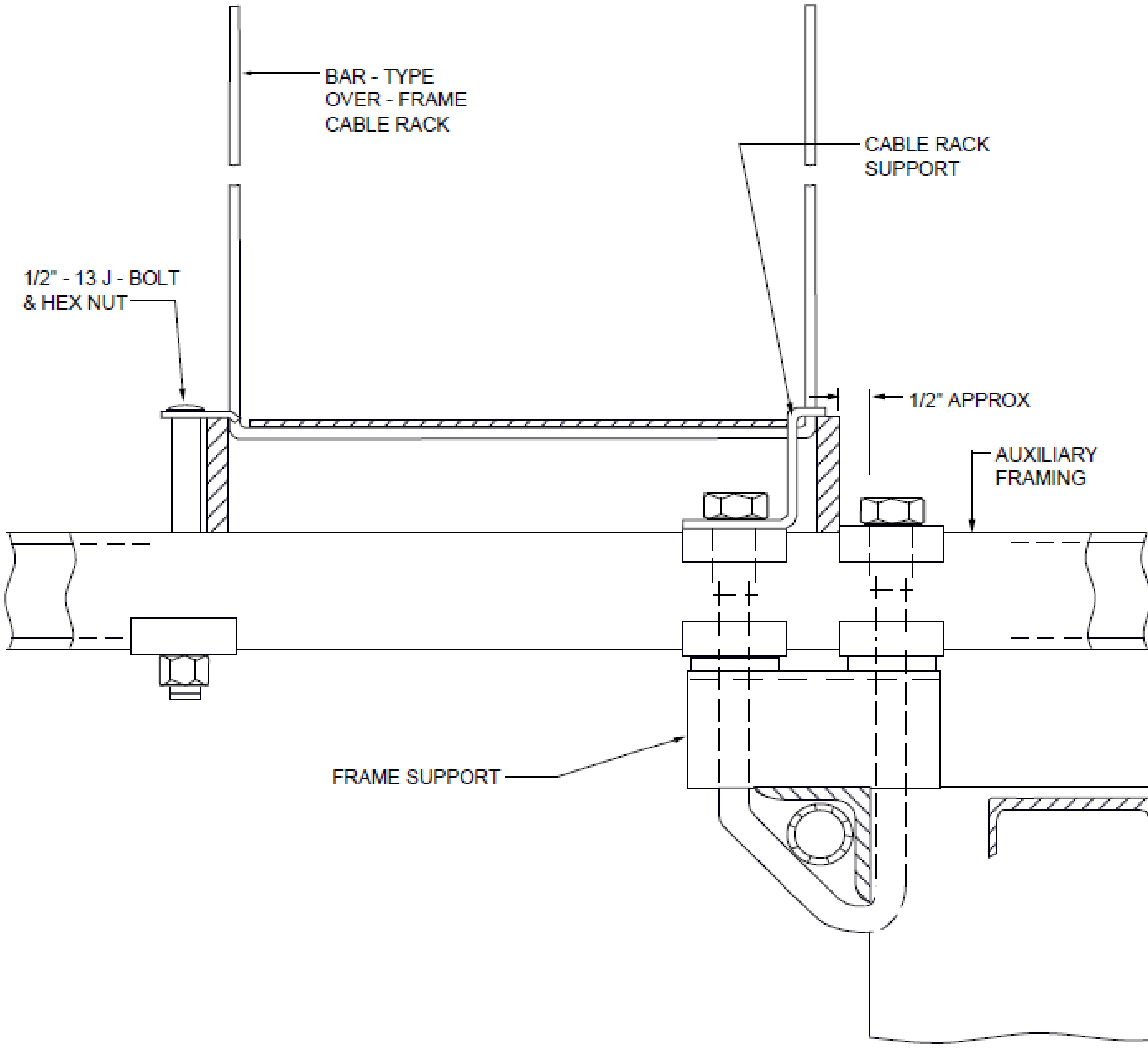
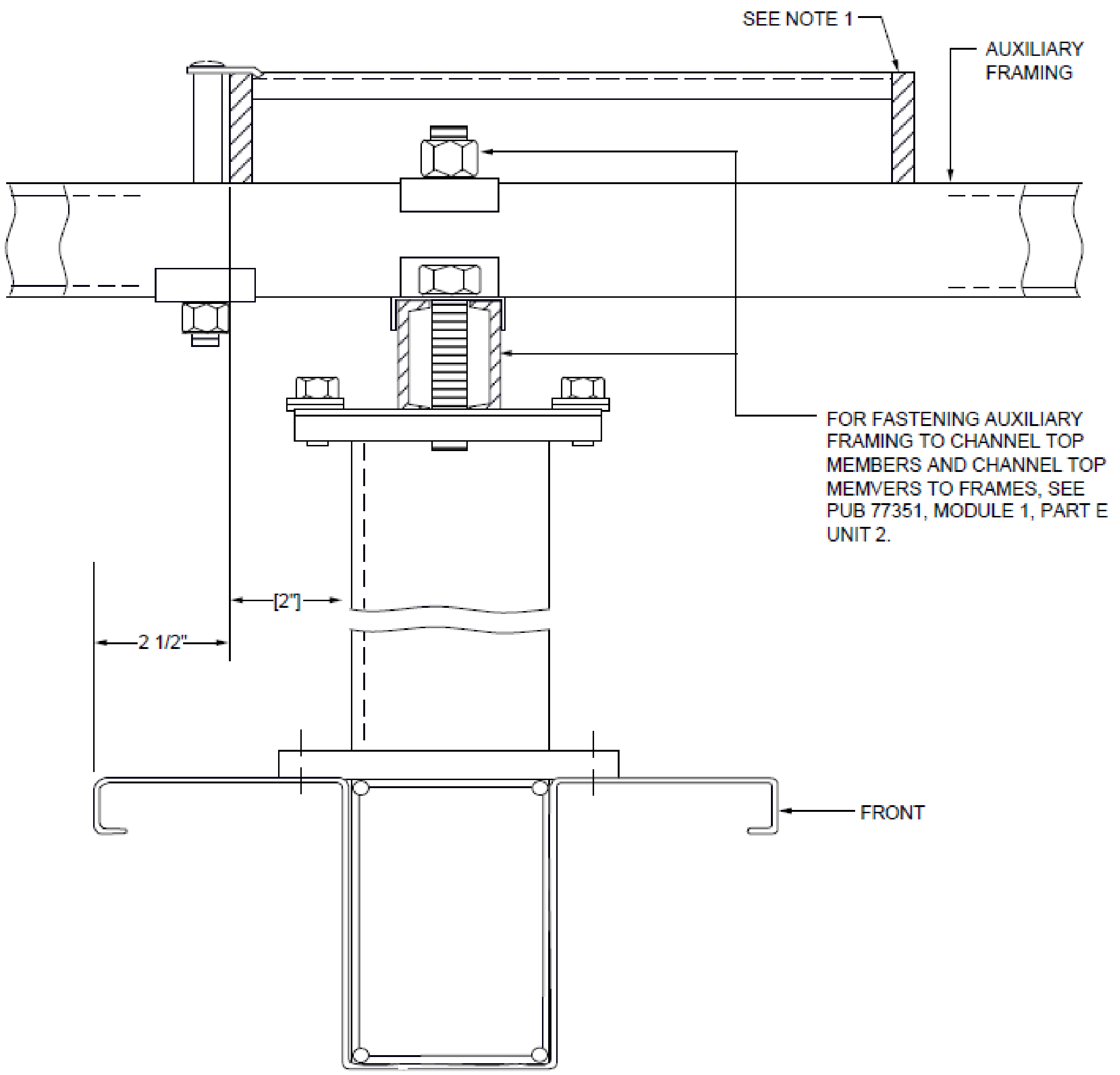


EXHIBIT 2-E1-62W (A&M)

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

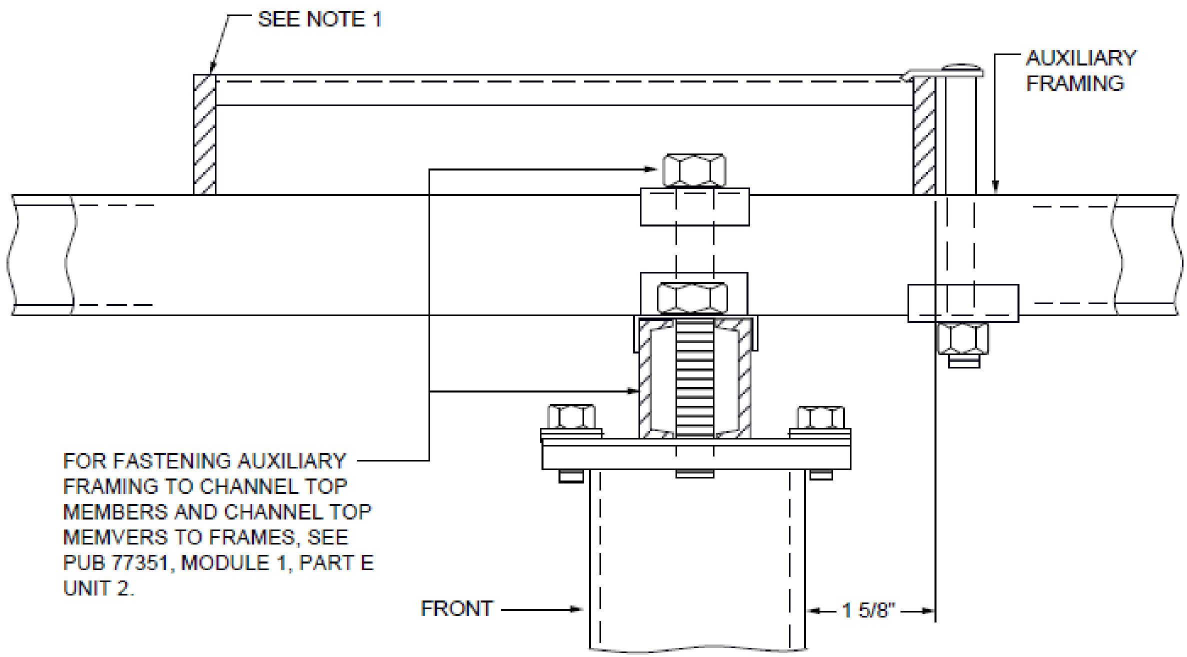


NOTE:

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)

2-E1-63A CABLE RACK SUPPORTED BY AUXILIARY FRAMING OVER BULB-ANGLE TYPE SWITCH FRAMES-STEP-BY-STEP SYSTEMS-11 FOOT 8 INCH FRAMING

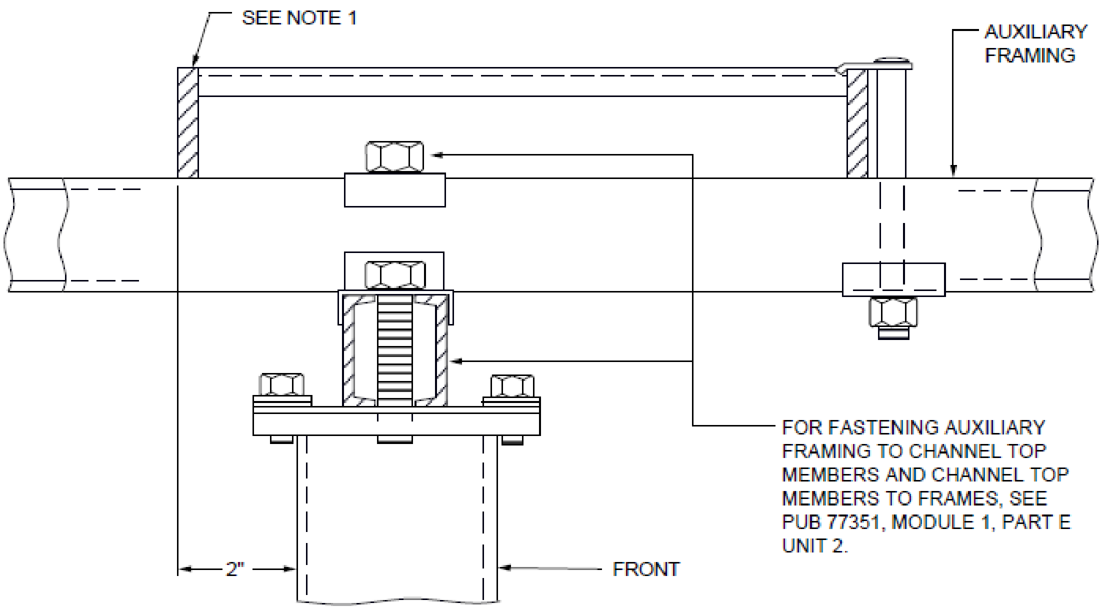


NOTE:

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)

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)

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

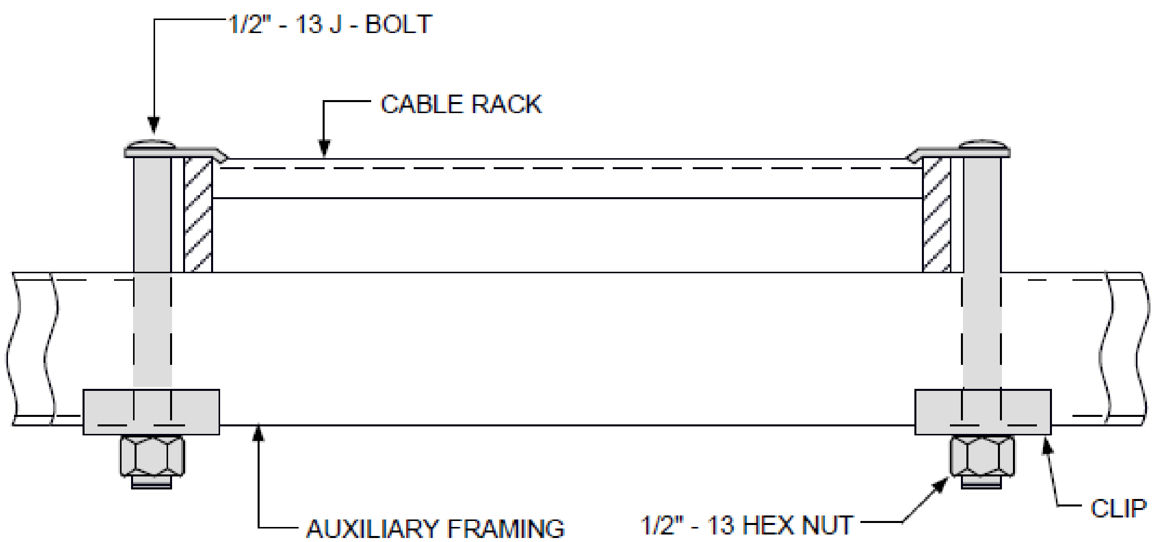


EXHIBIT 2-E1-65

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

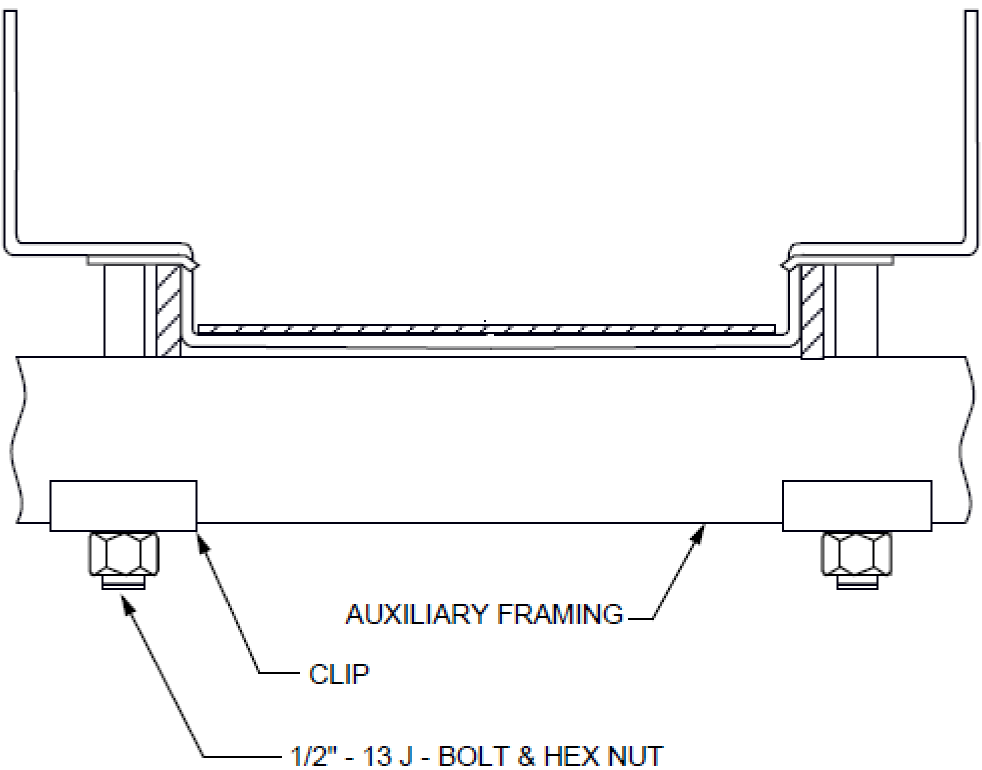


EXHIBIT 2-E1-65B (A&M)
2-E1-65 (A&M) BAR-TYPE CABLE RACK SUPPORTED BY LOW-TYPE AUXILIARY FRAMING BAR- TYPE OVER-AISLE RACK SHOWN

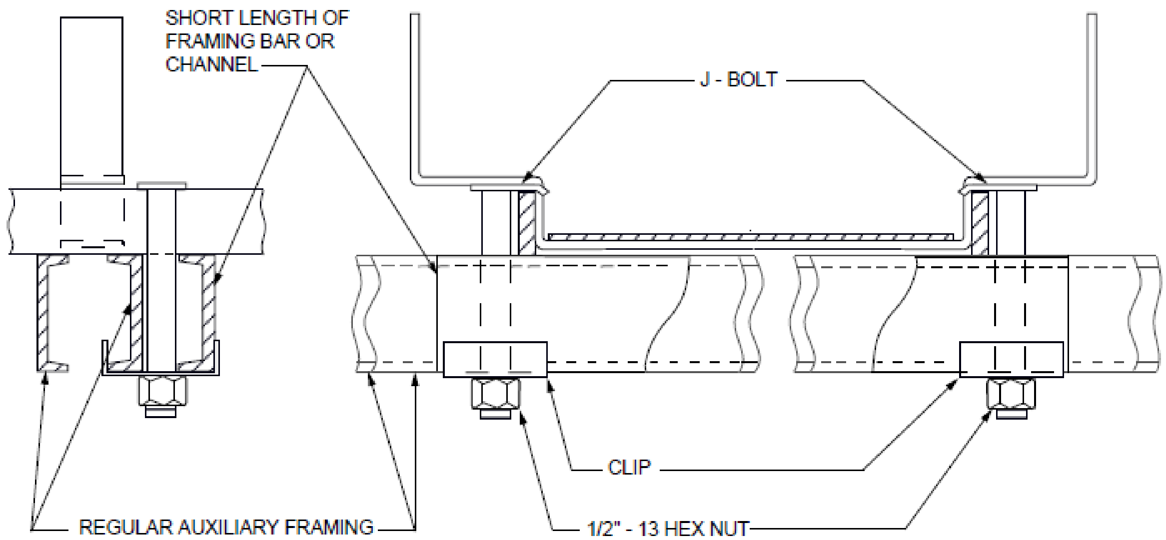
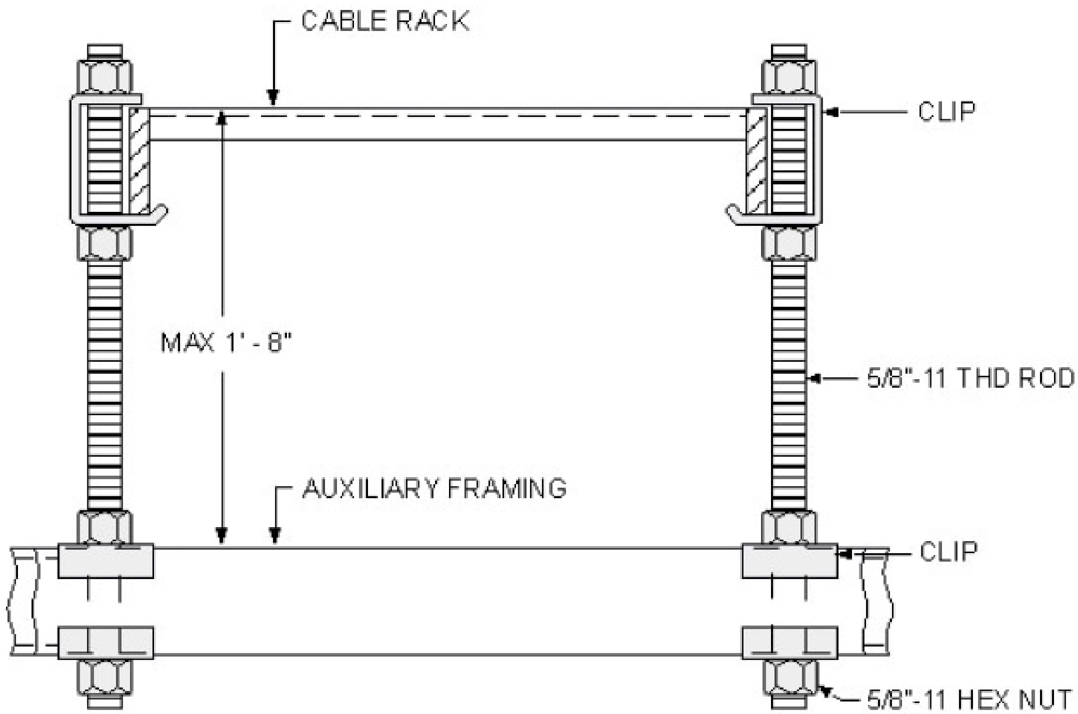


EXHIBIT 2-E1-65C (A&M)

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



NOTE: SUPPORT FOR FLOOR TYPE SUPPORTED ENVIRONMENTS ONLY. NOT FOR USE WITH CEILING SUPPORTED FRAMING.

EXHIBIT 2-E1-66

2-E1-66 CABLE RACK SUPPORTED WITH G-CLIPS ABOVE LOW-TYPE AUXILIARY FRAMING BY THREADED RODS

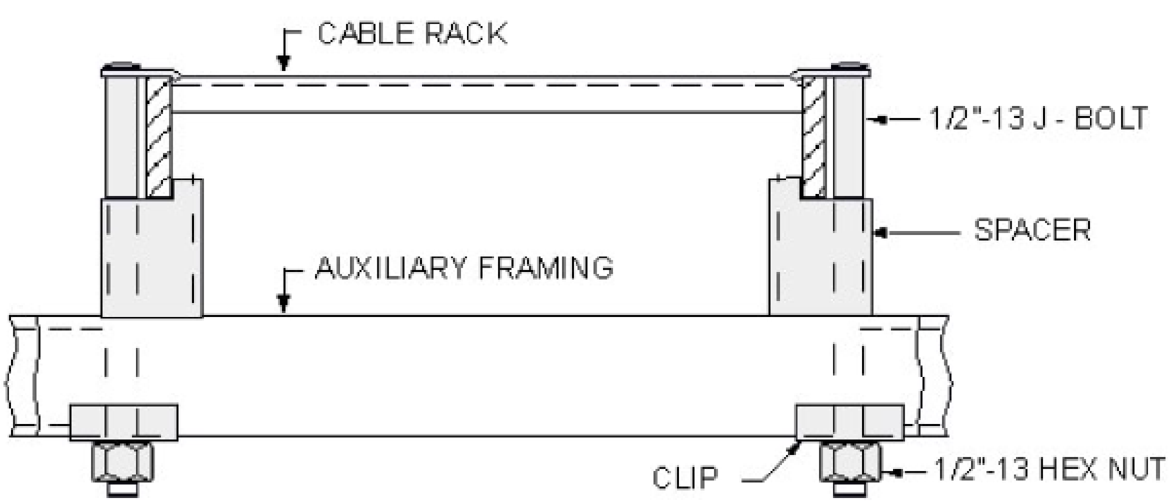
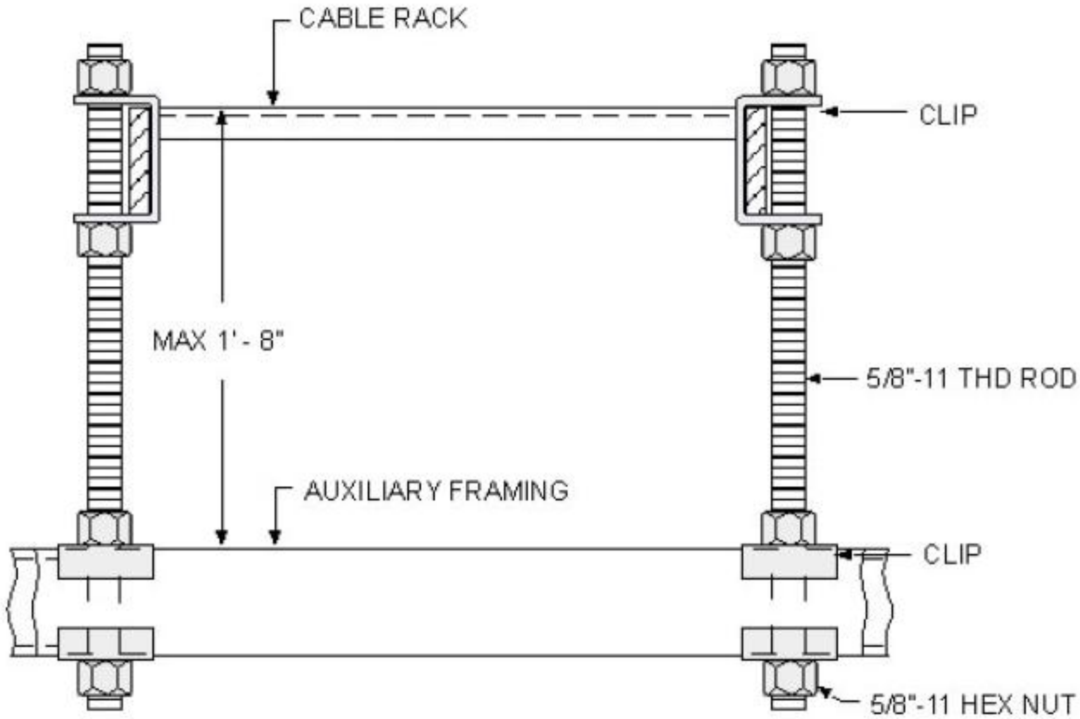


EXHIBIT 2-E1-66A

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



NOTE: SUPPORT FOR FLOOR TYPE SUPPORTED ENVIRONMENTS ONLY. NOT FOR USE WITH CEILING SUPPORTED FRAMING.

EXHIBIT 2-E1-66C

2-E1-66C CABLE RACK SUPPORTED WITH C-CLIPS ABOVE LOW-TYPE AUXILIARY FRAMING BY THREADED RODS

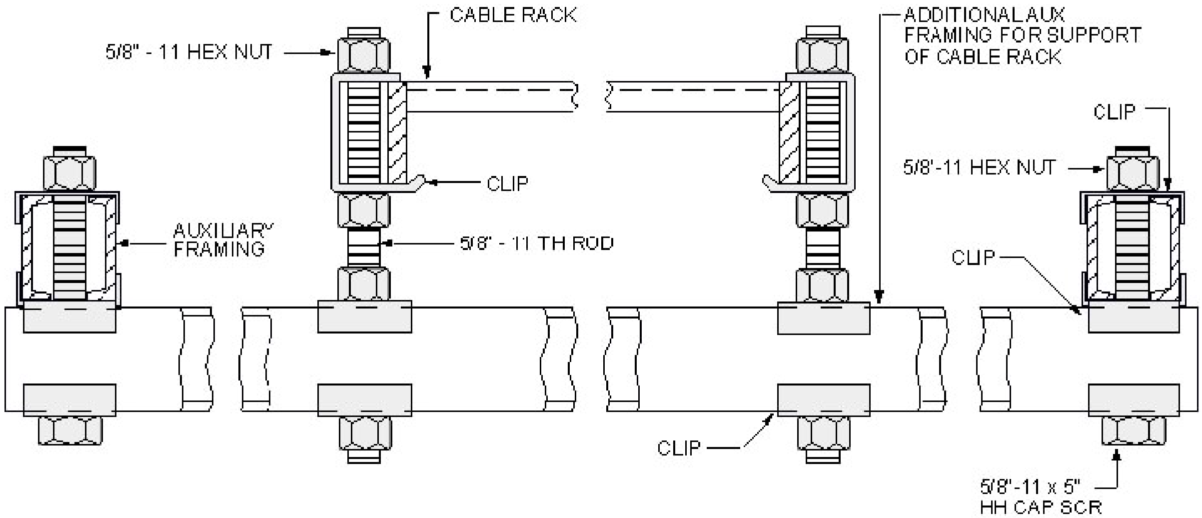


EXHIBIT 2-E1-67

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

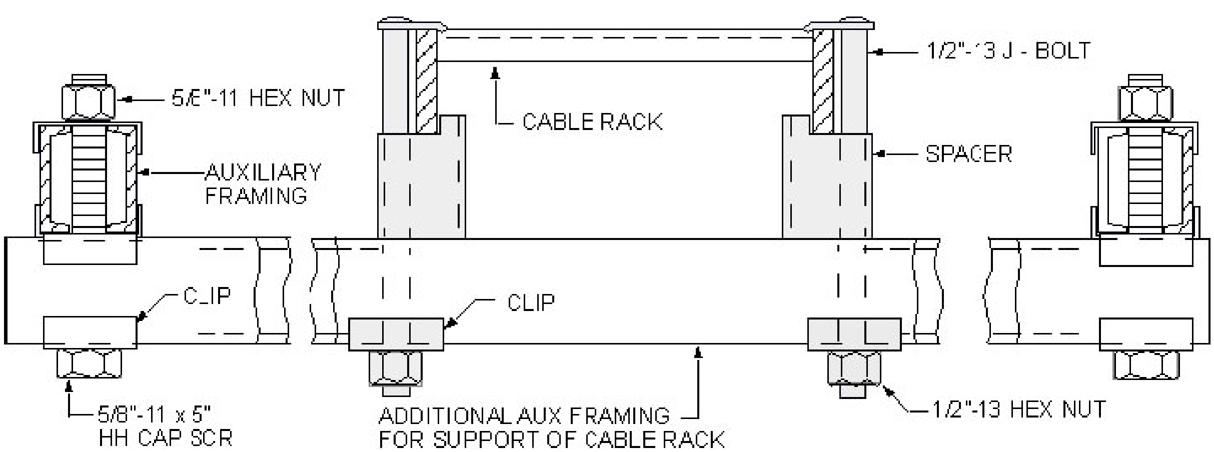


EXHIBIT 2-E1-67A

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

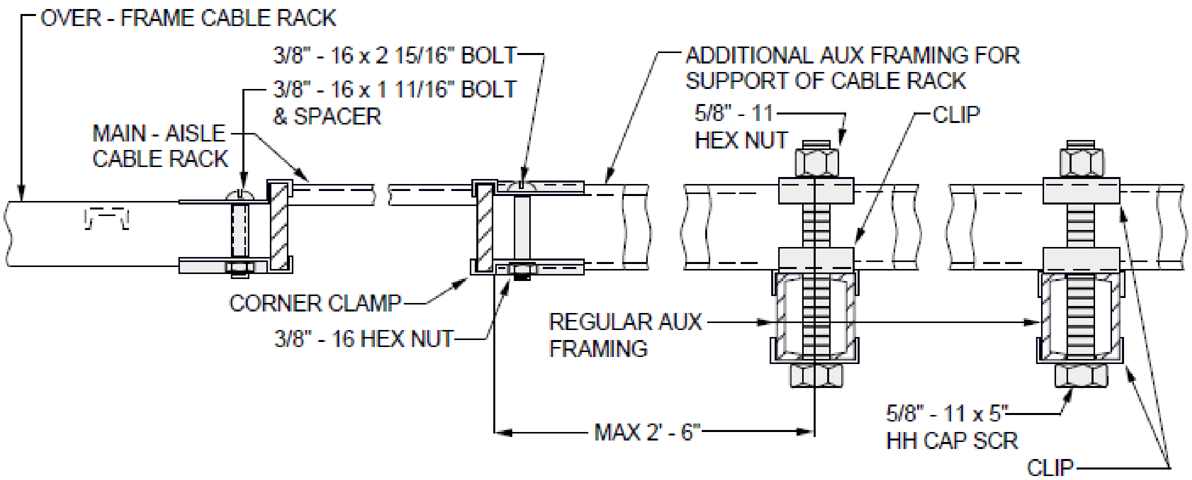


EXHIBIT 2-E1-68 (DISCONTINUED)

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

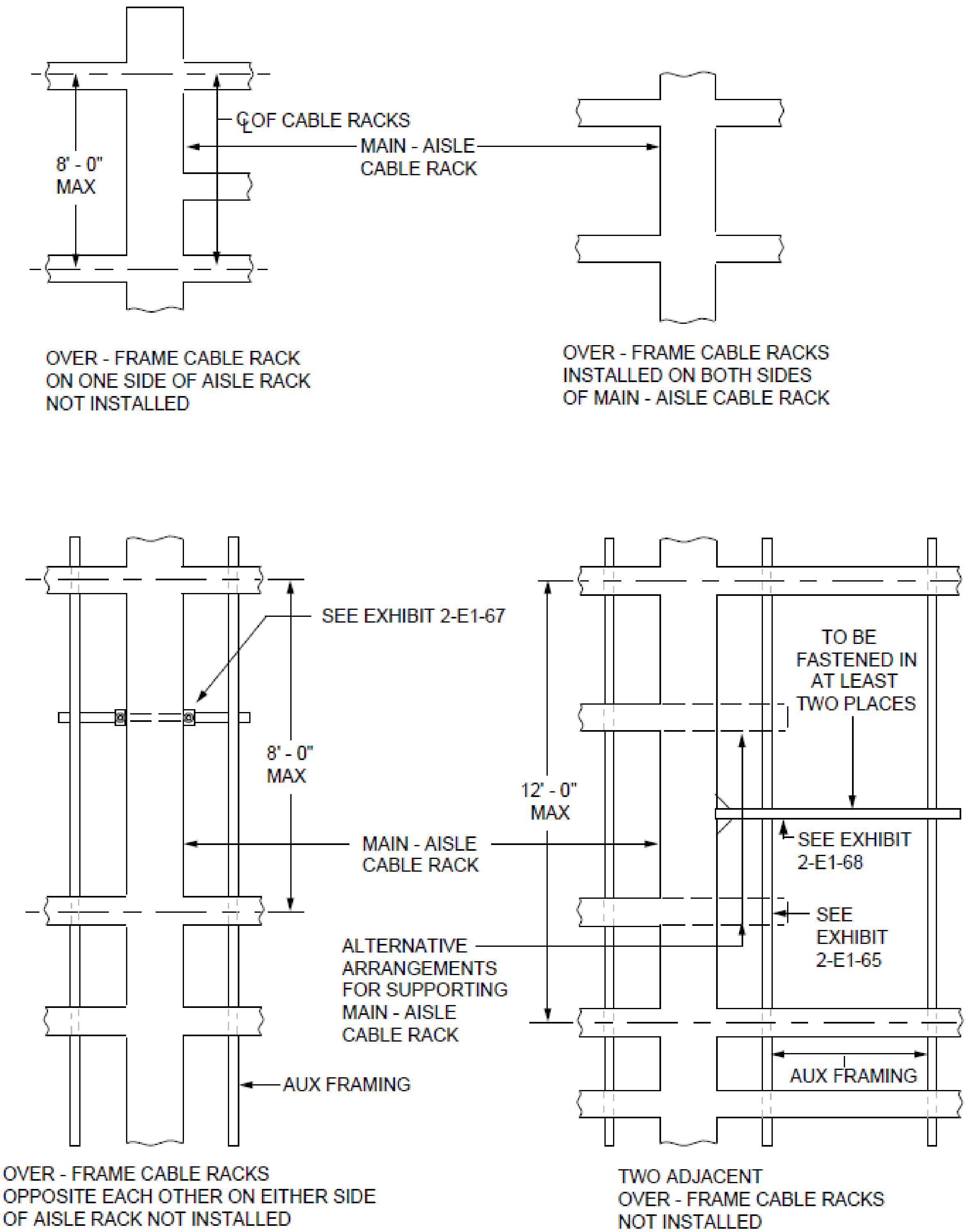


EXHIBIT 2-E1-69 (A&M)

2-E1-69 (A&M) CABLE RACKS OVER MAIN AISLES

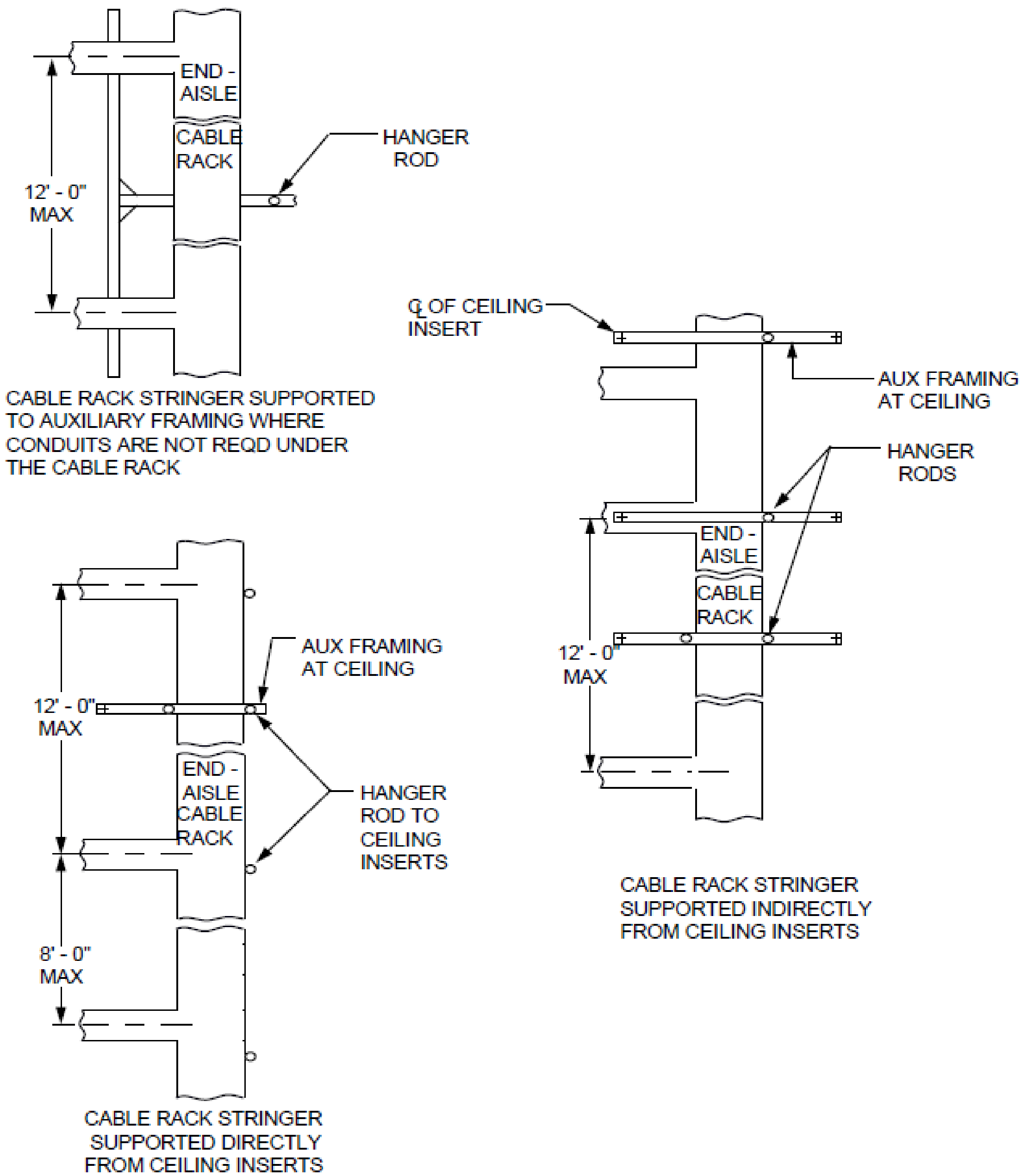


EXHIBIT 2-E1-70 (A&M)

2-E1-70 CABLE RACKS OVER END AISLES

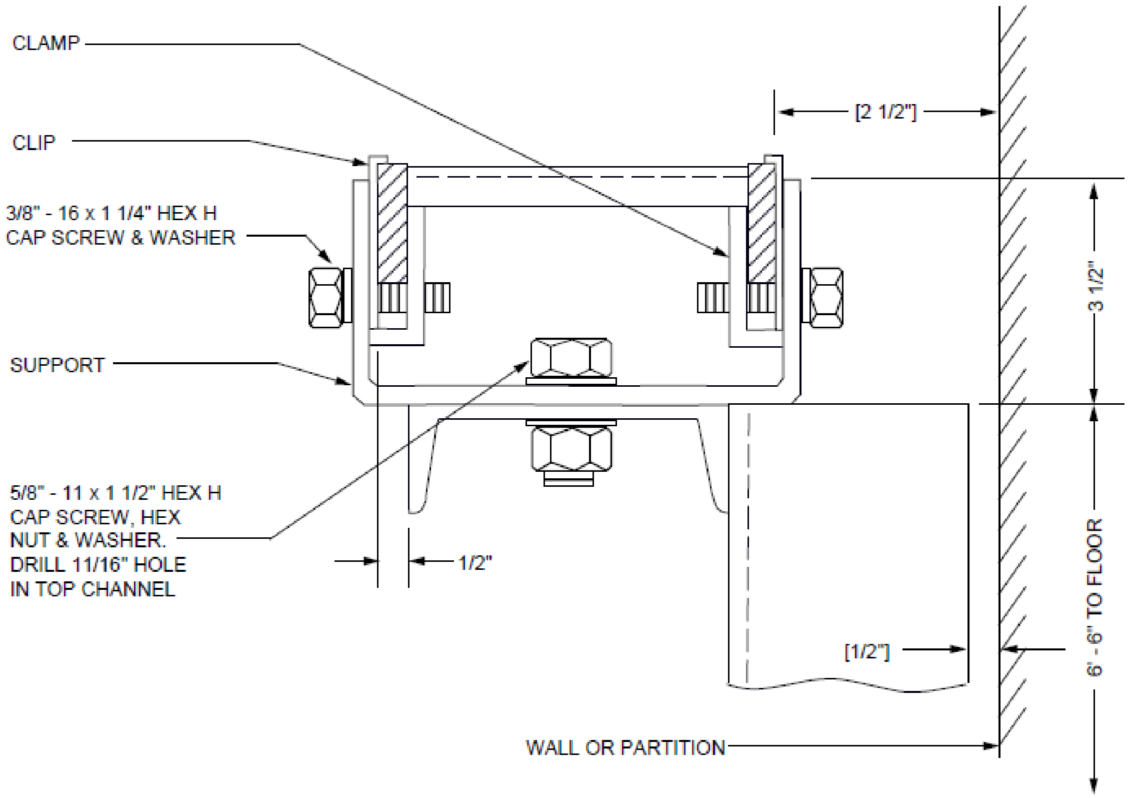


EXHIBIT 2-E1-70A (A&M)

2-E1-70A (A&M) CABLE RACKS ATTACHED TO TRAFFIC REGISTER CABINET

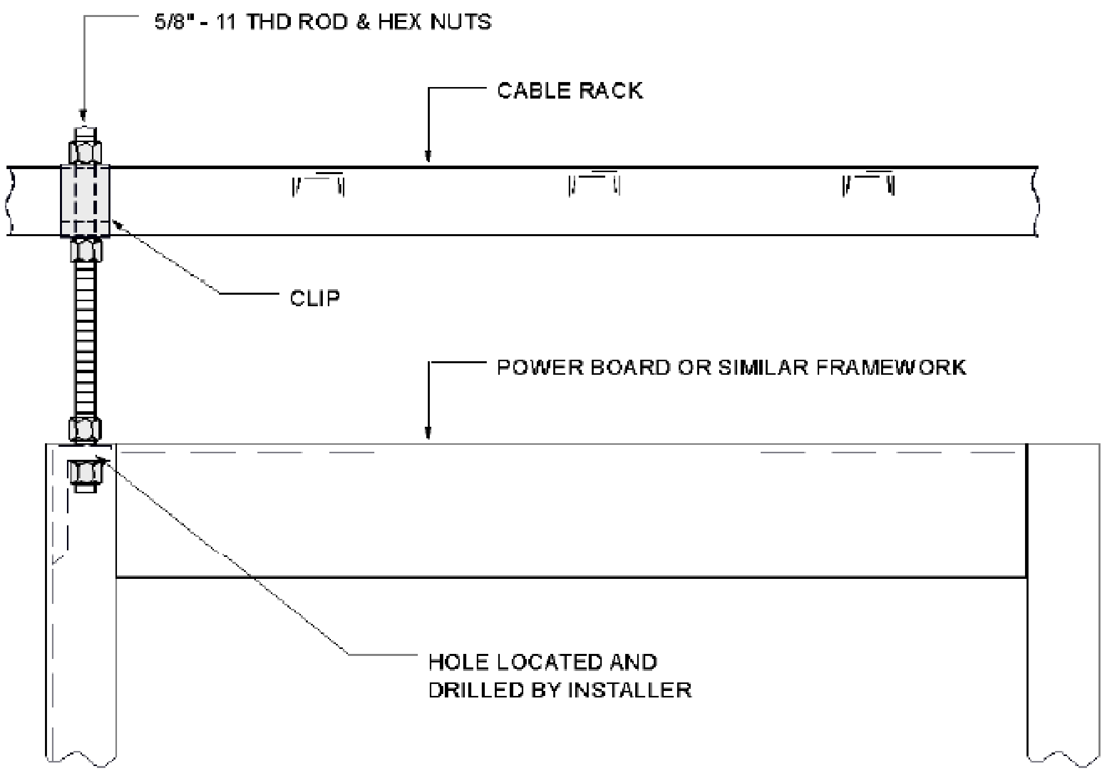


EXHIBIT 2-E1-71 (A&M)
2-E1-71 (A&M) CABLE RACK ATTACHED TO POWER BOARD OR SIMILAR FRAME WORK

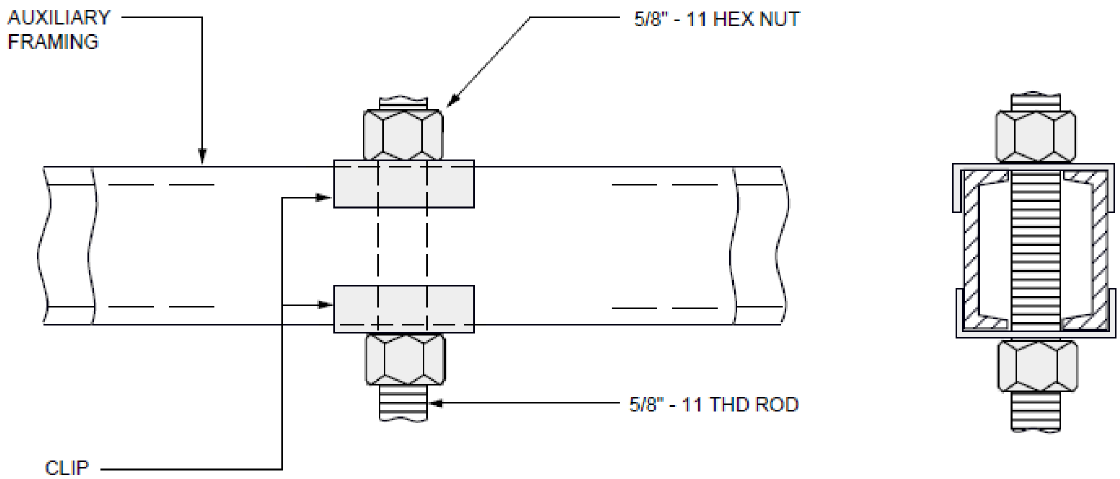


EXHIBIT 2-E1-72

2-E1-72 HANGER ROD ATTACHED TO AUXILIARY FRAMING

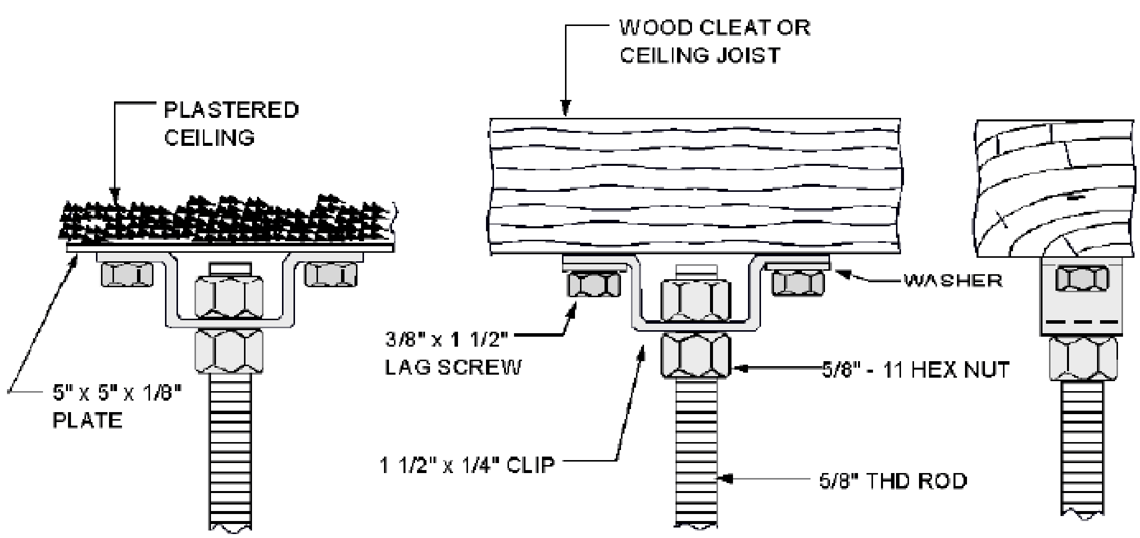


EXHIBIT 2-E1-73

2-E1-73 HANGER ROD ATTACHED DIRECTLY TO CEILING

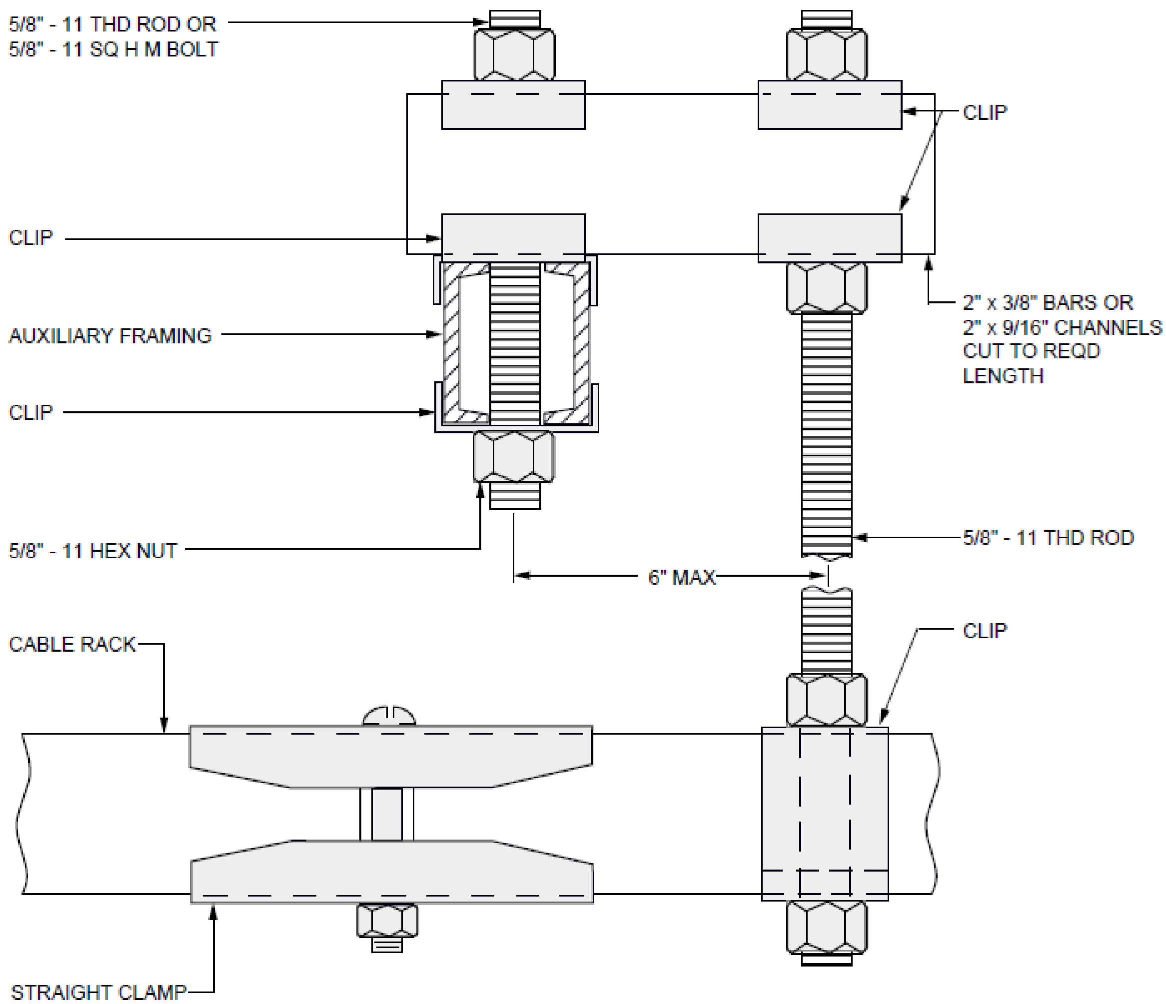


EXHIBIT 2-E1-74

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

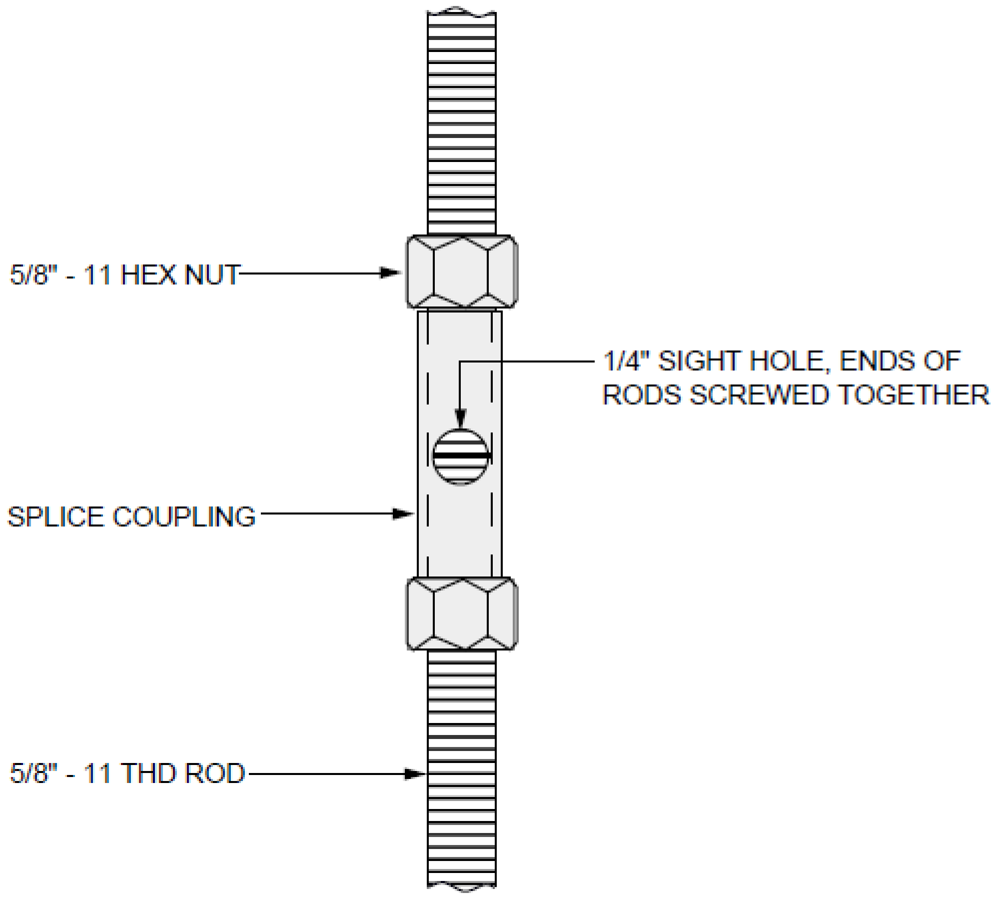


EXHIBIT 2-E1-75

2-E1-75 HANGER ROD EXTENDED WITH SPLICED COUPLING

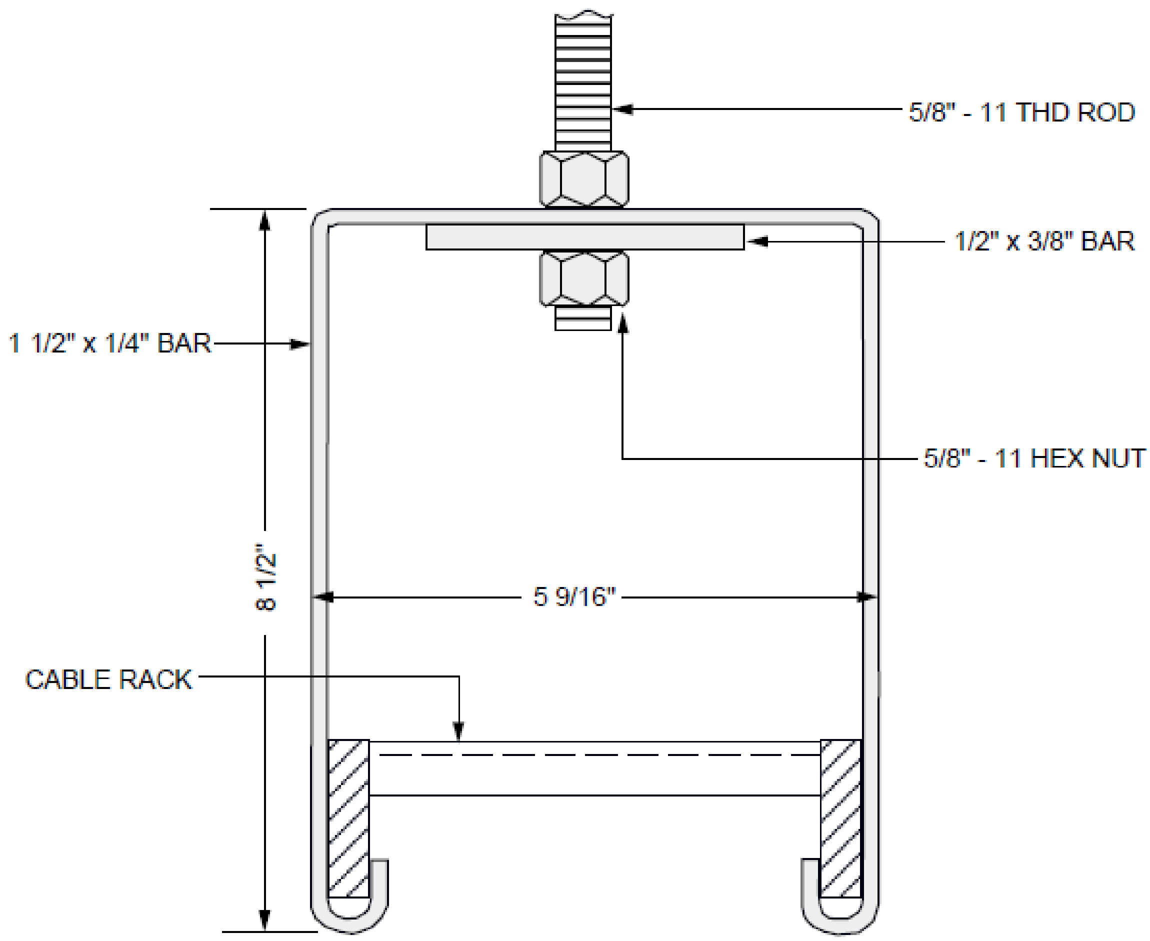


EXHIBIT 2-E1-76

2-E1-76 SUPPORTING RACKS 5 INCHES WIDE

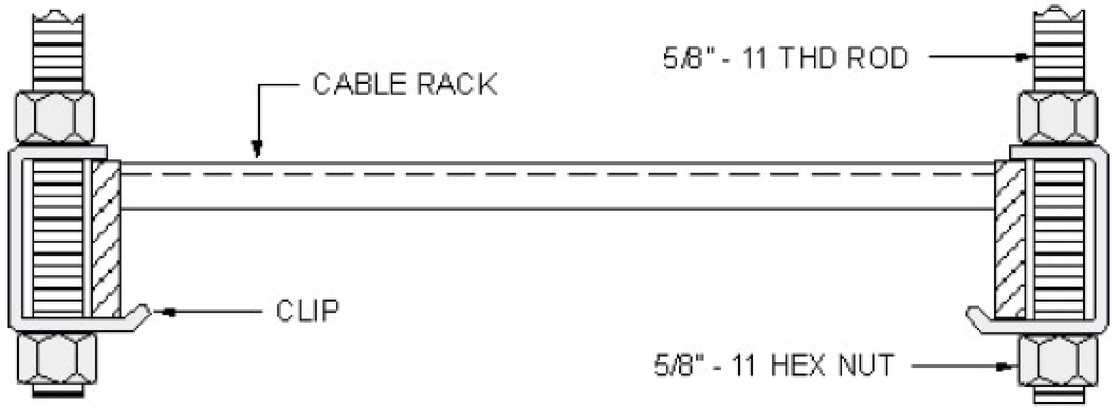


EXHIBIT 2-E1-77

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

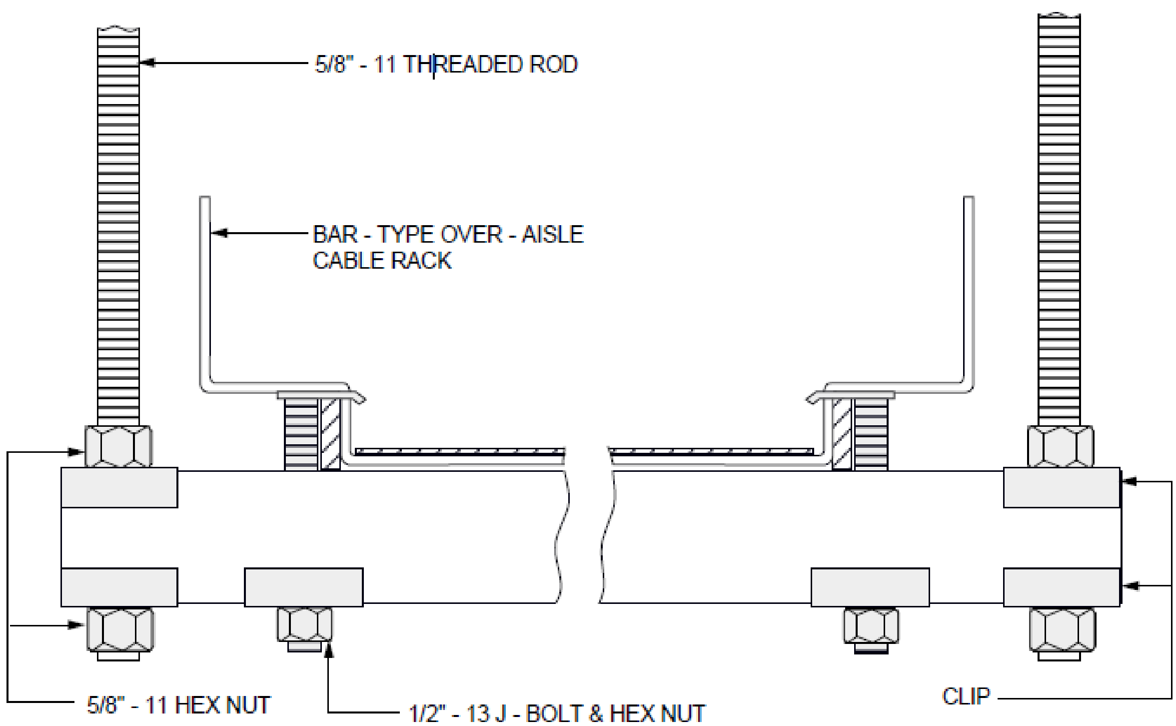


EXHIBIT 2-E1-77B

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

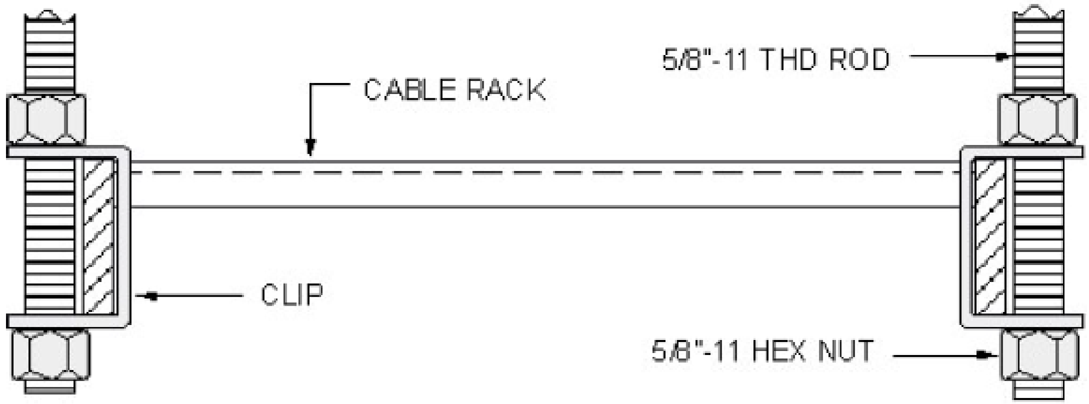


EXHIBIT 2-E1-77C

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

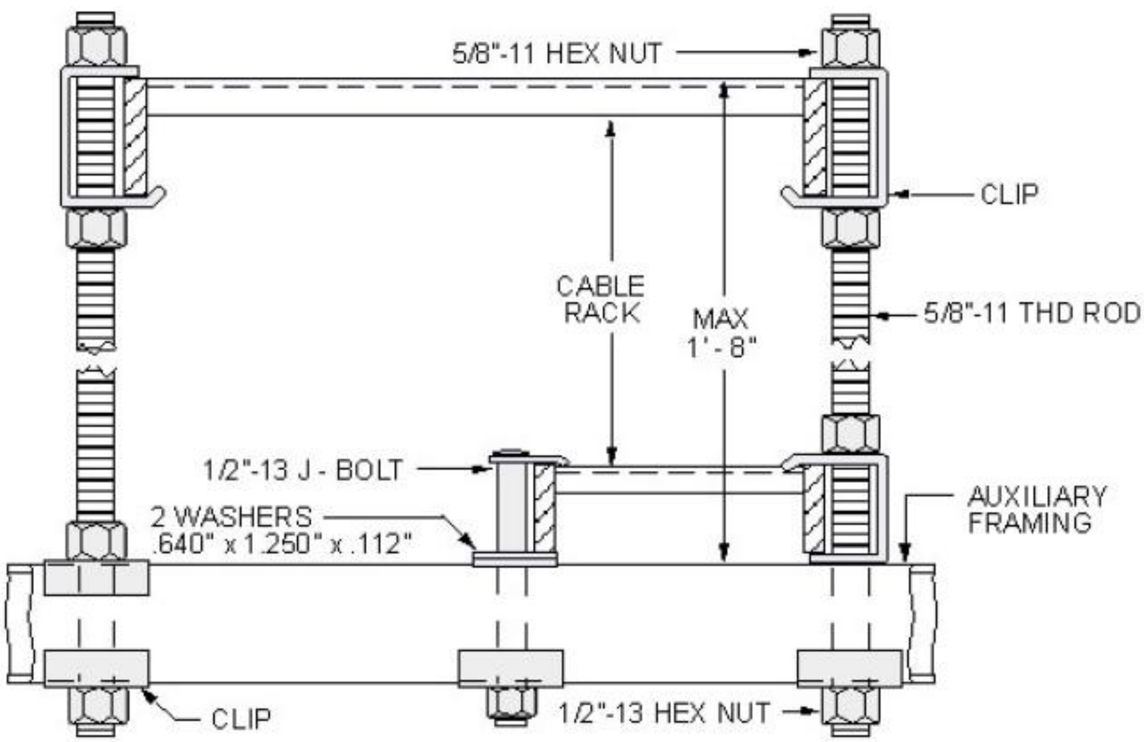
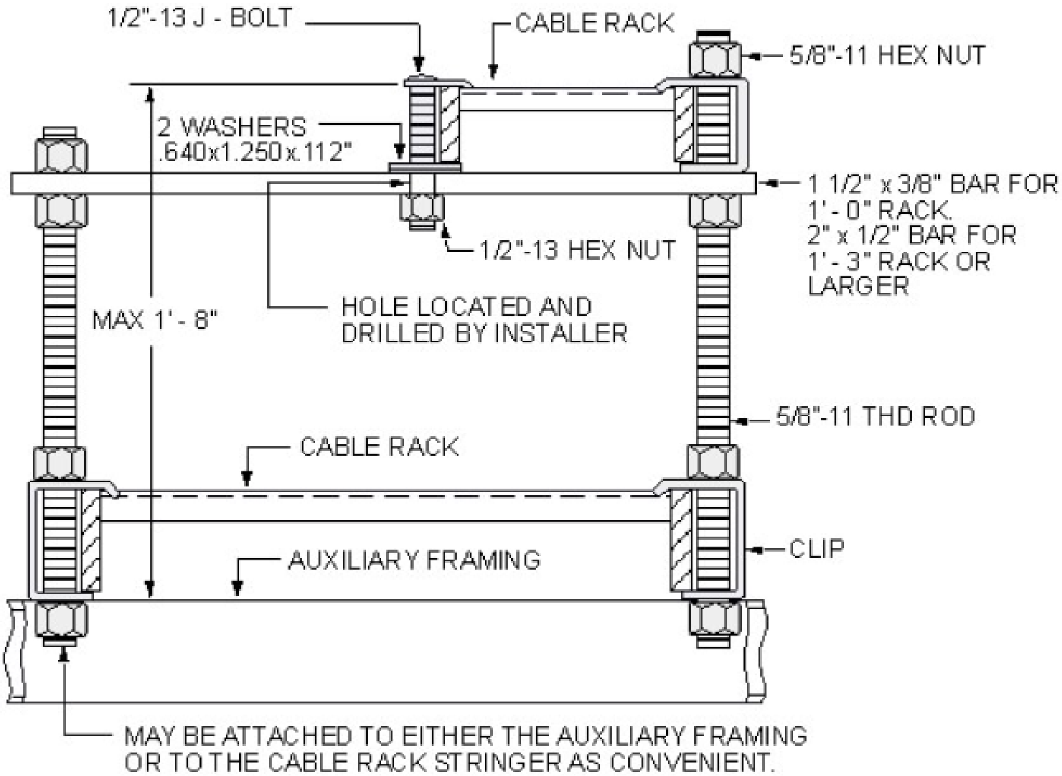


EXHIBIT 2-E1-81

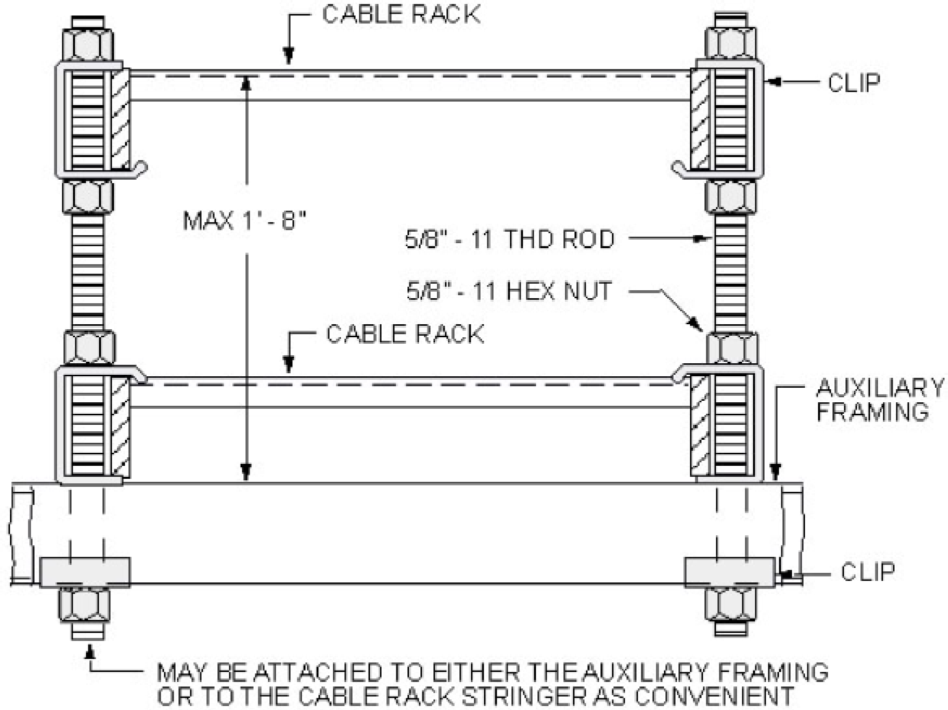
2-E1-81 SUPPORTING ONE RACK ABOVE ANOTHER RACK-LARGE RACK ABOVE



NOTE: WHEN THE SUPPORT WILL BE FROM THE CABLE RACK STRINGER, THE SUPPORT WILL BE LOCATED NEXT TO THE AUXILIARY FRAMING CHANNELS.

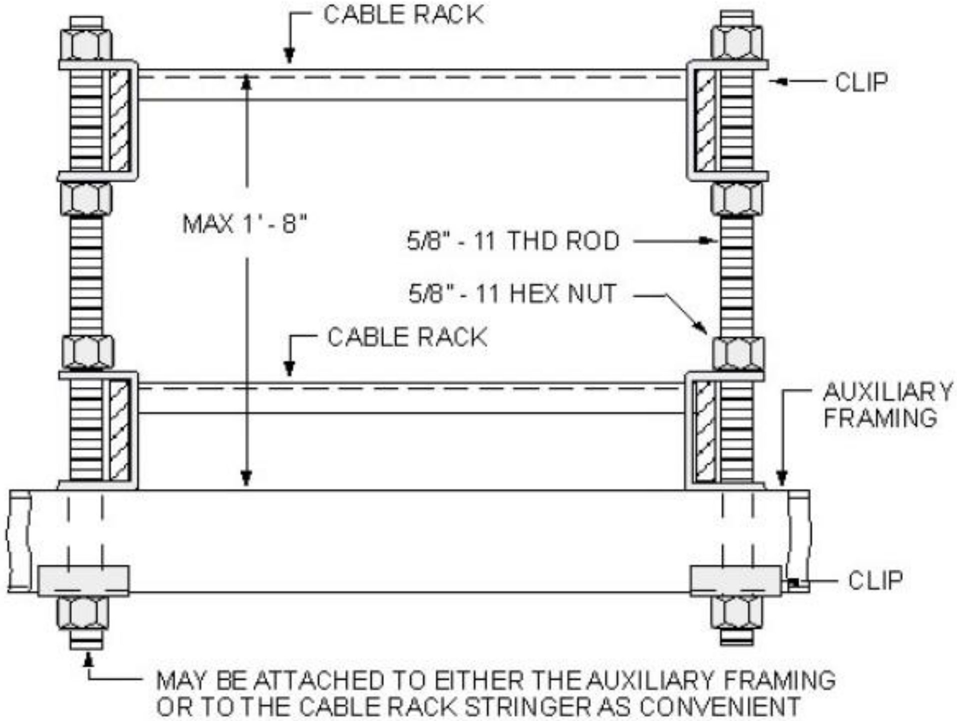
EXHIBIT 2-E1-82

2-E1-82 SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK-LARGER RACK BELOW



NOTE: WHEN THE SUPPORT WILL BE FROM THE CABLE RACK STRINGER, THE SUPPORT WILL BE LOCATED NEXT TO THE AUXILIARY FRAMING CHANNELS.

EXHIBIT 2-E1-832-E1-83 SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK WITH G-CLIPS - RACKS SAME SIZE



NOTE: WHEN THE SUPPORT WILL BE FROM THE CABLE RACK STRINGER, THE SUPPORT WILL BE LOCATED NEXT TO THE AUXILIARY FRAMING CHANNELS.

EXHIBIT 2-E1-83C

2-E1-83C SUPPORTING ONE RACK ABOVE AND FROM ANOTHER RACK WITH C-CLIPS - RACKS SAME SIZE

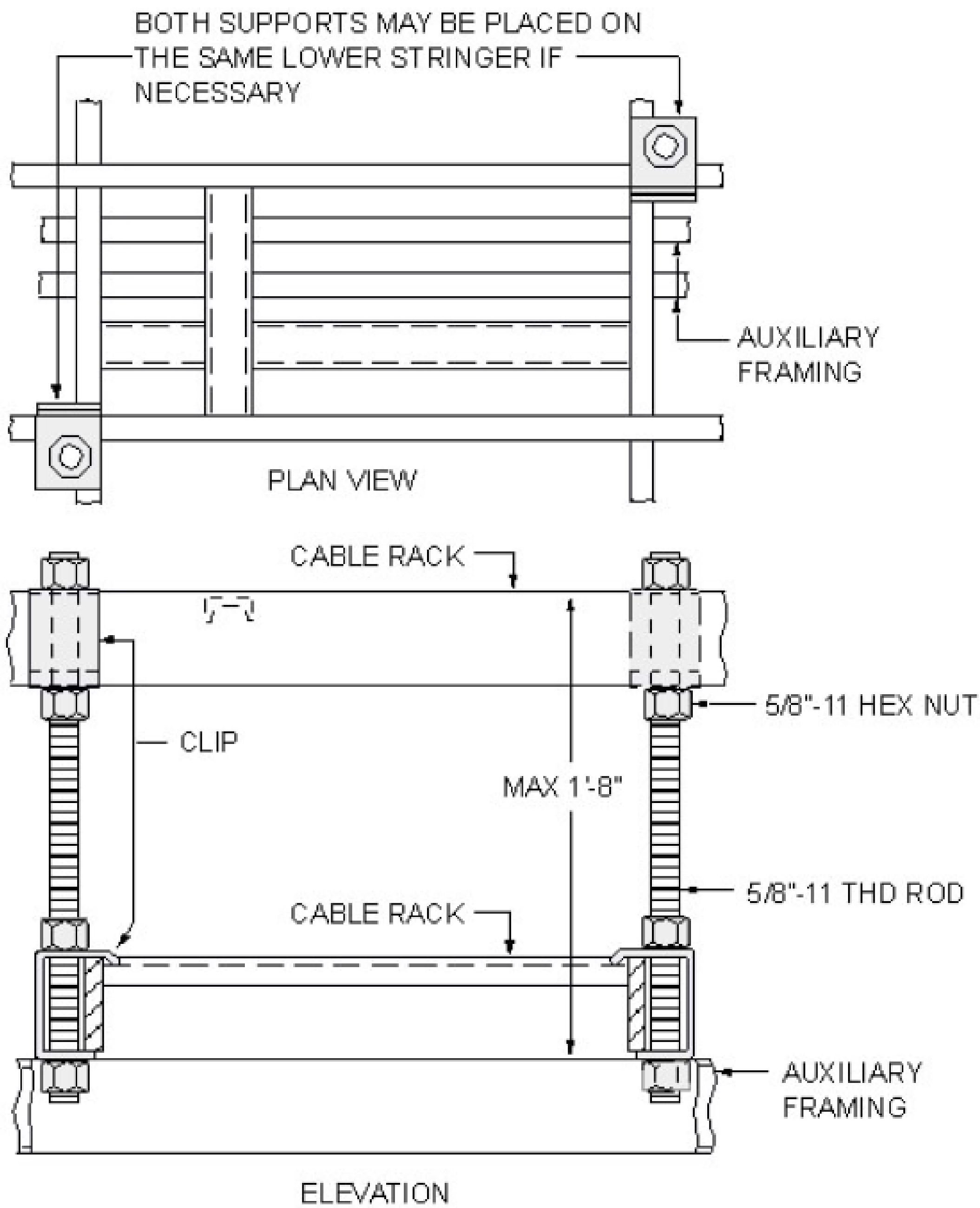


EXHIBIT 2-E1-84

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

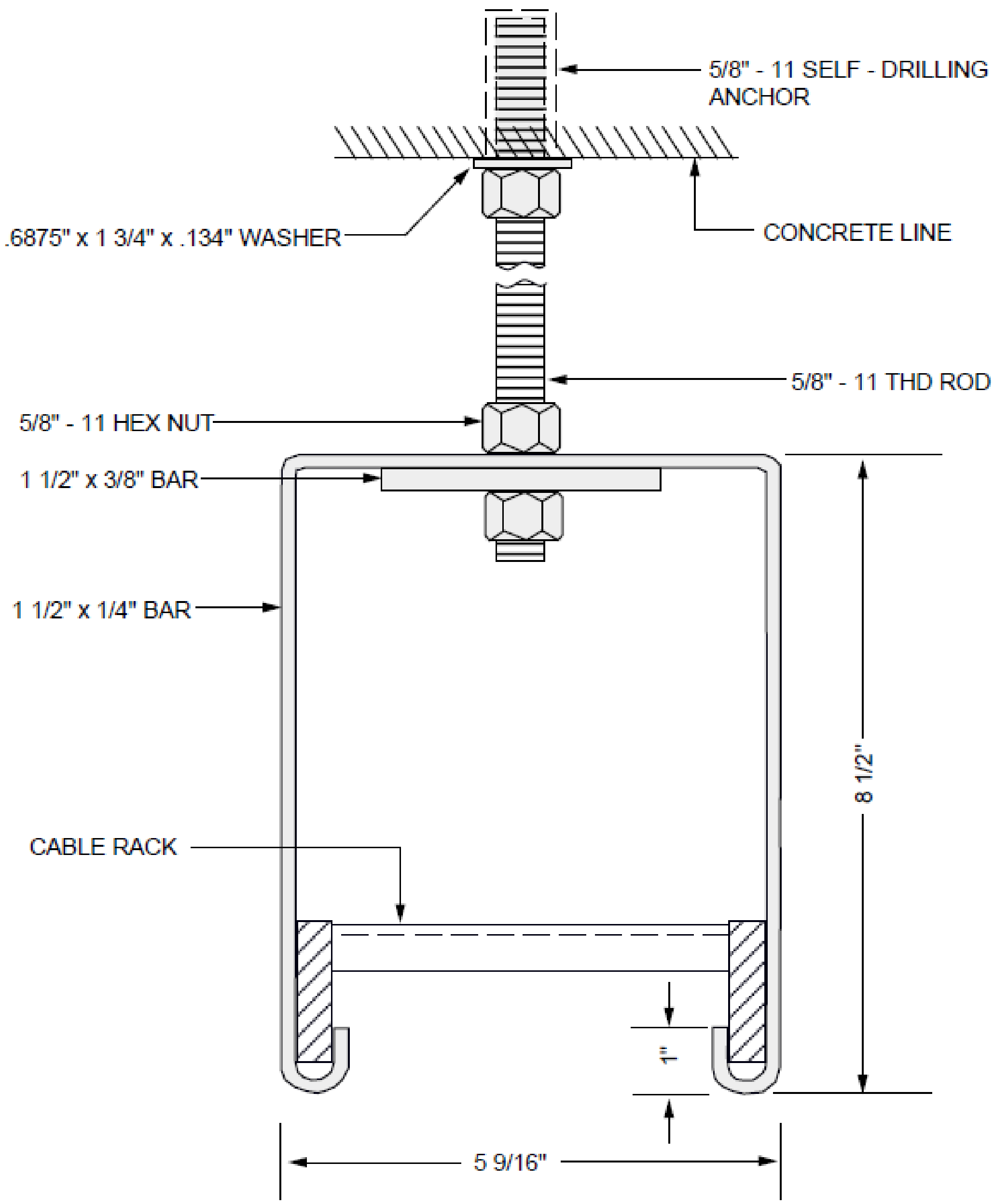
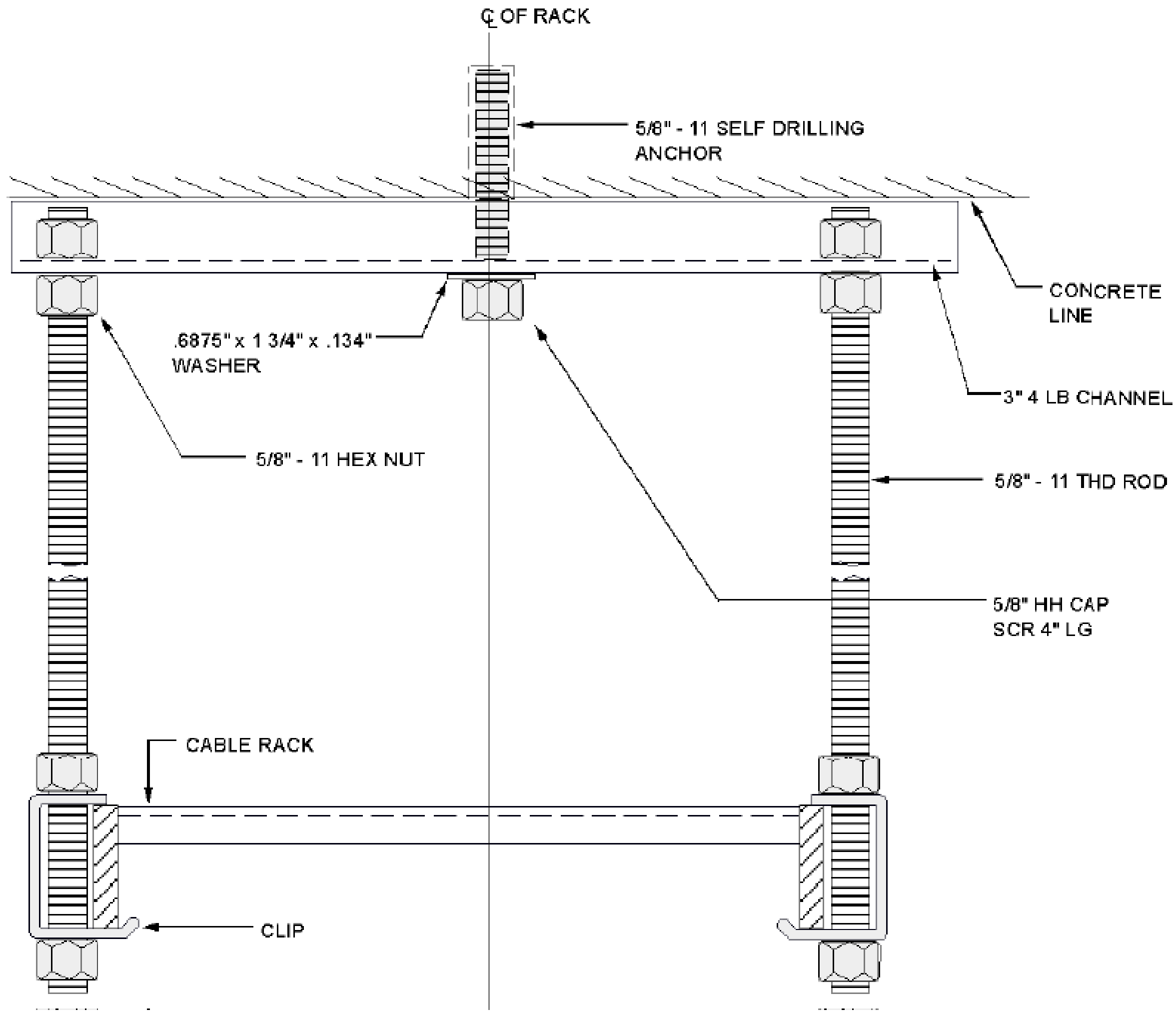


EXHIBIT 2-E1-85

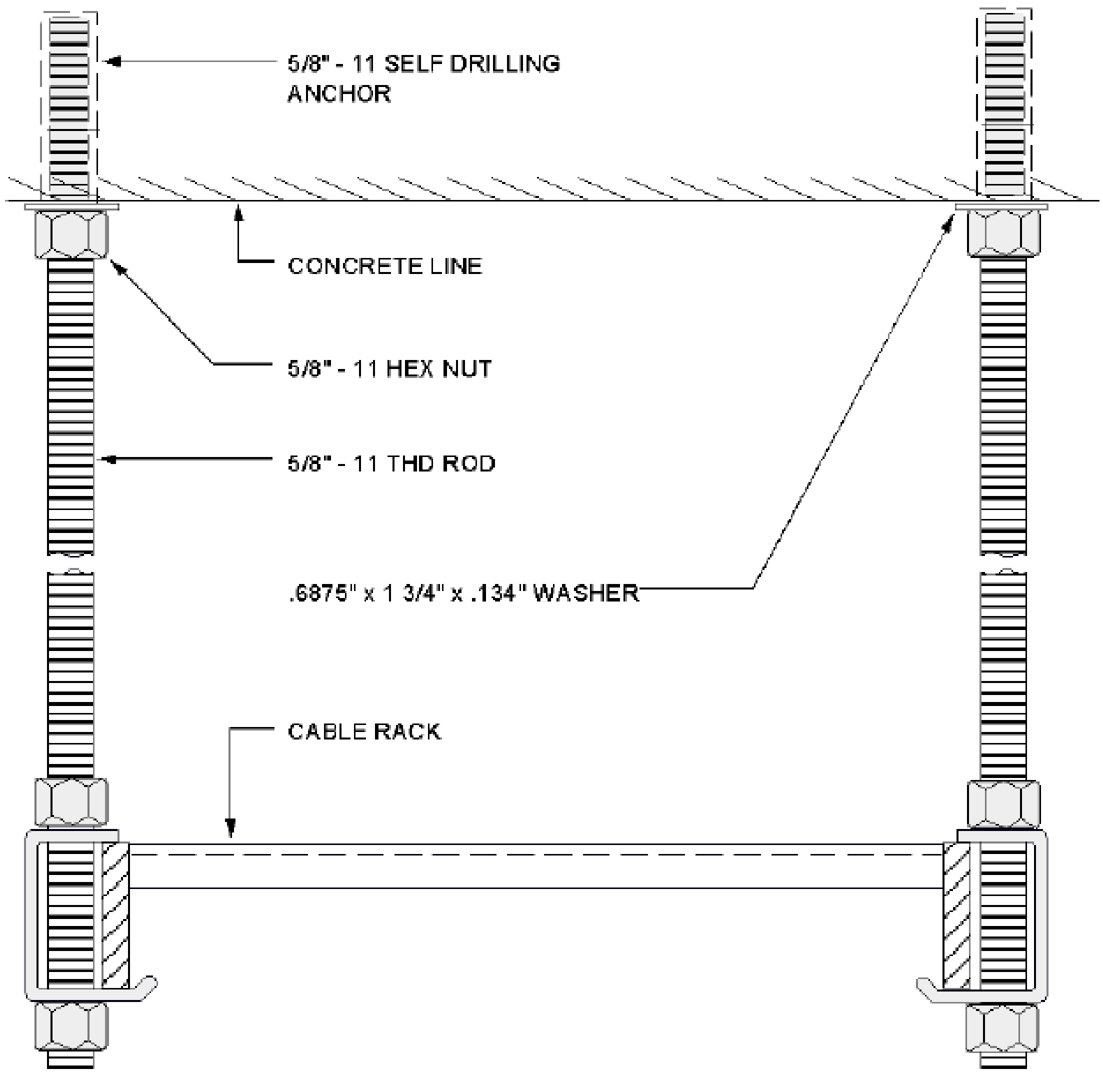
2-E1-85 SUPPORTING 5 INCH CABLE RACK EMBEDDED INSERT IN CEILING



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

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

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

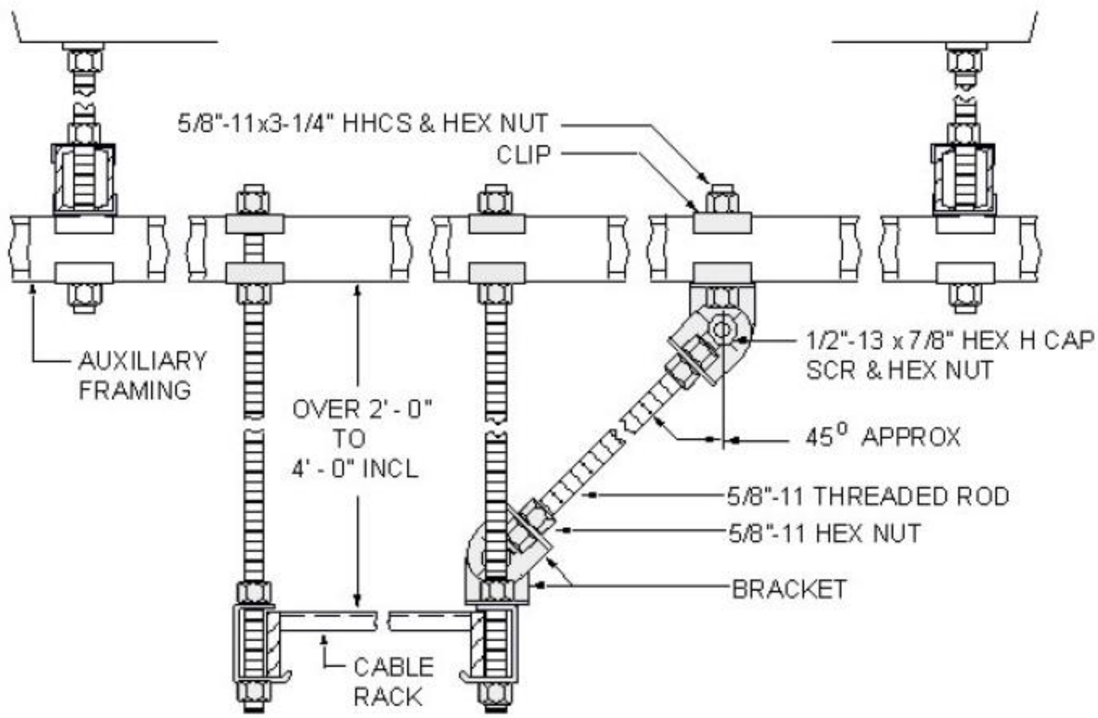


EXHIBIT 2-E1-88

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

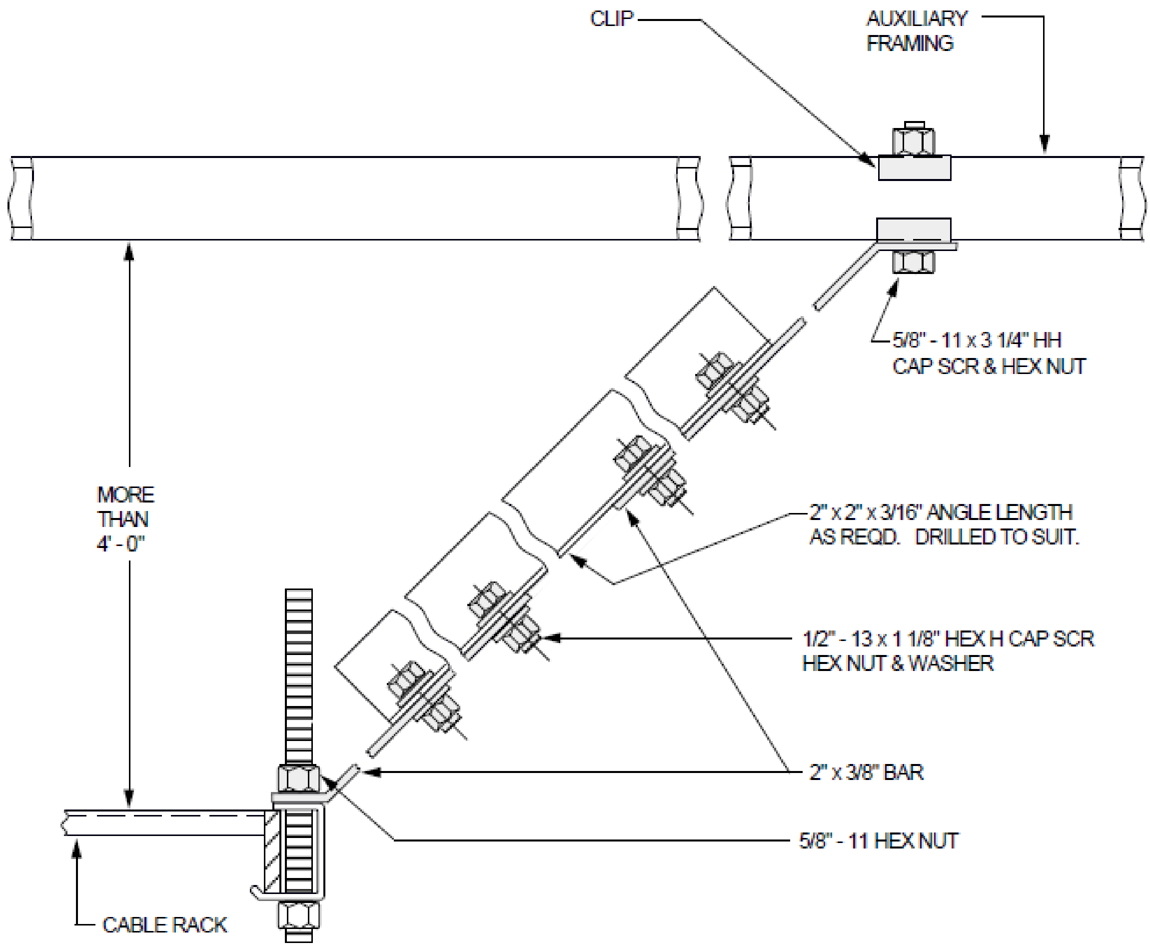


EXHIBIT 2-E1-89

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

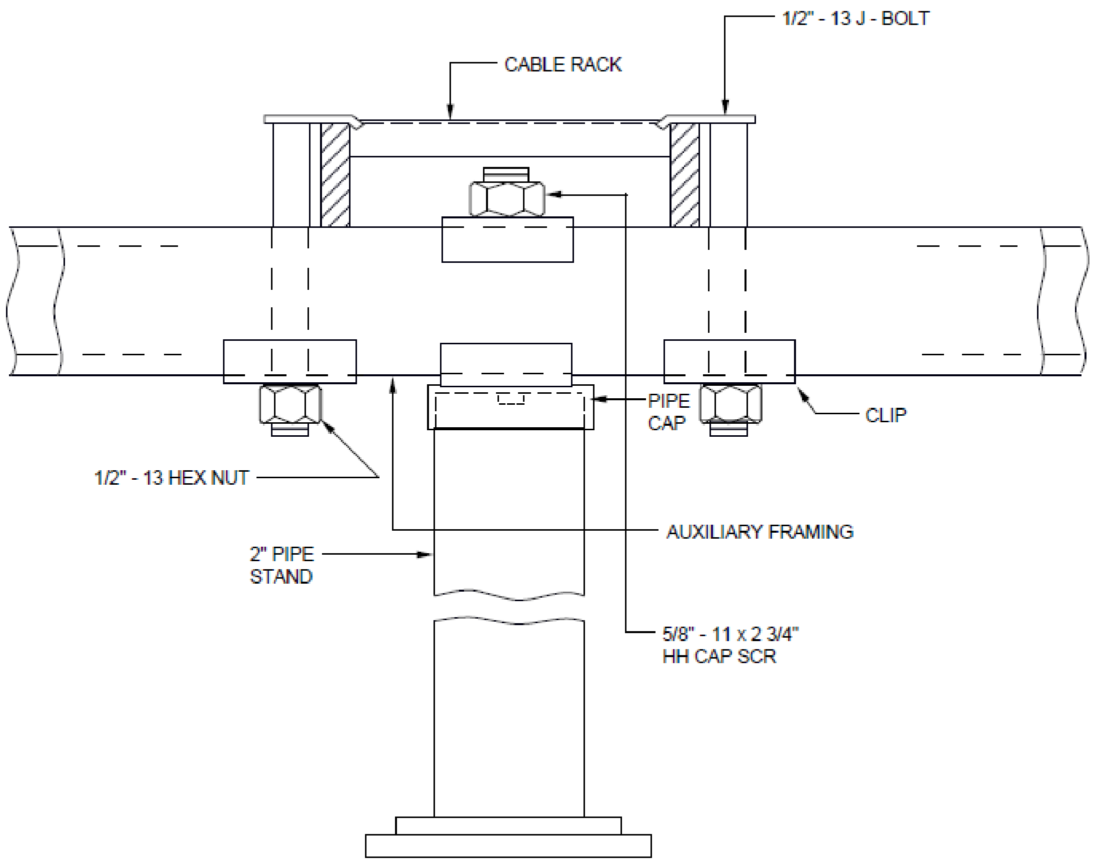


EXHIBIT 2-E1-90

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

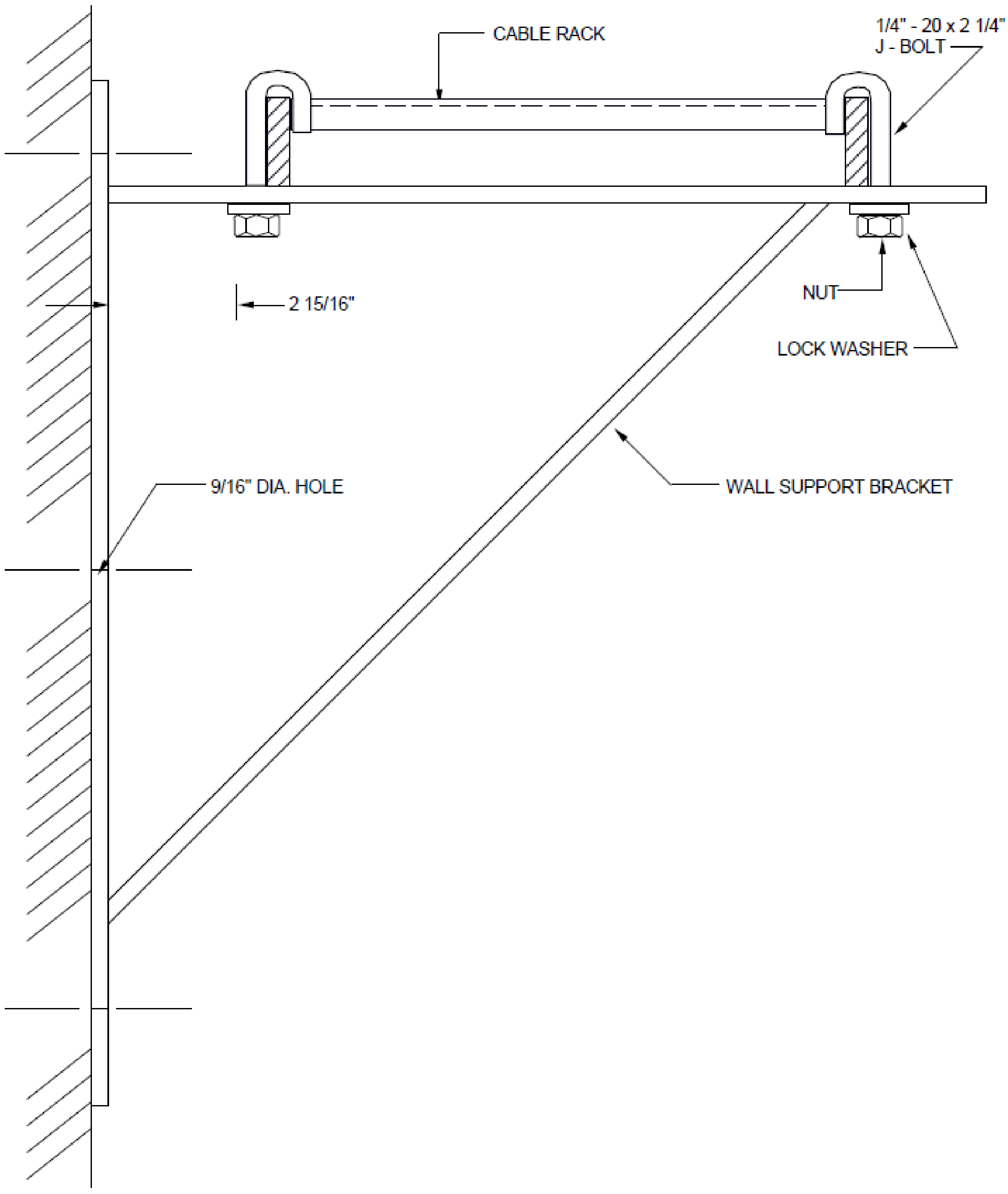


EXHIBIT 2-E1-91

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

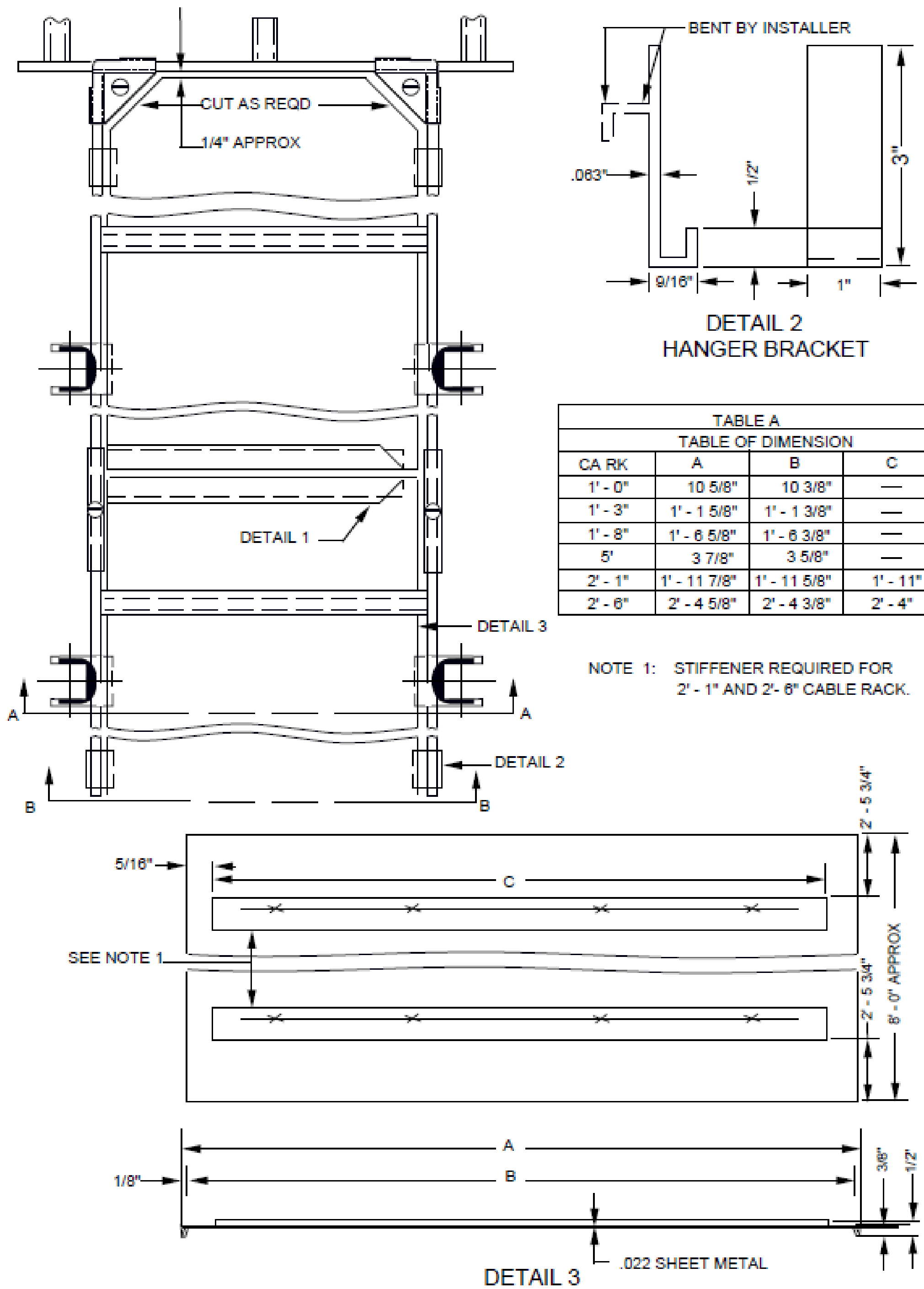


TABLE A

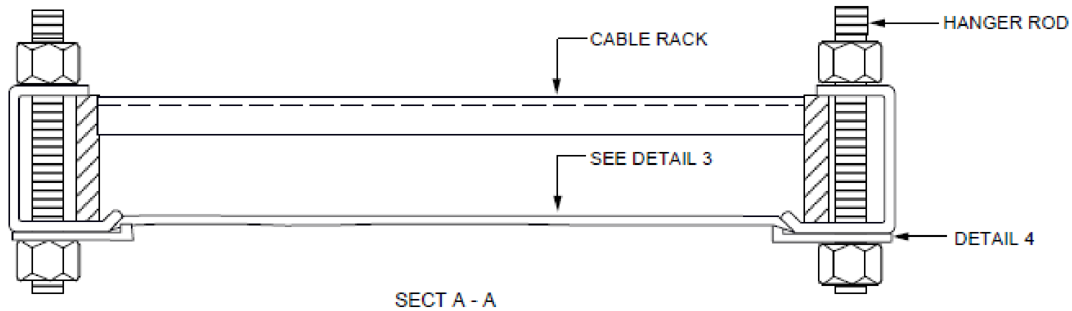
TABLE OF DIMENSION

CA RK	A	B	C
1' - 0"	10 5/8"	10 3/8"	—
1' - 3"	1' - 1 5/8"	1' - 1 3/8"	—
1' - 8"	1' - 6 5/8"	1' - 6 3/8"	—
5'	3 7/8"	3 5/8"	—
2' - 1"	1' - 11 7/8"	1' - 11 5/8"	1' - 11"
2' - 6"	2' - 4 5/8"	2' - 4 3/8"	2' - 4"

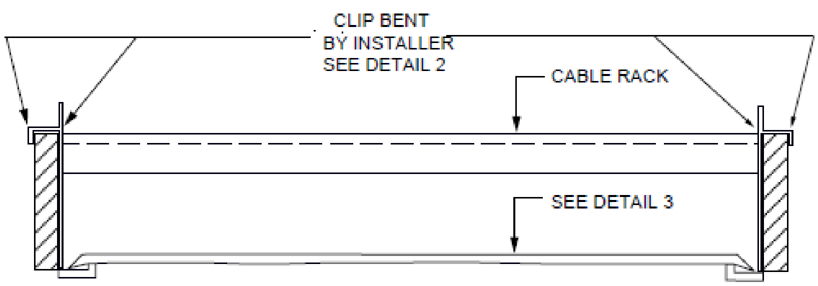
NOTE 1: STIFFENER REQUIRED FOR 2' - 1" AND 2'- 6" CABLE RACK.

EXHIBIT 2-E1-92 (PAGE 1 OF 2)

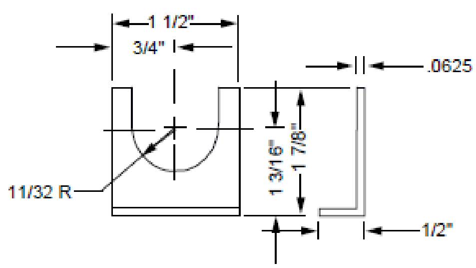
2-E1-92 (PAGE 1 OF 2) SCREEN ASSEMBLY FOR UNDERSIDE OF 5 INCHES-30 INCHES LADDER-TYPE CABLE RACK



SECT A - A
SCREEN SUPPORTED FROM
THREADED ROD HANGERS

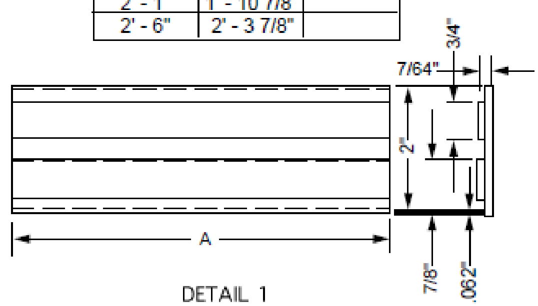


SECT B - B
SCREEN SUPPORTED FROM
CABLE RACK STRINGER



DETAIL 4
SCREEN SUPPORT CLIP

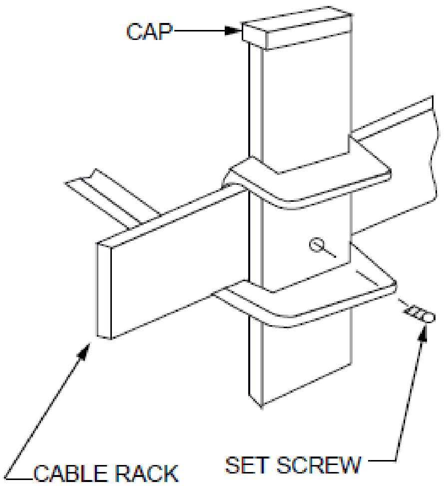
TABLE B TABLE OF DIMENSIONS		
CA RK	A	
1' - 0"	9 7/8"	
1' - 3"	1' - 0 7//8"	
1' - 8"	1' - 3 7/8"	
5'	2 7/8"	
2' - 1"	1' - 10 7/8"	
2' - 6"	2' - 3 7/8"	

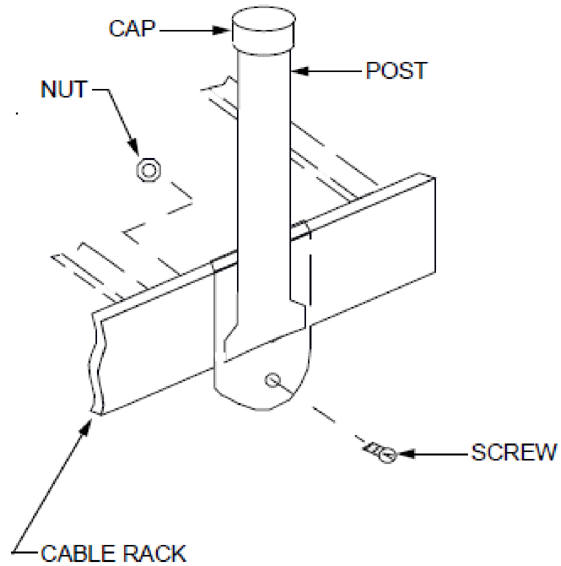


DETAIL 1

EXHIBIT 2-E1-92 (PAGE 2 OF 2)

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





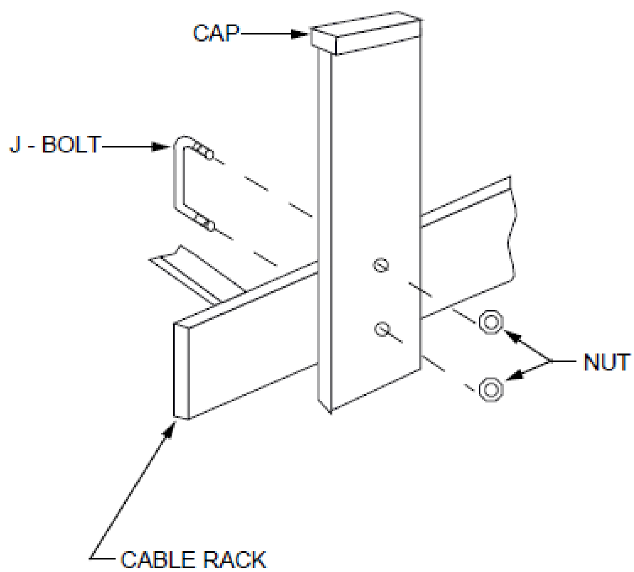


EXHIBIT 2-E1-93 (DISCONTINUED)

2-E1-93 (DISCONTINUED) EXAMPLES OF CABLE RETAINING BRACKETS

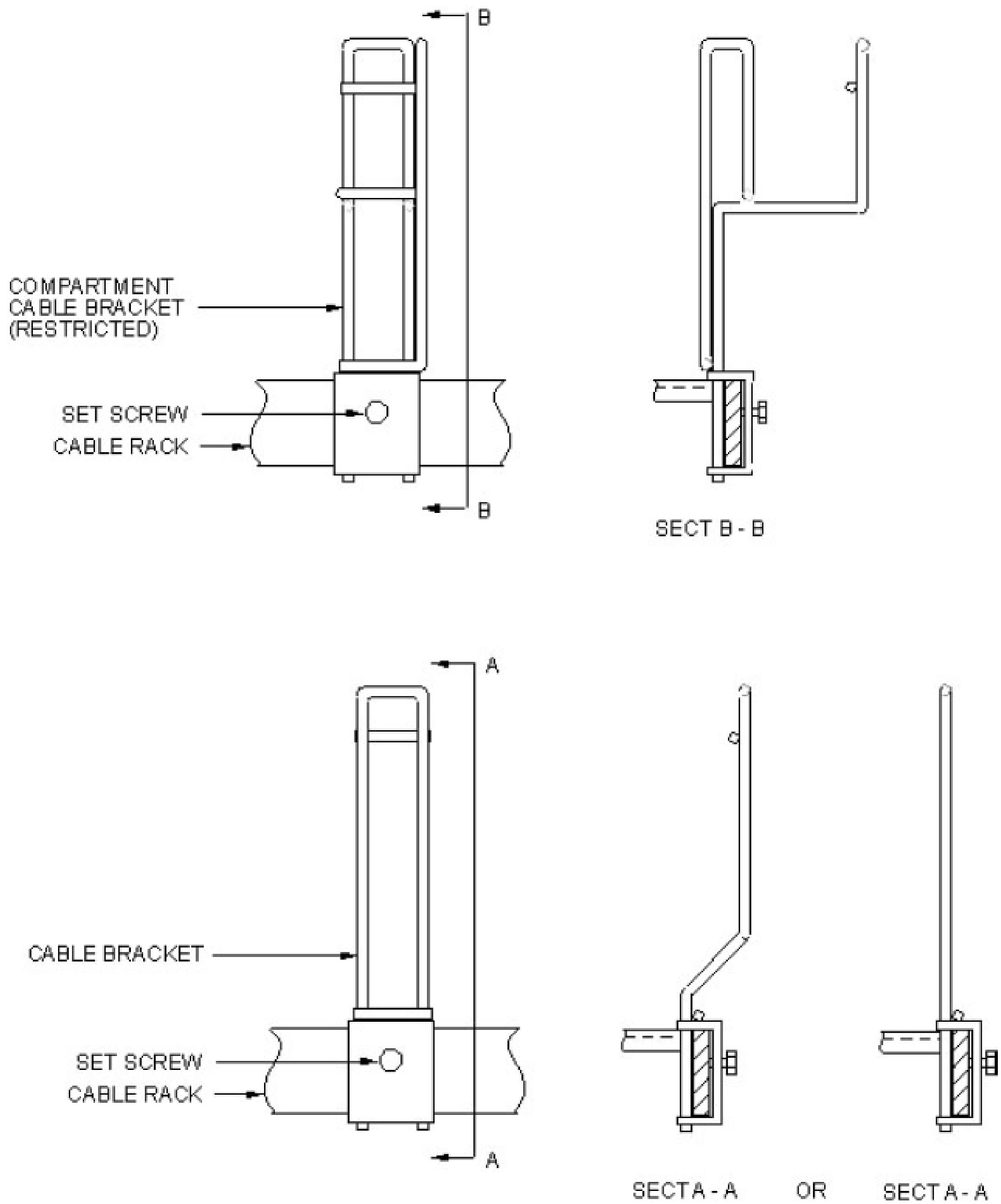


EXHIBIT 2-E1-93A

2-E1-93A EXAMPLES OF TYPICAL CABLE RETAINING BRACKETS

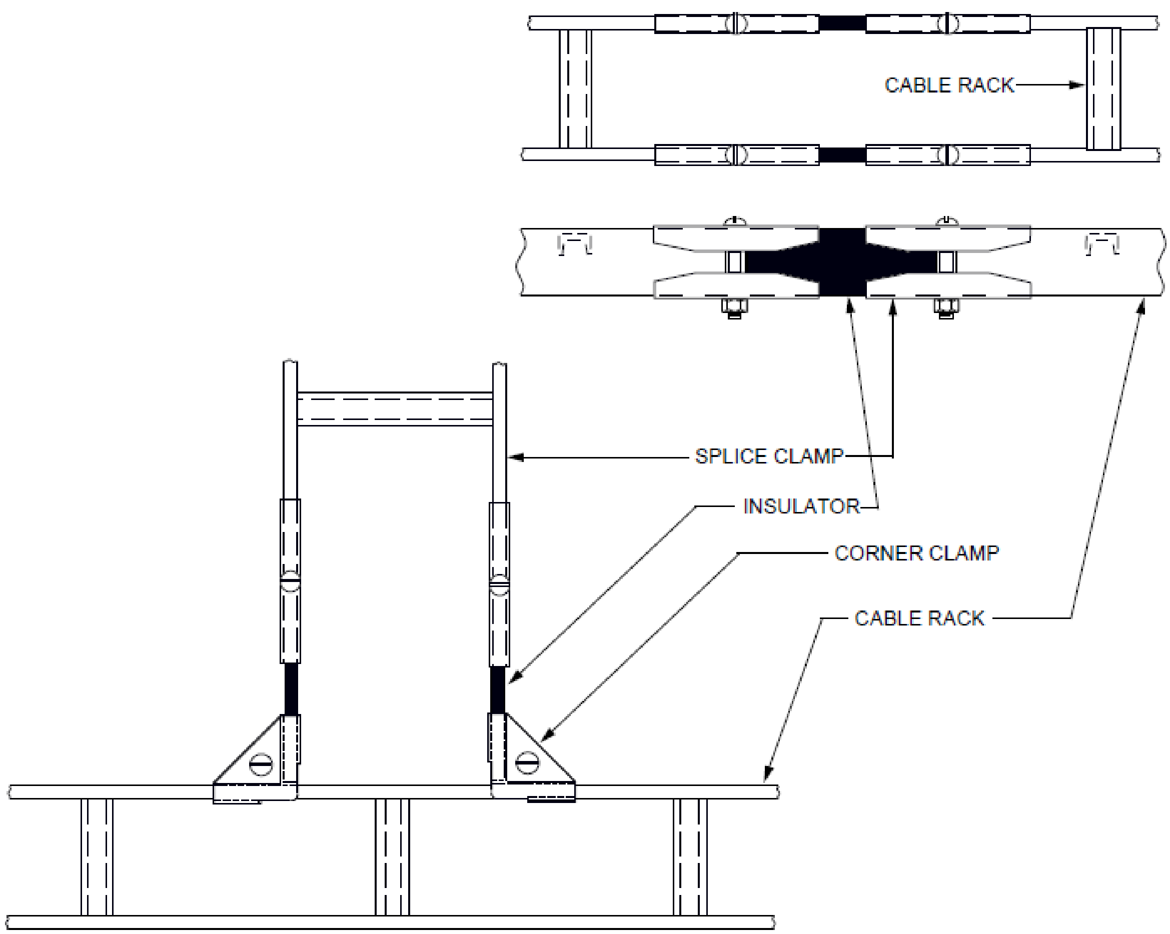


EXHIBIT 2-E1-94

2-E1-94 INSULATING JUNCTION FOR CABLE RACK

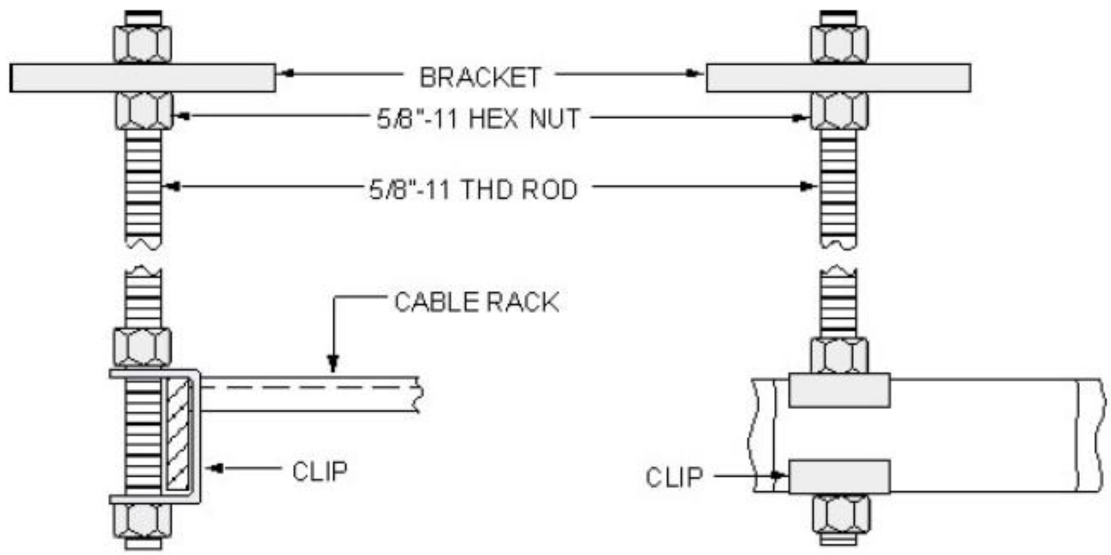
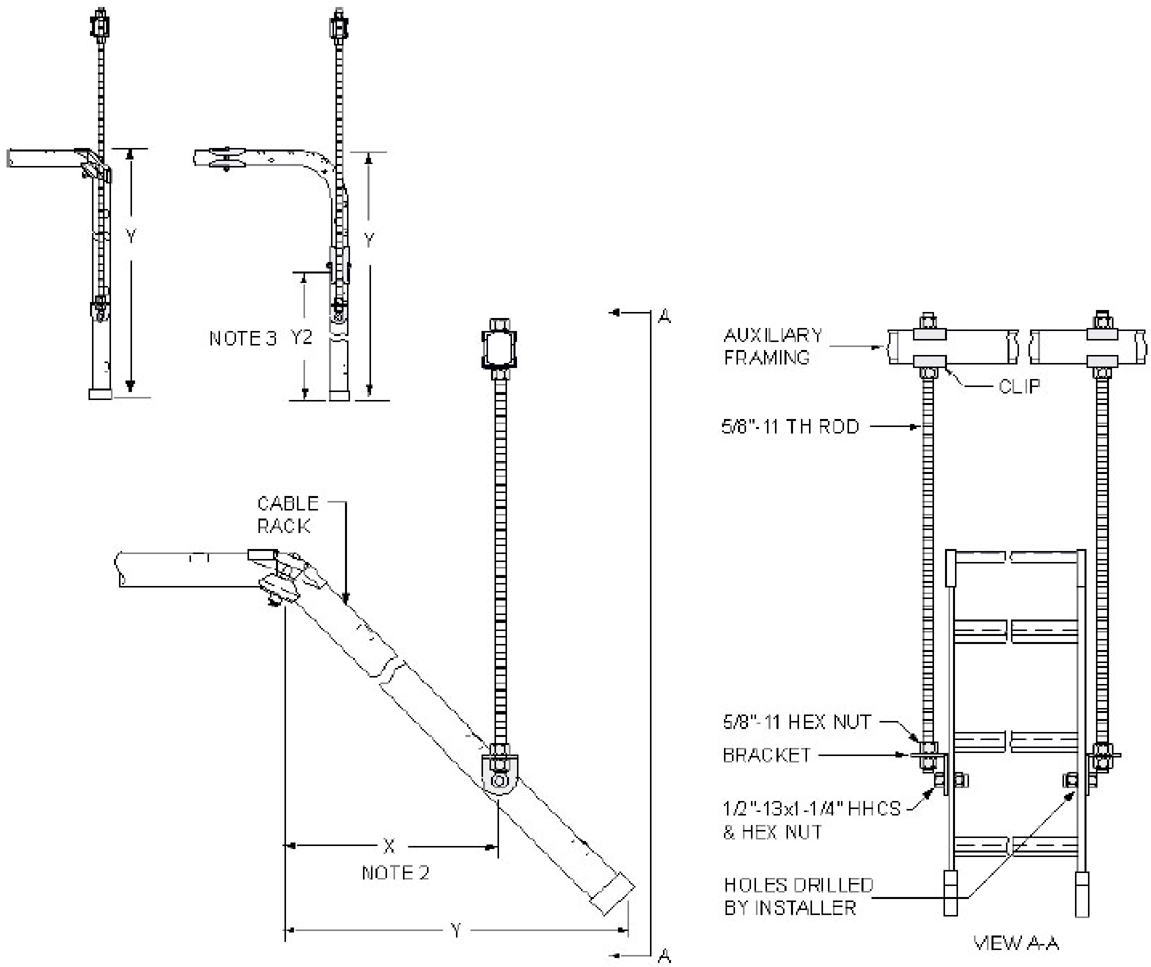


EXHIBIT 2-E1-95

2-E1-95 CABLE SUPPORT BRACKET FROM CABLE RACK STRINGER OR AUXILIARY FRAMING



NOTE

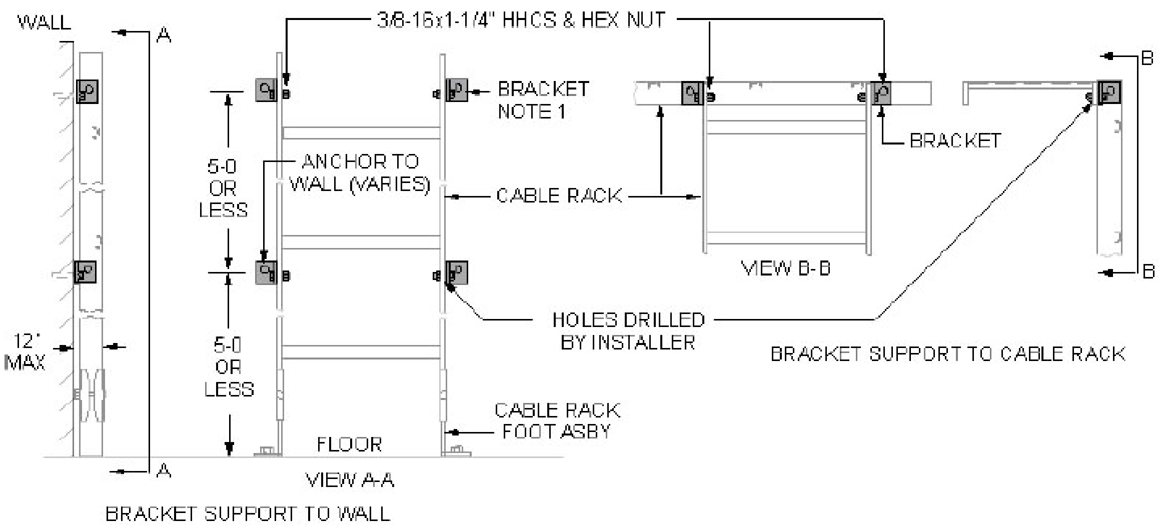
1. THIS SUPPORT CAN BE USED ON FIXED CLAMP, ADJUSTABLE CLAMP, OR FIXED TURN TRANSITIONS (45 DEGREE FIXED CLAMP TURN ILLUSTRATED).

2. THE THREADED ROD SUPPORT SHALL BE POSITIONED NO LESS THAN 1/2 OF DIMENSION "Y". IDEAL PLACEMENT IS BETWEEN THE LAST AND SECOND TO LAST CABLE RACK CROSS-STRAP.

3. WHEN A SECTION OF CABLE RACK IS SUPPORTED TO AND BELOW A FORMED CABLE TURN THE THREADED ROD SUPPORT SHALL BE POSITIONED NO LESS THAN 1/2 OF DIMENSION "Y2". IDEAL PLACEMENT IS BETWEEN THE LAST AND SECOND TO LAST CABLE RACK CROSS-STRAP.

EXHIBIT 2-E1-96

2-E1-96 FREE ENDED TURN SUPPORT

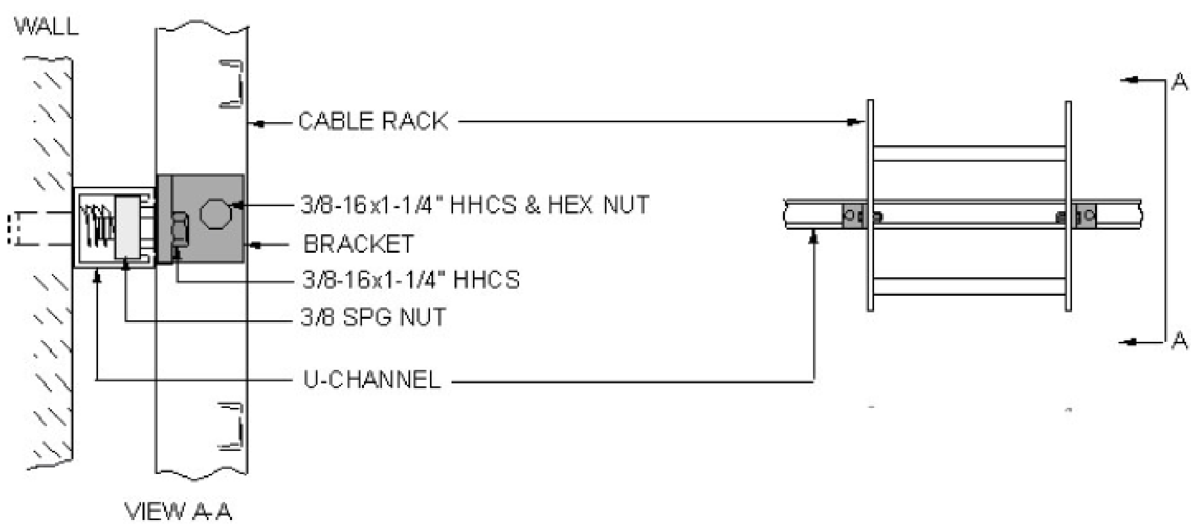


NOTE

1. BRACKET LENGTH CAN VARY DEPENDING ON THE DISTANCE SUPPORTED FROM THE WALL. LONGER BRACKETS ARE DRILLED BY INSTALLER.

EXHIBIT 2-E1-97

2-E1-97 BRACKET SUPPORT TO WALL OR CABLE RACK



NOTE

1. BRACKET LENGTH CAN VARY DEPENDING ON THE DISTANCE SUPPORTED FROM THE U-CHANNEL. LONGER BRACKETS ARE DRILLED BY INSTALLER.

EXHIBIT 2-E1-98

2-E1-98 BRACKET SUPPORT TO U-CHANNEL

Contents

TABLES

EXHIBITS

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 Network Facility.

Alternate methods of auxiliary framing support and assembly, not identified herein, are generally not approved. Authorization shall be obtained from the CenturyLink 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 for environments other than the 7 foot floor support.
- 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 Network Facility.

- Framing parts shall be directly butted. All measurements shown in Exhibits indicate maximum or minimum allowable gap tolerances.
- Some clips and plates tend to distort when nuts are tightened excessively. Tightening of nuts should be stopped when perceptible bending is noted.

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 CenturyLink 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 Descriptions of Auxiliary Framing

One inch channel type auxiliary framing is 1 inch by 2 inches and is manufactured in various lengths.

- One inch channel is oriented with the 2 inch flat side to the bottom as illustrated in Exhibit 2-E2-3 and may be encountered in some hut environments

Parallel bar type auxiliary framing is usually 2 inches by 3/8 of an inch and is manufactured in various lengths.

- Bars are paired as illustrated in Exhibit 2-E2-3 and may be encountered in some old Central Office and small CDO environments.
- Some small office environments use 1-1/2 inch by 3/8 inch bar. These bars may be single or paired. They shall not be used for auxiliary framing type support applications without Planning and Engineering Guidelines Common Systems approval.

Parallel 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-E2-3.
- 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.

- Plating should be colored to be distinguished from non-plated components

Where channels and hardware are intended to provide an electrical bond, refer to CenturyLink Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines" and CenturyLink 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 surrounding 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 operations or installation 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 CenturyLink 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 CenturyLink 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 (u-channel, inserts, etc.), 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 CenturyLink Environmental Standards for fire treated lumber.
- Attachment to a wall should be made when no other means of support is available (ceiling inserts, unistrut, floor supported stanchions)

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.
- Cable hole structure shall not be used as a means of support for auxiliary framing.

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.

- Auxiliary framing shall be placed no more than 8 inches above the top of the framework (as measured from the top of the framework to the bottom of the auxiliary framing) per Exhibit 2-E2-2G.
- 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 8 foot, 9 foot, 10 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 Network Facilities 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.

TABLE 6B.1 AUXILIARY FRAMING FASTENED TO FRAMES

Frame/Framing Height	Primary	Alternate
Duct-Type Frameworks w/top angles		
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-E27C
7-3 ½, 9-3 ½, 11-9 ½	2-E2-6R	2-E2-7E
Distributing Frames*		
7-0, 9-0, 11-6	2-E2-6	-
7-2, 9-2, 11-8	2-E2-7A	2-E2-7C
7-3 ½, 9-3 ½, 11-9 ½	2-E2-7E	2-E2-7D
BDFB		
7-0, 9-0, 11-6	2-E2-18A	
7-2, 9-2, 11-8	2-E2-18B	
7-3 ½, 9-3 ½, 11-9 ½	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 or wall 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.

BDFB RETURN BUSBARS: An example of auxiliary framing arrangement at the BDFB to support the BDFB return bars is shown in Exhibit 2-E2-21.

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.

BATTERY 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 2-E2-33 and 2-E2-33A 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 of a 7 foot environment include:

- Areas where a minimum of two adjacent parallel lineups can be engineered for an initial planned lineup length of at least ten feet (based on ironwork supported at 5 foot intervals). Actual length of lineup ironwork will exceed 10 feet.
- Lineups should be facing each other when establishing a new floor supported environment.
- Adequate space and clearance must be available to transition from an existing environment (8 foot, 9 foot, 10 foot, 11 foot 6) to the 7 foot environment.

Areas inappropriate for engineering of a 7 foot environment include:

- Single lineups.
- 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.
- In small offices with established 9-0 or 11-6 environments and small areas for equipment growth.
- Individual lineups engineered with more than one support environment (i.e. 7 foot with 11 foot 6) within the same lineup is prohibited.

Floor supported environments are dependent on 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 and in no cases shall exceed 6 feet. Initial secondary framing shall be engineered approximately 10 inches in from the main aisle reference line per Exhibit 2-E2-3.

- A recommended 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.
- Typical approved stanchions shall be 7 feet 6 inches in height and at no time shall the exposed threaded rod at the top of the stanchion exceed 2 inches.
- Framework stanchions shall be included at a future lineup where light switches are necessary for equipment lighting.
- Framework stanchions and approved pipe type stanchions shall be located similar to Exhibit 2-E2-2F.

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 (column bracing is no longer an approved method of support).

- Wall support: Framing extends to walls for support but usually not to ceilings. May include column bracing in older environments (column bracing is no longer an approved method of support).

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 Network Facilities 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.

- Pipe stanchions are no longer the approved stanchion for cable rack and auxiliary framing support and shall not be re-used when removed or relocated from its original position.
- For measuring purposes, stanchions shall be dimensioned from the stanchion base when measuring aisle space and dimensioned from the stanchion upright when close to walls, columns or other obstructions where aisle space would not be applicable.
- Only seismically approved stanchions are allowed in heavy seismic zones.
- Stanchions shall be engineered so that the stanchion base will be located entirely within the equipment base footprint for the lineup. Exception For cabinet lineups the stanchion base may extend approximately 2 inches into an equipment aisle.
- Stanchions shall be placed at approximately 5 feet intervals, 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 next to the intersection of the primary and secondary framing as shown in Exhibit 2-E2-2G (not directly below the intersection using the same threaded rod for support).
- Column type stanchions with a 10 inch or smaller square base shall be anchored using two anchors in light seismic zones and four anchors in heavy seismic zones.

- Column type stanchions with square bases larger than 10 inches shall be anchored using four anchors in all seismic zones.
- The height of column type stanchions shall be matched to the height of the auxiliary framing being supported and at no time shall the exposed threaded rod at the top of the stanchion exceed 2 inches. This allowance will provide for fluctuations in the floor while keeping the environment level. When a column stanchion cannot be installed next to the intersection of primary and secondary auxiliary framing due to fluctuations in the floor level the column 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 column type stanchion to the bottom of auxiliary framing shall not exceed 2 inches.
- Stanchions, as illustrated in Exhibit 2-E2-11, may be used to support framing bars or channels in those buildings where ceilings cannot 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:

TABLE 6B.2 AUXILIARY FRAMING BRACING REQUIREMENTS

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.

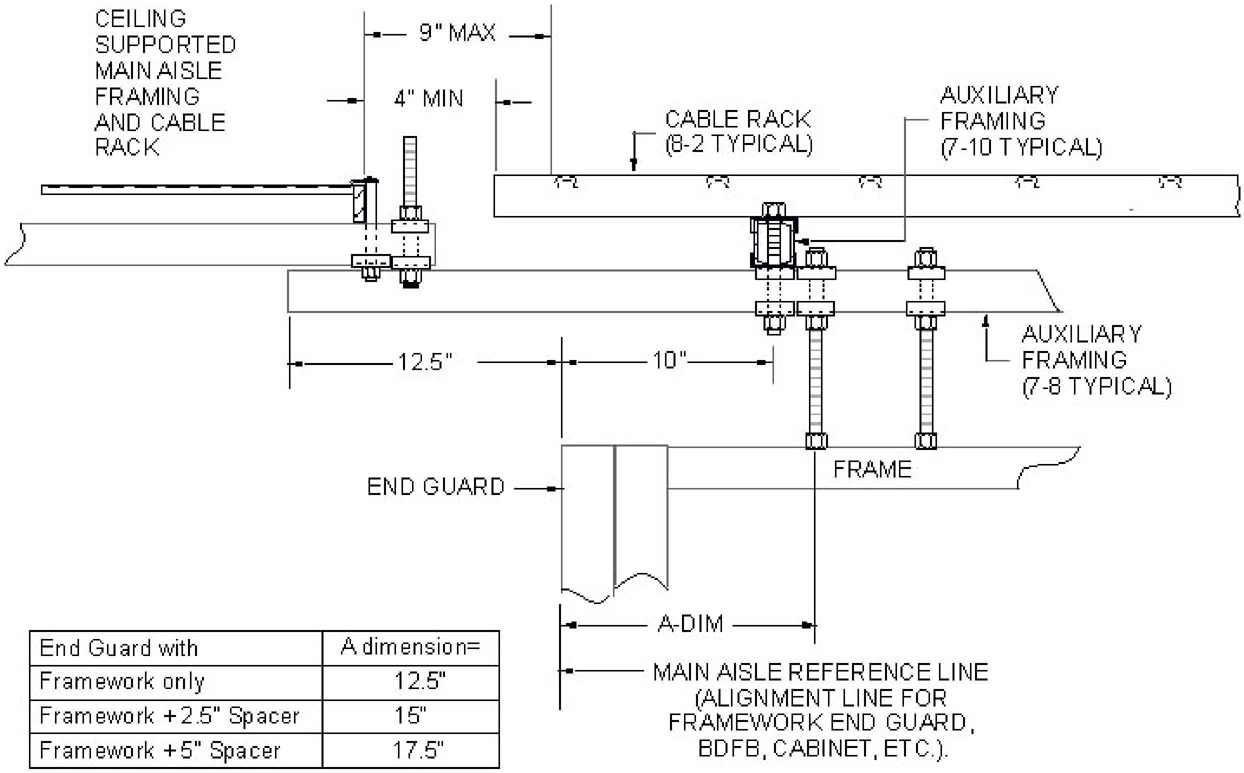
The above bracing requirements address only situations between low type (primary and secondary) auxiliary framing and ceilings. Refer to Auxiliary Framing - High Type for bracing requirements for multiple levels of auxiliary framing.

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 cannot be provided, may be obtained per Exhibit 2-E2-8C, attaching auxiliary framing to outside block or framed walls.

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



End Guard with	A dimension=
Framework only	12.5"
Framework +2.5" Spacer	15"
Framework +5" Spacer	17.5"

EXHIBIT 2-E2-1

2-E2-1 TYPICAL ARRANGEMENT OF AUXILIARY FRAMING AND CABLE RACK FOR 7-0 LOW LEVEL ENVIRONMENT AT A MAIN AISLE

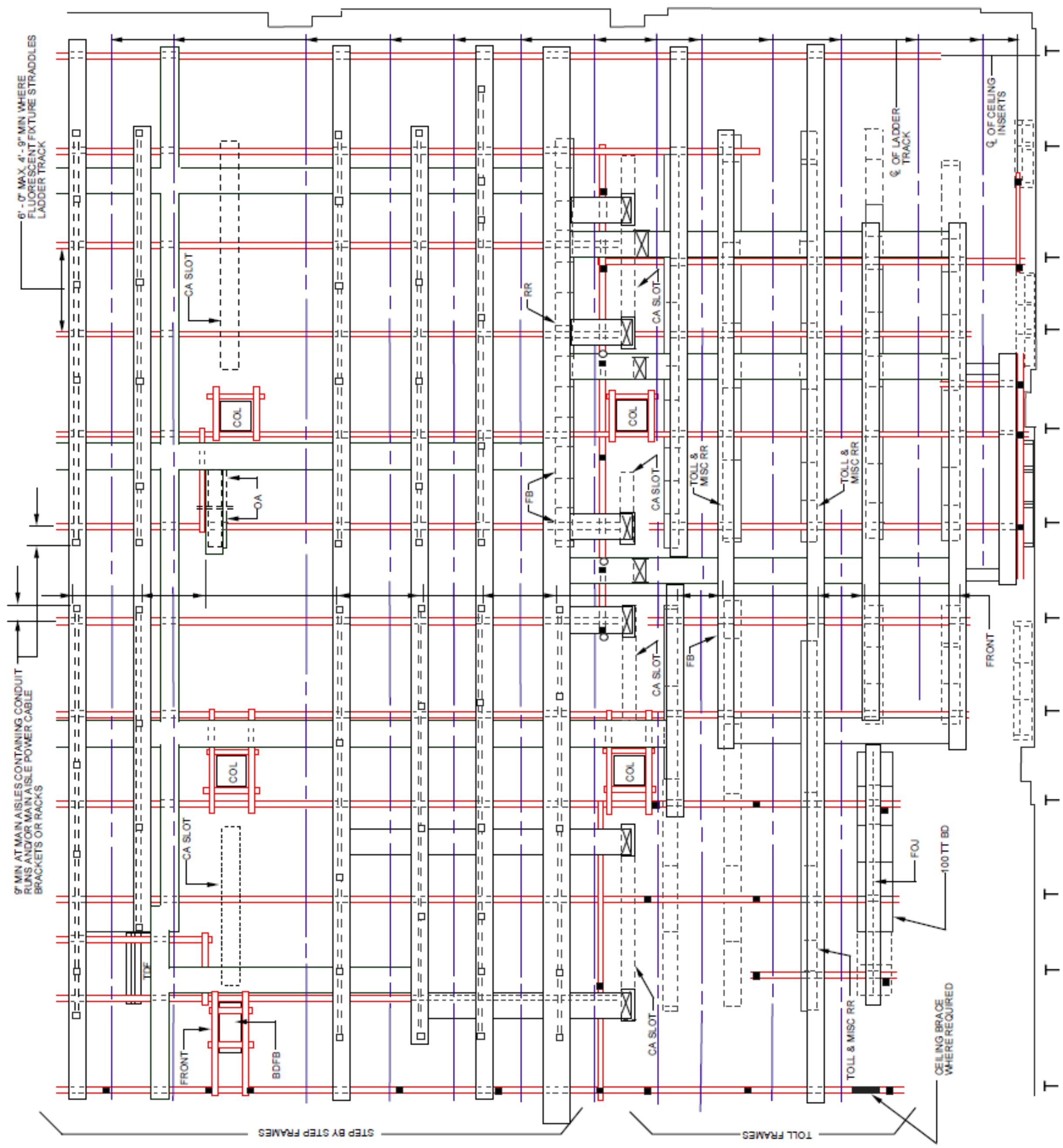


EXHIBIT 2-E2-1A (A&M)

2-E2-1A (A&M) TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR COMBINED STEP-BY-STEP AND TOLL OFFICE-11 FOOT 8 INCH FRAMING-LADDER-TYPE CABLE RACK OVER LINE-UP OF FRAMES-HISTORICAL ONLY

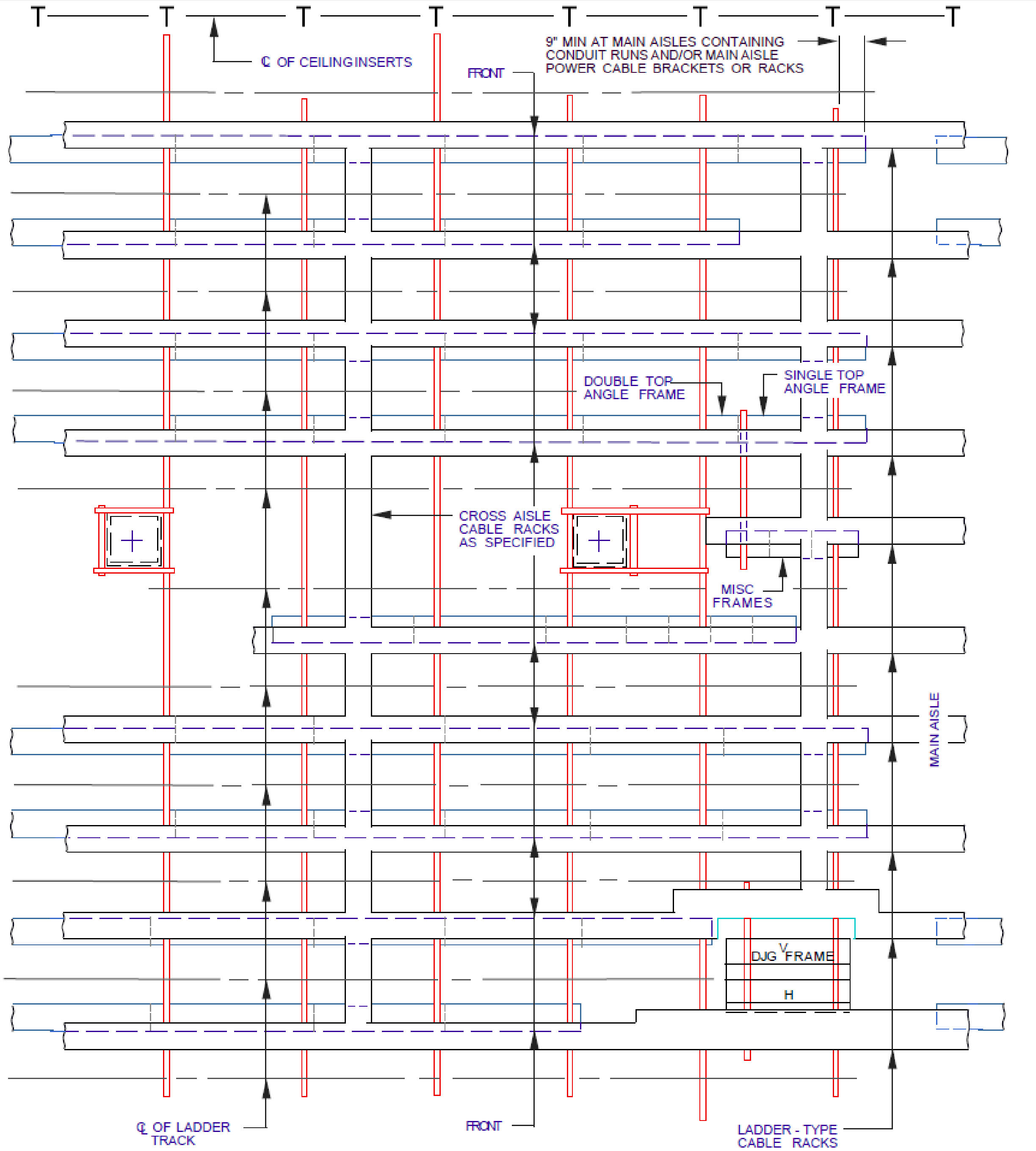


EXHIBIT 2-E2-2A (A&M)

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

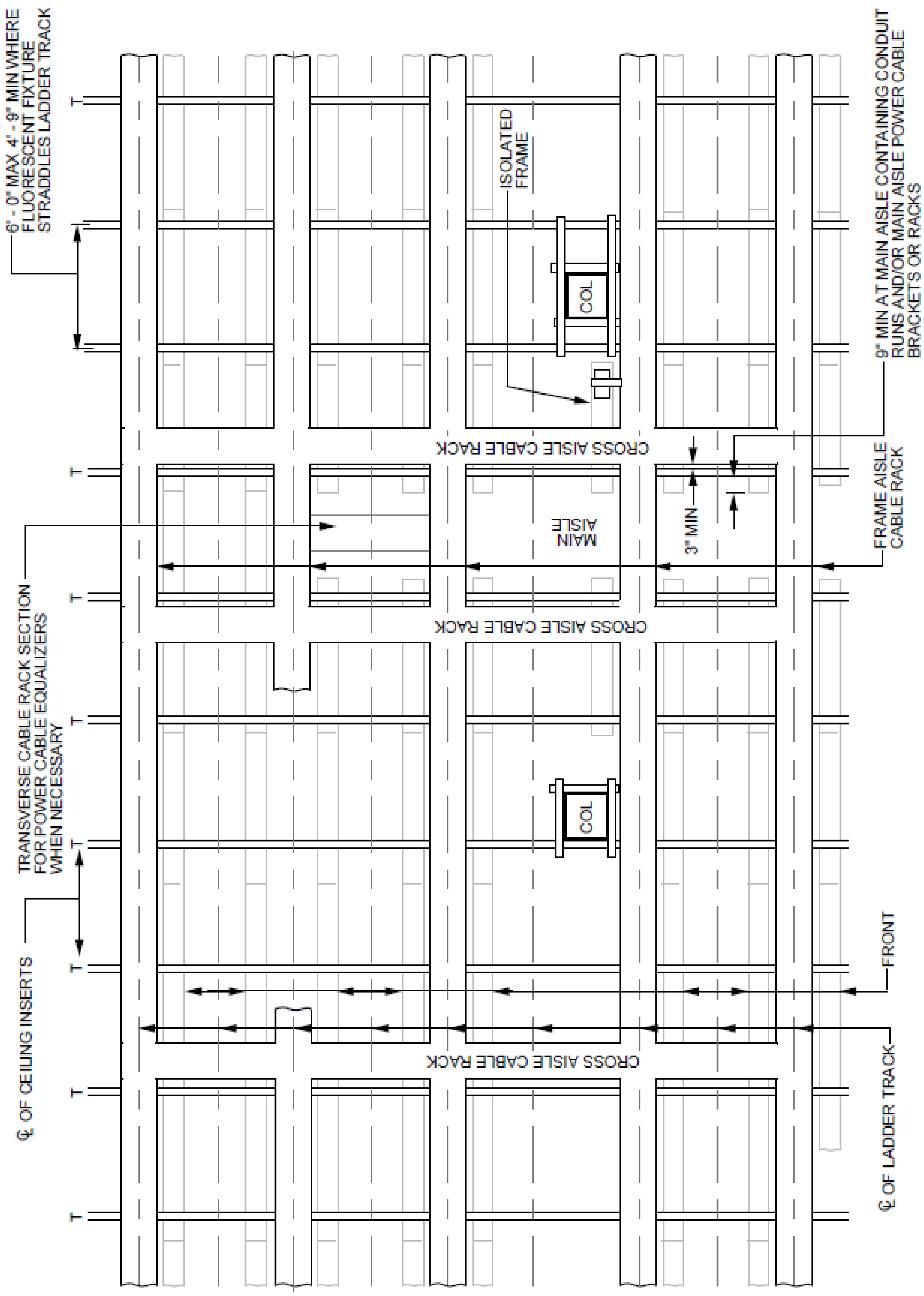


EXHIBIT 2-E2-2B (A&M)

2-E2-2B (A&M) TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR NO. 5 CROSSBAR OFFICES WITHOUT PREARRANGED PATTERN OF CEILING INSERTS

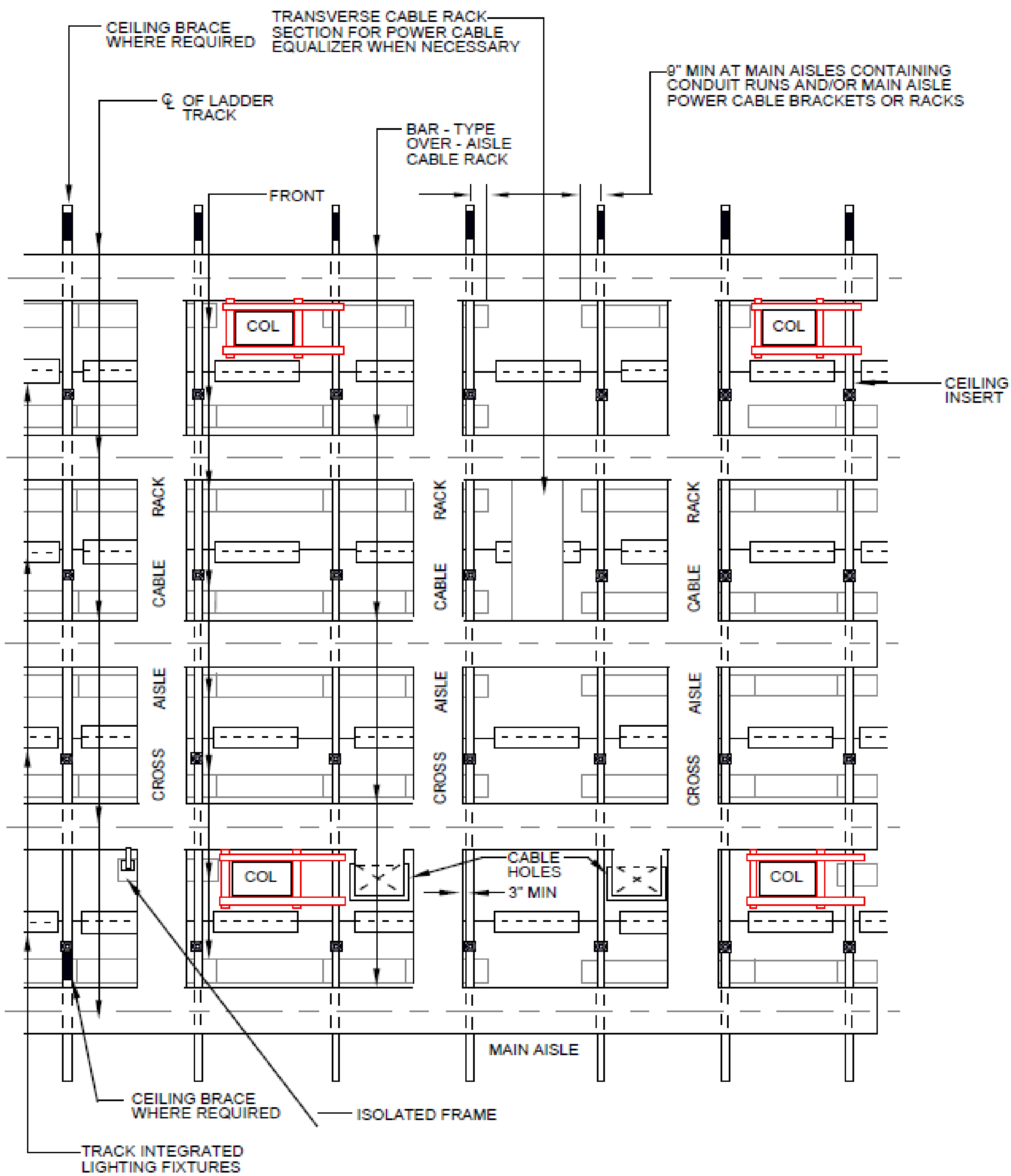


EXHIBIT 2-E2-2C (A&M)

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

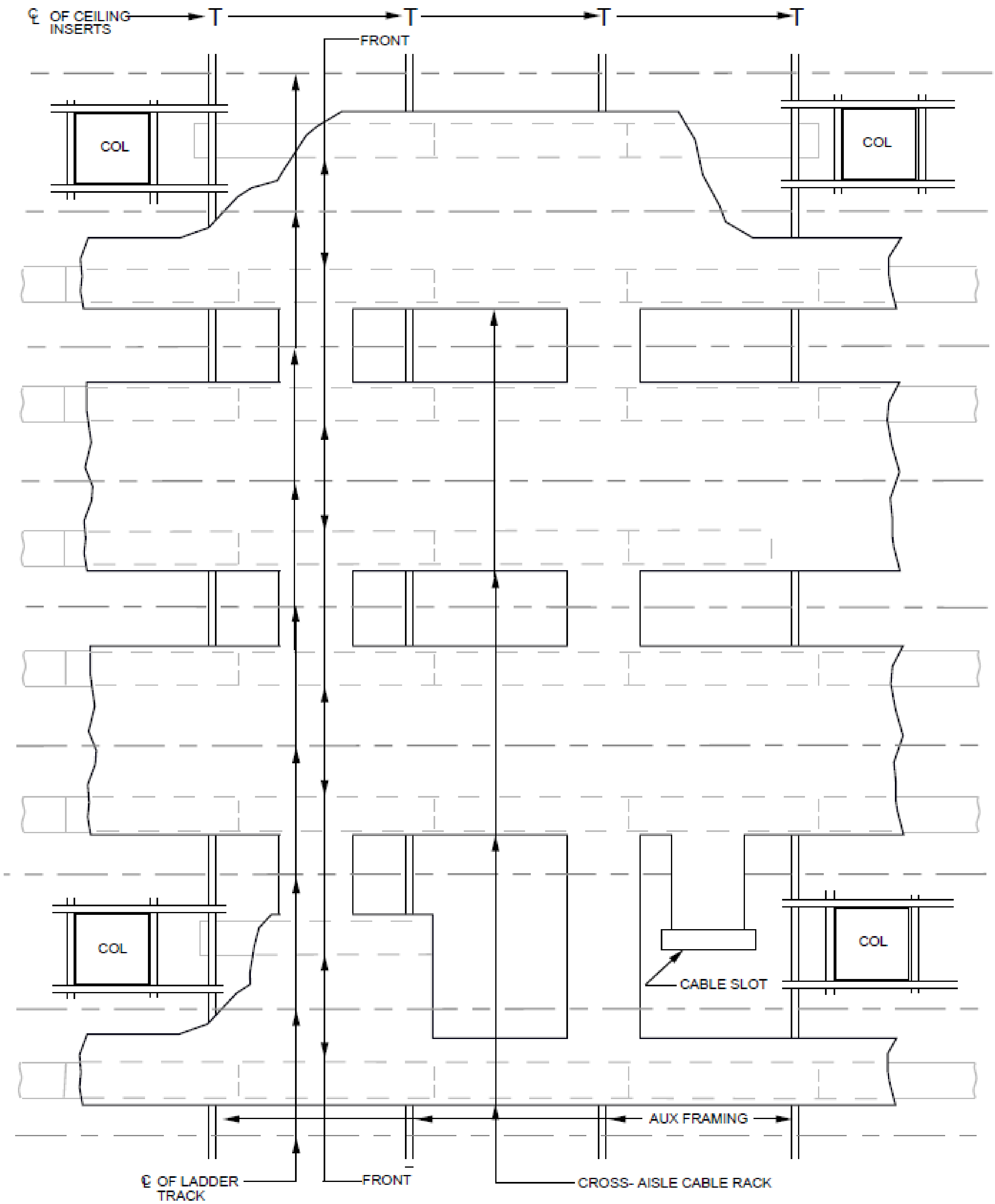


EXHIBIT 2-E2-2D (A&M)

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

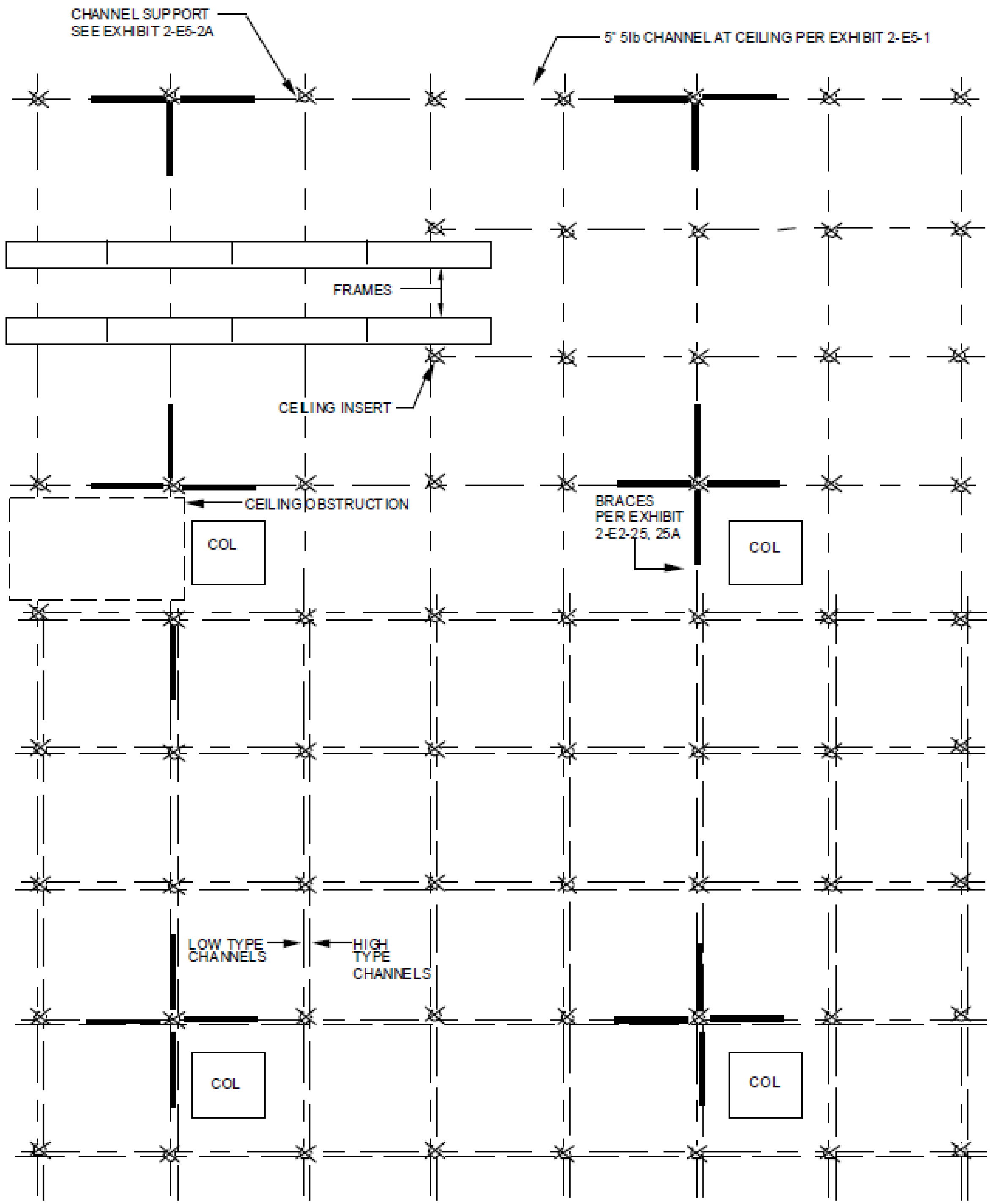


EXHIBIT 2-E2-2E

2-E2-2E TYPICAL BRACING SCHEME – LIGHT

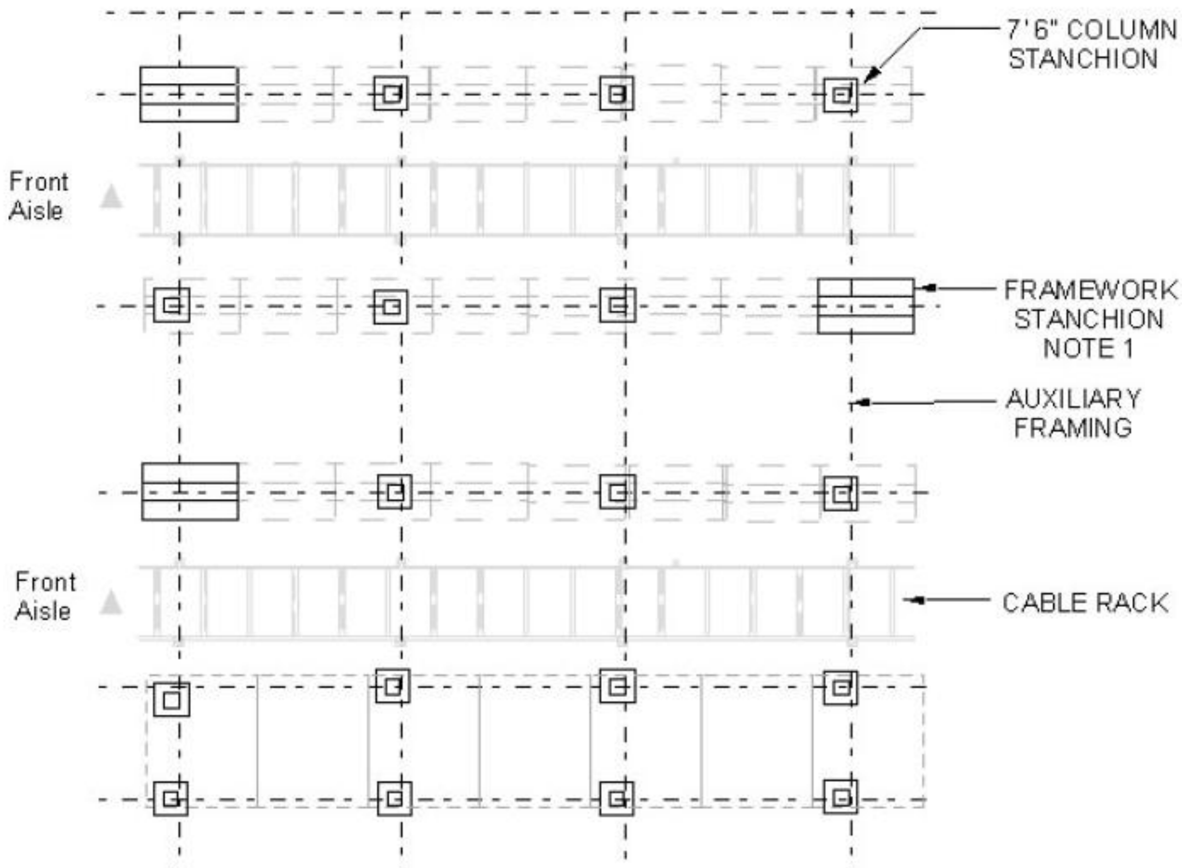
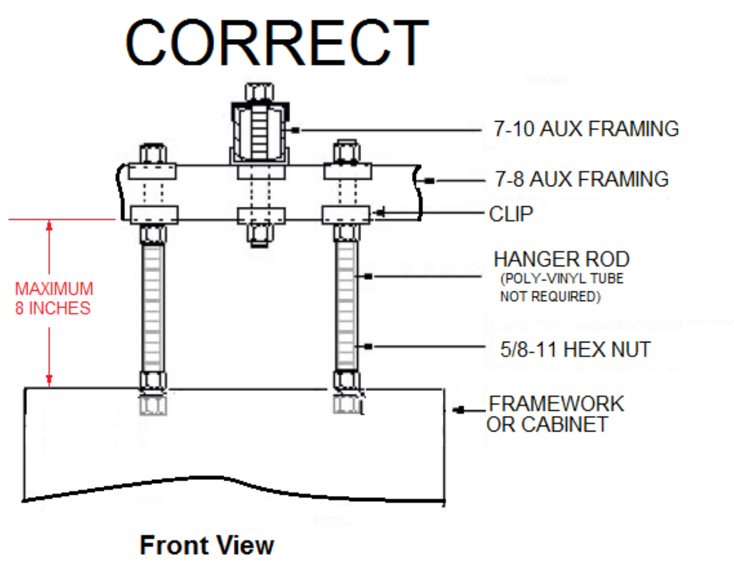
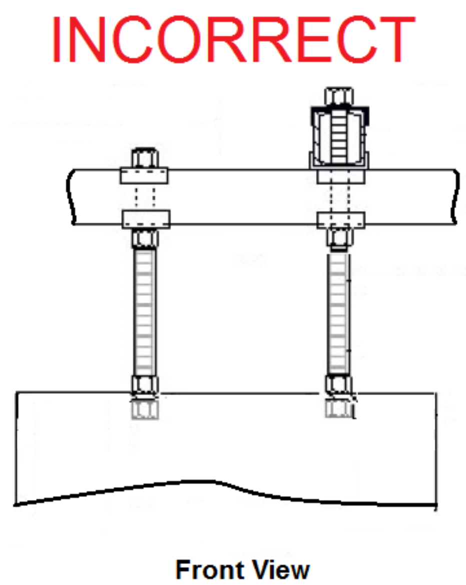
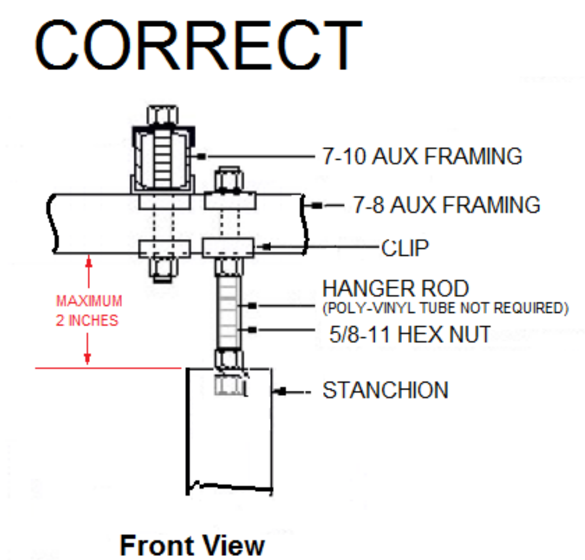


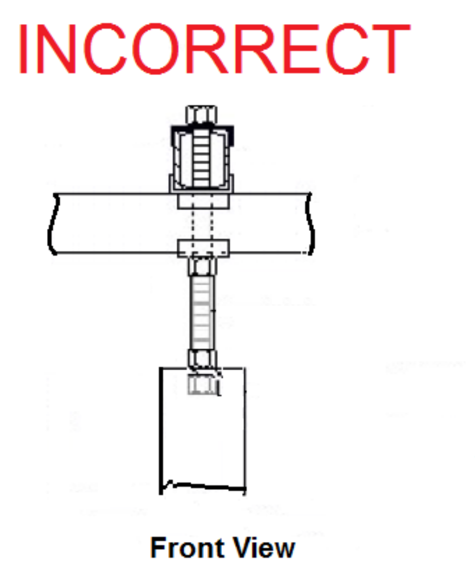
EXHIBIT 2-E2-2F

2-E2-2F TYPICAL STANCHION ARRANGEMENT









NOTE: STANCHION, FRAMEWORK AND CABINET TOP SUPPORT SHALL BE INSTALLED OFFSET FROM THE 7-8 AND 7-10 INTERSECTION AS TO NOT UTILIZE THE SAME THREADED ROD FROM THE TOP SUPPORT TO THE 7-10 AUXILIARY FRAMING.

EXHIBIT 2-E2-2G

2-E2-2G TYPICAL 7FT LOW LEVEL STANCHION, FRAMEWORK OR CABINET SUPPORT

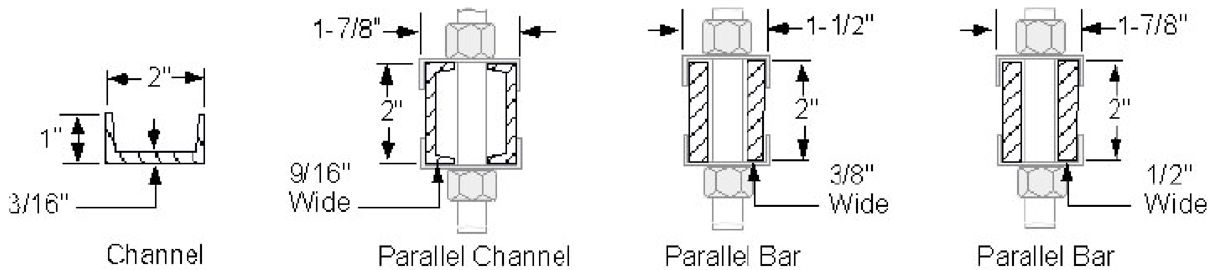


EXHIBIT 2-E2-3
2-E2-3 TYPICAL AUXILIARY FRAMING

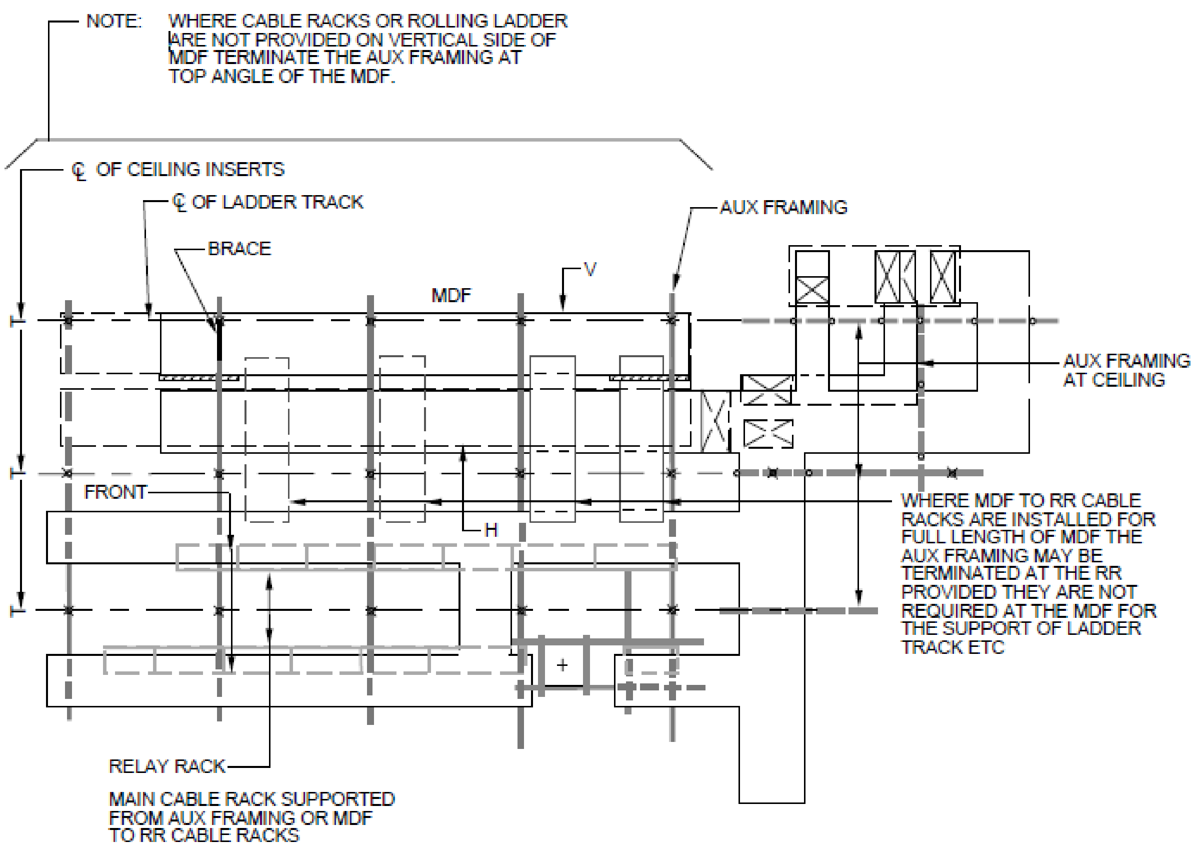


EXHIBIT 2-E2-4A (A&M)
2-E2-4A (A&M) TYPICAL ARRANGEMENT OF AUXILIARY FRAMING FOR NO. 11 OFFICES-11 FOOT 8 INCH FRAMING-OVER FRAME CABLE RACKS

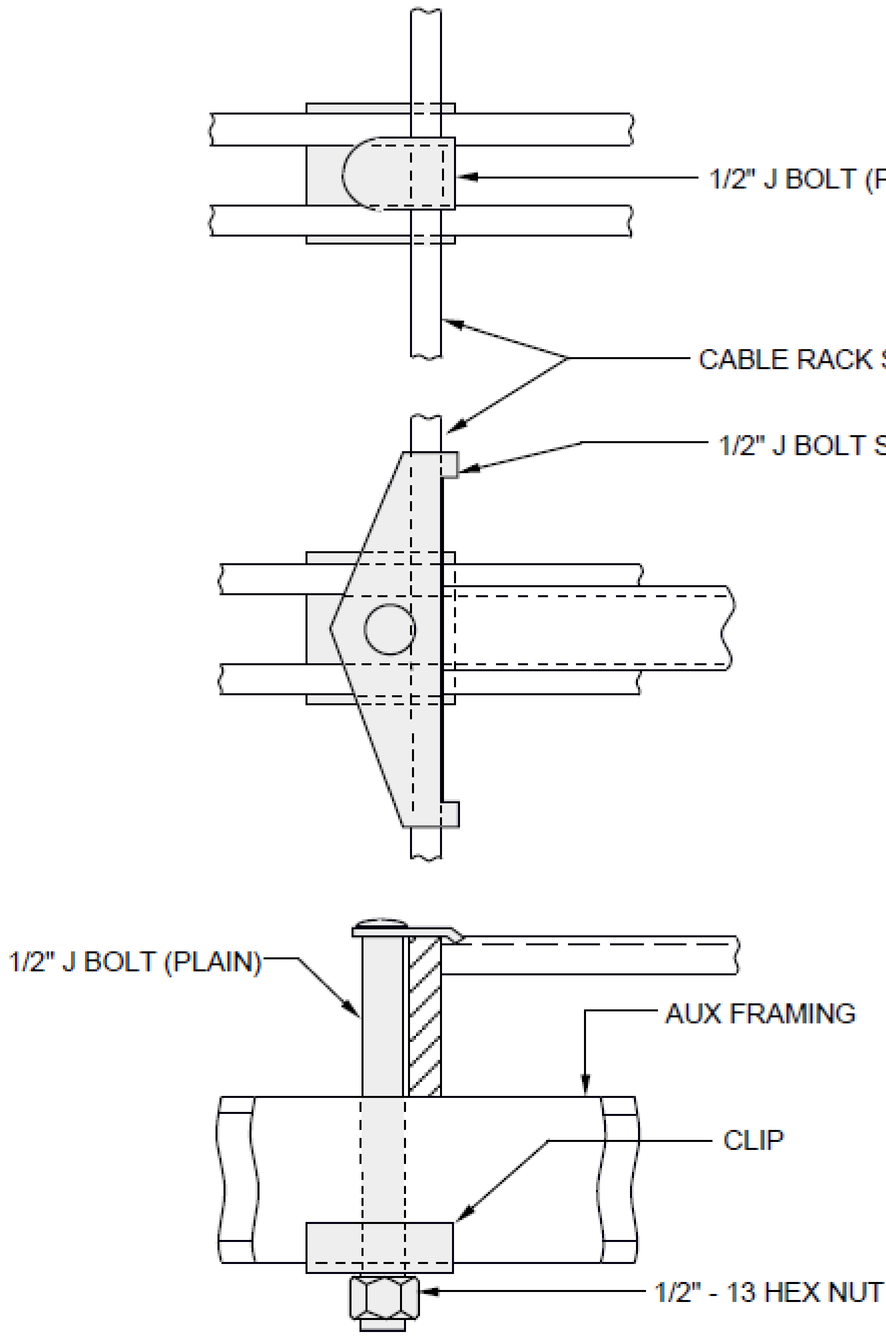


EXHIBIT 2-E2-5

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

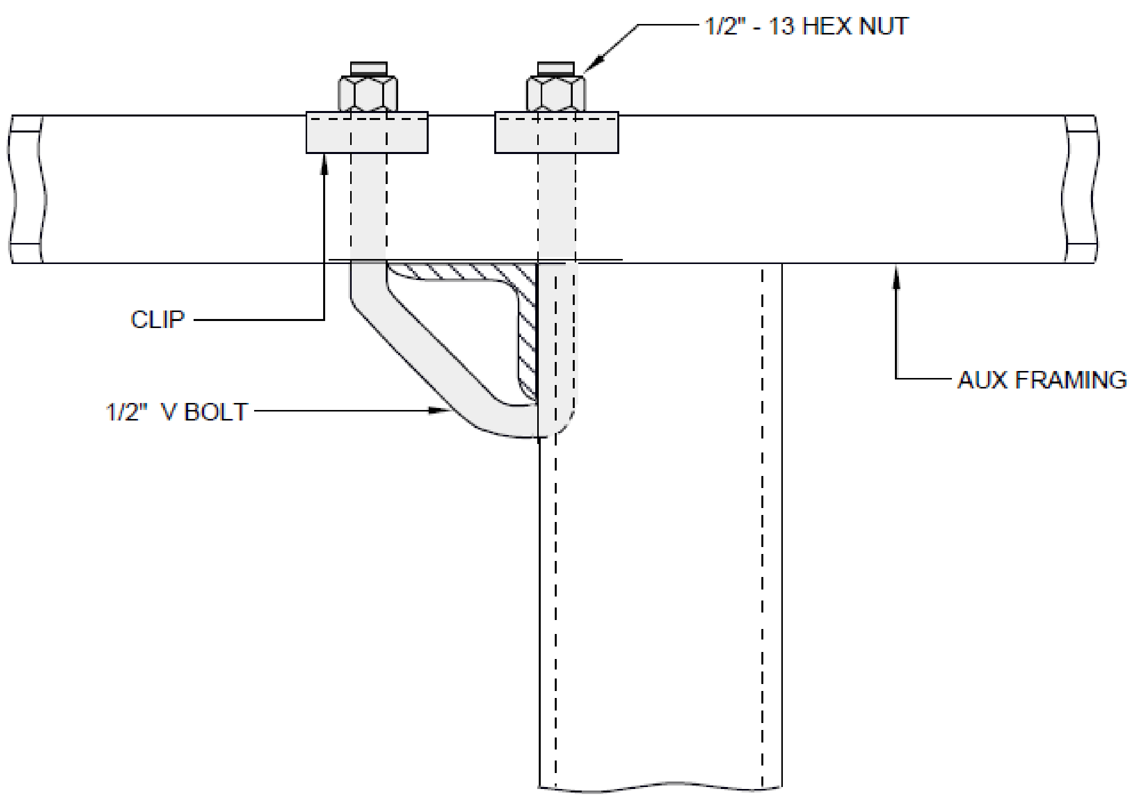


EXHIBIT 2-E2-6

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

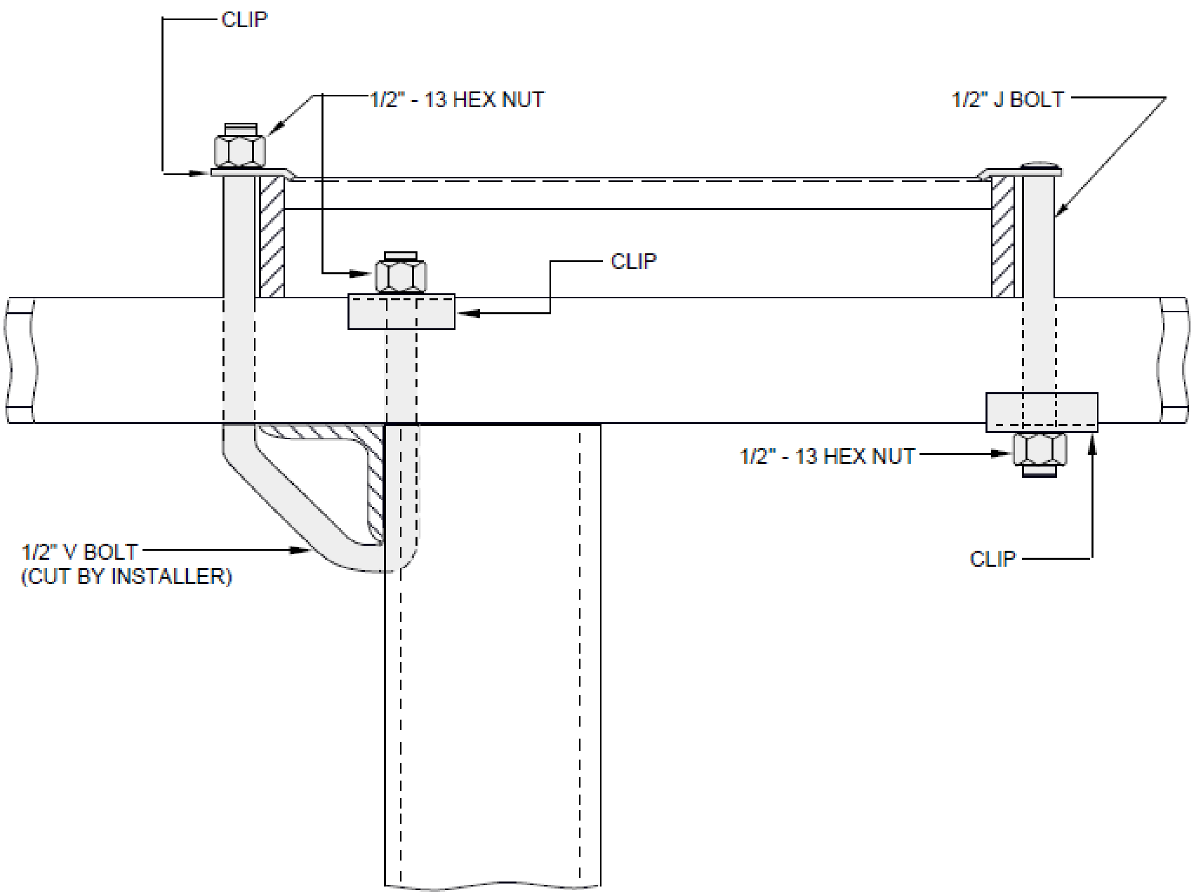


EXHIBIT 2-E2-6A

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

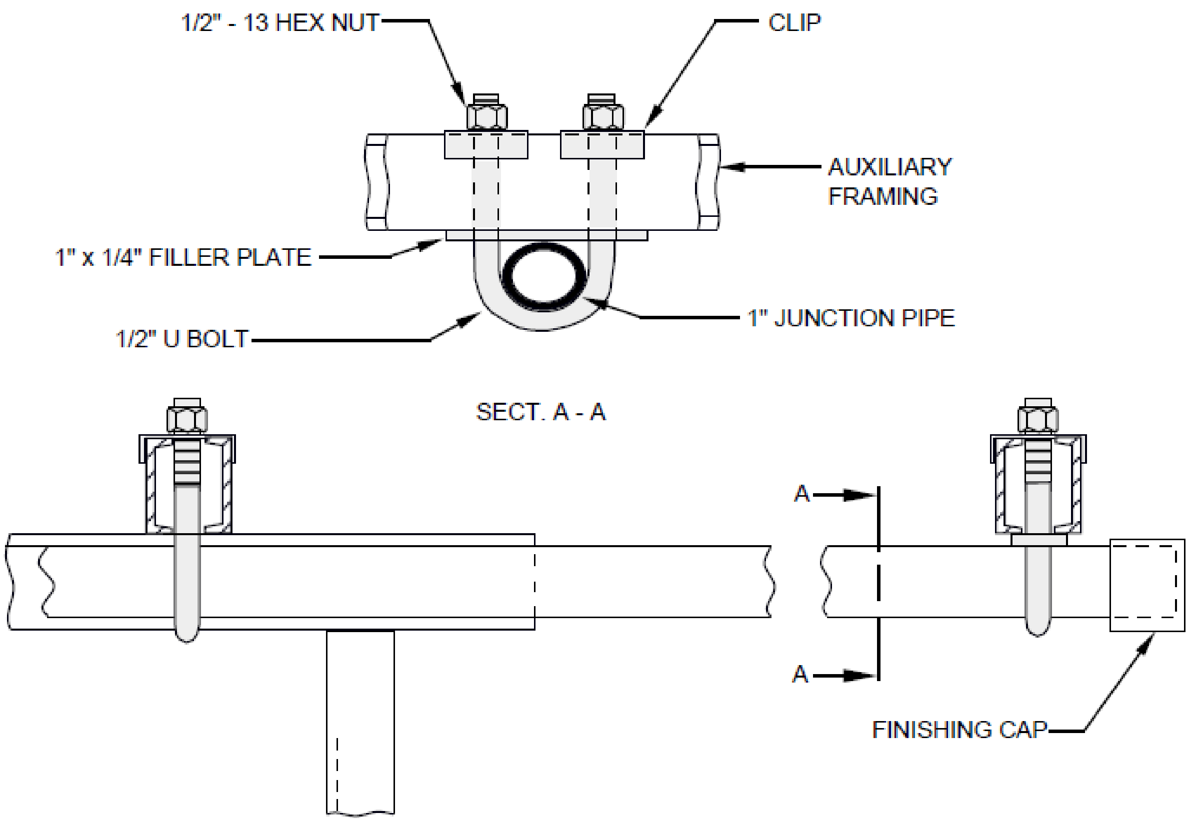
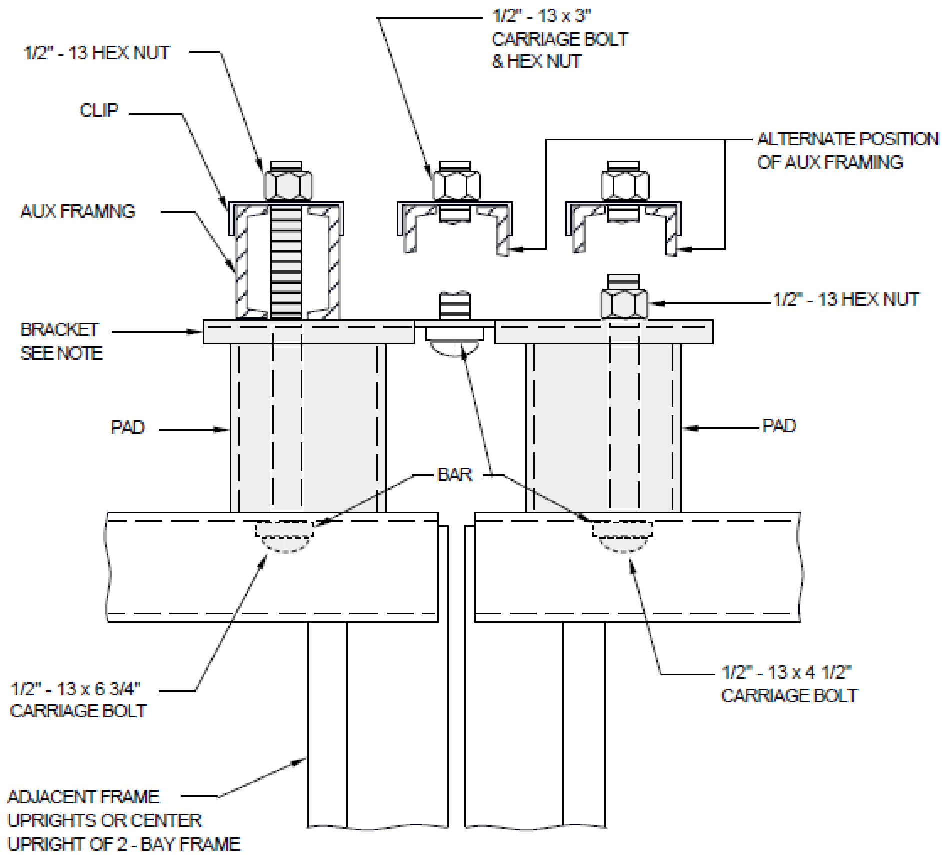


EXHIBIT 2-E2-6F

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

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

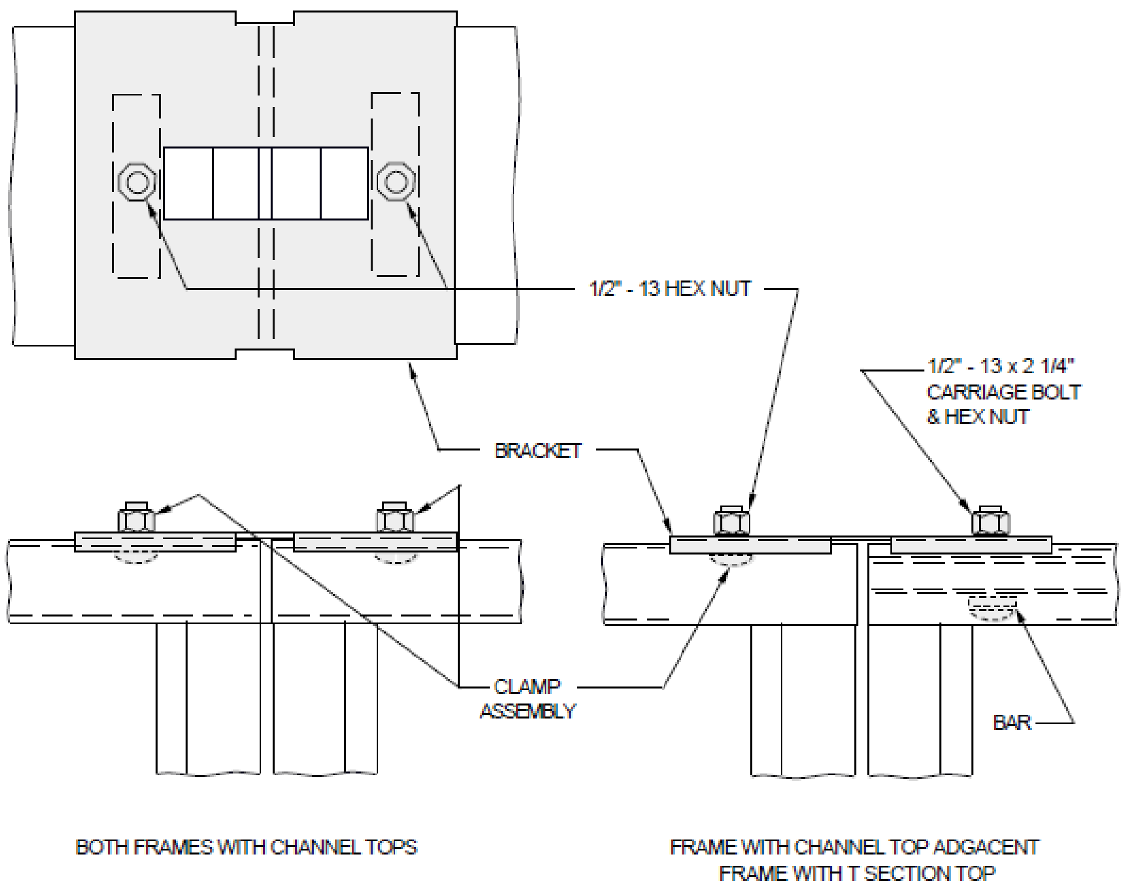


EXHIBIT 2-E2-6H (A&M)

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

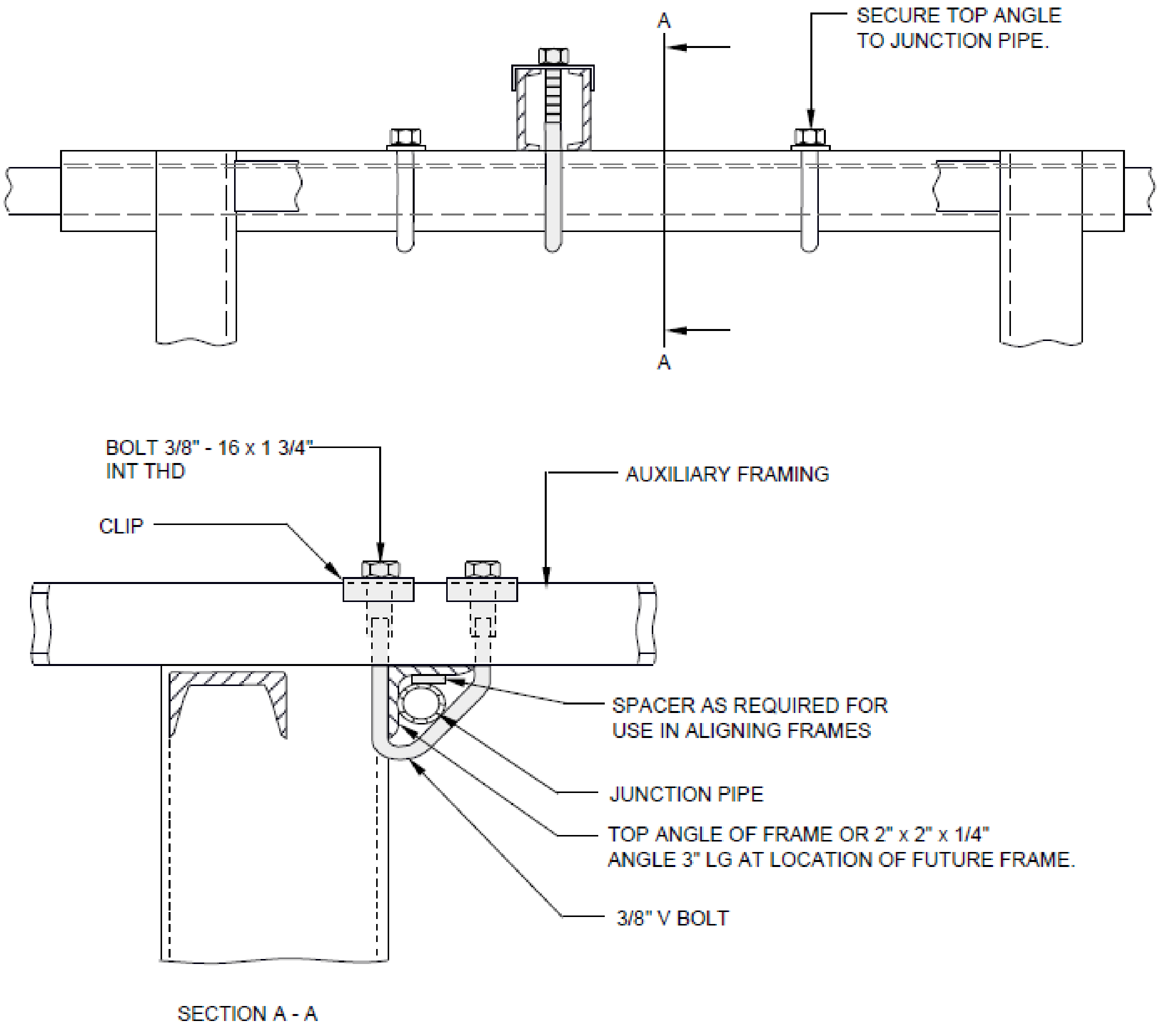


EXHIBIT 2-E2-6J

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

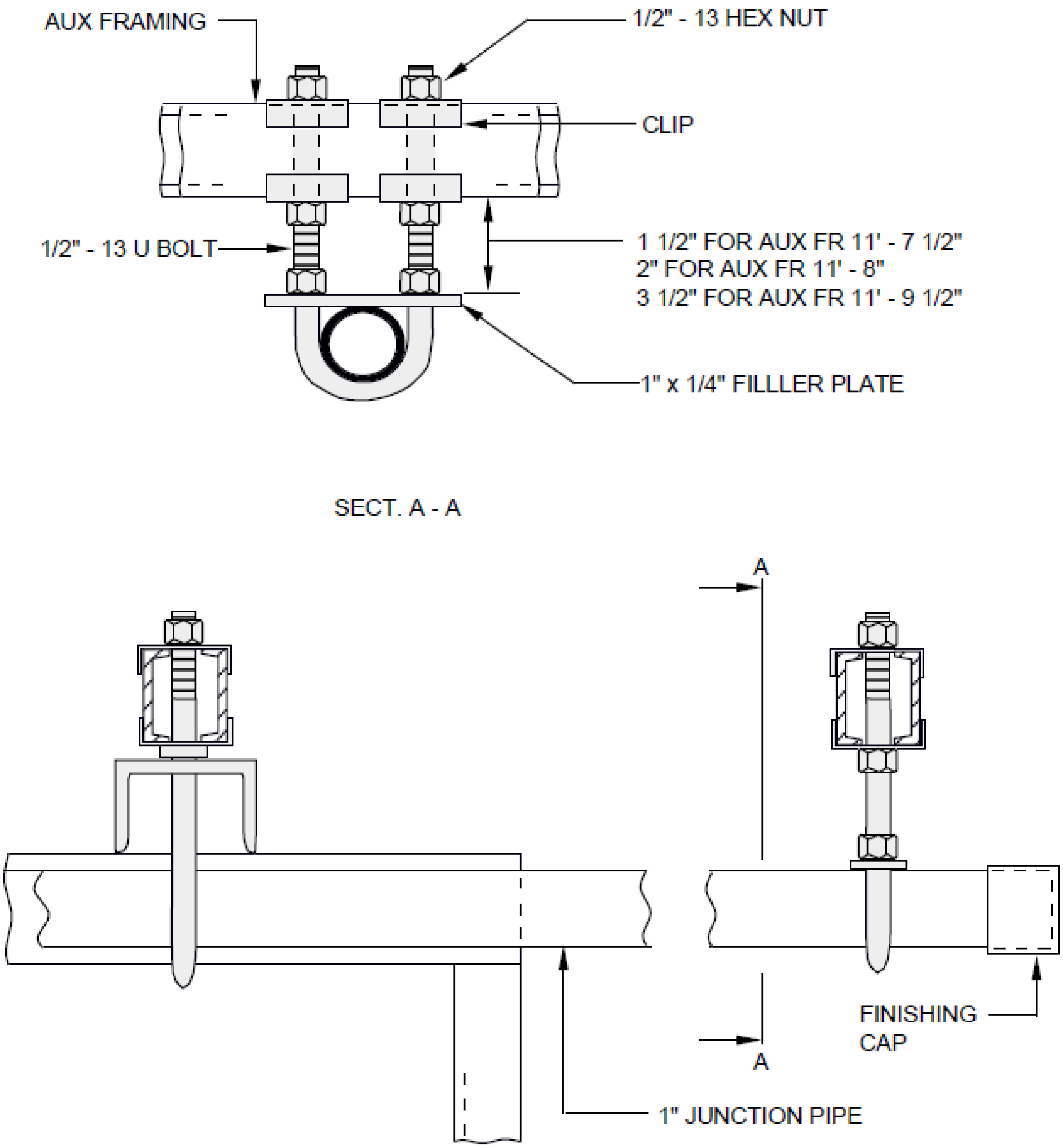


EXHIBIT 2-E2-6L

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

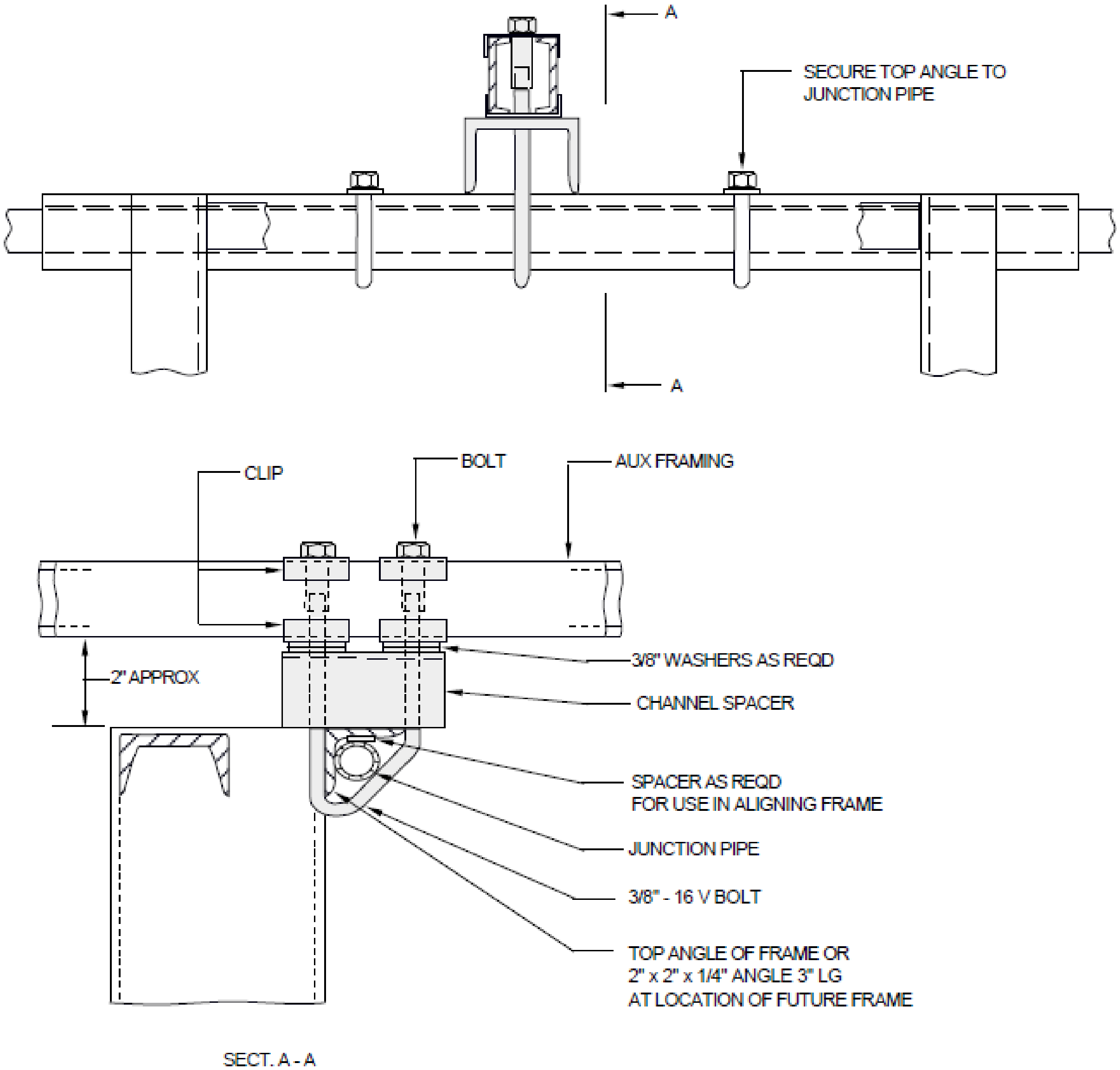


EXHIBIT 2-E2-6M

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

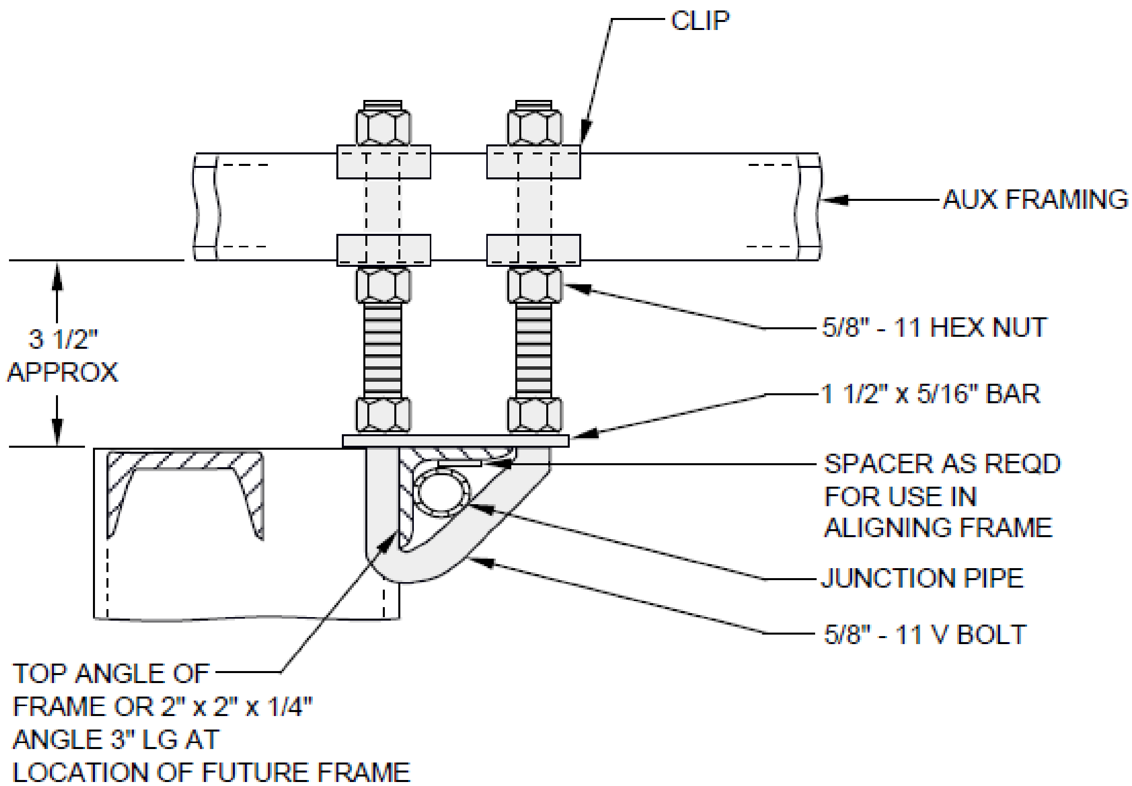


EXHIBIT 2-E2-6R

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

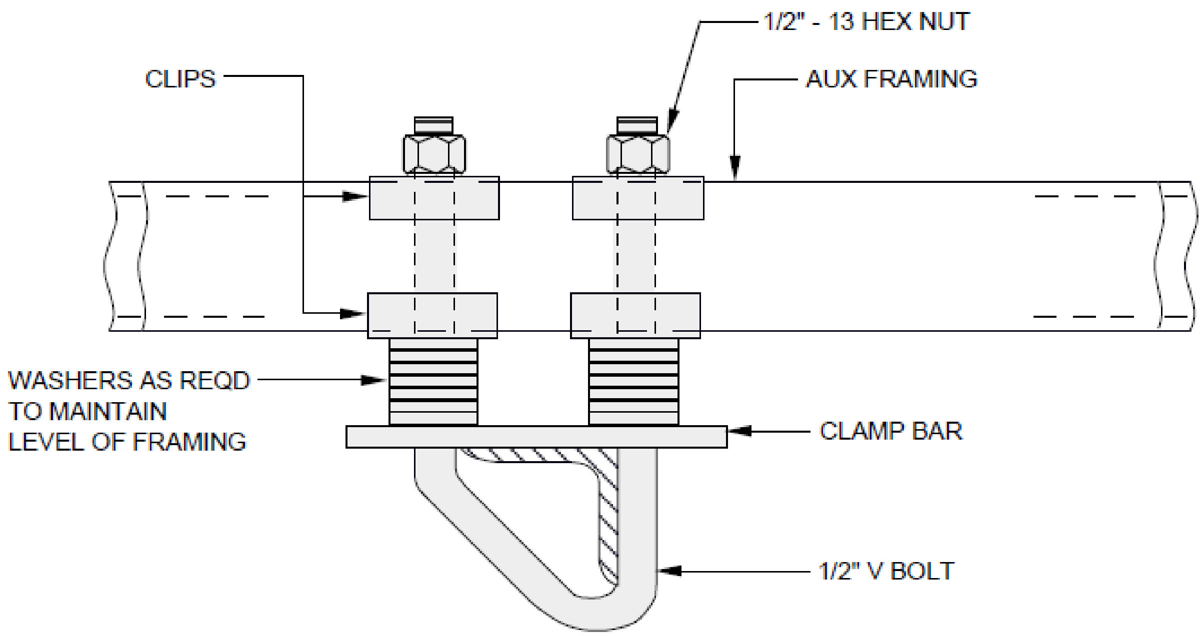


EXHIBIT 2-E2-7

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

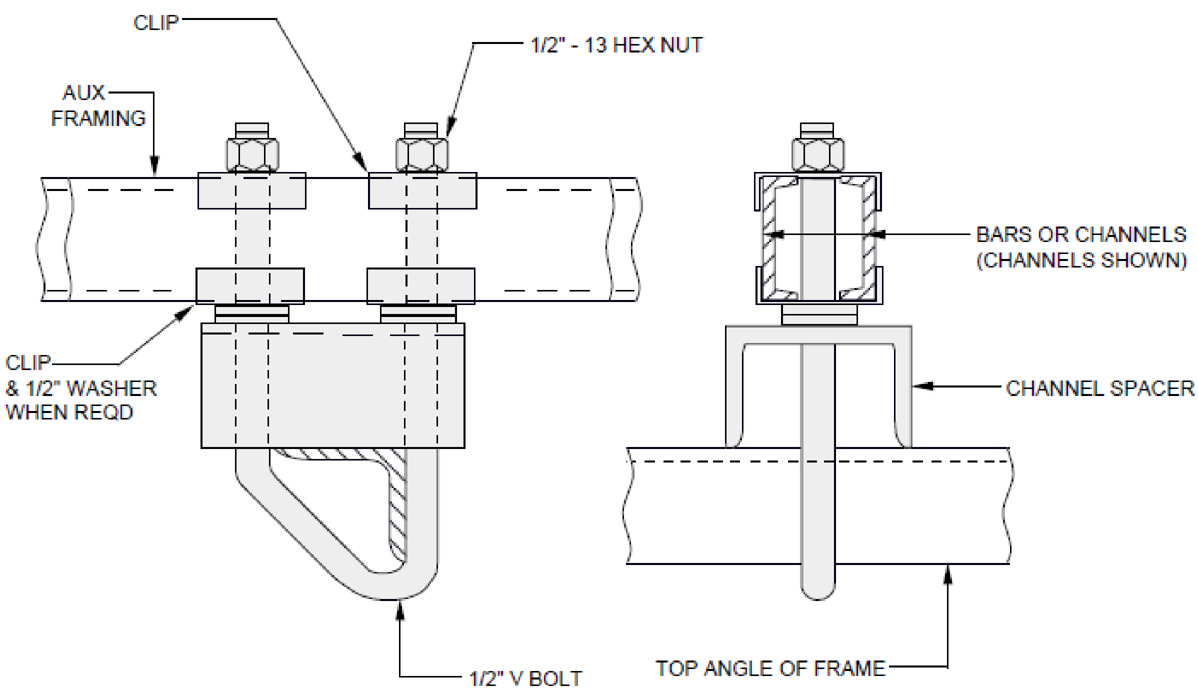


EXHIBIT 2-E2-7A

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

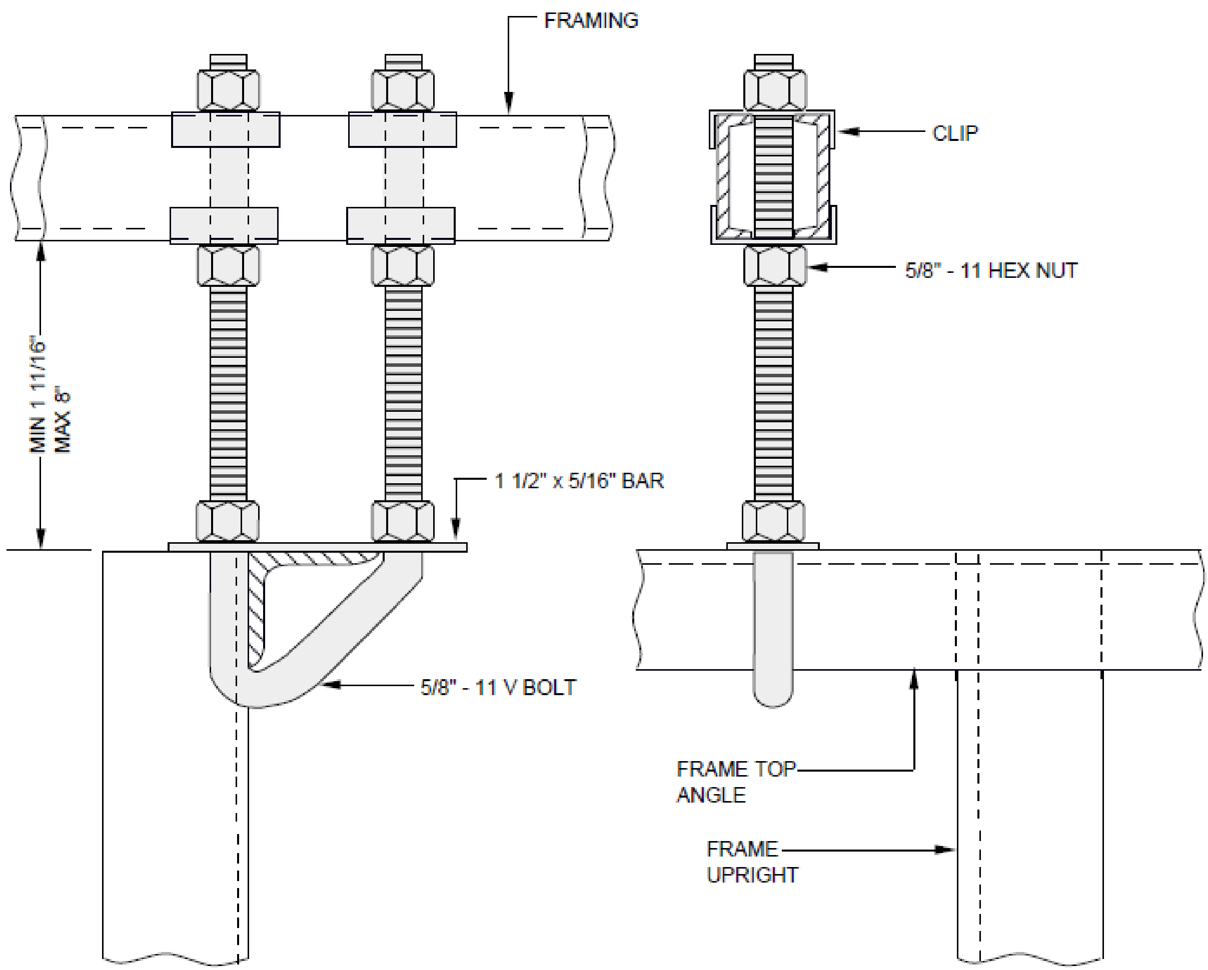


EXHIBIT 2-E2-7B

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

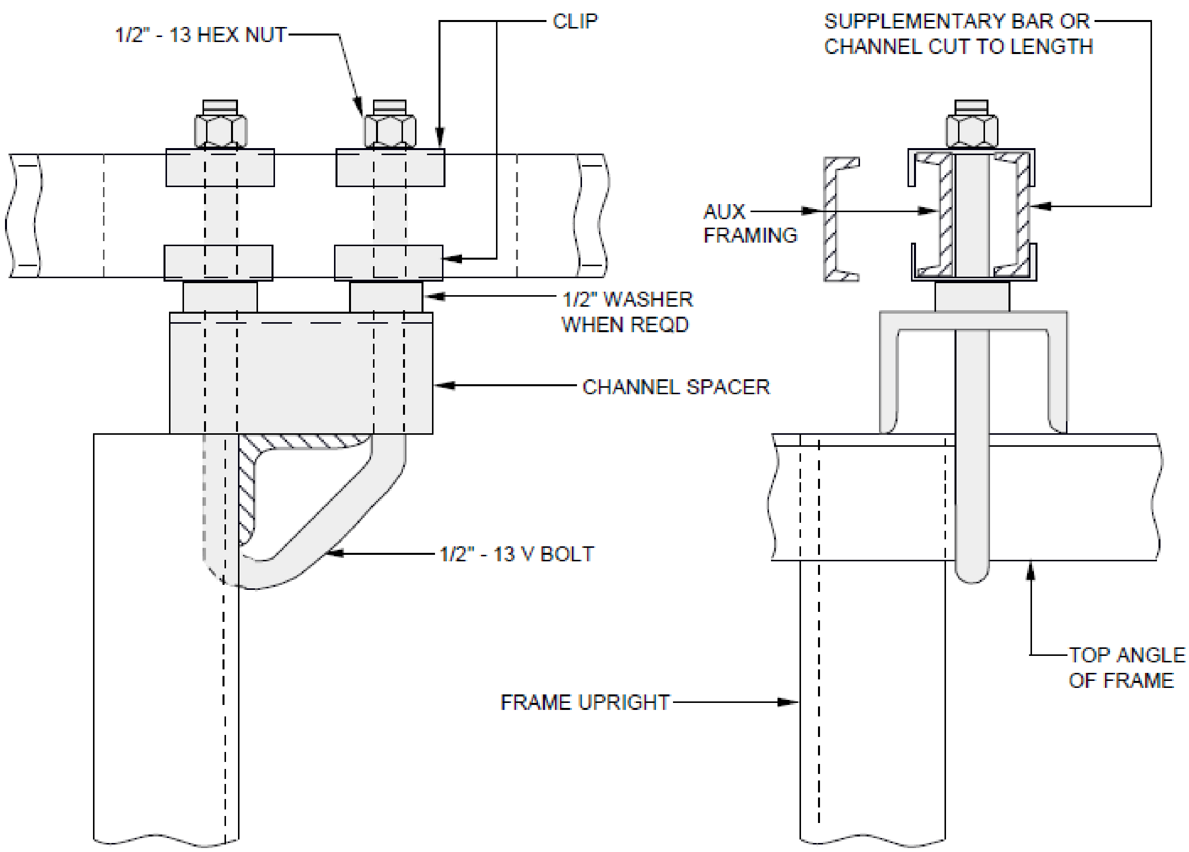


EXHIBIT 2-E2-7C

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

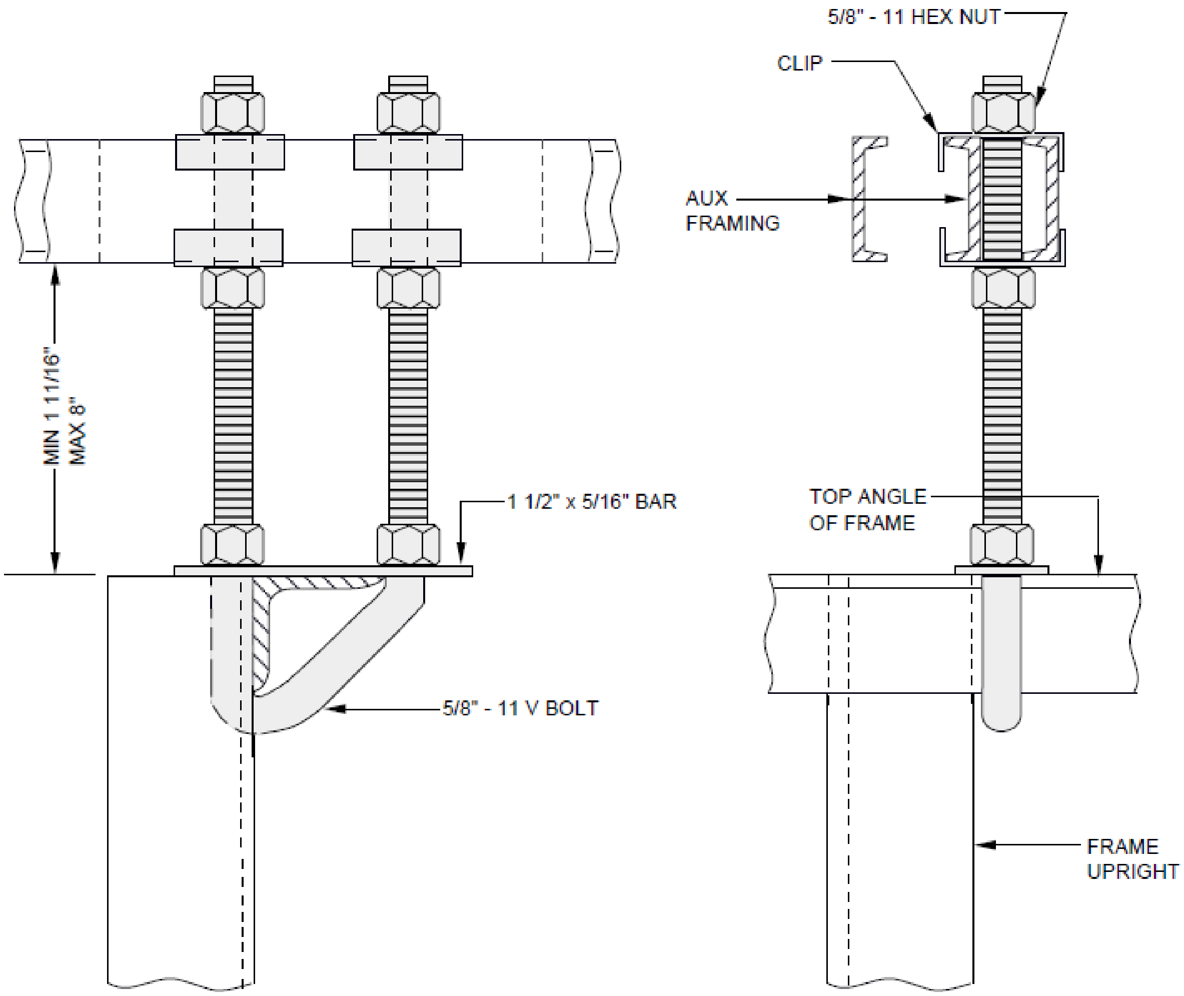


EXHIBIT 2-E2-7D

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

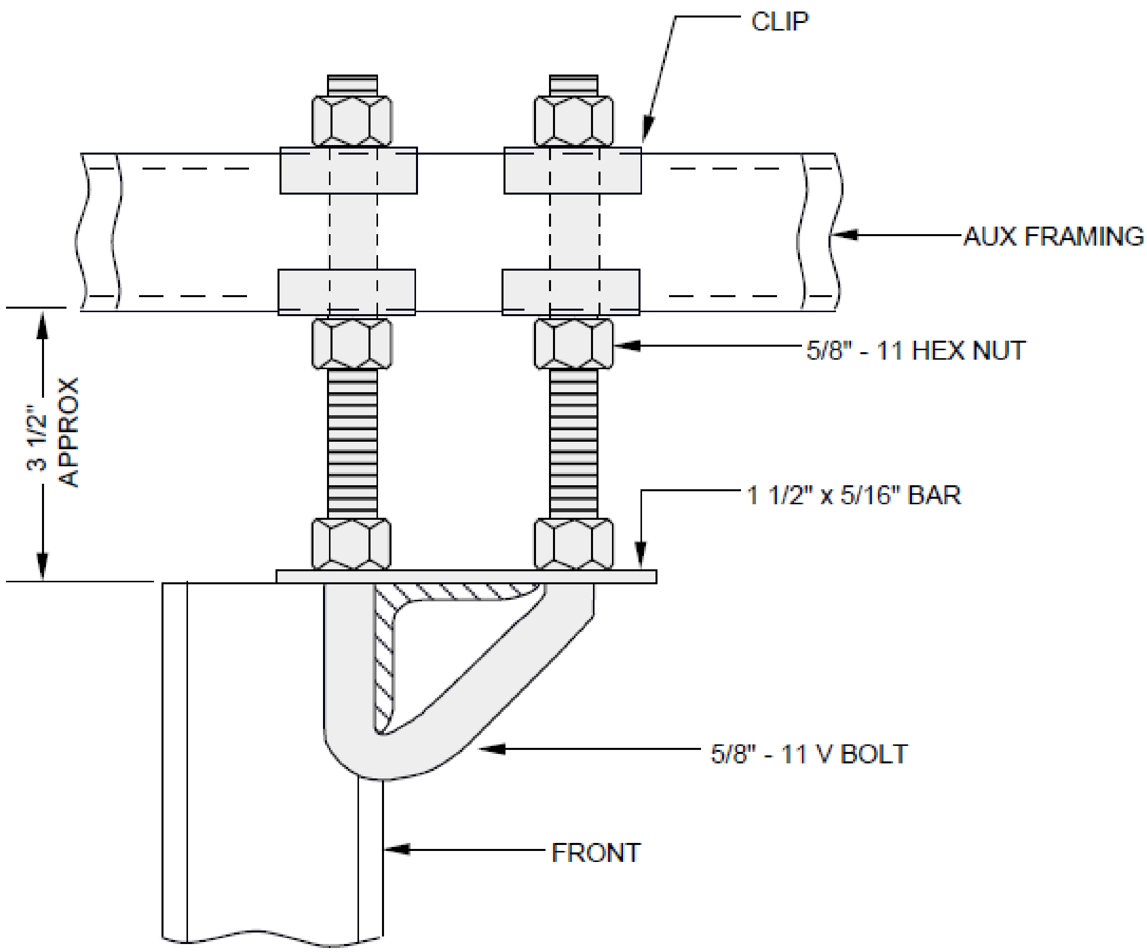


EXHIBIT 2-E2-7E

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. II MAN.	NO. 1 CSBR CSBR TDM NO.4 TOLL	NO. 5 CROSS-BAR
FRONT OF FUTURE LINE FACES OUTSIDE AISLE	4'-4 1/2"		6'-5"	5'-3"	4'-6 1/2"	4'-5 1/2" △
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 OUITSIDE 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"				

NOTES:

1. WHERE HIGH INTENSITY LIGHTING IS INSTALLED IN PANEL SYSTEMS 1 1/2" SHALL BE ADDED TO THE PANEL FIGURES.
2. WHERE NO. 1 CROSSBAR FRAMES ARE INSTALLED IN STEP BY STEP SYSTEMS, THE CROSSBAR FIGURES SHALL APPLY FOR THESE FRAMES.
3. △ THIS DIMENSION APPLIES WHERE WIRING AISLES AR 1 FOOT 11 INCHES. SUBTRACT 2 INCHES WHERE WIRING AISLE ARE 1 FOOT 9 INCHES.
4. □ THIS DIMENSION APPLIES WHERE APPARATUS AISLES ARE 2 FEET 6 INCHES. ADD 6 INCHES WHERE APPARATUS AISLES ARE 3 FEET.

EXHIBIT 2-E2-8

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

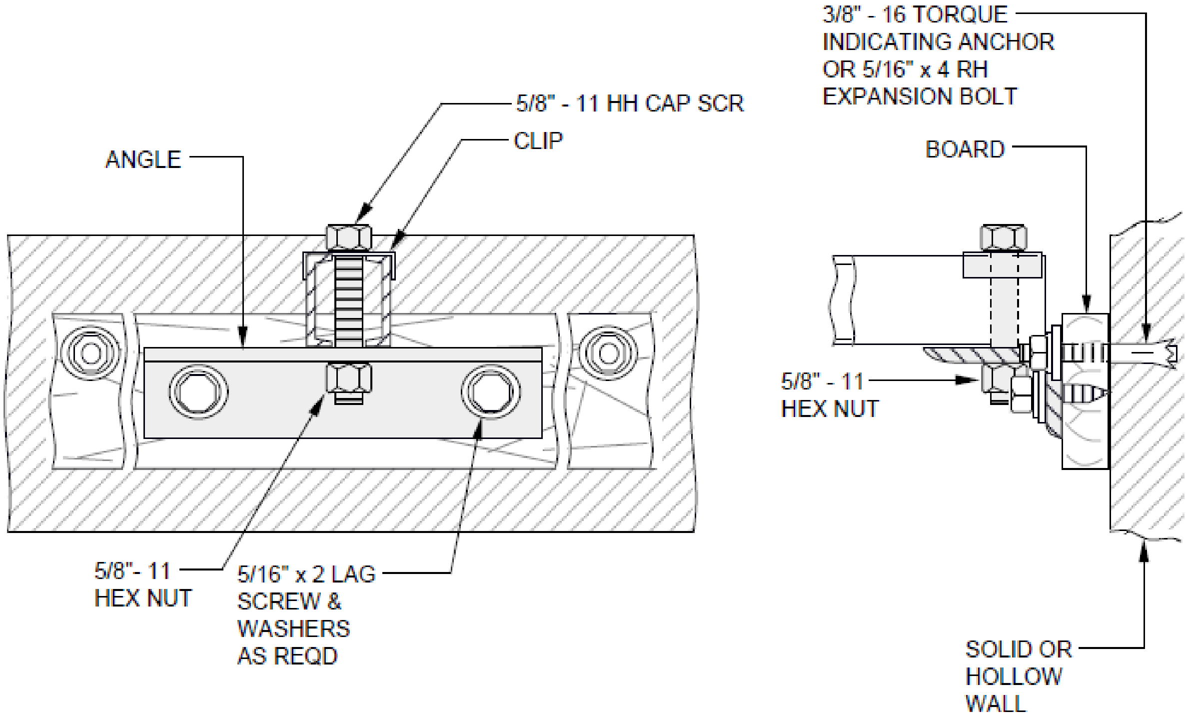


EXHIBIT 2-E2-8C

2-E2-8C AUXILIARY FRAMING SUPPORTED AT WALLS

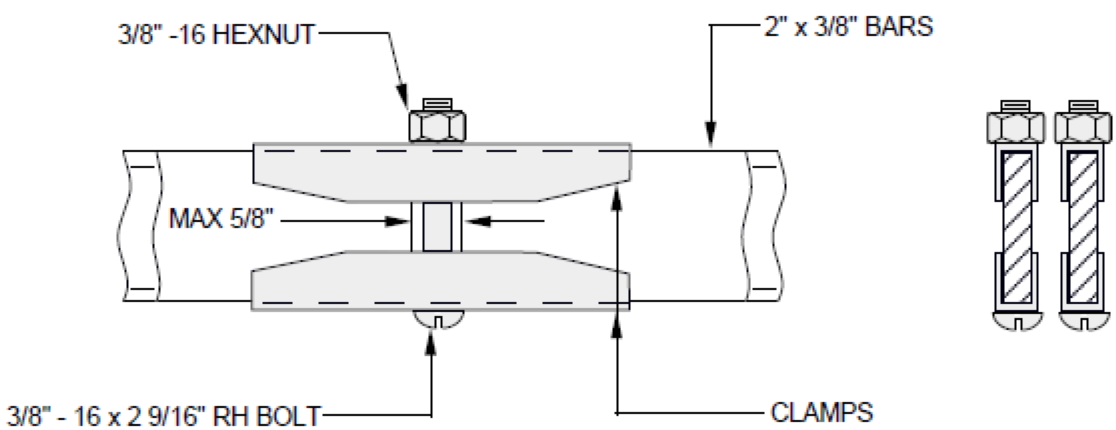


EXHIBIT 2-E2-9 (A&M)

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

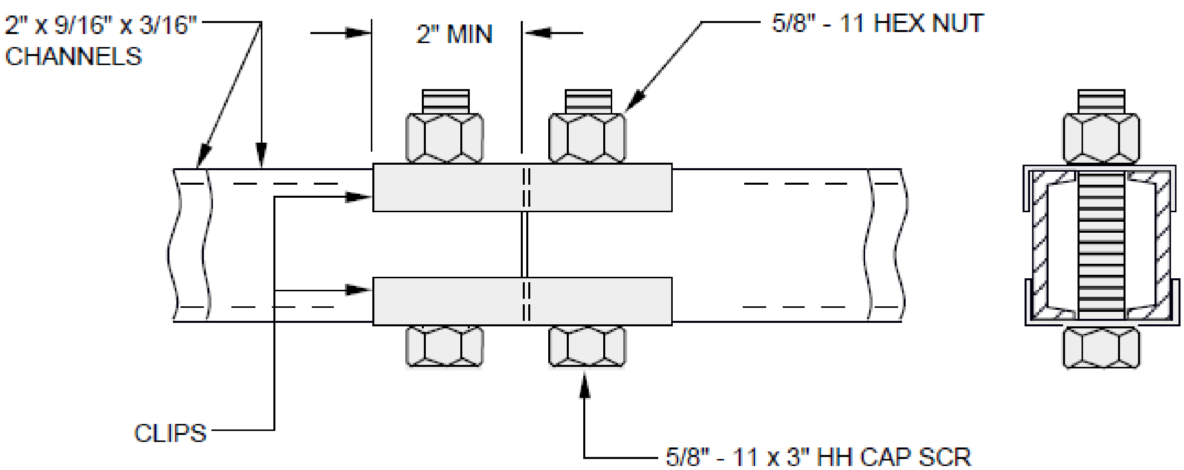


EXHIBIT 2-E2-9A (DISCONTINUED)

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

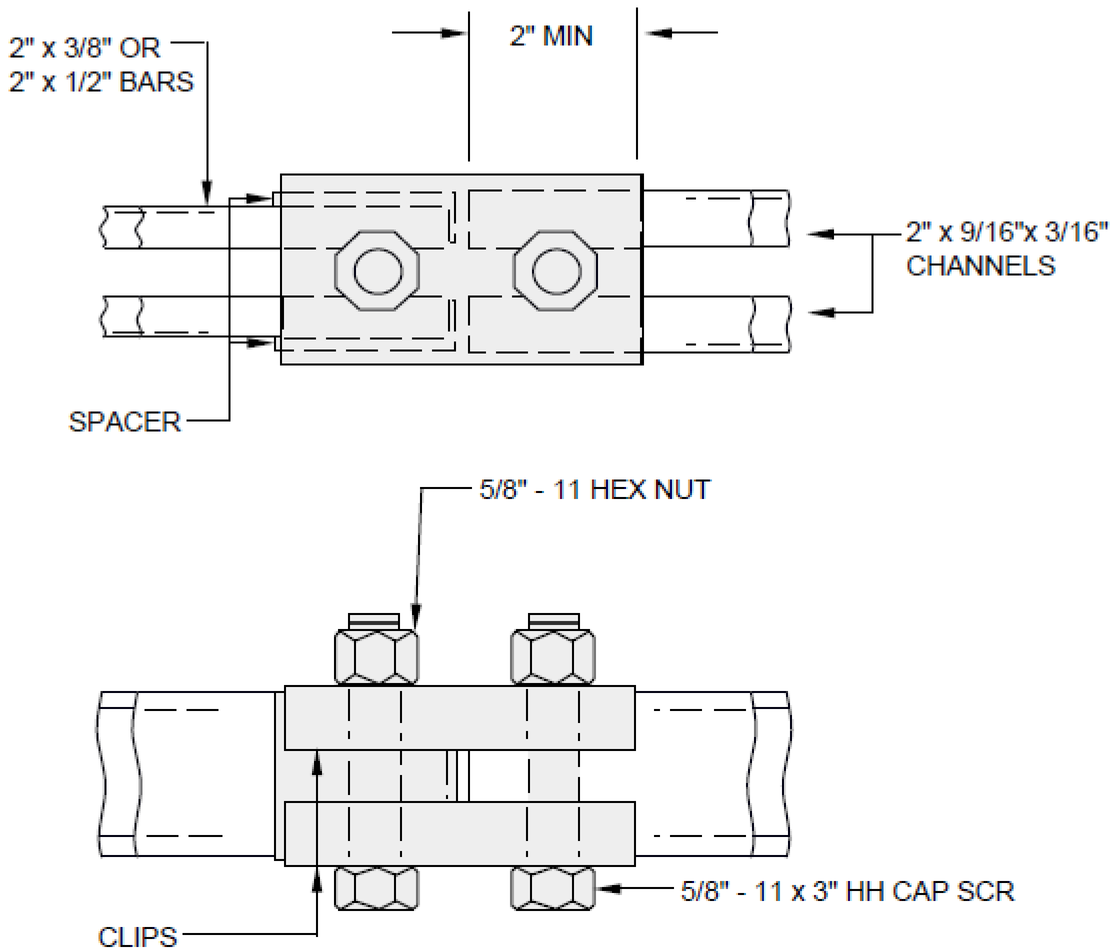


EXHIBIT 2-E2-9B (DISCONTINUED)

2-E2-9B SPLICING AUXILIARY FRAMING-CHANNELS TO BARS

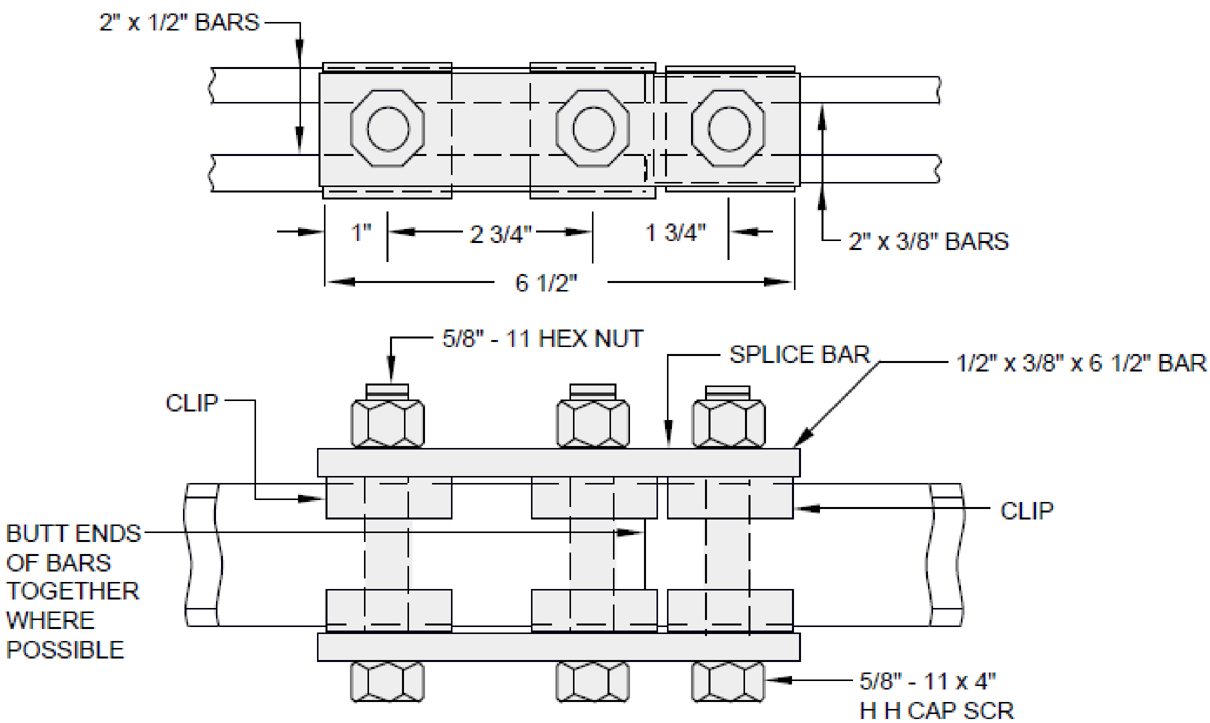
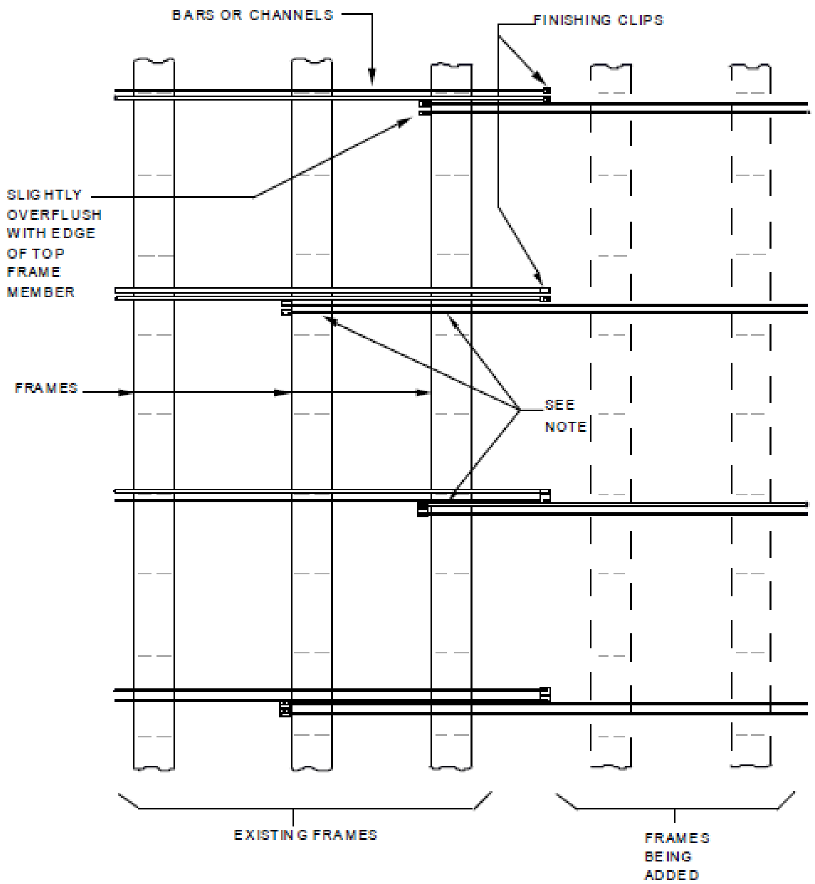


EXHIBIT 2-E2-9C

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

2-E2-9D ARRANGEMENT FOR EXTENDING BAR OR CHANNEL FRAMING TO ELIMINATE NECESSITY OF CUTTING BACK EXISTING FRAMING

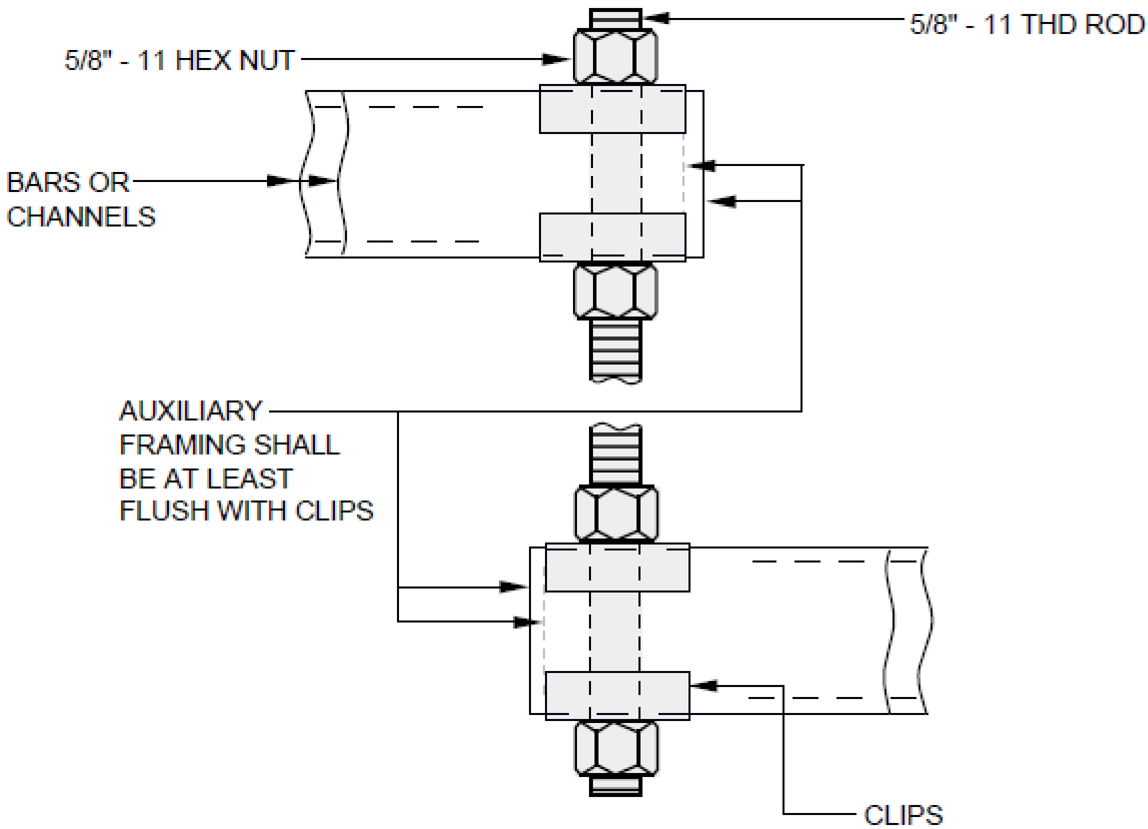
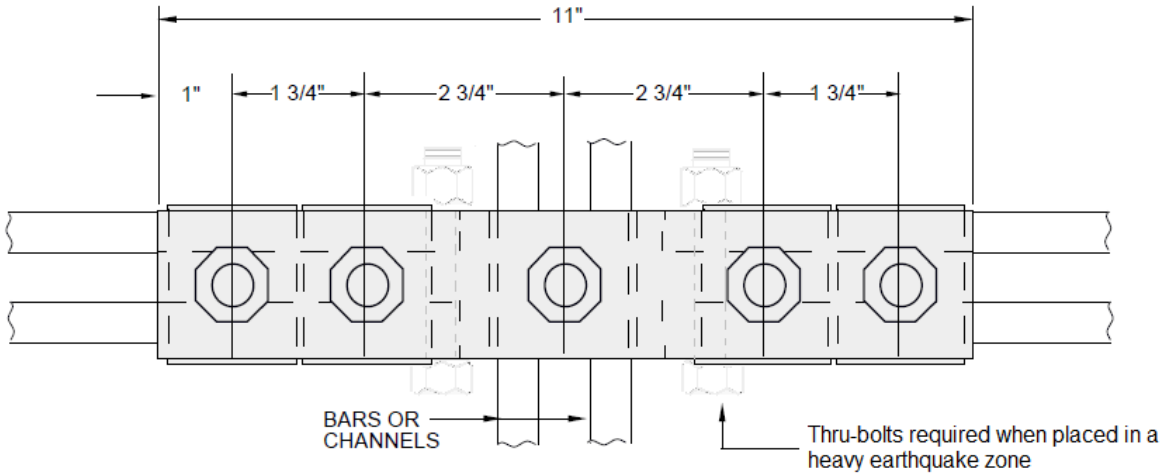


EXHIBIT 2-E2-9E

2-E2-9E JUNCTIONING LOW-TO HIGH-LEVEL FRAMING



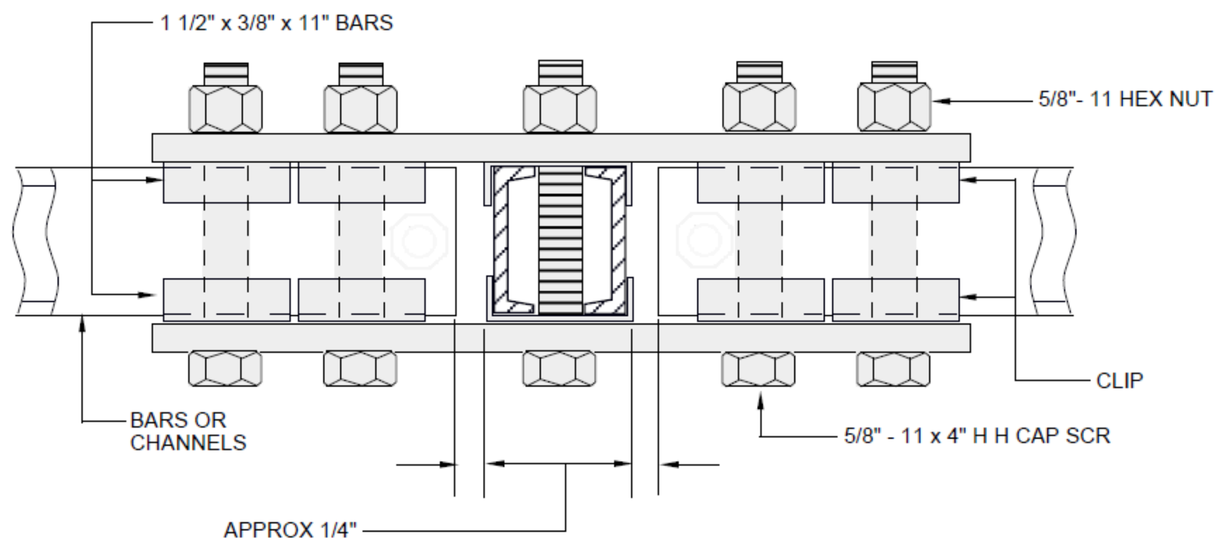


EXHIBIT 2-E2-9F

2-E2-9F SINGLE-LEVEL AUXILIARY FRAMING INTERSECTION OF PRIMARY AND SECONDARY BARS OR CHANNELS

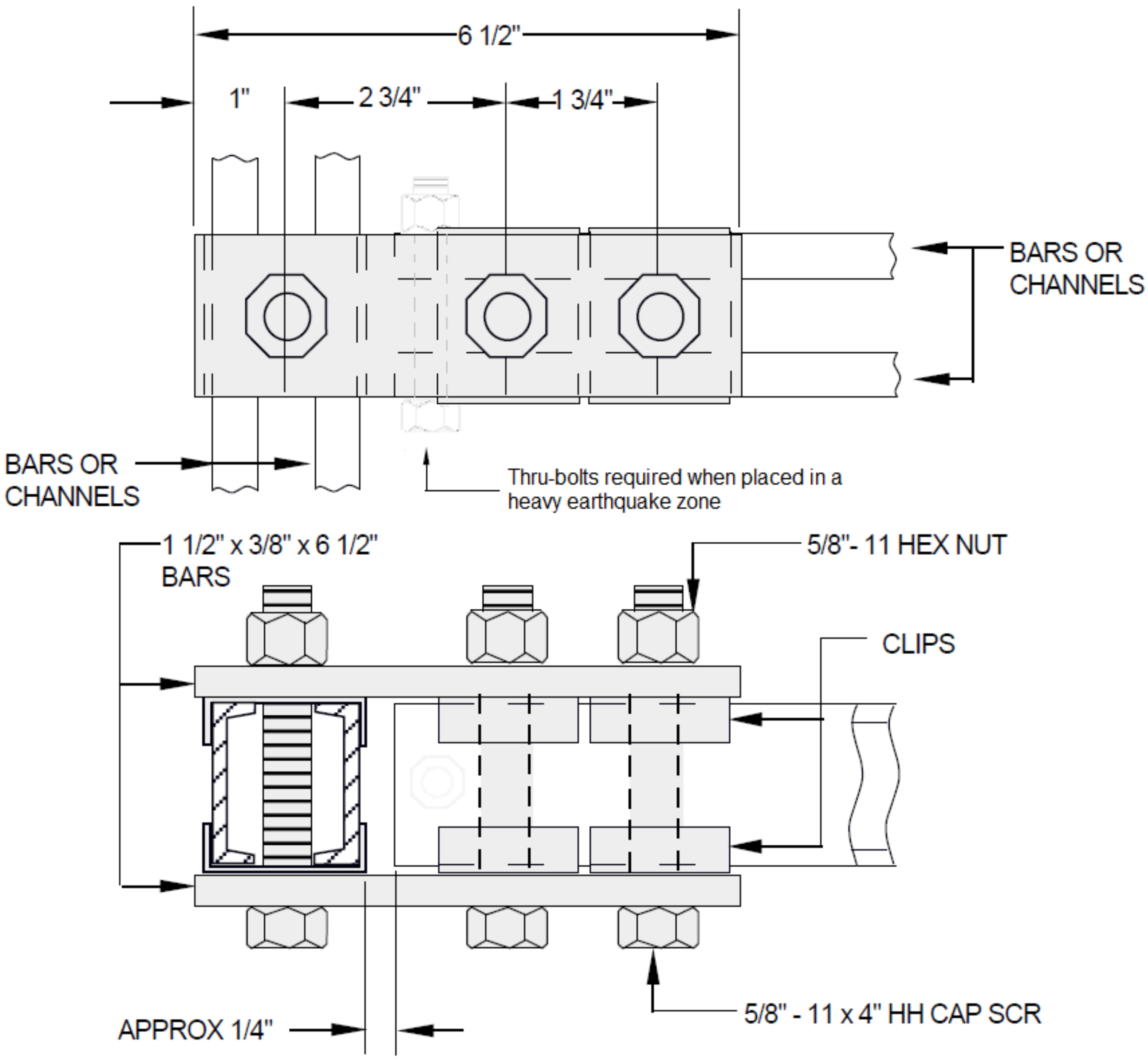


EXHIBIT 2-E2-9G

2-E2-9G SINGLE-LEVEL AUXILIARY FRAMING JUNCTION OF PRIMARY AND SECONDARY BARS OR CHANNELS

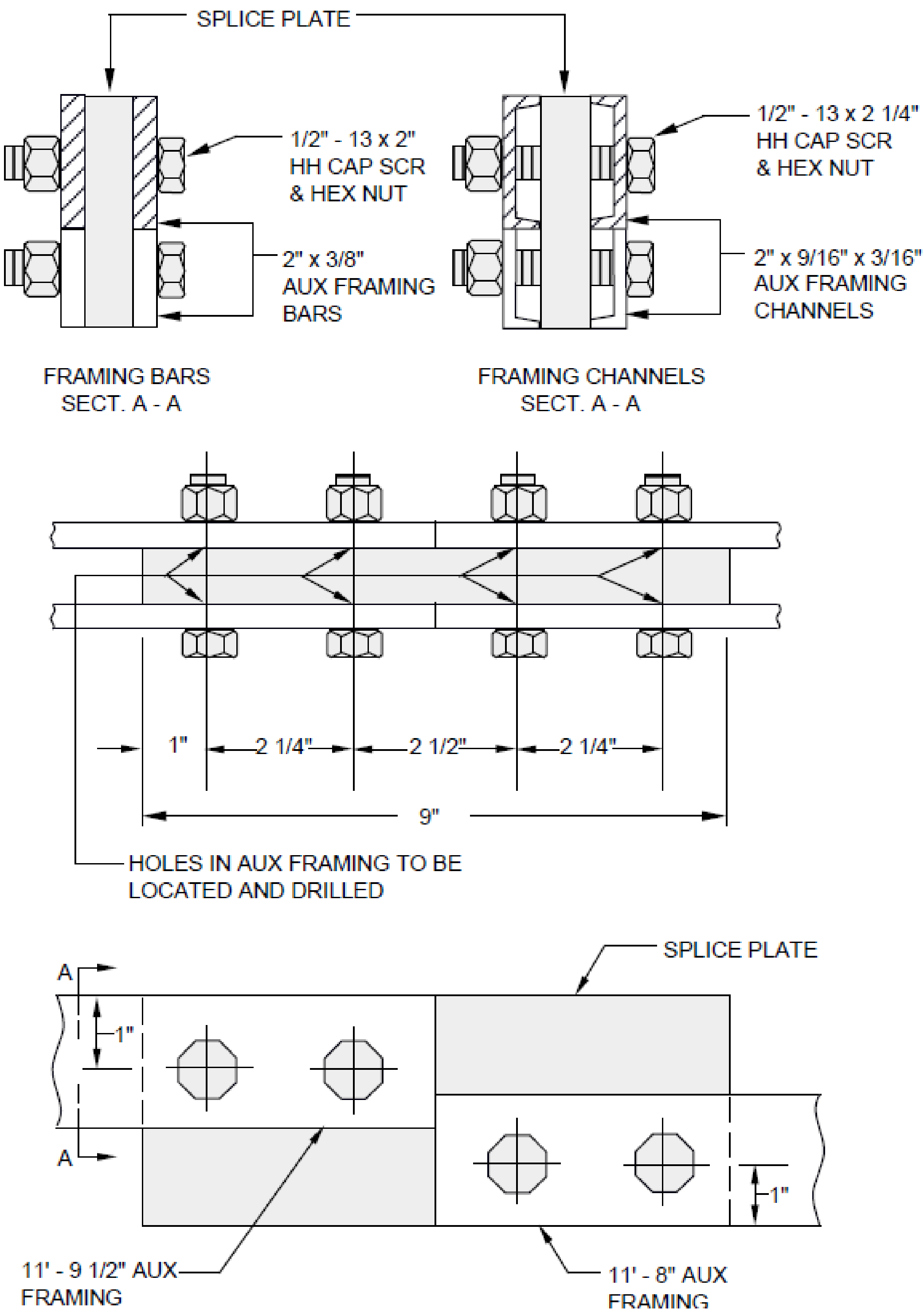


EXHIBIT 2-E2-9H

2-E2-9H SPLICING AUXILIARY FRAMING 11 FOOT 8 INCH AND 11 FOOT 9 and 1/2 INCH FRAMING

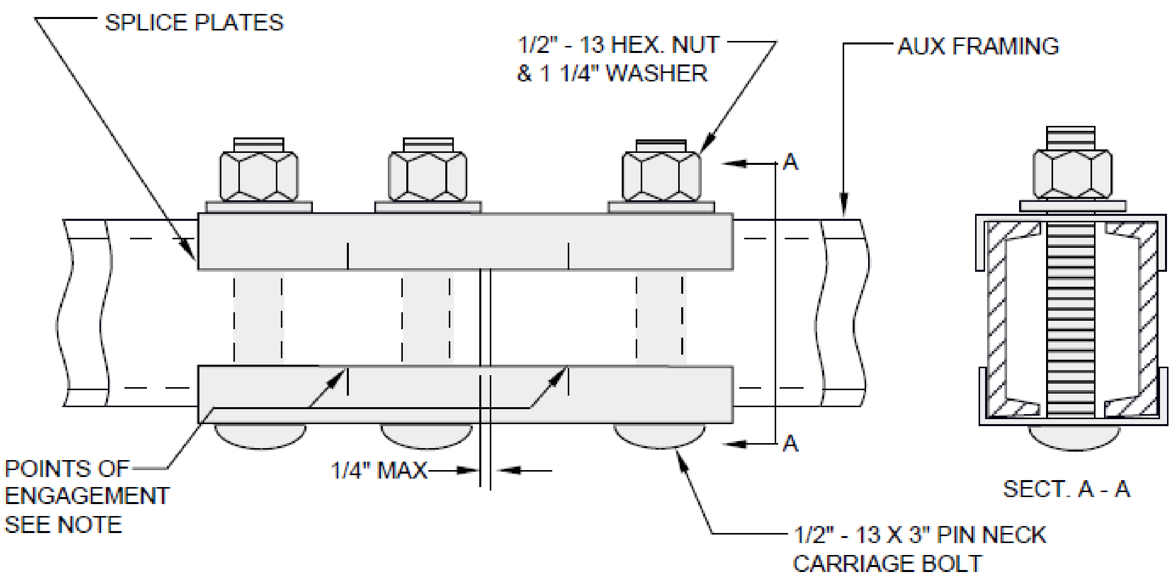
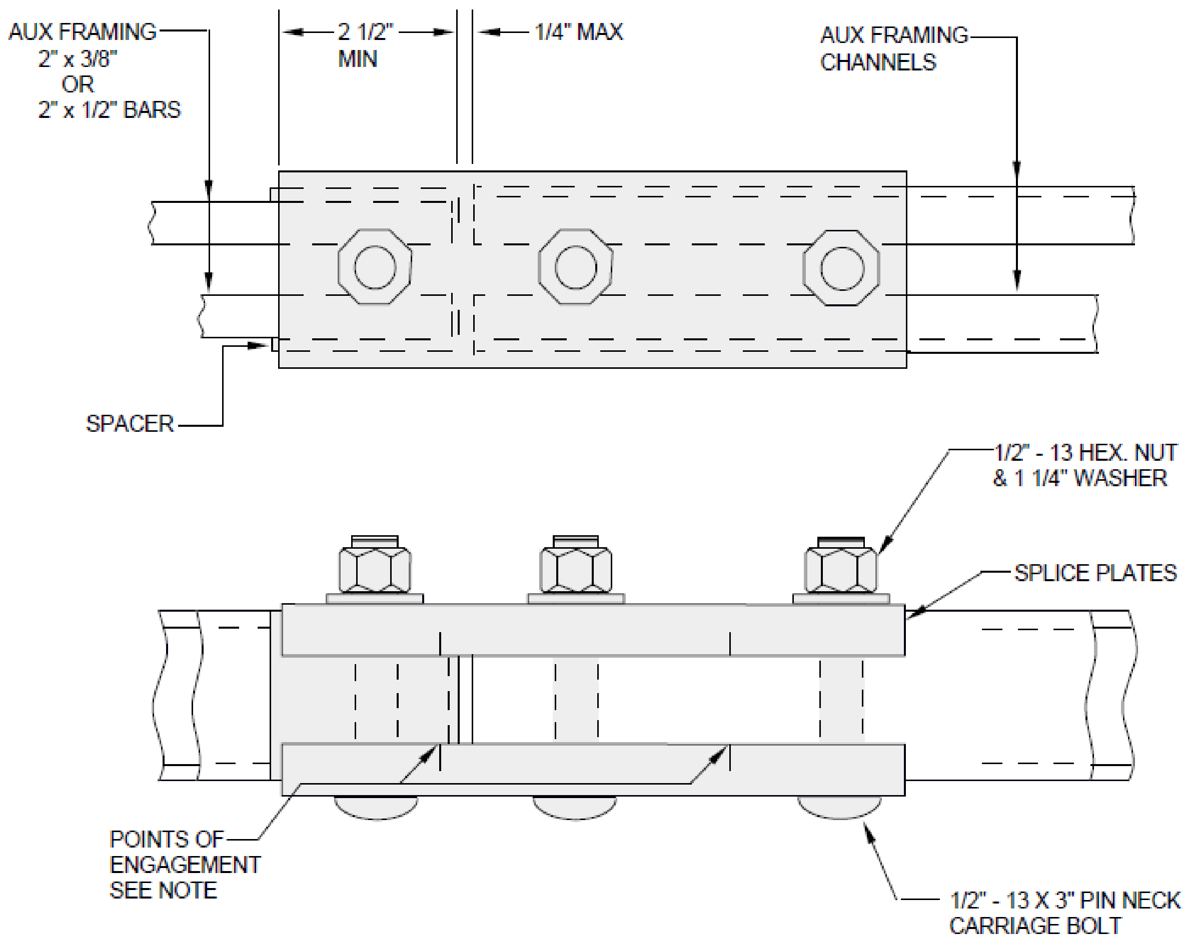


EXHIBIT 2-E2-9J

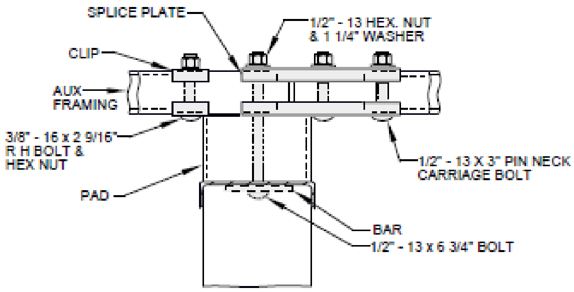
2-E2-9J SPLICING AUXILIARY FRAMING-CHANNELS TO CHANNELS USING 3-HOLE SPLICE PLATES



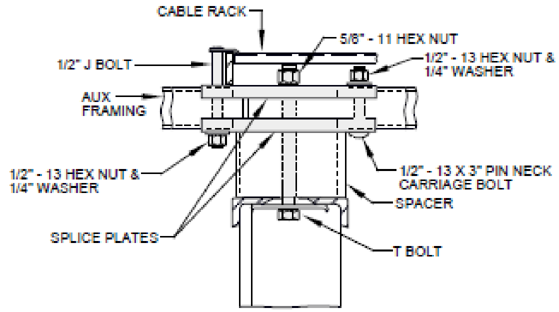
NOTE:
THE AUXILIARY FRAMING BAR AND CHANNEL ENDS MUST BE LOCATED WITHIN THE POINTS OF ENGAGEMENT WHICH ARE MARKED ON THE SIDES OF THE SPLICE PLATE.

EXHIBIT 2-E2-9K

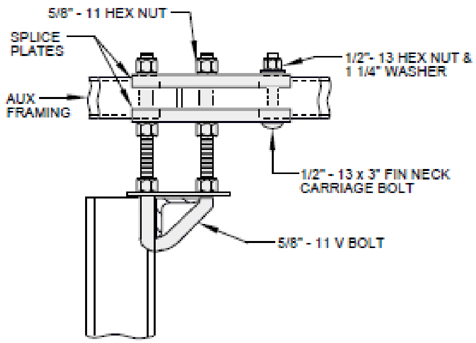
2-E2-9K SPLICING AUXILIARY FRAMING-CHANNELS TO BARS-USING 3-HOLE SPLICE PLATES



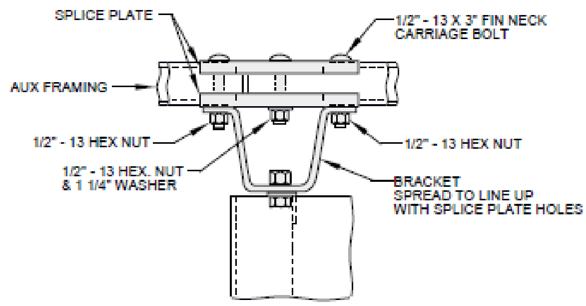
NO. 5 CROSSBAR FRAME



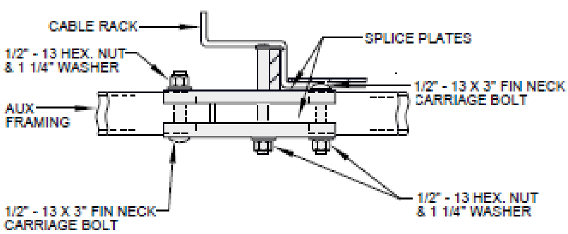
BULB ANGLE FRAME AND/OR LADDER - TYPE CABLE RACK



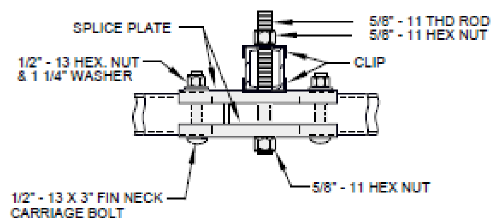
SINGLE TOP - ANGLE FRAME



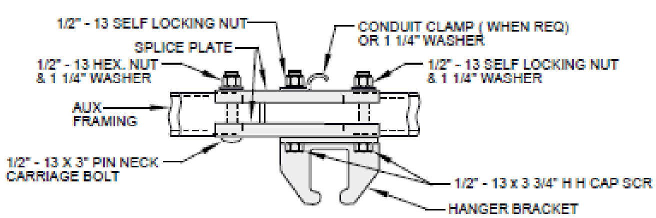
BATTERY DISTRIBUTION FUSE BOARD



BAR - TYPE CABLE RACK



DOUBLE LEVEL AUXILIARY FRAMING

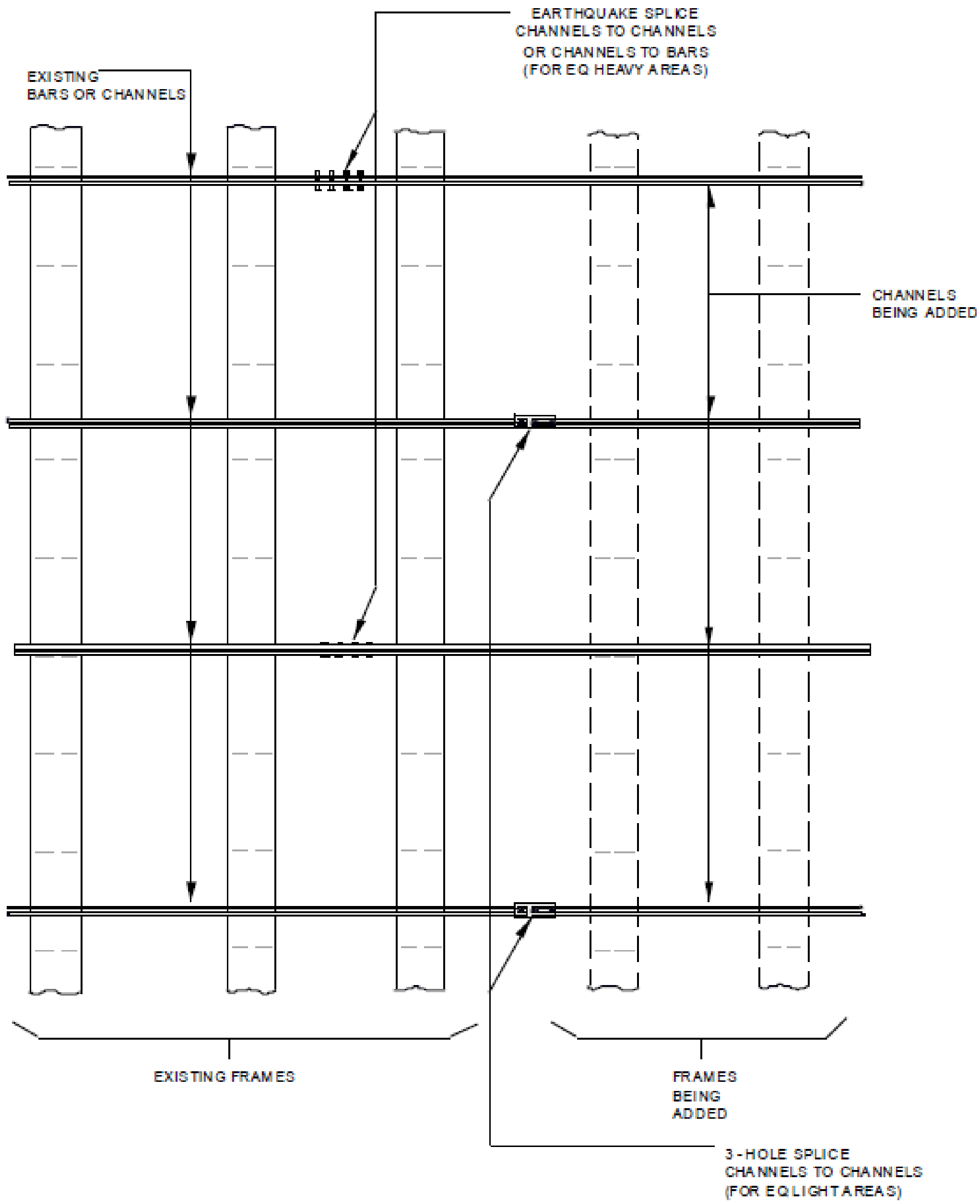


LADDER TRACK BRACKET

NOTE: HANGER BRACKET & CONDUIT CLAMP TO BE DRILLED FOR 1/2" CAP SCR

EXHIBIT 2-E2-9L

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
2-E2-9M ARRANGEMENT FOR EXTENDING BAR OR CHANNEL FRAMING WITH CHANNEL FRAMING-ELIMINATING NECESSITY OF CUTTING BACK EXISTING FRAME

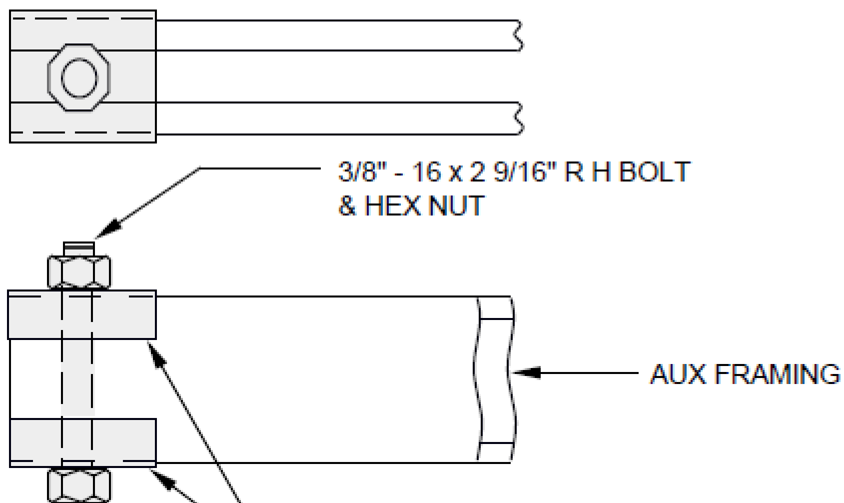


EXHIBIT 2-E2-10
2-E2-10 FINISHING CLIPS ON AUXILIARY FRAMING

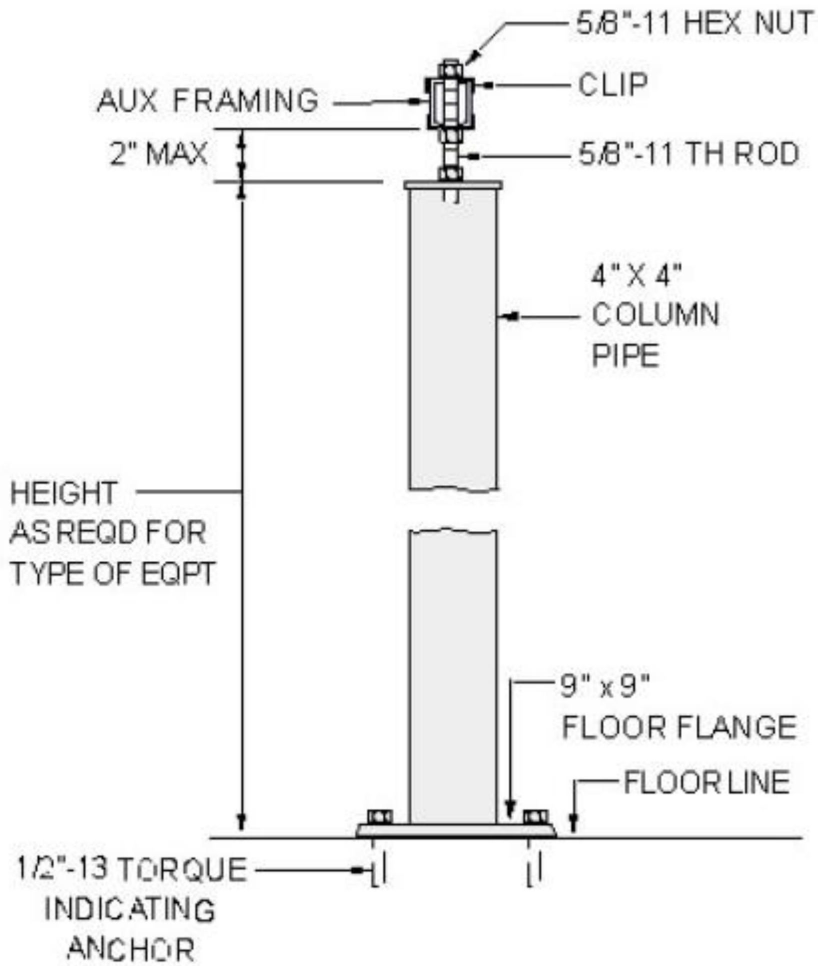


EXHIBIT 2-E2-11

2-E2-11 PIPE STAND SUPPORT OF AUXILIARY FRAMING

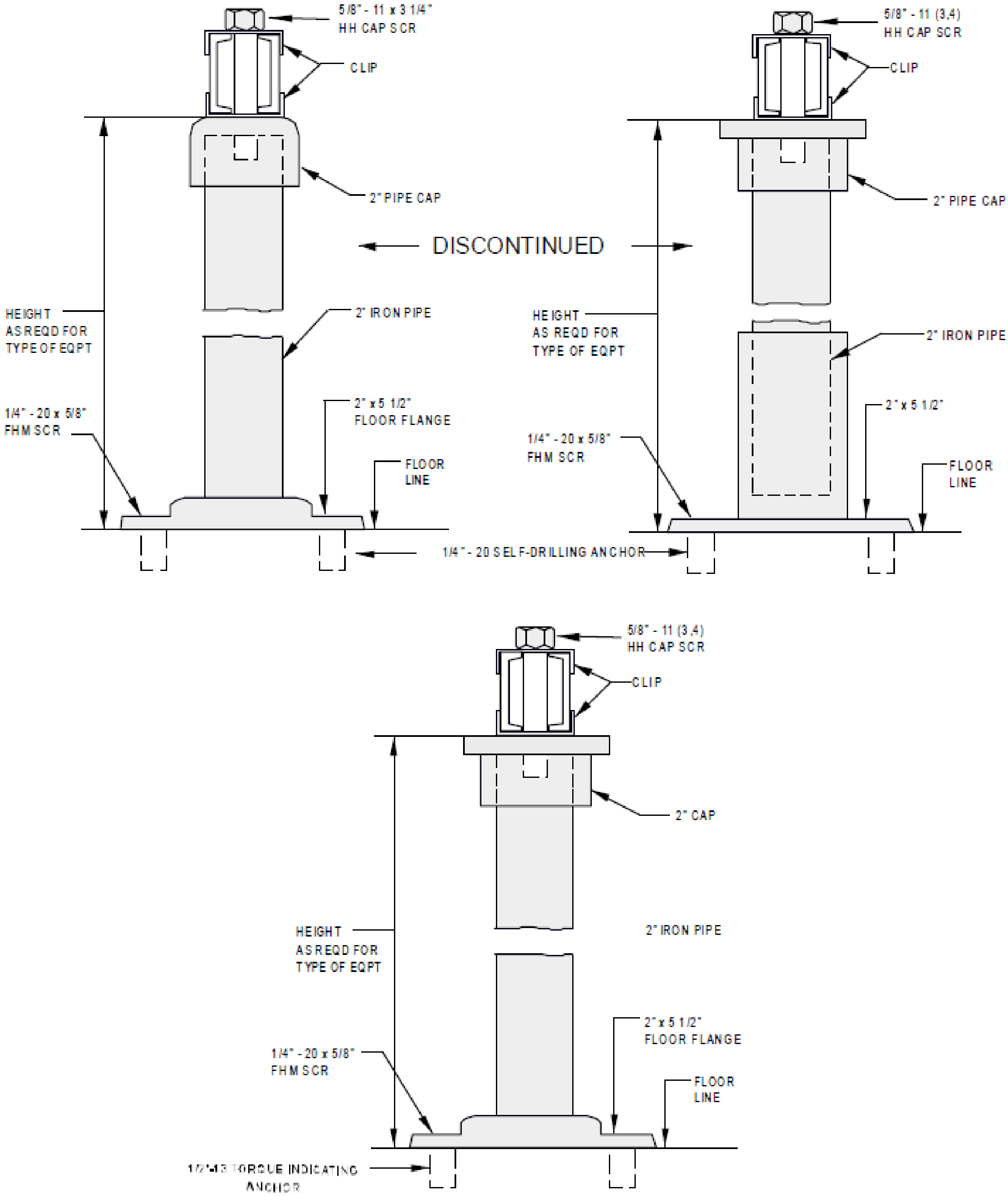


EXHIBIT 2-E2-11A

2-E2-11A PIPE STAND SUPPORT OF AUXILIARY FRAMING (A&M)

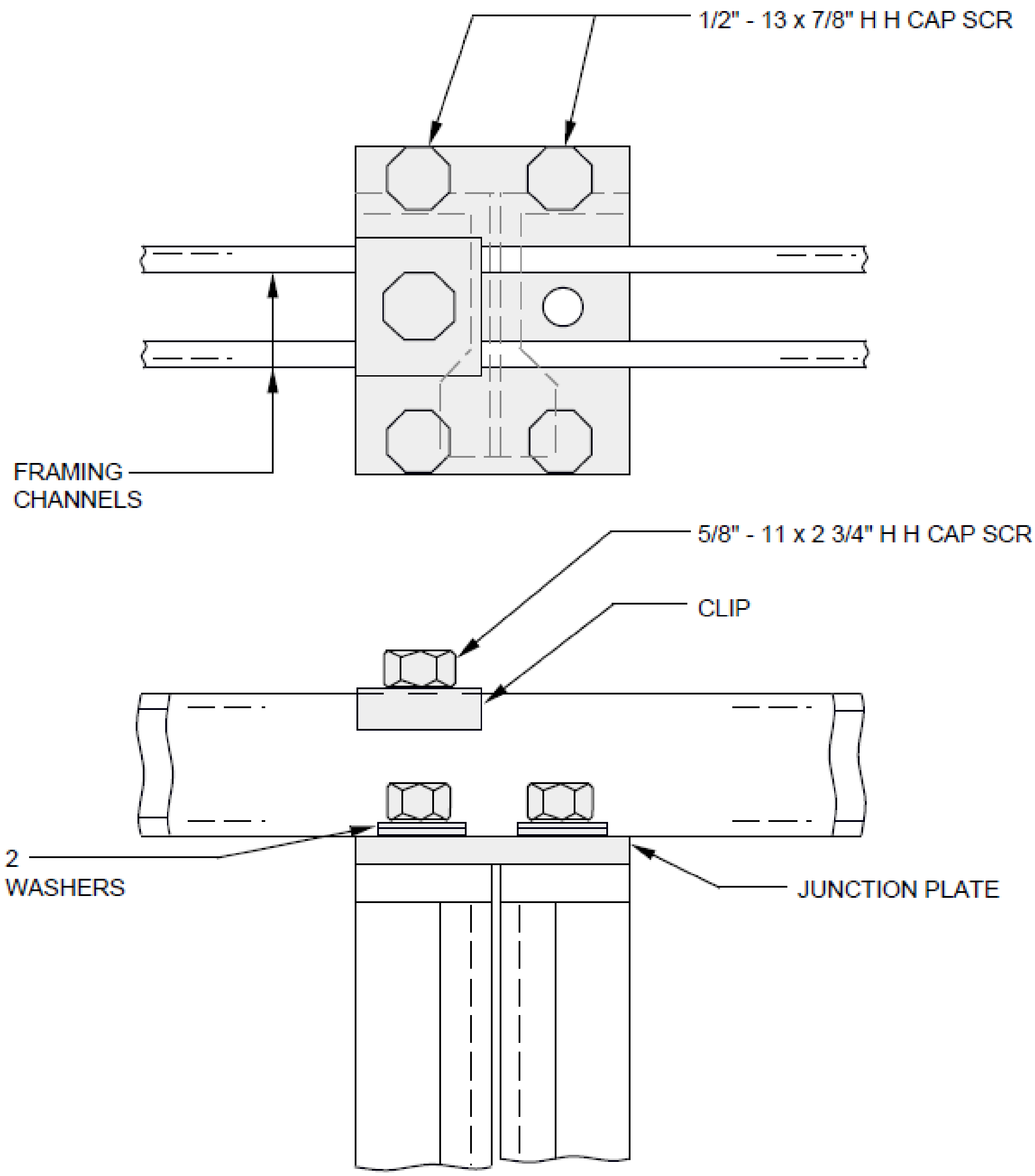


EXHIBIT 2-E2-11B (A&M)

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

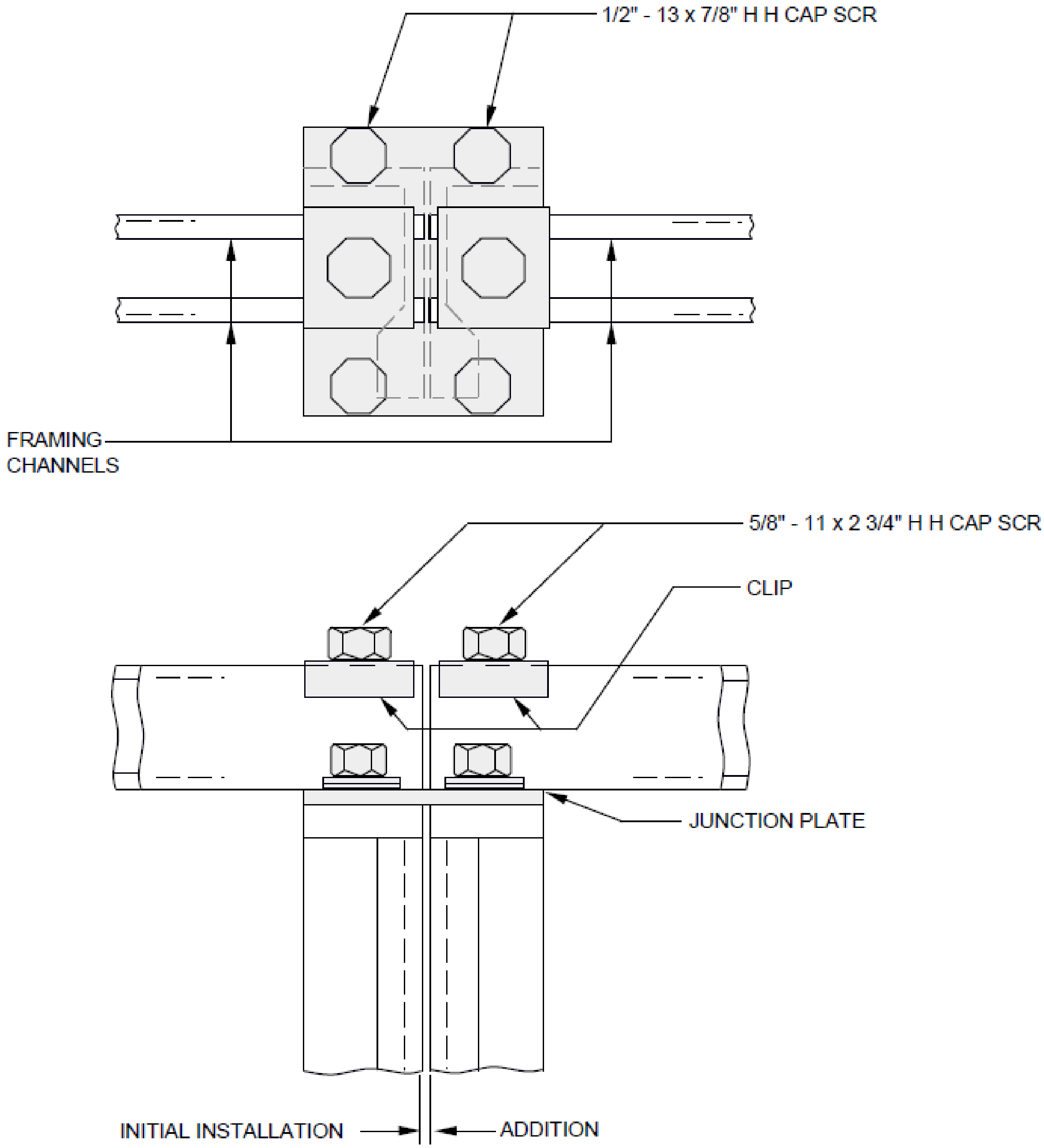


EXHIBIT 2-E2-11C (A&M)

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

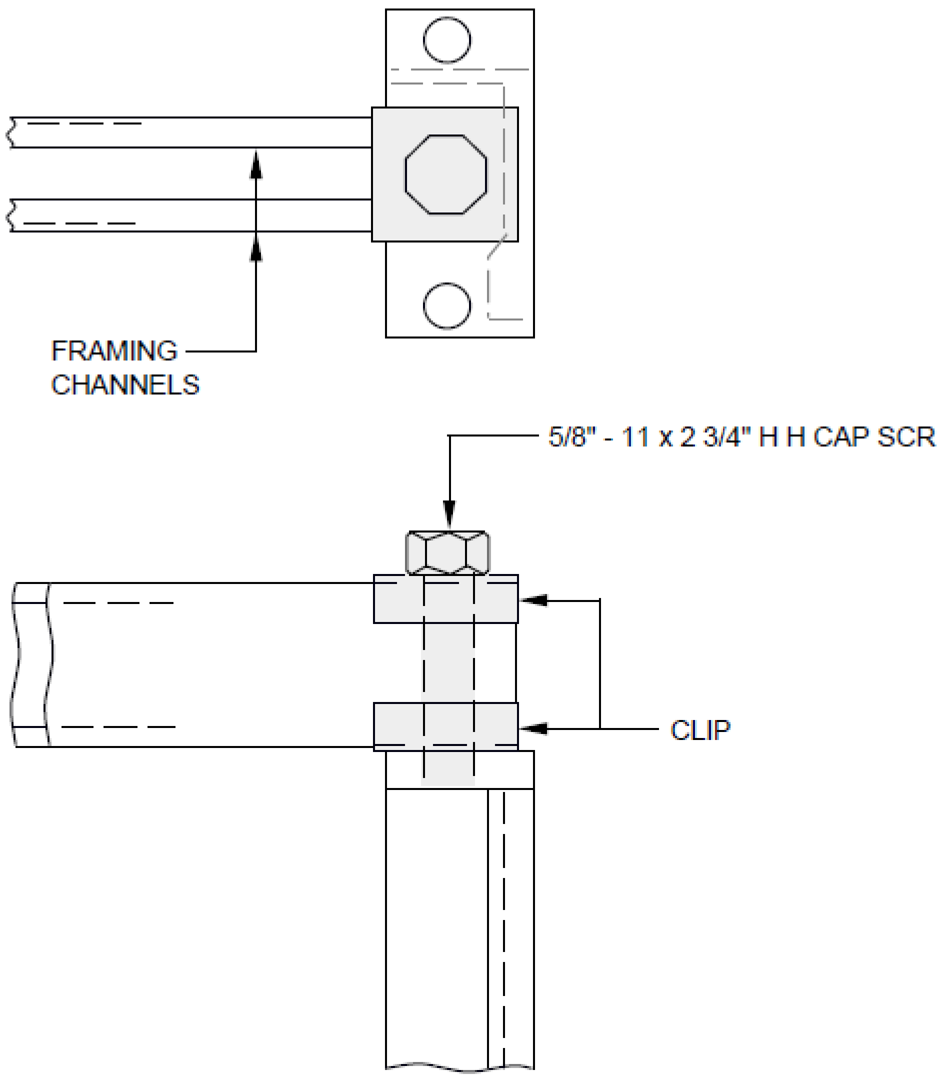


EXHIBIT 2-E2-11D (A&M)

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

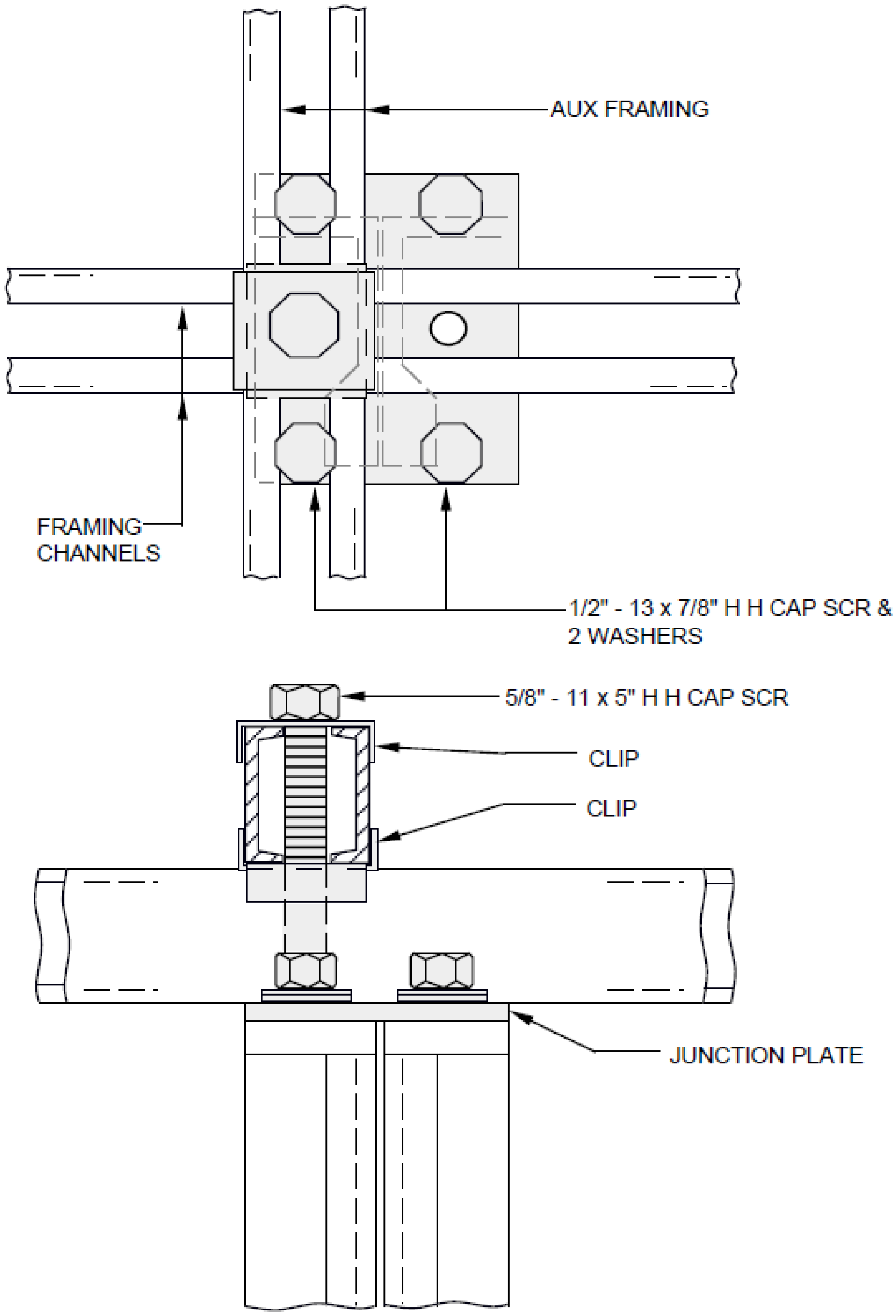


EXHIBIT 2-E2-11E (A&M)
2-E2-11E (A&M) JUNCTIONING ADJACENT FRAME UPRIGHTS HAVING 2 INCH CHANNEL TOP MEMBER WITH AUXILIARY FRAMING OVER ONE OF THE UPRIGHTS-BULB-ANGLE OR CHANNEL-TYPE STEP-BY-STEP FRAMES-BULB-ANGLE TYPE SHOWN 11 FOOT 8 INCH FRAMING

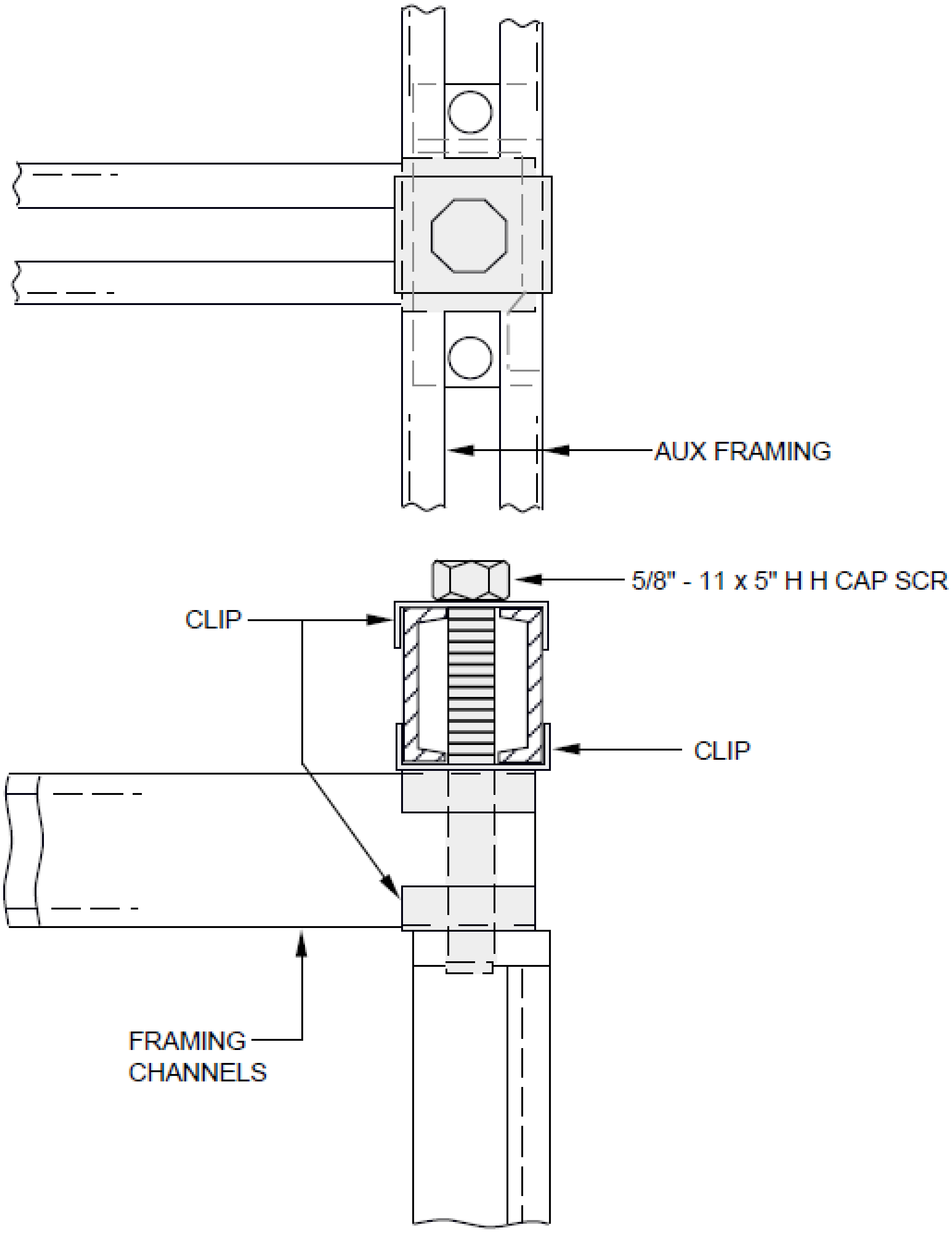


EXHIBIT 2-E2-11F (A&M)

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

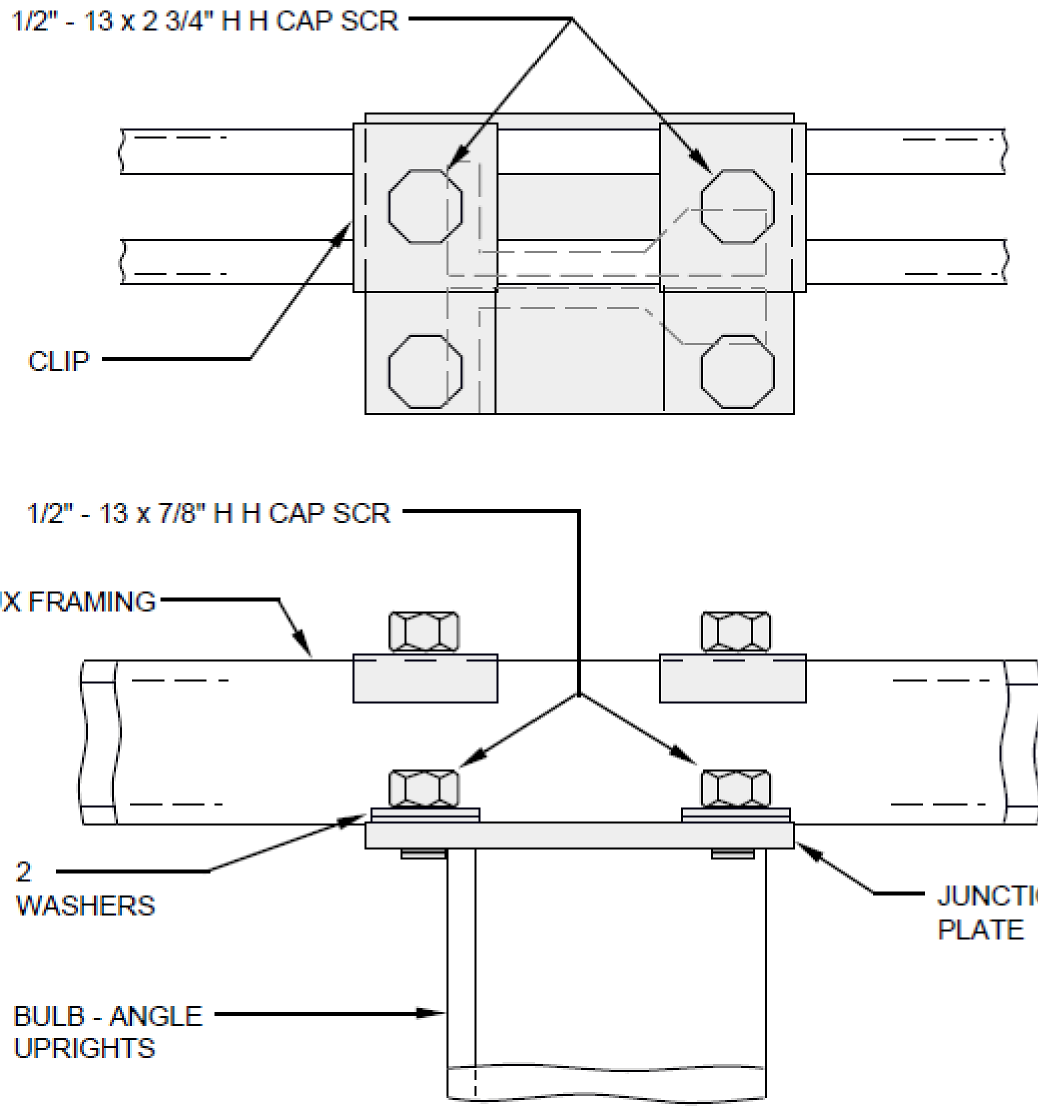


EXHIBIT 2-E2-11G (A&M)

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

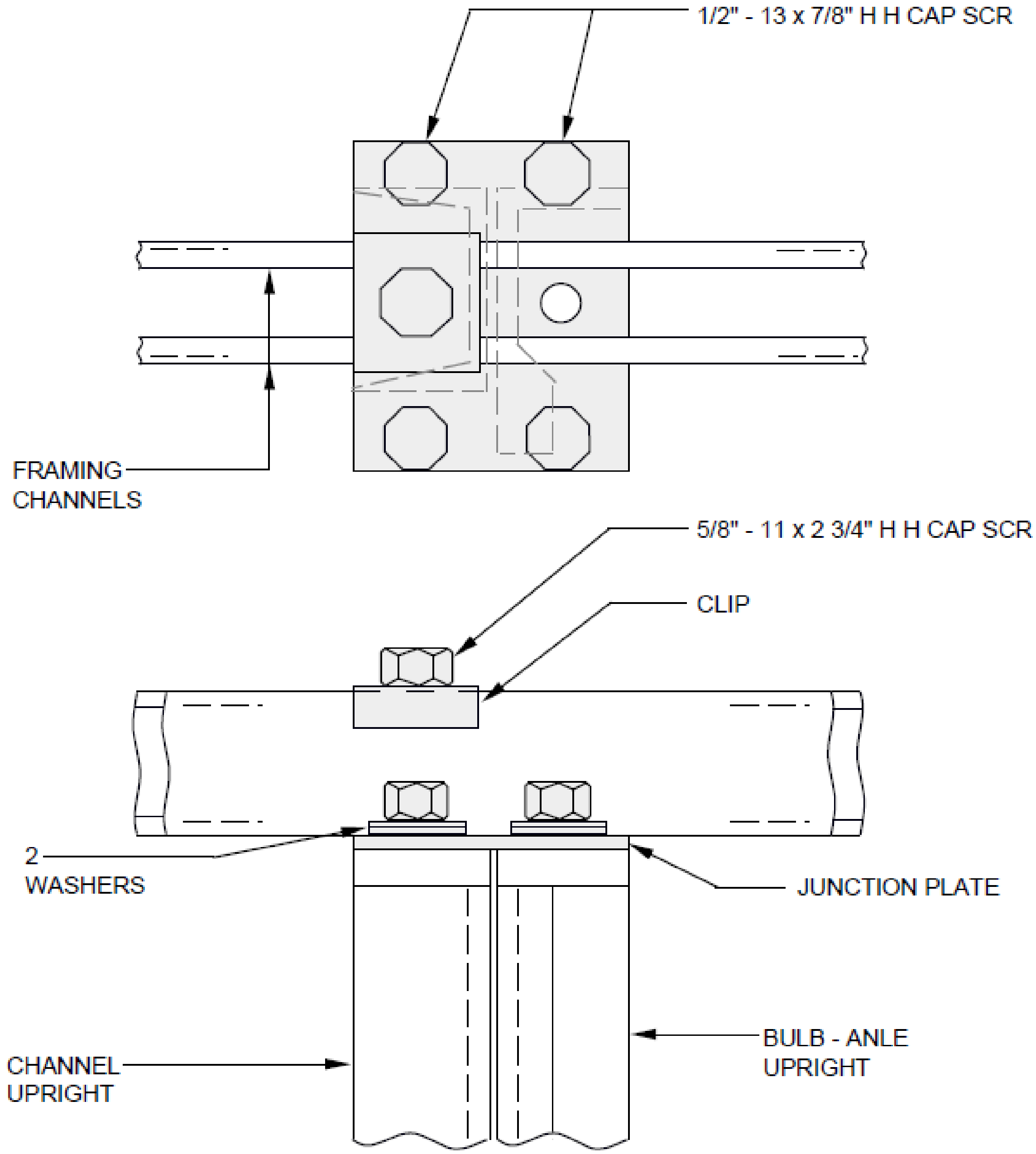


EXHIBIT 2-E2-11H (A&M)

2-E2-11H (A&M) JUNCTIONING ADJACENT FRAME UPRIGHTS WITH CHANNEL-TYPE TOP MEMBERS BULB-ANGLE TO CHANNEL-TYPE STEP-BY-STEP SWITCH FRAMES

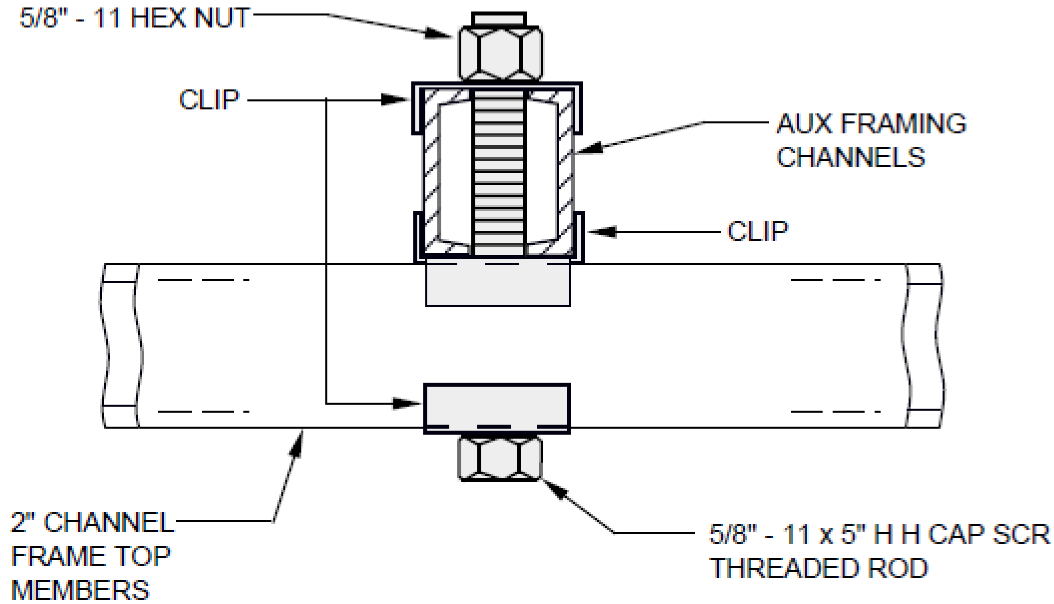


EXHIBIT 2-E2-11J

2-E2-11J DOUBLE-LEVEL AUXILIARY FRAMING-FASTENING CHANNEL OVER CHANNEL

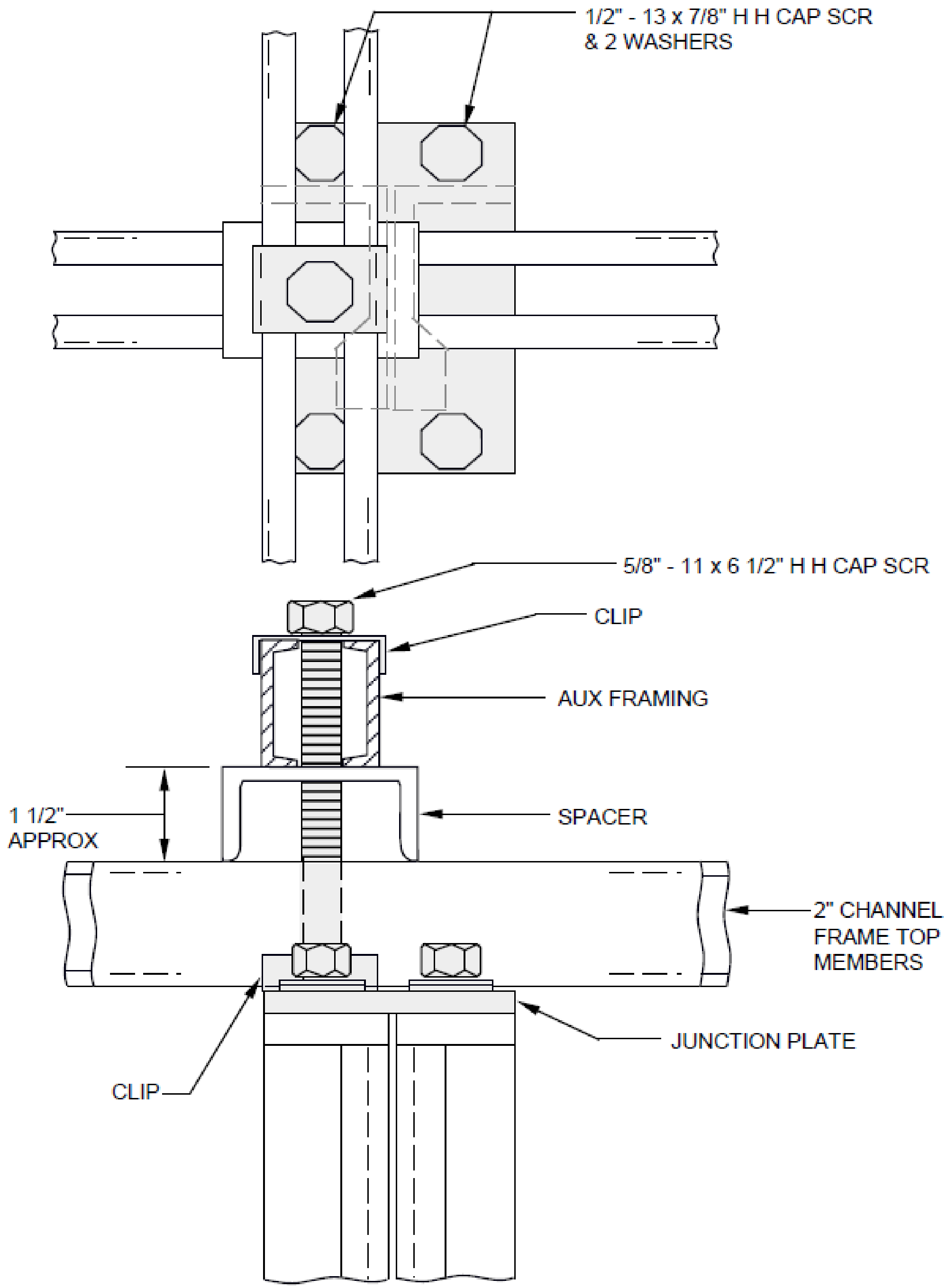


EXHIBIT 2-E2-11K (A&M)

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

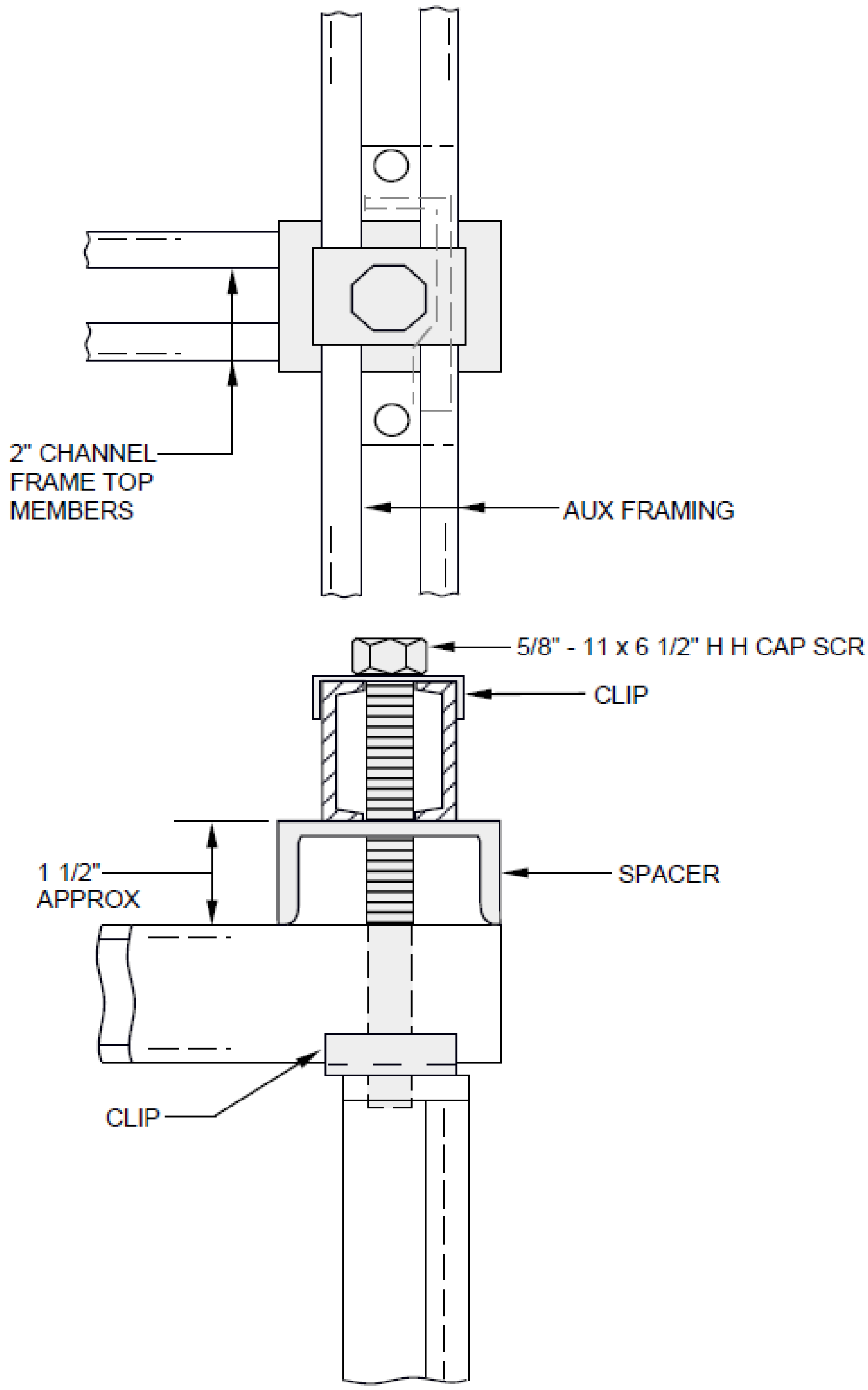


EXHIBIT 2-E2-11L (A&M)

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

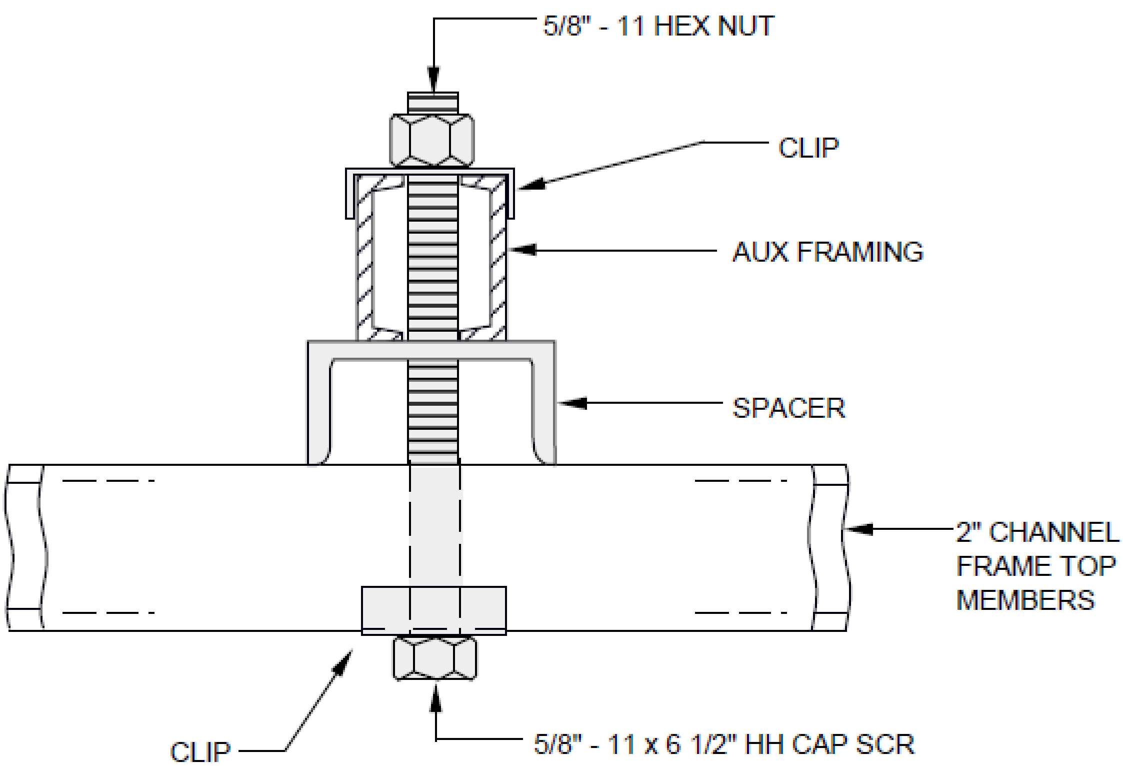


EXHIBIT 2-E2-11M (A&M)
2-E2-11M (A&M) AUXILIARY FRAMING ATTACHED TO 2 INCH CHANNEL TOP MEMBERS OF STEP-BY-STEP SWITCH FRAMES-FASTENING BETWEEN FRAME UPRIGHTS 11 FOOT 9 and 1/2 INCH FRAMING

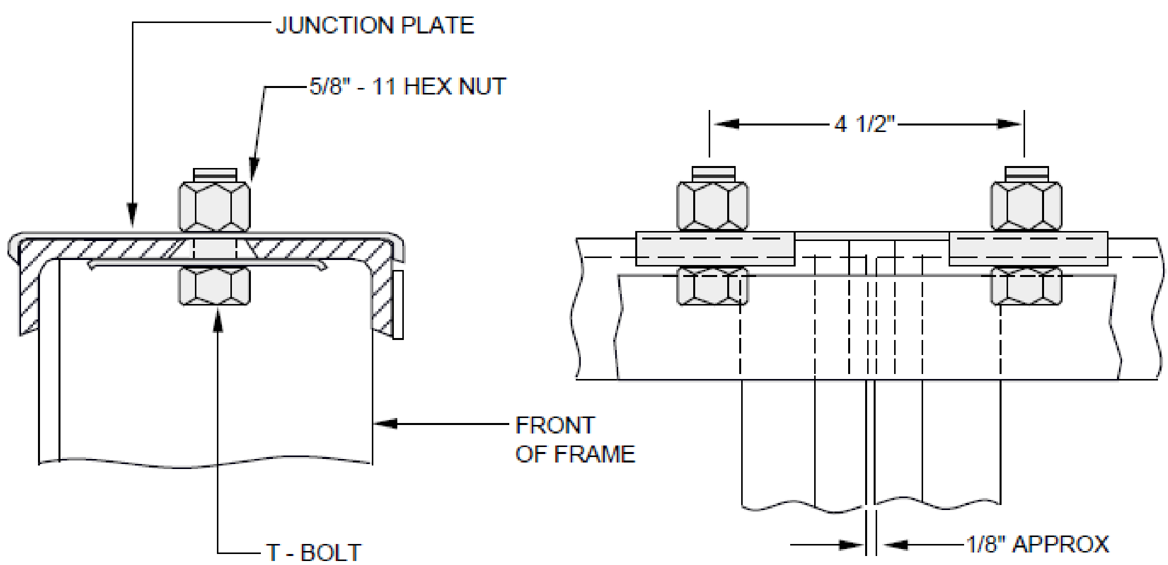


EXHIBIT 2-E2-12B (A&M)

2-E2-12B (A&M) JUNCTIONING TOP ANGLES OF BULB-ANGLE-TYPE FRAMES

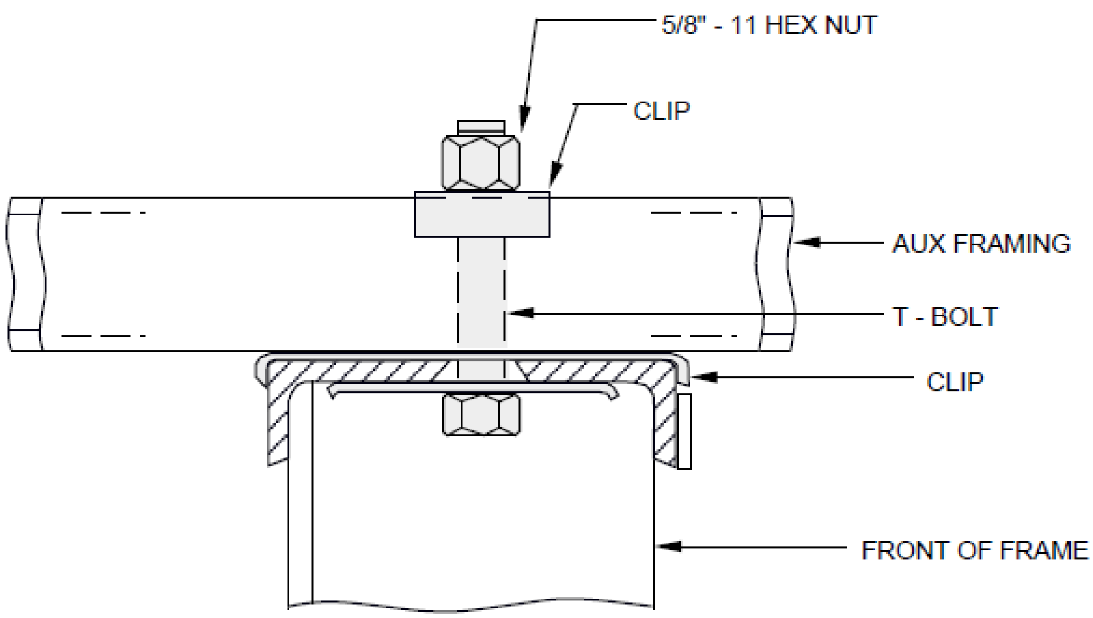
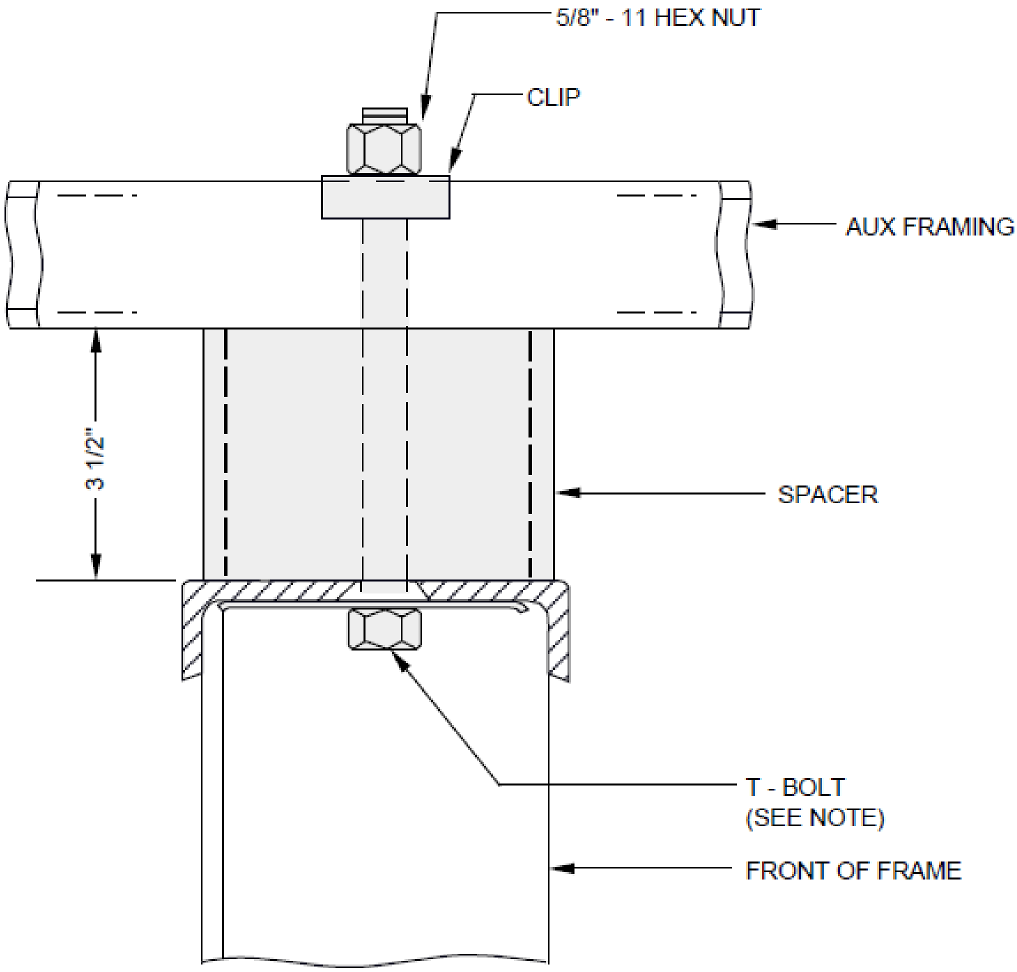
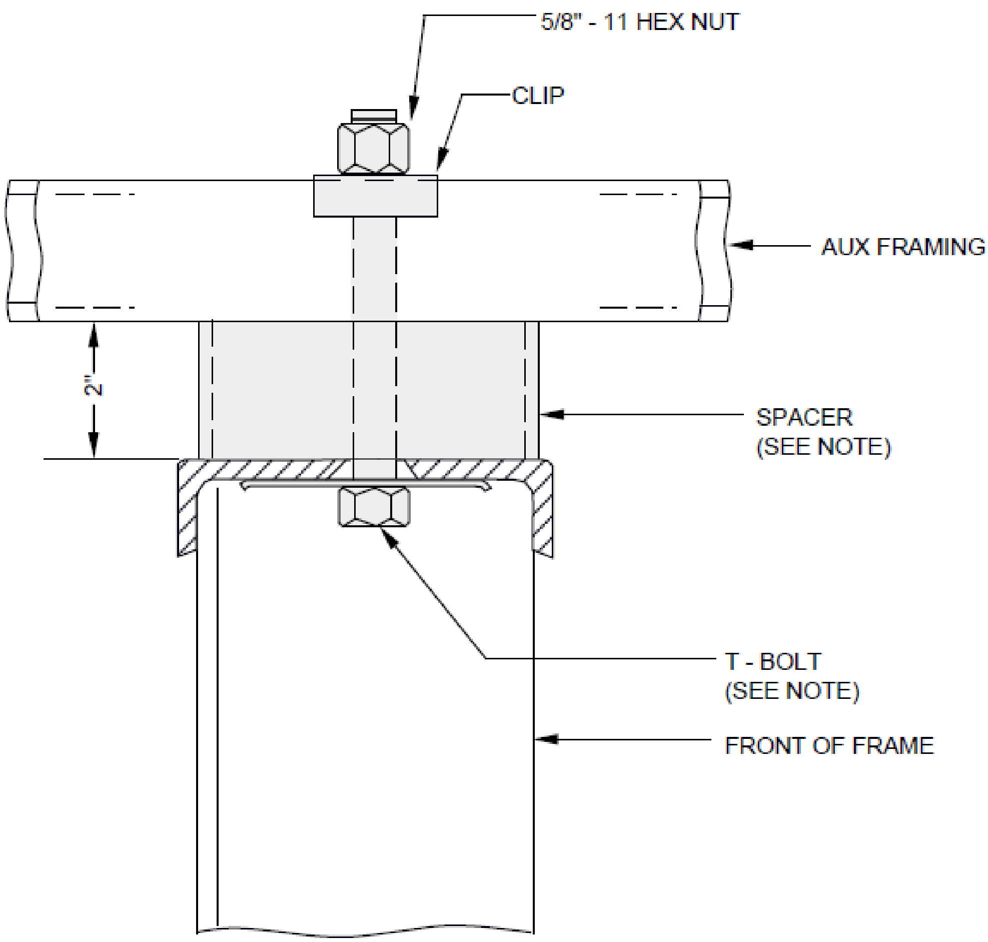


EXHIBIT 2-E2-12C (A&M)
2-E2-12C (A&M) AUXILIARY FRAMING ATTACHED DIRECTLY TO TOP ANGLES OF BULB-ANGLE-TYPE FRAMES



NOTE:
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-12F (A&M)
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)
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

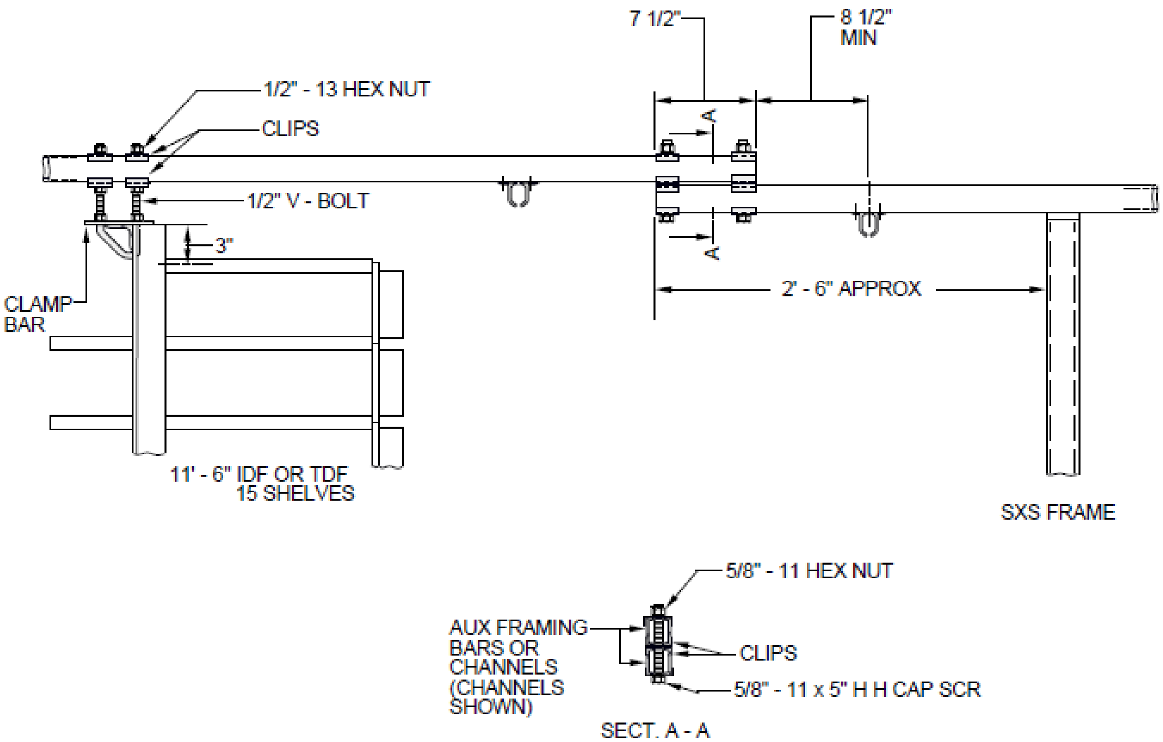


EXHIBIT 2-E2-13

2-E2-13 AUXILIARY FRAMING RAISED AND EXTENDED OVER STEP-BY-STEP DISTRIBUTING FRAMES-11 FOOT 6 INCH FRAMING-ADDITIONS ONLY

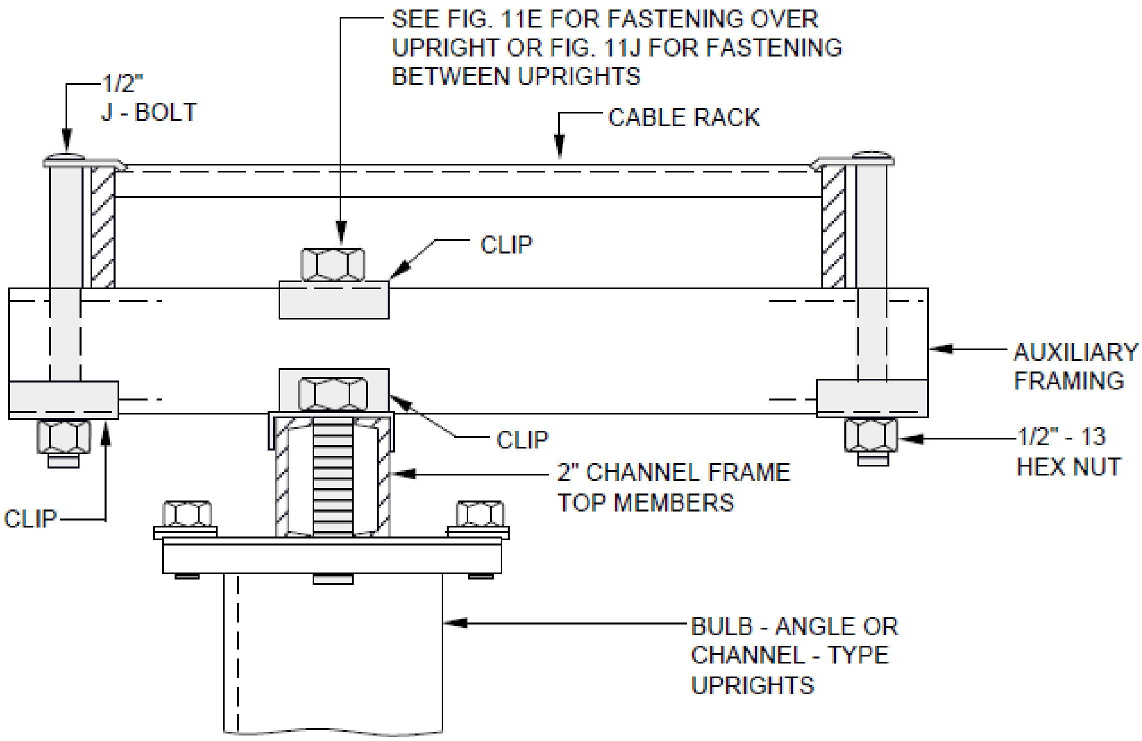


EXHIBIT 2-E2-15B (A&M)

2-E2-15B (A&M) ISOLATED STEP-BY-STEP FRAMES SUPPORTED FROM ONE CABLE RACK 11 FOOT 8 INCH FRAMING

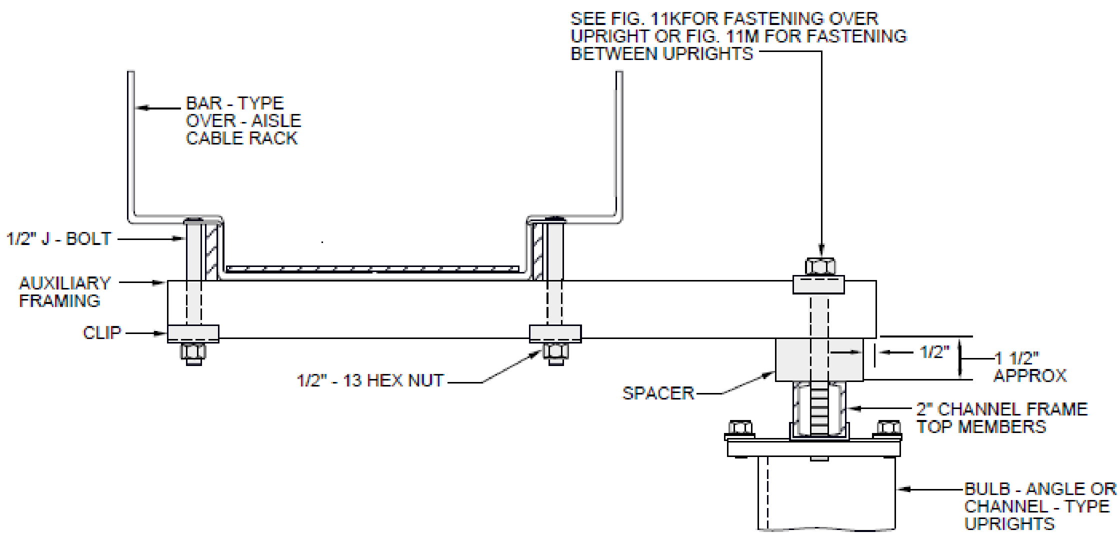
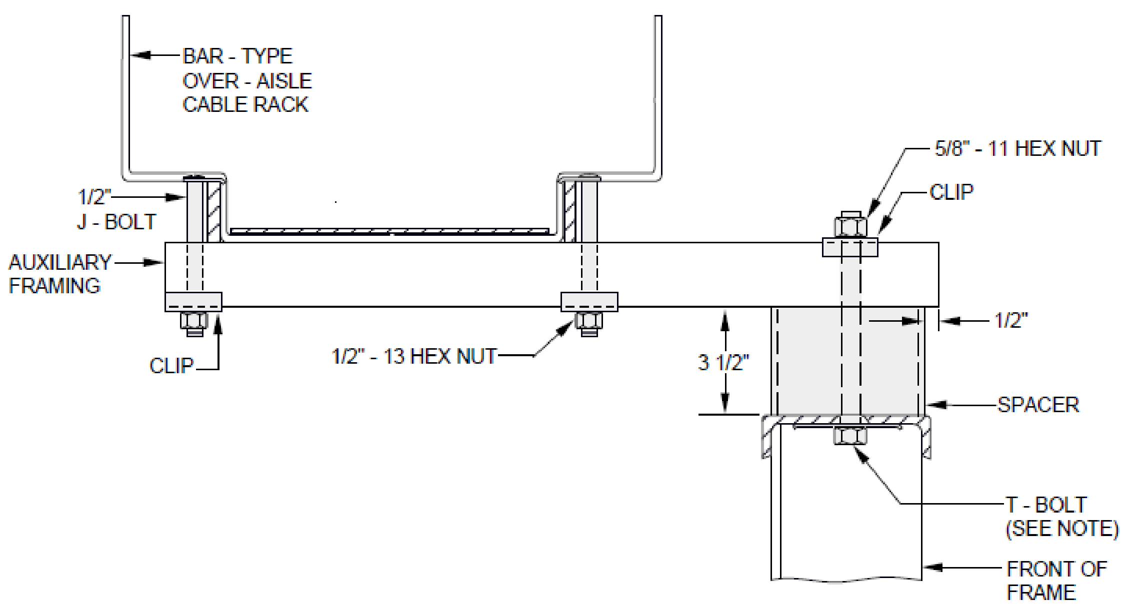


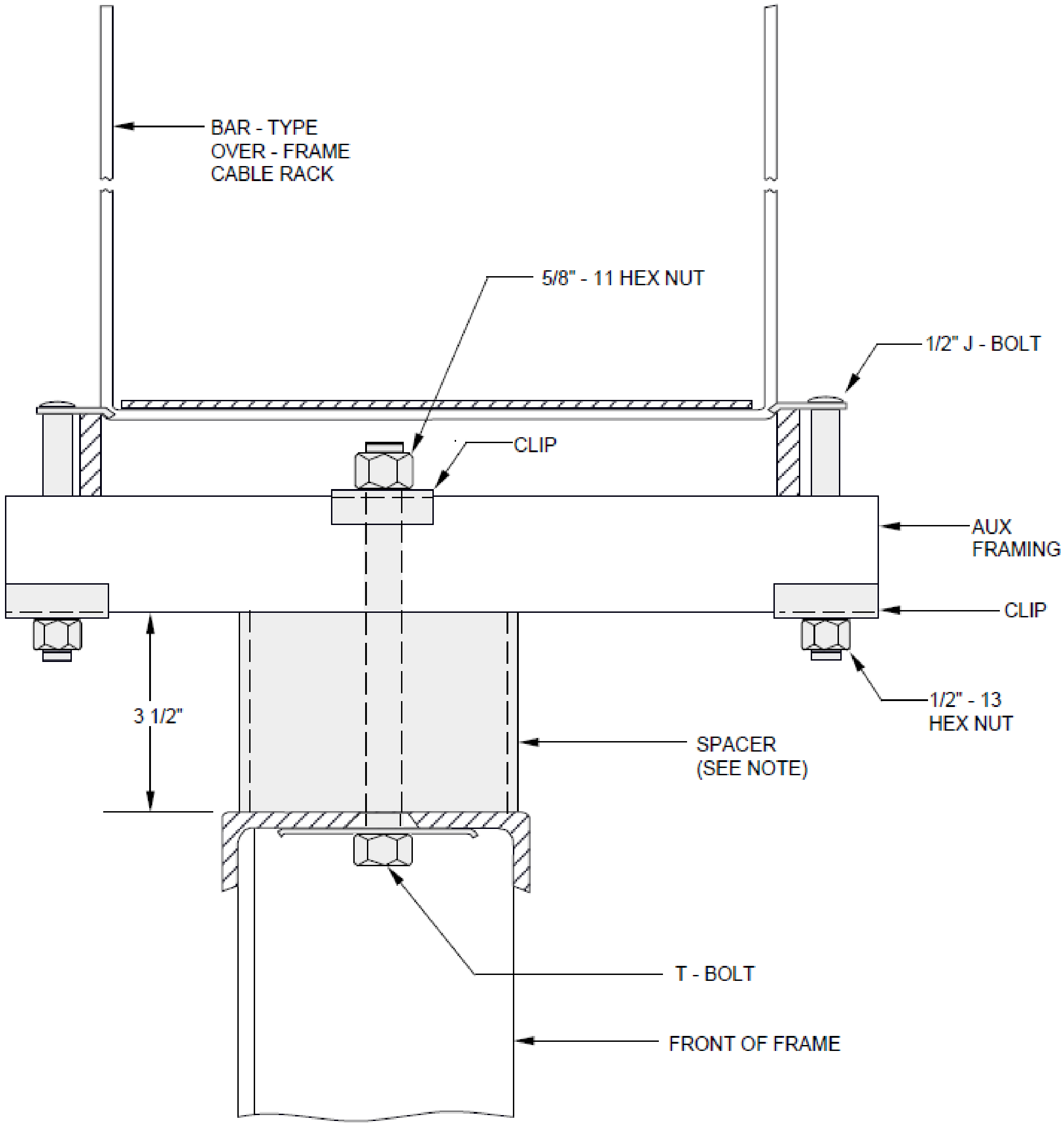
EXHIBIT 2-E2-15C (A&M)

2-E2-15C (A&M) ISOLATED STEP-BY-STEP FRAMES SUPPORTED FROM ONE CABLE RACK 11 FOOT 9 and 1/2 INCH FRAMING



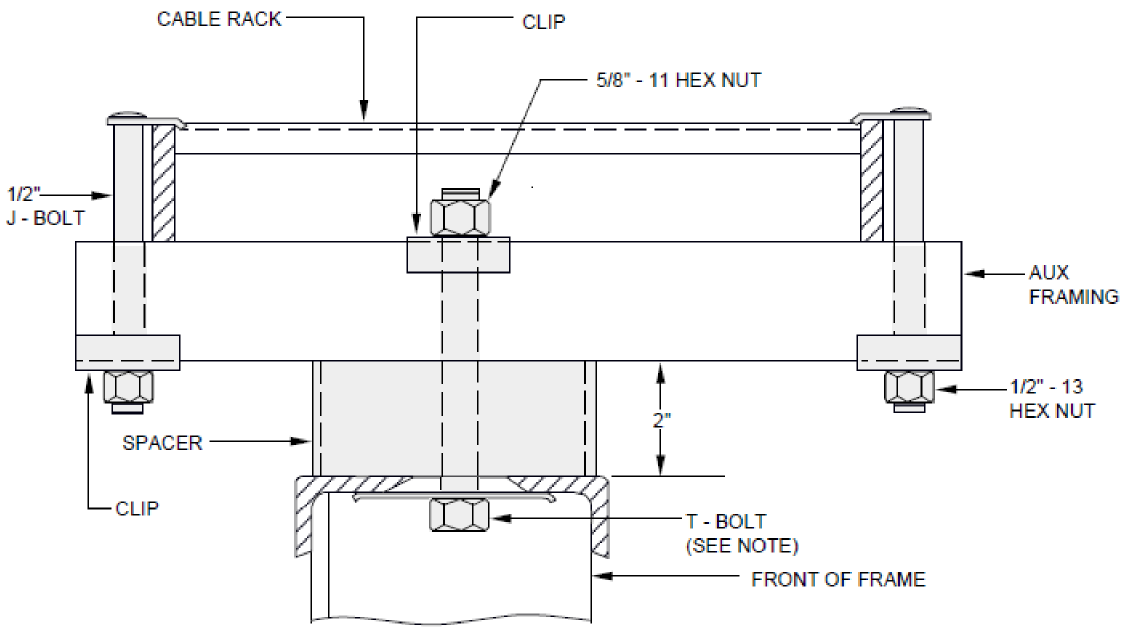
NOTE:
T-BOLT AND SPACER SHALL BE CONCENTRIC ON ASSEMBLY.

EXHIBIT 2-E2-15D (A&M)
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)
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)
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

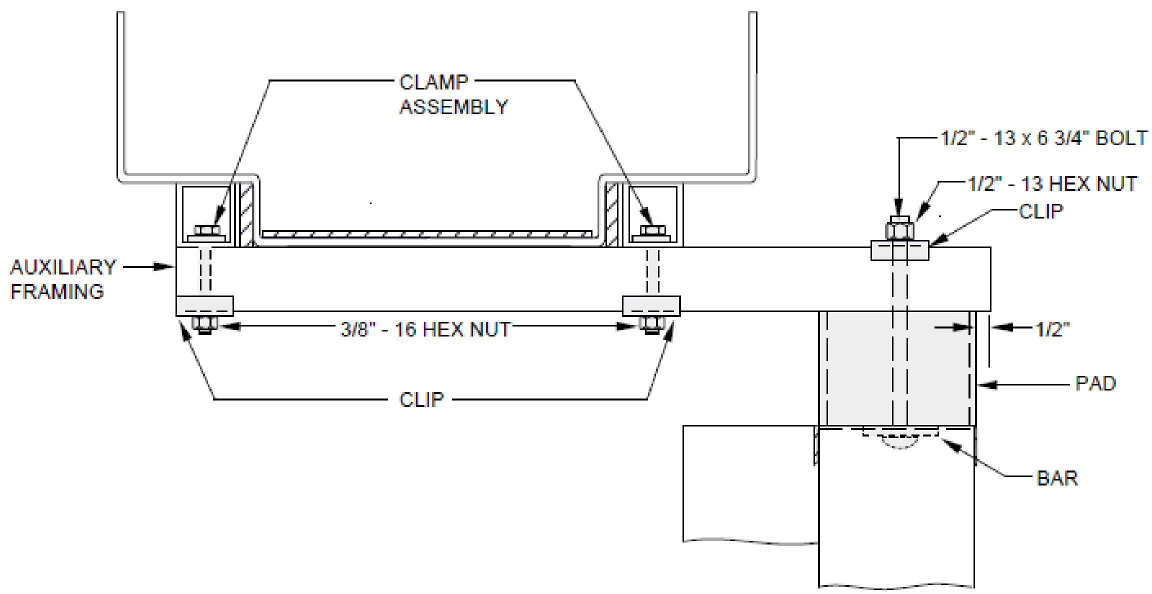


EXHIBIT 2-E2-16B (A&M)

2-E2-16B (A&M) ISOLATED CROSSBAR FRAMES SUPPORTED FROM ONE CHANNEL-TYPE CABLE RACK-ADDITIONS ONLY

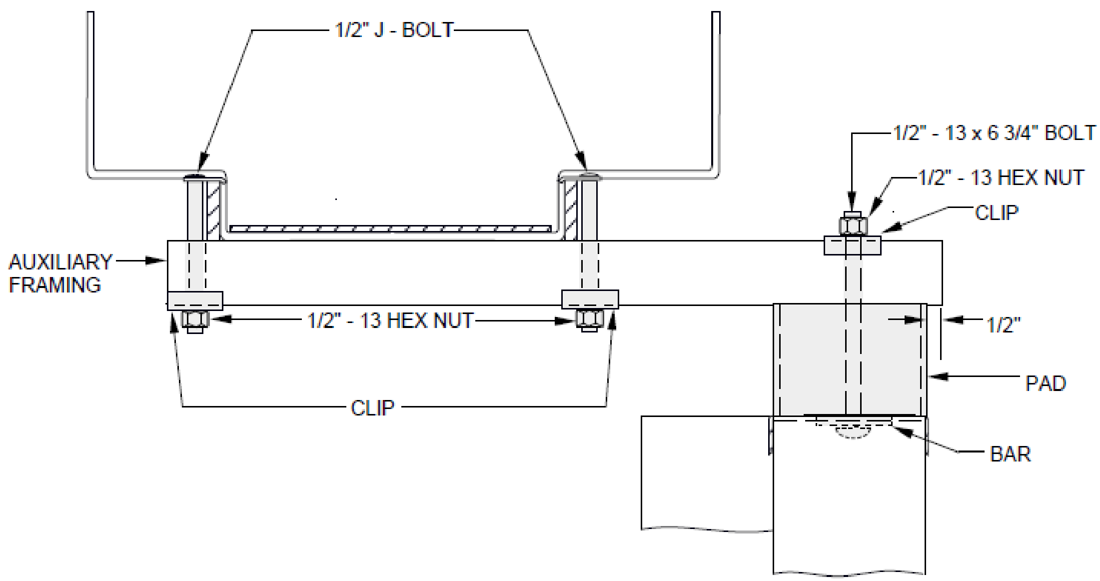


EXHIBIT 2-E2-16C (A&M)

2-E2-16C (A&M) ISOLATED CROSSBAR FRAMES SUPPORTED FROM ONE BAR-TYPE CABLE RACK

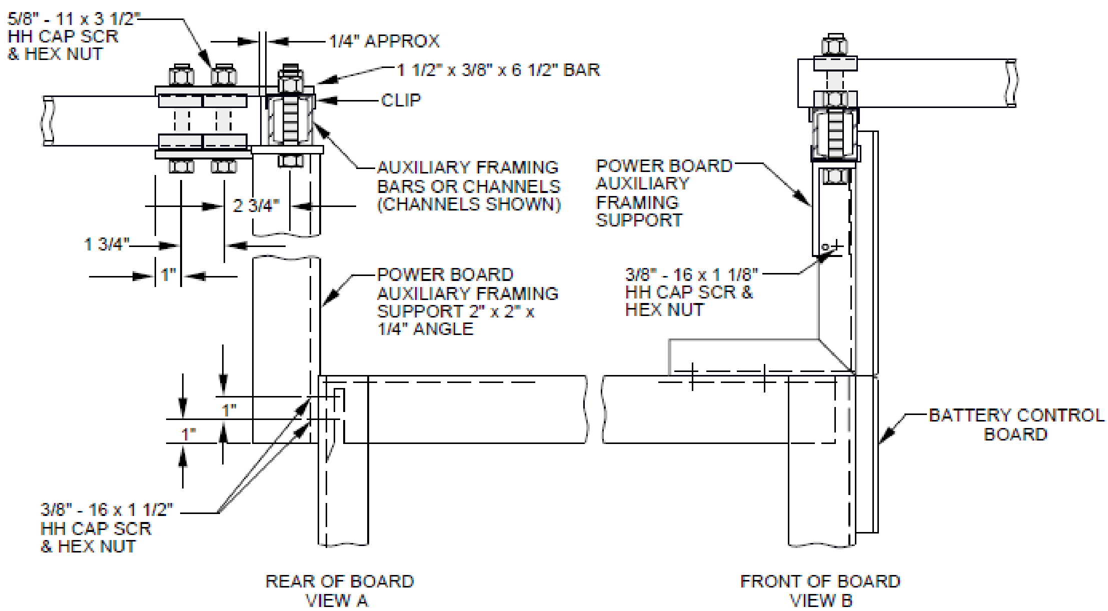


EXHIBIT 2-E2-18

2-E2-18 AUXILIARY FRAMING OVER BATTERY CONTROL BOARDS

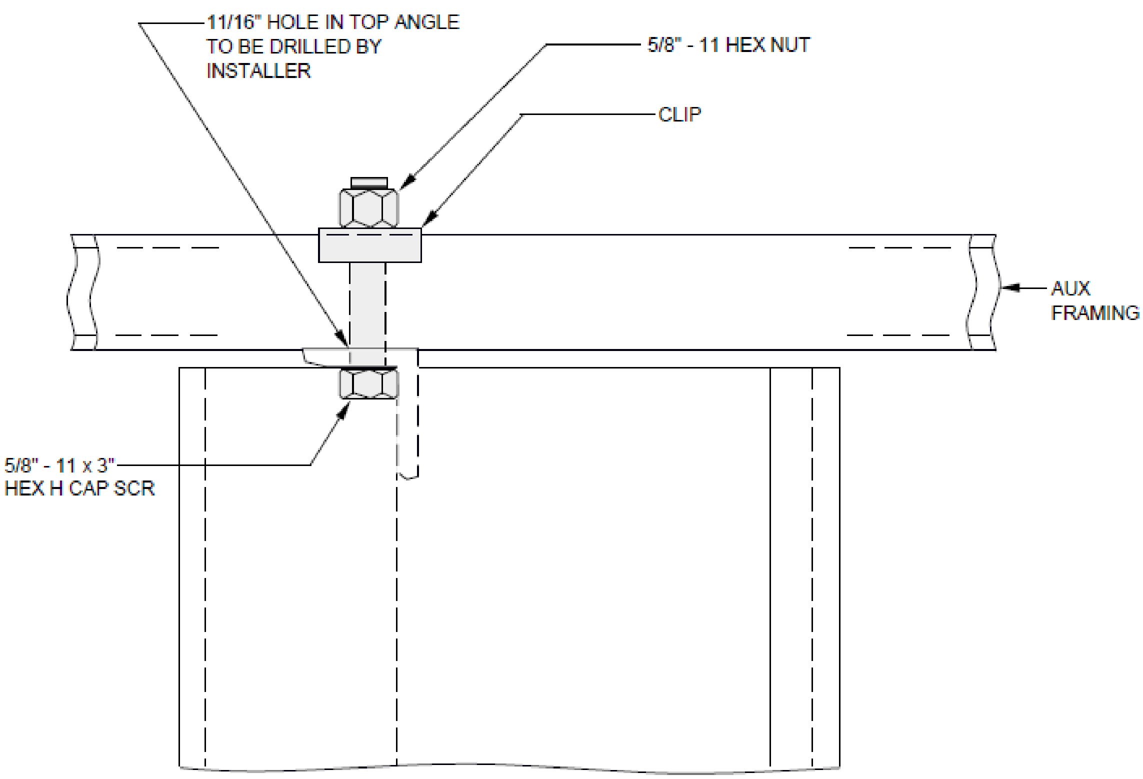


EXHIBIT 2-E2-18A

2-E2-18A AUXILIARY FRAMING ATTACHED DIRECTLY TO TOP-ANGLES OF BATTERY DISTRIBUTING FUSE BOARDS-11 FOOT 6 INCH FRAMING

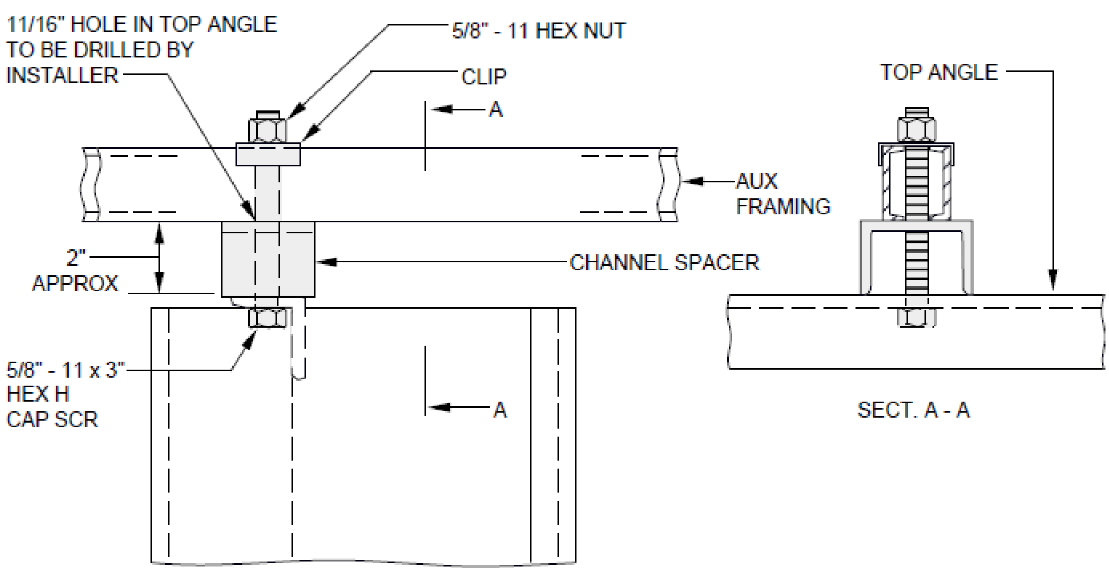


EXHIBIT 2-E2-18B

2-E2-18B AUXILIARY FRAMING ATTACHED TO TOP-ANGLES OF BATTERY DISTRIBUTION FUSE BOARDS-11 FOOT 8 INCH FRAMING

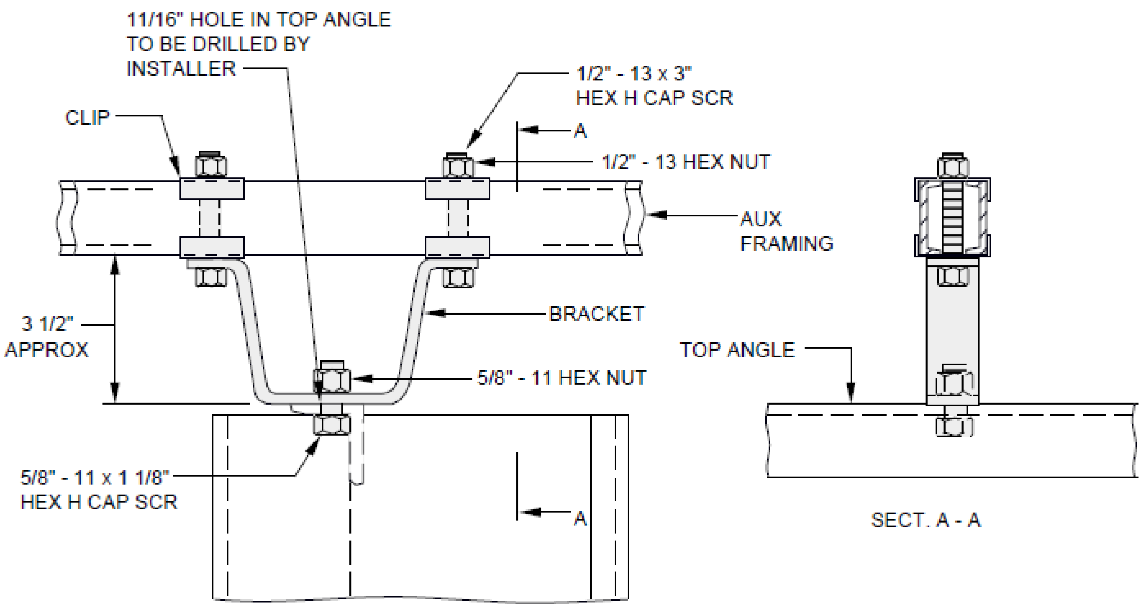


EXHIBIT 2-E2-18C

2-E2-18C AUXILIARY FRAMING ATTACHED TO TOP-ANGLES OF BATTERY DISTRIBUTION FUSE BOARDS-11 FOOT 9 and 1/2 INCH FRAMING

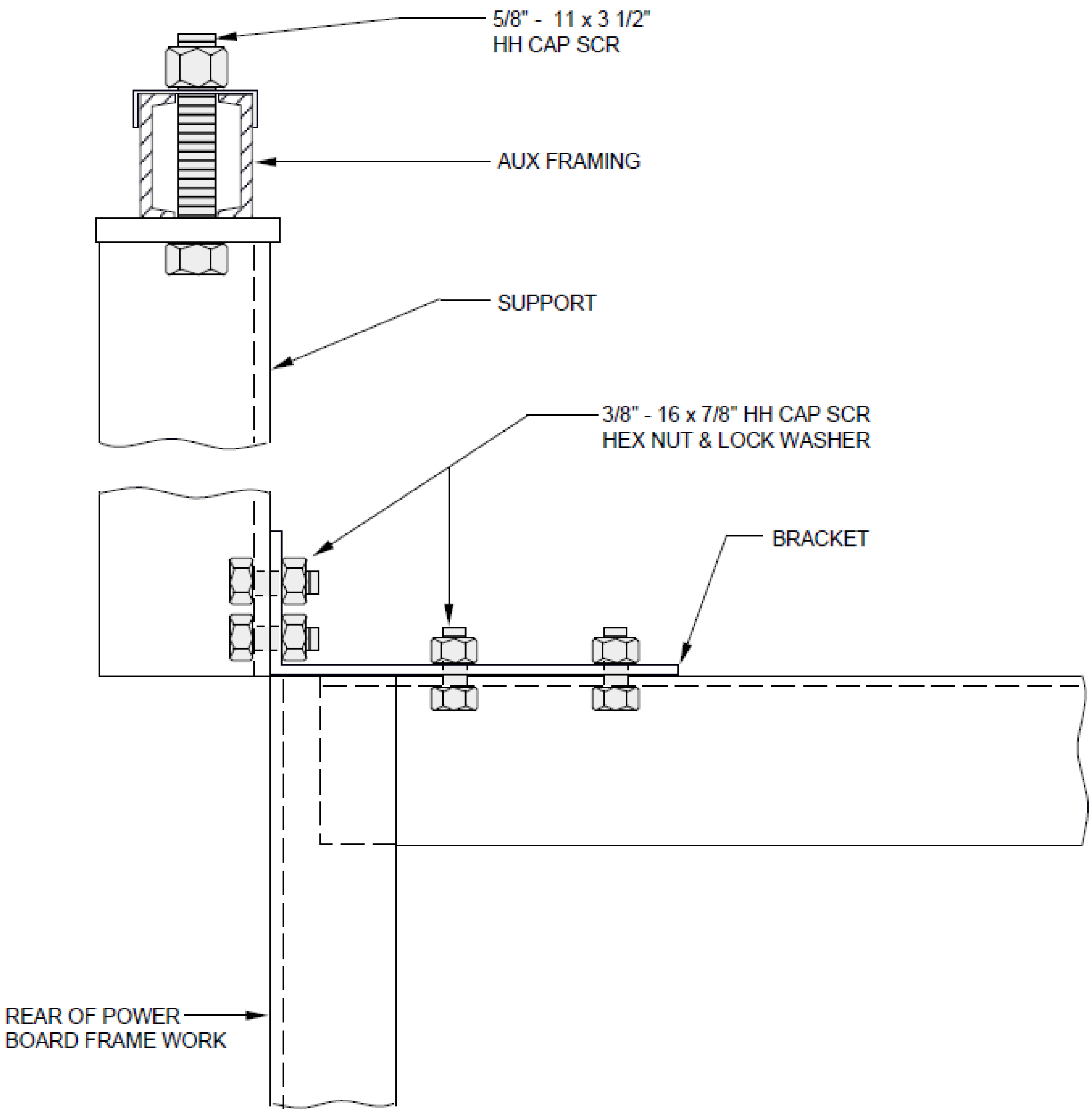


EXHIBIT 2-E2-18D

2-E2-18D AUXILIARY FRAMING OVER BATTERY CONTROL BOARDS EQUIPPED WITH REAR DOORS

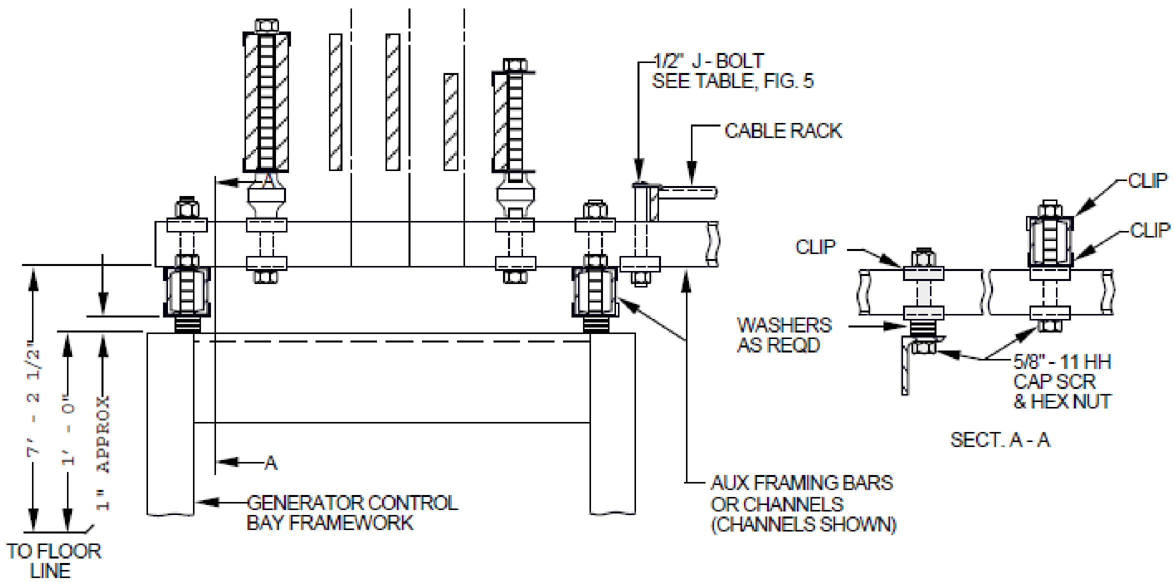


EXHIBIT 2-E2-19

2-E2-19 AUXILIARY FRAMING OVER GENERATOR CONTROL PANELS

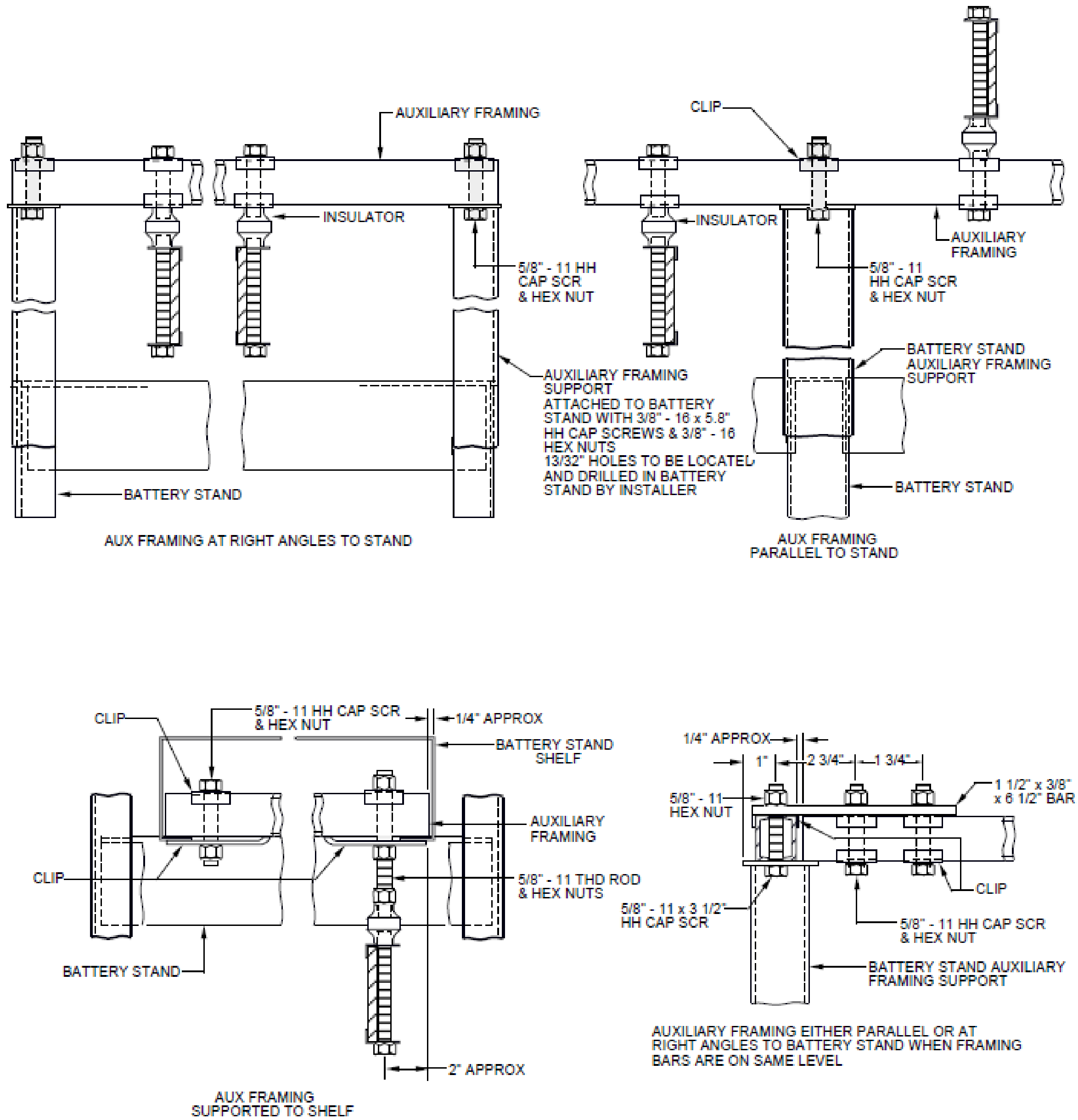
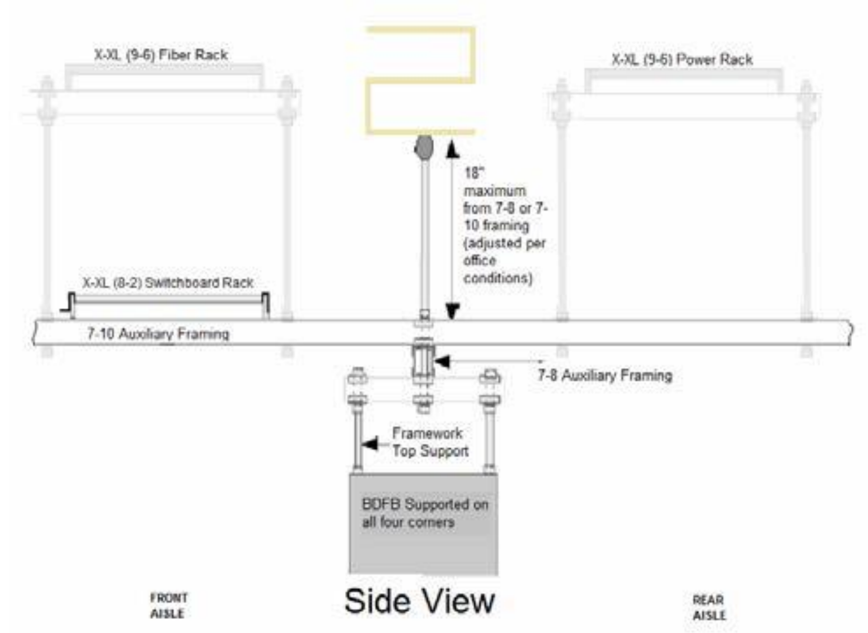
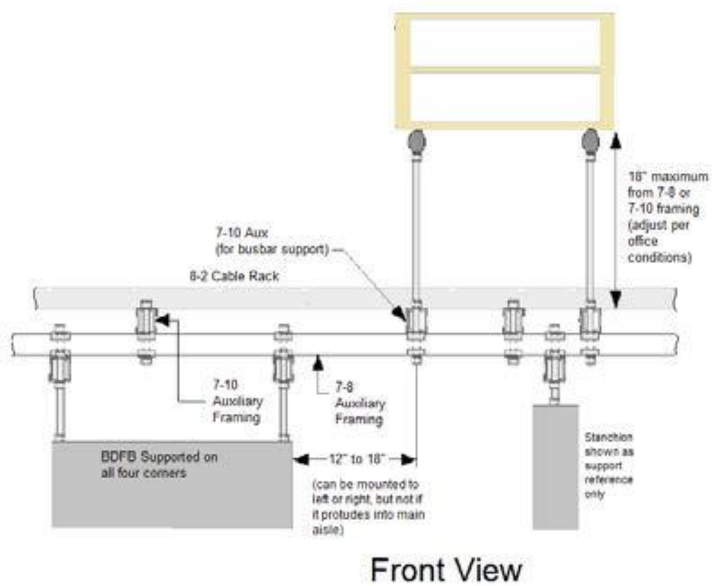


EXHIBIT 2-E2-20

2-E2-20 AUXILIARY FRAMING SUPPORT OF BUS BARS AT BATTERY STANDS





NOTES:

1. Return bar is illustrated in preferred method parallel to BDFB. Return bar may also be mounted perpendicular to BDFB.
2. Return bar may be adjusted vertically to account for cable rack height.
3. Return bar shall be mounted so the 2nd (middle) tier is level or slightly above the power cable rack.

EXHIBIT 2-E2-21

2-E2-21 AUXILIARY FRAMING SUPPORT OF RETURN BUS BARS AT 7FT BDFB

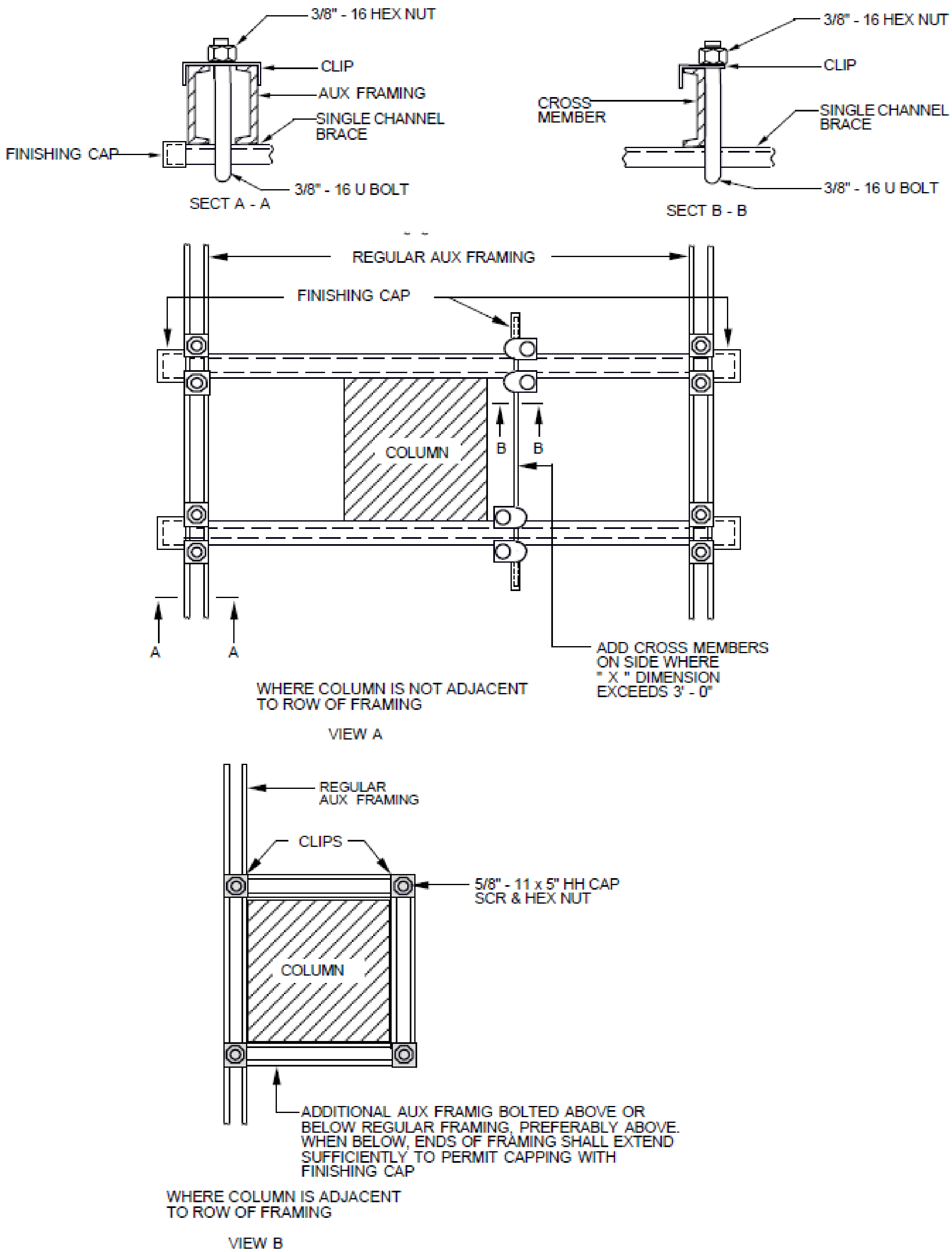


EXHIBIT 2-E2-23 (DISCONTINUED)

2-E2-23 (DISCONTINUED) BRACING AUXILIARY FRAMING TO COLUMNS HISTORICAL ONLY

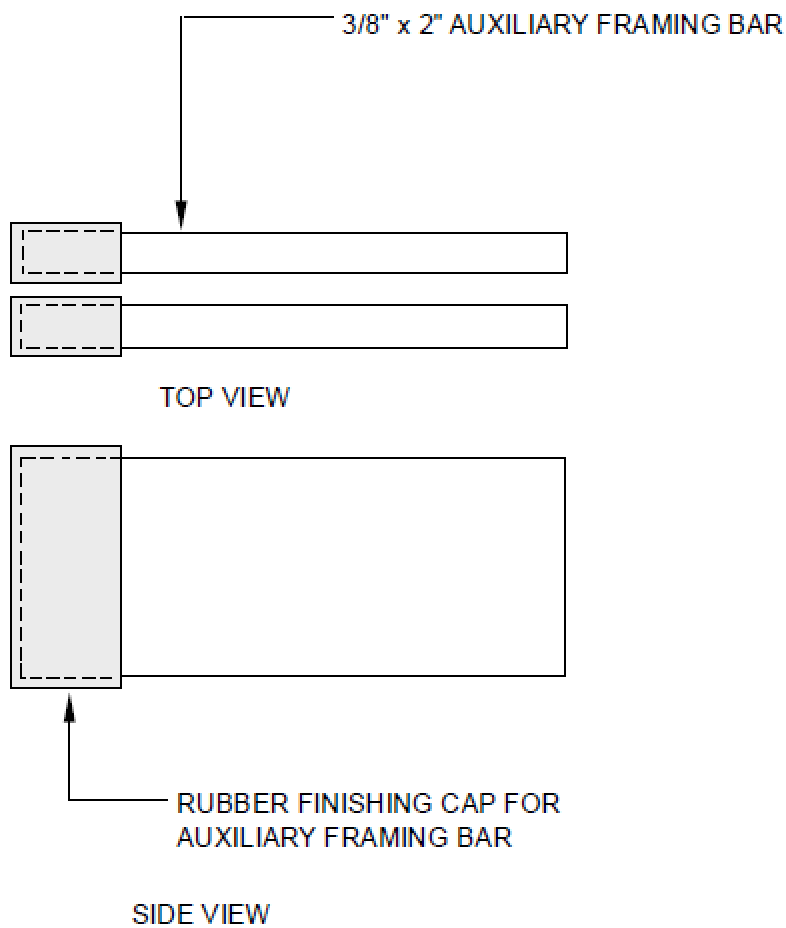


EXHIBIT 2-E2-23C

2-E-23C FINISHING CAPS ON AUXILIARY FRAMING

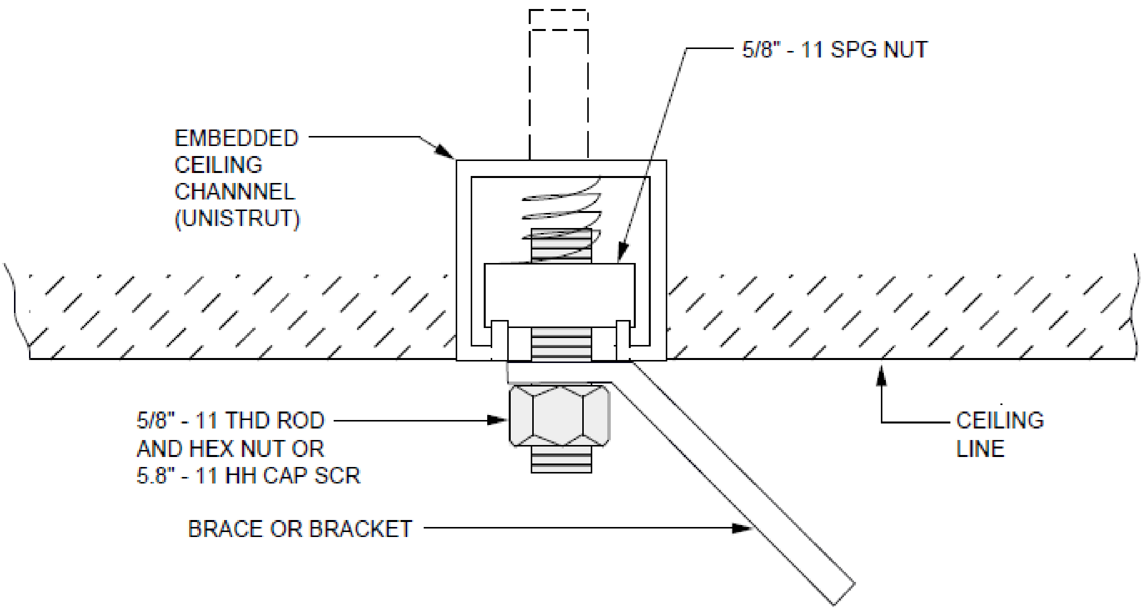


EXHIBIT 2-E2-24

2-E2-24 BRACING OF AUXILIARY FRAMING WITH SINGLE BRACE

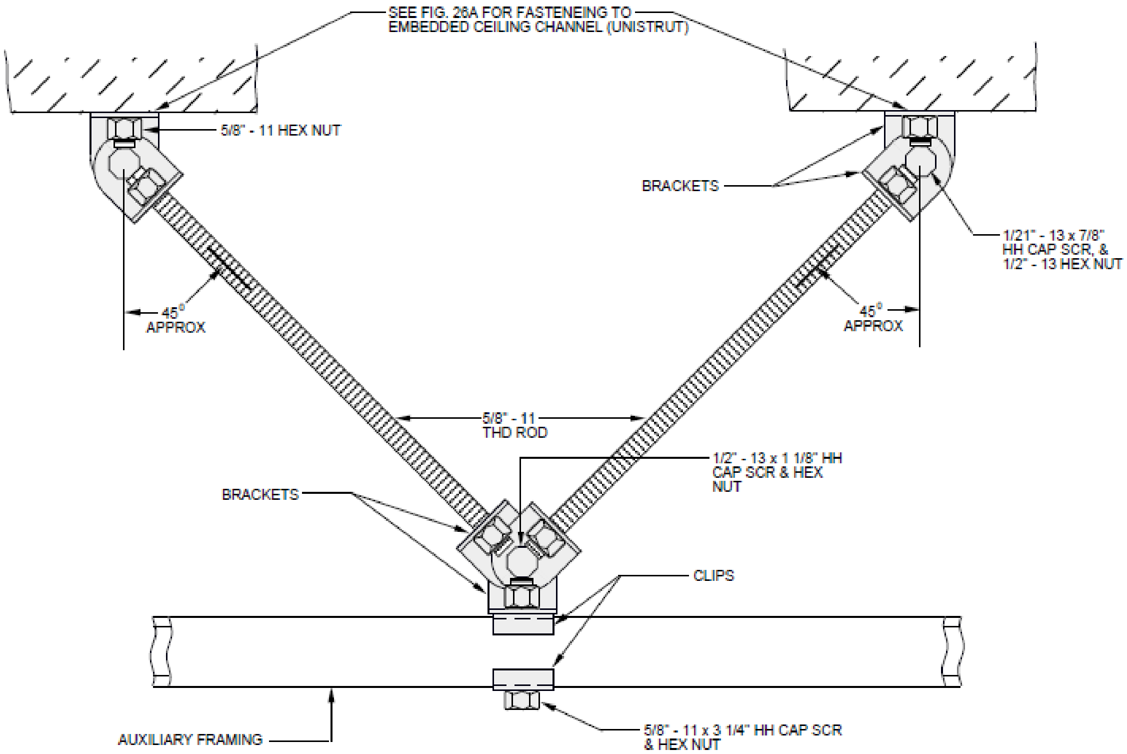


EXHIBIT 2-E2-25

2-E2-25 BRACING OF AUXILIARY FRAMING WITH SINGLE-ROD BRACES

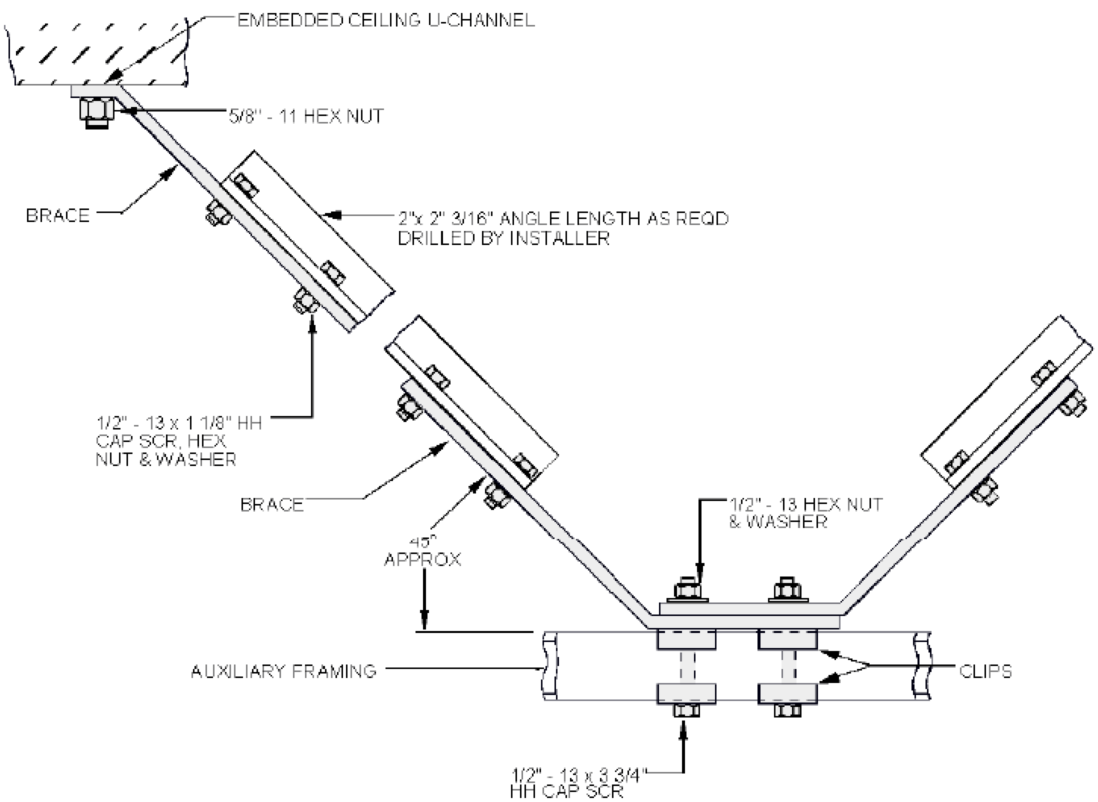


EXHIBIT 2-E2-25A

2-E2-25A BRACING OF AUXILIARY FRAMING WITH DOUBLE - ANGLE BRACES

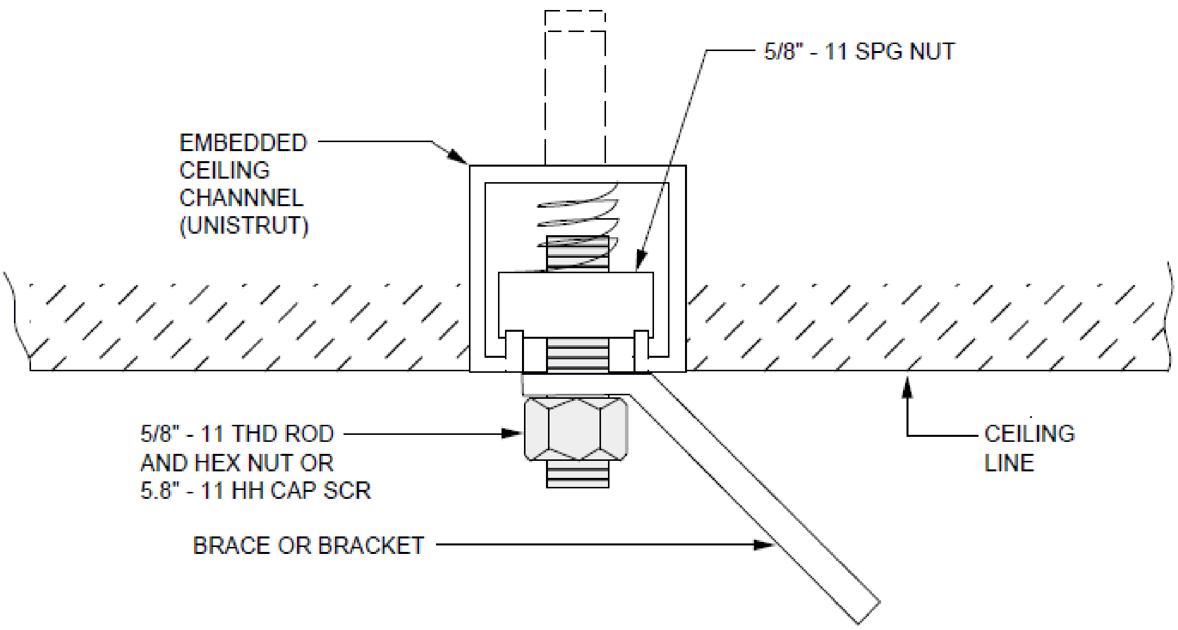


EXHIBIT 2-E2-26A

2-E2-26A FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL

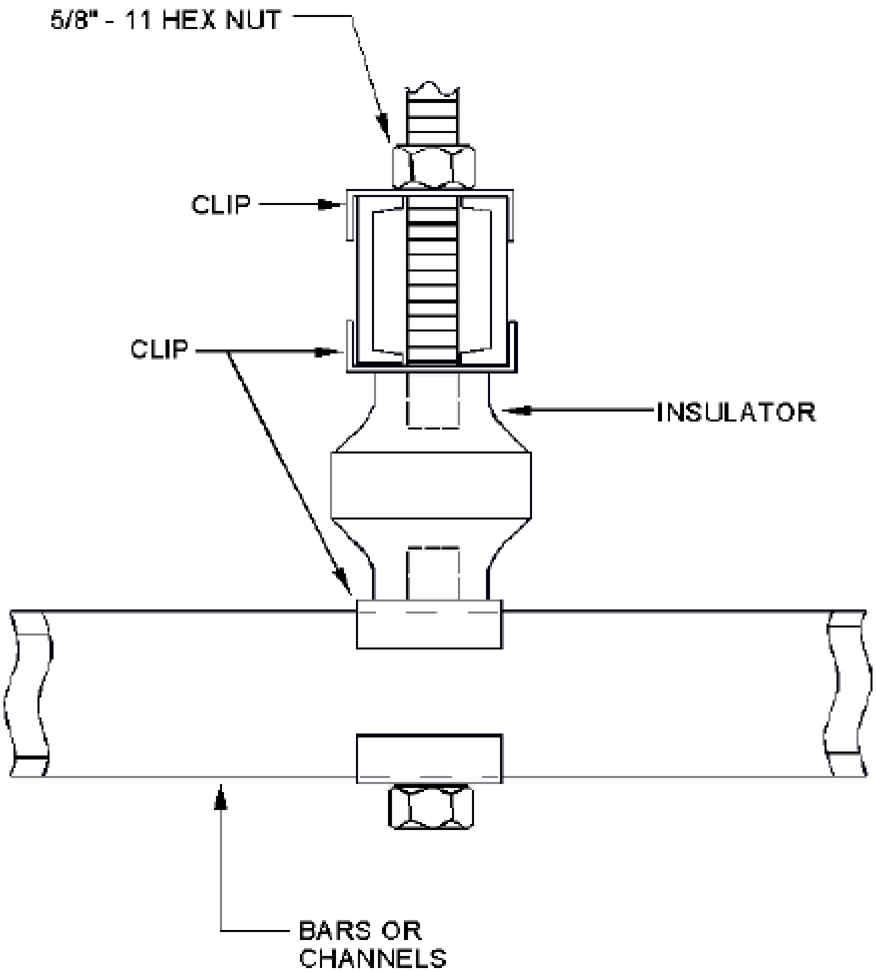


EXHIBIT 2-E2-27

2-E2-27 DOUBLE-LEVEL AUXILIARY FRAMING-ISOLATING TWO LEVELS OF CHANNEL

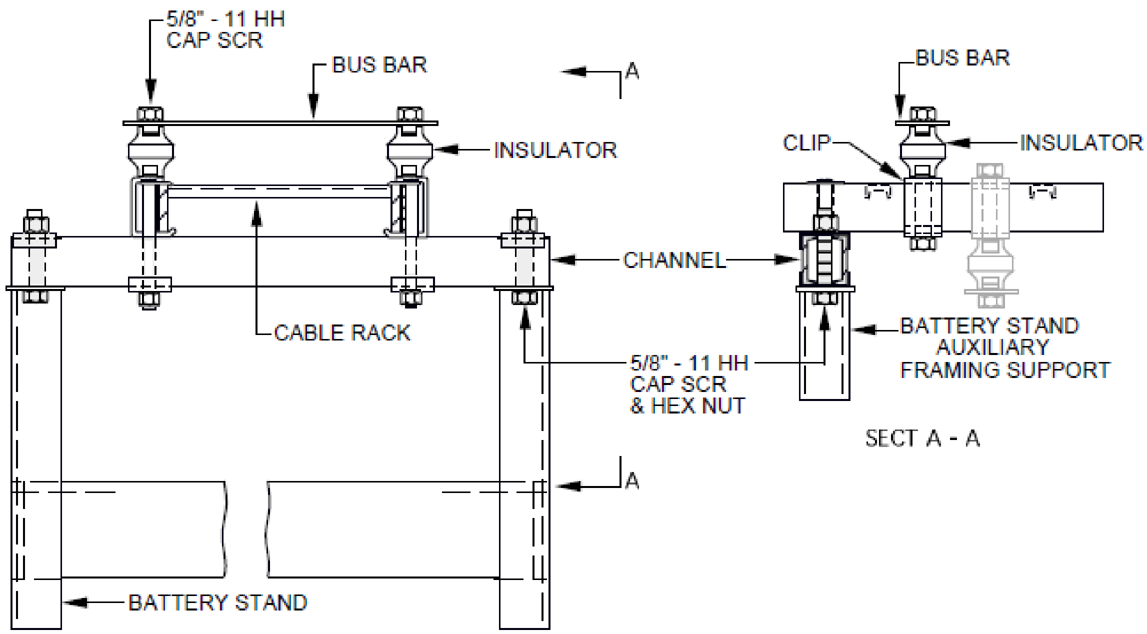


EXHIBIT 2-E2-28

2-E2-28 AUXILIARY FRAMING SUPPORT FOR SHORT BUS BARS ABOVE BATTERY STANDS

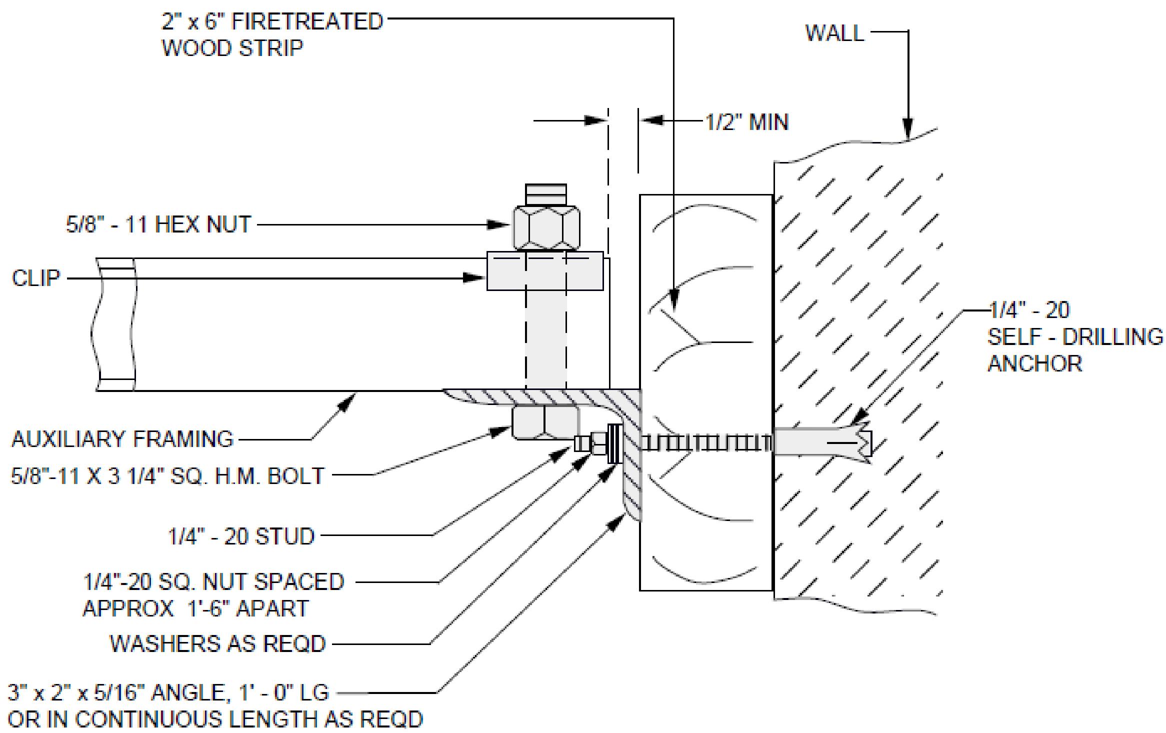


EXHIBIT 2-E2-29

2-E2-29 DOUBLE FRAMING ATTACHED TO WALLS WHERE ANGLE IS DRILLED

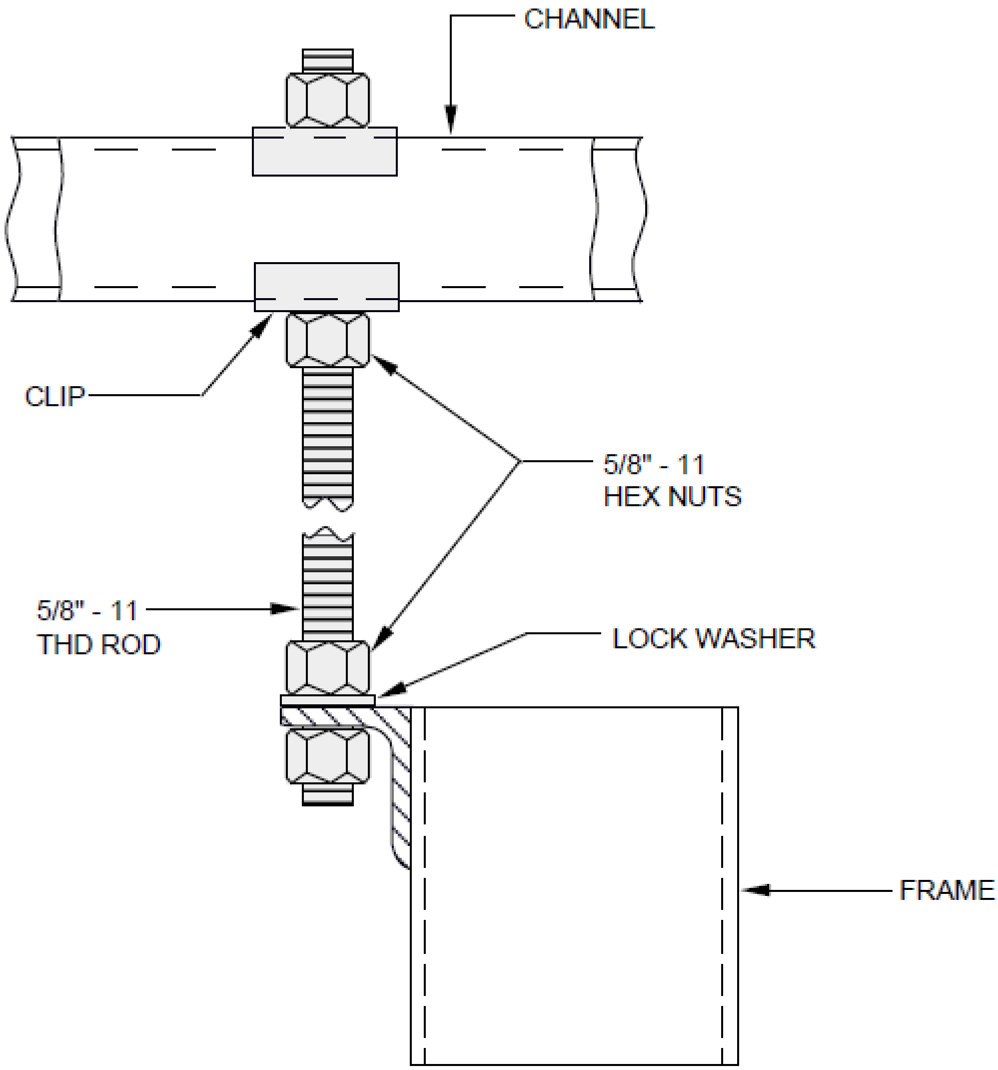


EXHIBIT 2-E2-30

2-E2-30 SUPPORTING FRAME WITH THREADED ROD FROM FRAMING

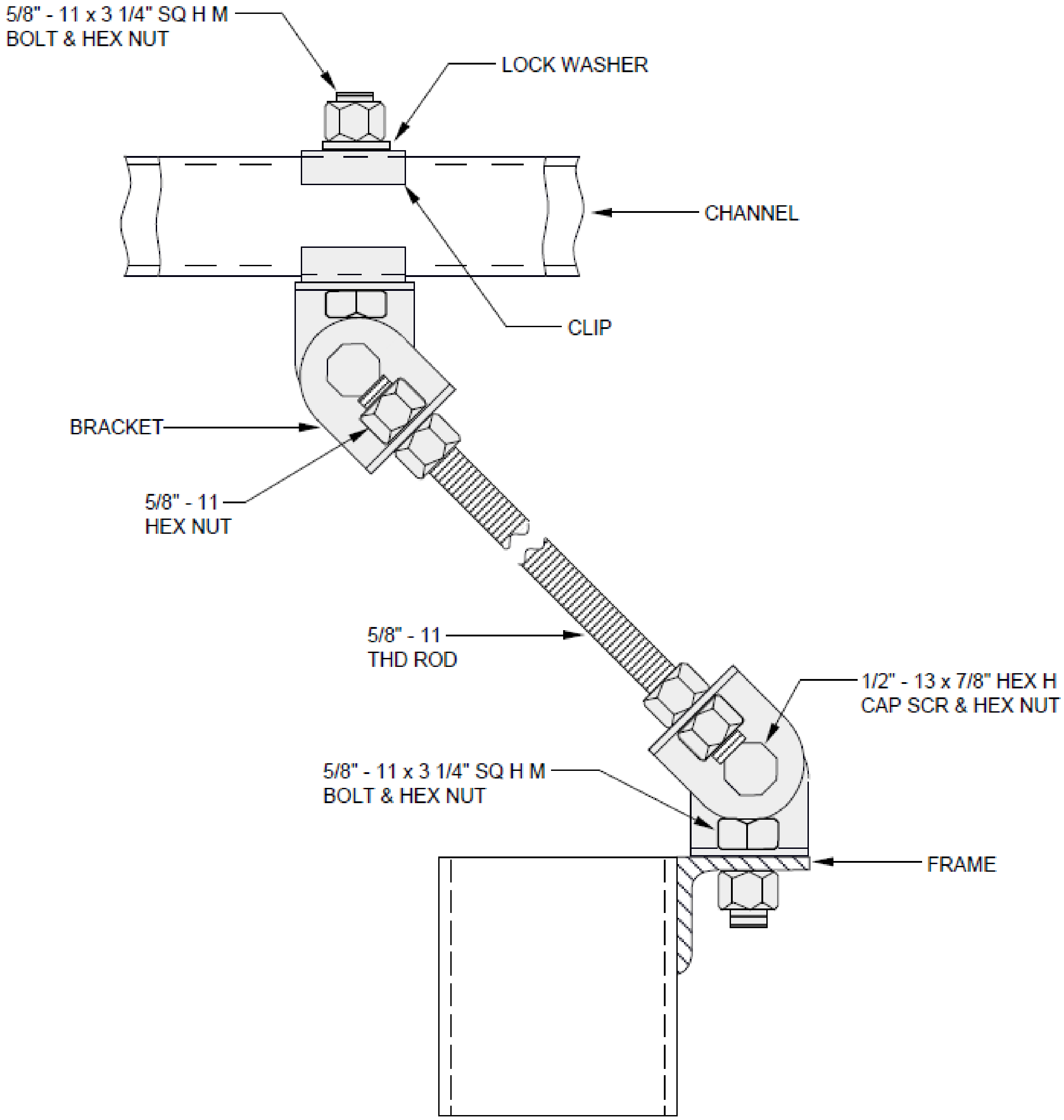
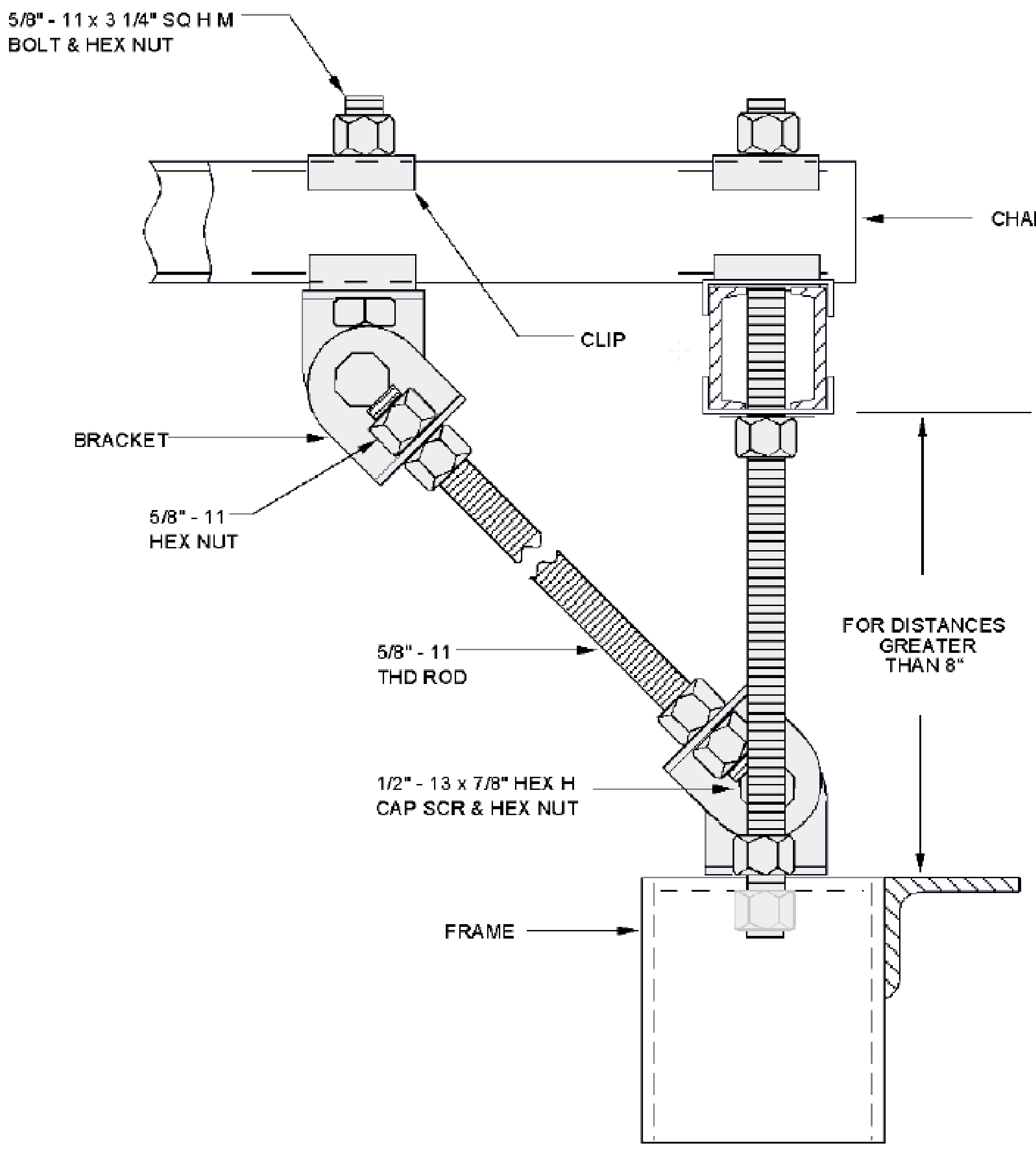


EXHIBIT 2-E2-31

2-E2-31 BRACING FRAMES FROM AUXILIARY FRAMING



2-E2-31A (DISCONTINUED)

2-E2-31A (DISCONTINUED) BRACING LOW LEVEL ENVIRONMENT FRAMES

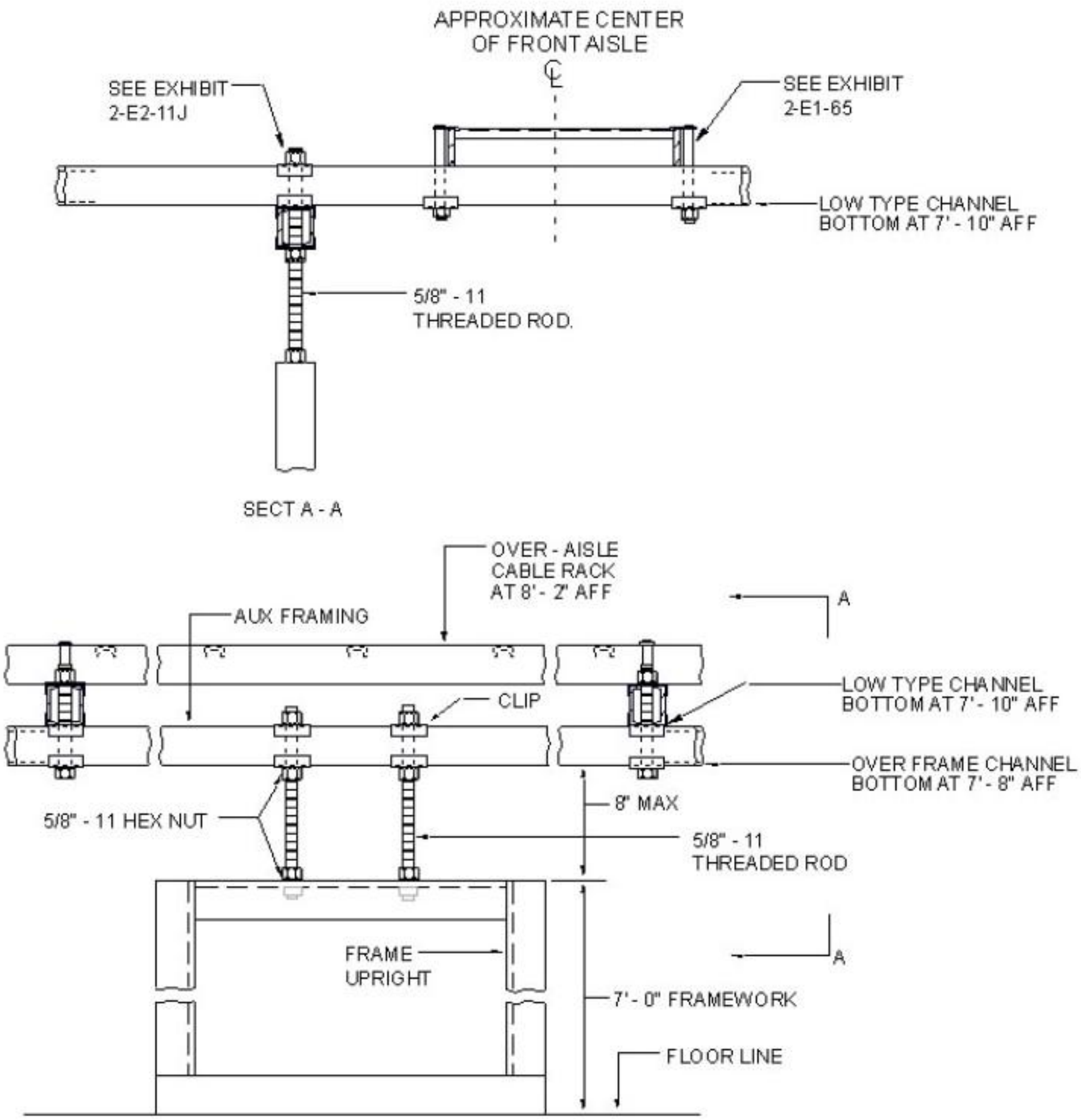


EXHIBIT 2-E2-32

2-E2-32 TYPICAL FRAMEWORK AND IRONWORK ARRANGEMENT FOR A 7′-0″ FLOOR SUPPORTED SYSTEM

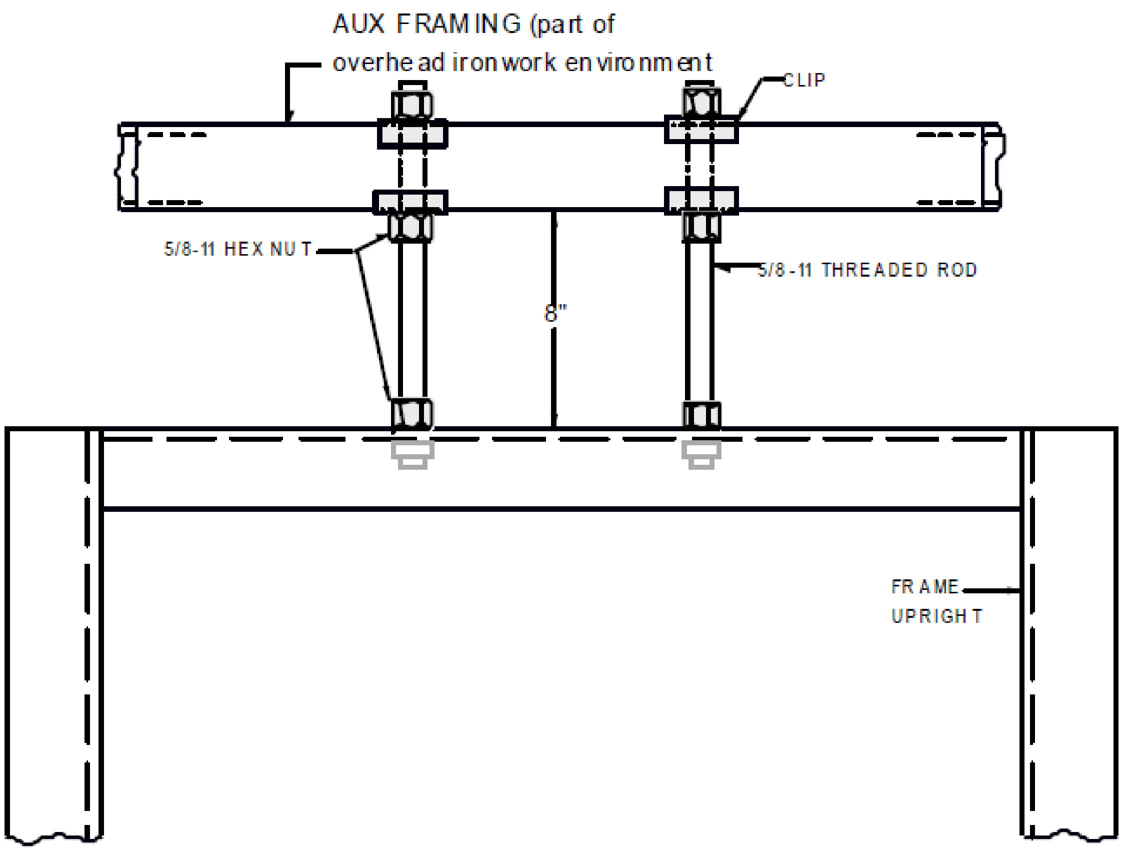
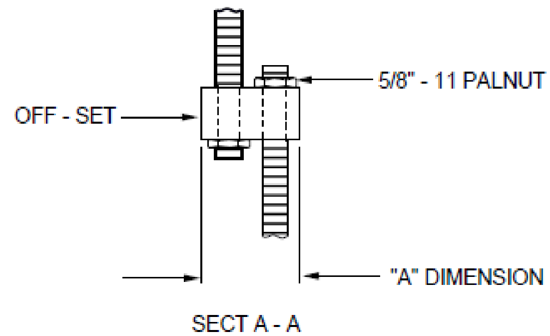


EXHIBIT 2-E2-32A

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



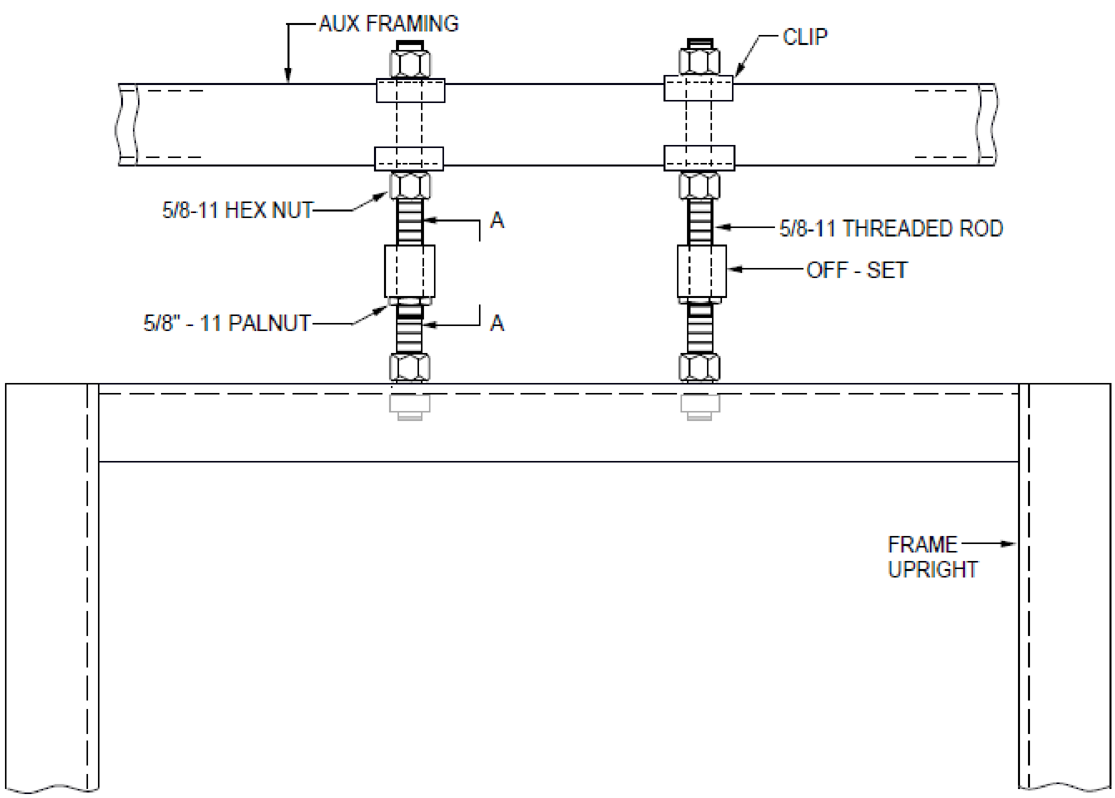


EXHIBIT 2-E2-32B

2-E2-32B TYPICAL METHOD OF INSTALLING HANGER ROD OFF-SET TO MAINTAIN GUARD RAIL ALIGNMENT

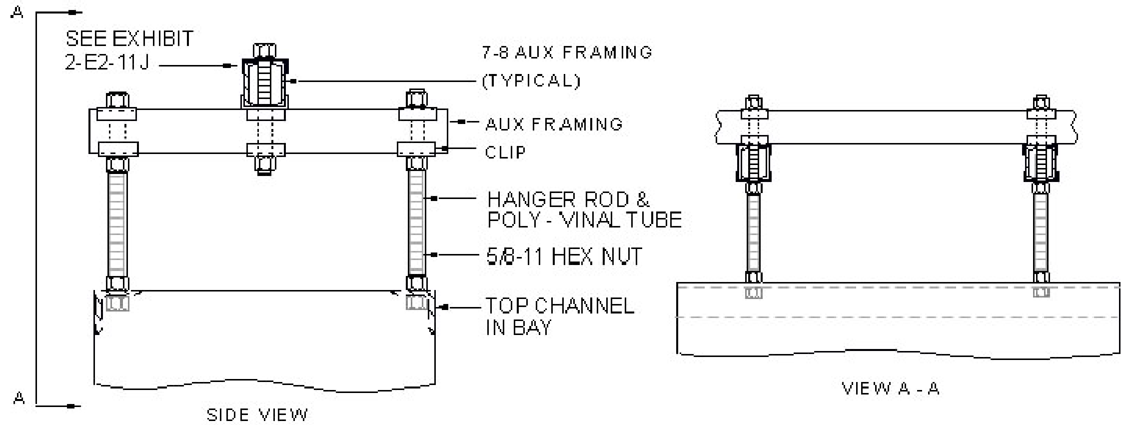


EXHIBIT 2-E2-32C

2-E2-32C TYPICAL METHOD OF SUPPORTING AUXILIARY FRAMING OVER A 7′-0″ BDFB

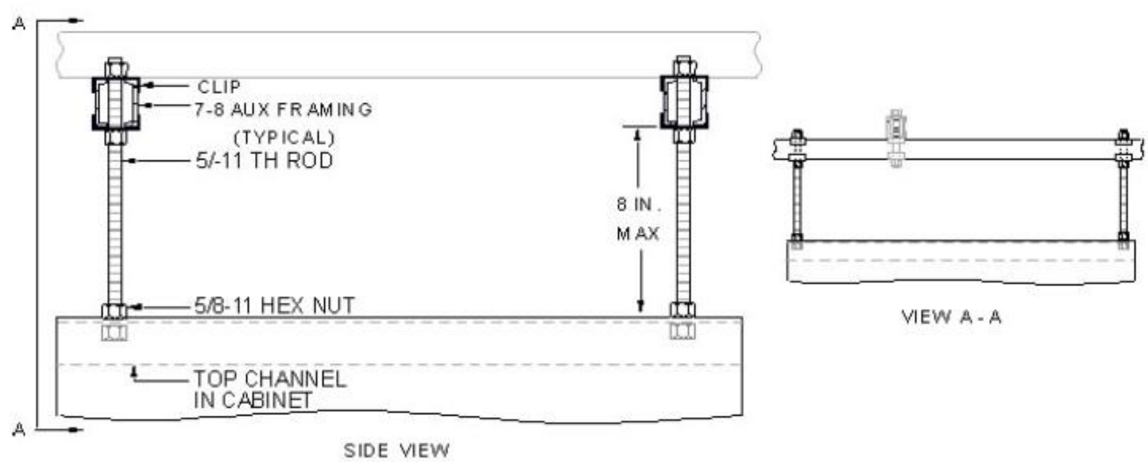


EXHIBIT 2-E2-32D

2-E2-32D TYPICAL METHOD OF SUPPORTING AUXILIARY FRAMING OVER A 7′-0″ CABINET

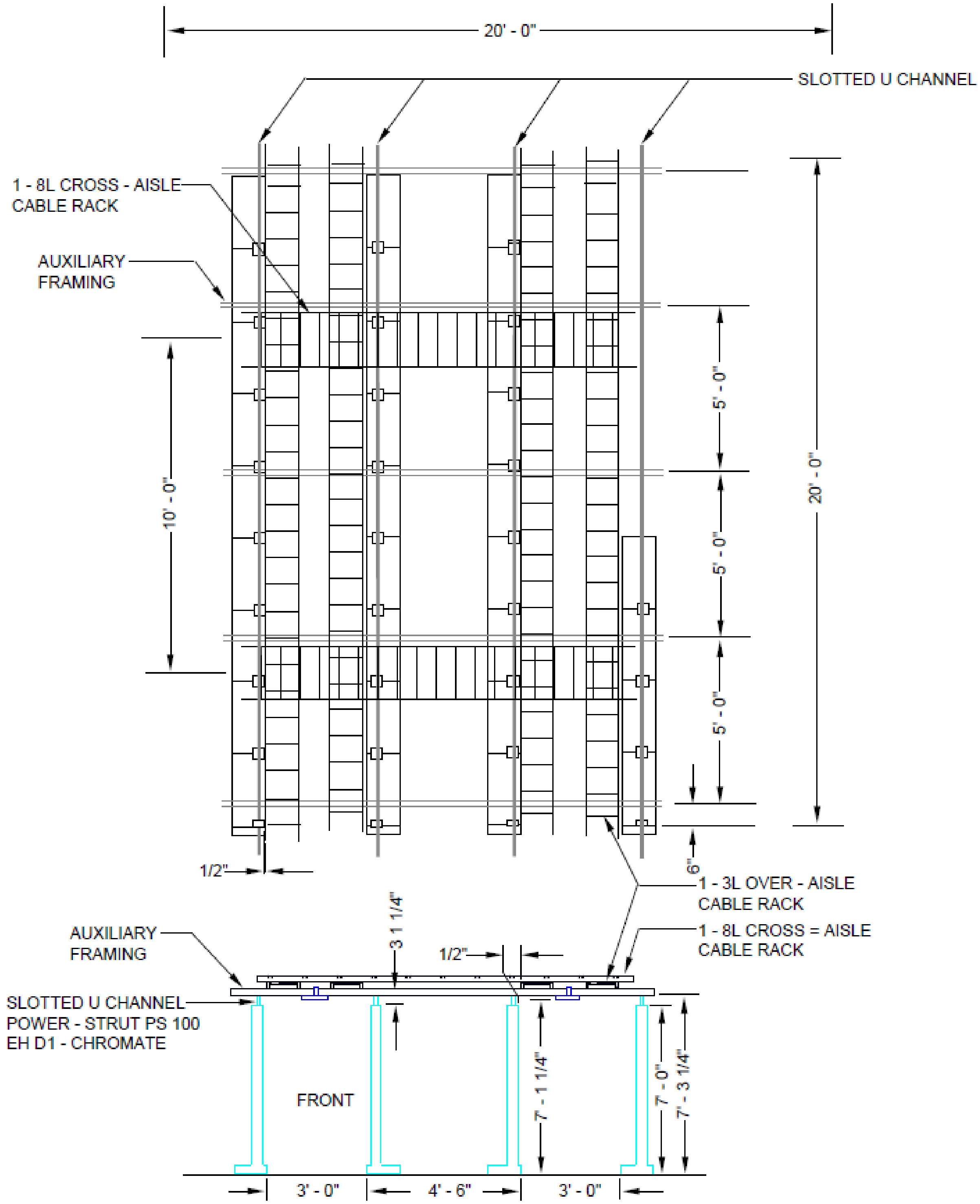


EXHIBIT 2-E2-33 (A&M)

2-E2-33 (A&M) LOW-LEVEL CABLE RACKING (TYPICAL IRONWORK LAYOUT)

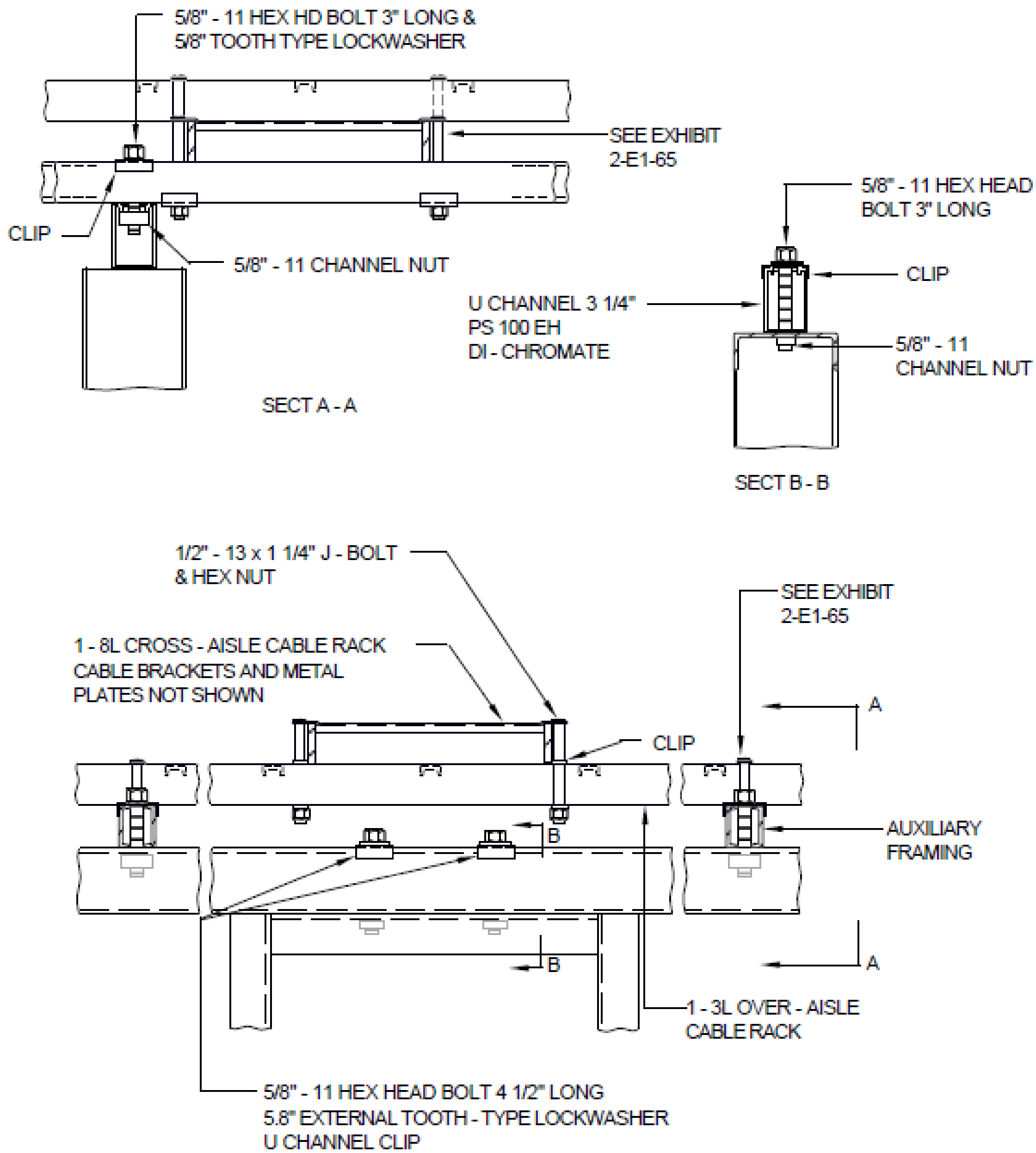


EXHIBIT 2-E2-33A (A&M)

2-E2-33A (A&M) TYPICAL METHOD OF SUPPORTING FRAMEWORK IN A 7′-0″ LOW LEVEL ENVIRONMENT

Contents

EXHIBITS

TABLES

6. Cable Rack and Auxiliary Framing-

6C 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 for framing used to support main aisle cable racking via cable rack support.

   1. between the ceiling and the top of framework
   2. for framing used to support main aisle cable racking
   3. via cable rack support.

Safe load limitations for u-channel, 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 Network Facility.

- 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.

Bolting details shall be installed as illustrated in the Exhibits.

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

6C.2 Ceiling Heights

The location and arrangement of high type auxiliary framing is dependent on ceiling height and clearance from obstructions such as ceiling beams, HVAC duct, and building conduit.

6C.3 Fastening Arrangements at Ceilings

Equipment areas are usually provided with embedded ceiling inserts, embedded ceiling channel, ceiling mounted u-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 usually spaced 5 feet to 6 feet apart.

- CenturyLink Real Estate shall be notified for any new ceiling supported cable rack layouts to ensure the structural integrity of the ceiling for the design weight load.
- 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 threads. Projects with ceiling support requiring the use of beam clamps shall notify Real Estate for review of the ceiling to determine the appropriate beam clamps required.
- An example of the embedded ceiling inserts is shown in Exhibit 2-E3-2. Where ironwork will be engineered to be supported from ceiling inserts, an auxiliary framing grid is required near the ceiling. The initial grid should be engineered close enough to the ceiling so that bracing is not required.
- Fastening threaded hanger rods or ceiling braces as shown in Exhibit 2-E3-6B, or 6C, or 6D.

CenturyLink 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.

Hanger bolts, as shown in Exhibit 2-E3-4, are occasionally used to support heavy loads where other building attachments have not been provided.

The addition of ceiling mounted u-channel, expansion anchors, etc., for attachments to ceilings is requested through Corporate Real Estate.

6C.4 Hanger Rods

Hanger rods (threaded rods) used for the support of auxiliary framing and cable rack shall be 5/8"-11 and threaded the entire length of the rod.

HANGER RODS ATTACHED AT CEILINGS:

- 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.
- Where u-channel is attached to a ceiling or suspended for other support purposes, a u-channel clip and 5/8"-11 nut shall be used on each rod as shown in Exhibit 2-E3-6D.
- 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.

SPLICING HANGER RODS:

- Hanger rods or threaded rods used for braces shall not 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. Auxiliary framing supports spaced greater than 5 feet in one direction should be placed less than 5 feet in the perpendicular direction to maintain the maximum allowable loading. As a general rule, the total square feet of the auxiliary framing supports shall not exceed 25 square feet (i.e. 5′6″ in one direction would require supports placed in approximately 4'6" in the perpendicular direction).

- Cable racking sized at 25 inches or greater and requiring auxiliary framing support may require spacing of auxiliary framing closer than 5 feet intervals.
- Single level framing bars shall be supported 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-E3-7 or 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 or where needed to provide required cable rack support where space is a concern.

Clips used for auxiliary framing assemblies are 1-7/8 inches wide. Where bar type framing is encountered, 1-1/2 inch wide framing clips shall be used.

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-E3-22A and 2-E3-23A.

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-E3-21A.
- The 2 by 3/8 inches bars or 2 by 1/2 inches bars shall be junctioned to channels as shown in Exhibit 2-E3-20A.
- (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 – Light Earthquake Zone

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 last support 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 per the table listed below.

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.

TABLE 6C.1 BRACING BETWEEN AUXILIARY FRAMING LEVELS IN A LIGHT EARTHQUAKE ZONE

DISTANCE TO CEILING OR BETWEEN AUXILIARY FRAMING LEVELS	TYPE OF BRACE	EXHIBIT
Less than 1 foot 0 inches	Not Required	N/A
1 foot 0 inches to 2 foot 6 inches	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.

Braces shall be attached to hanger rods specifically as illustrated by bracing Exhibits.

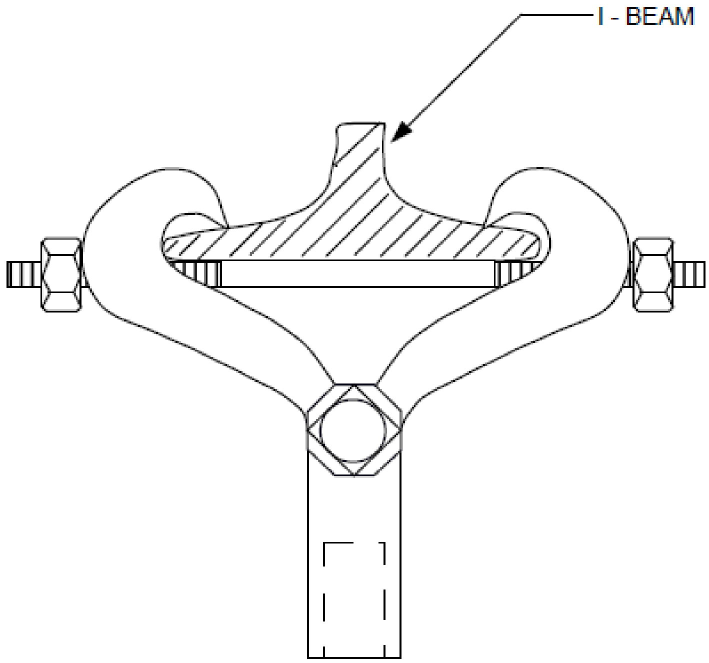


EXHIBIT 2-E3-1
2-E3-1 BEAM CLAMP

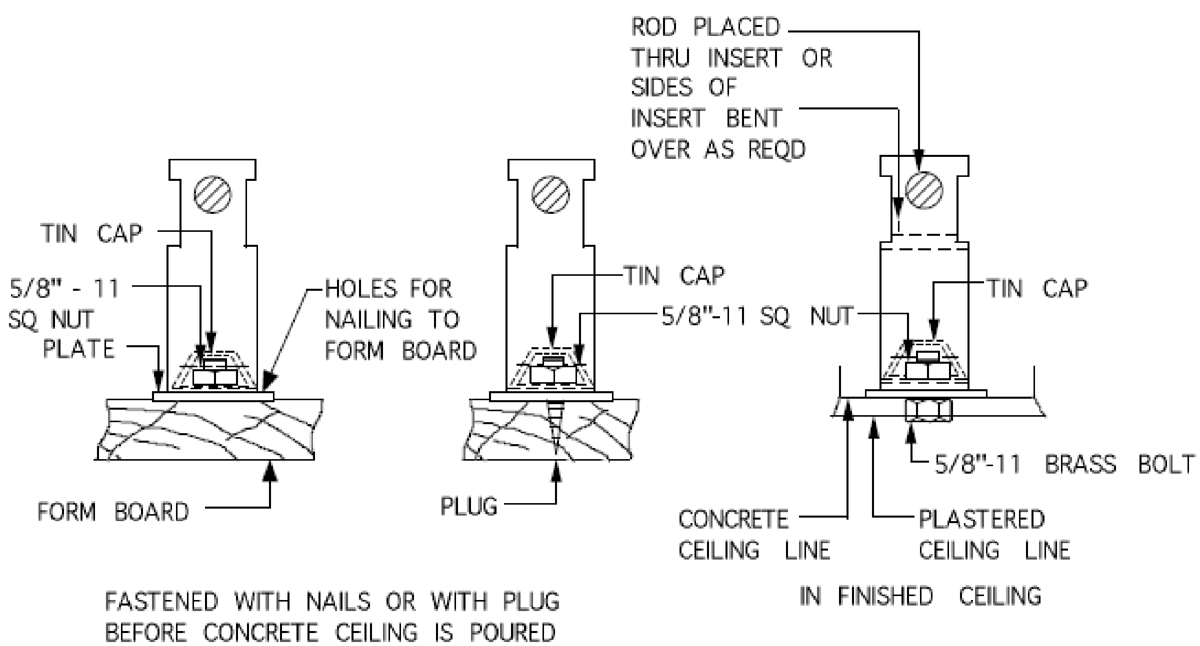


EXHIBIT 2-E3-2
2-E3-2 CEILING INSERT AS INSTALLED

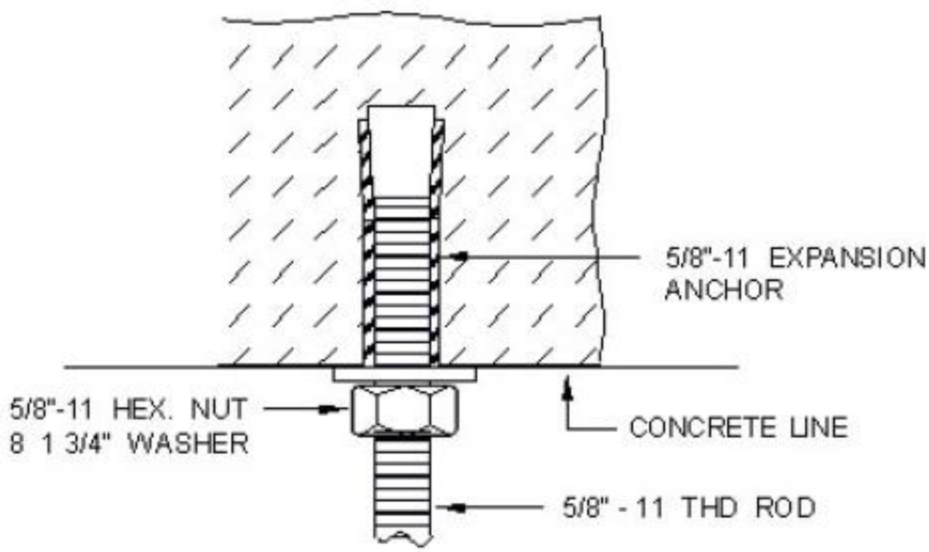


EXHIBIT 2-E3-3

2-E3-3 EXPANSION ANCHOR FOR HANGER ROD

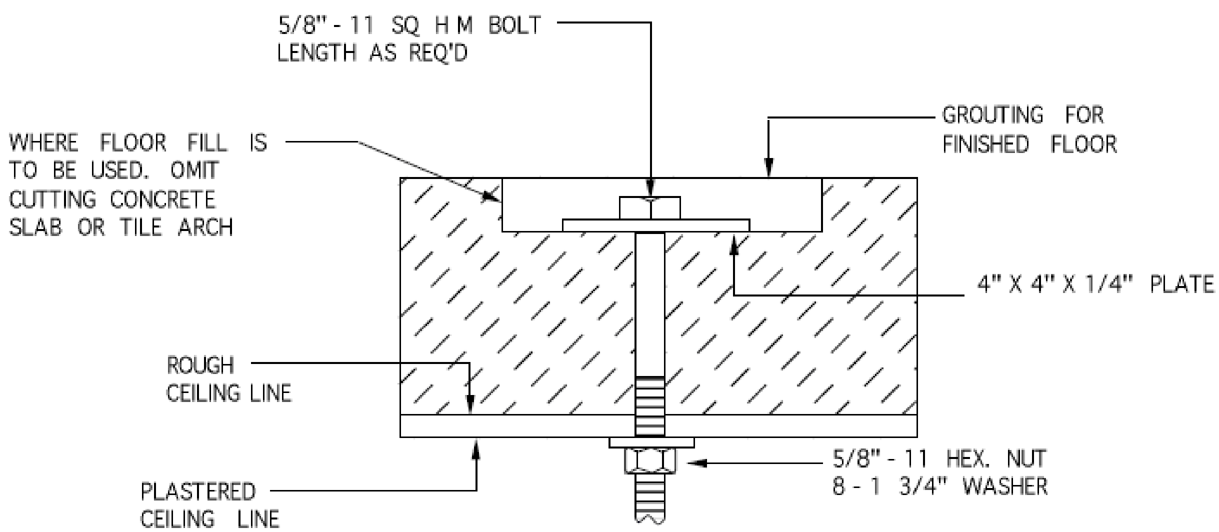


EXHIBIT 2-E3-4

2-E3-4 HANGER BOLTS USED WHERE BEAM CLAMPS OR EMBEDDED CEILING INSERTS ARE NOT PROVIDED

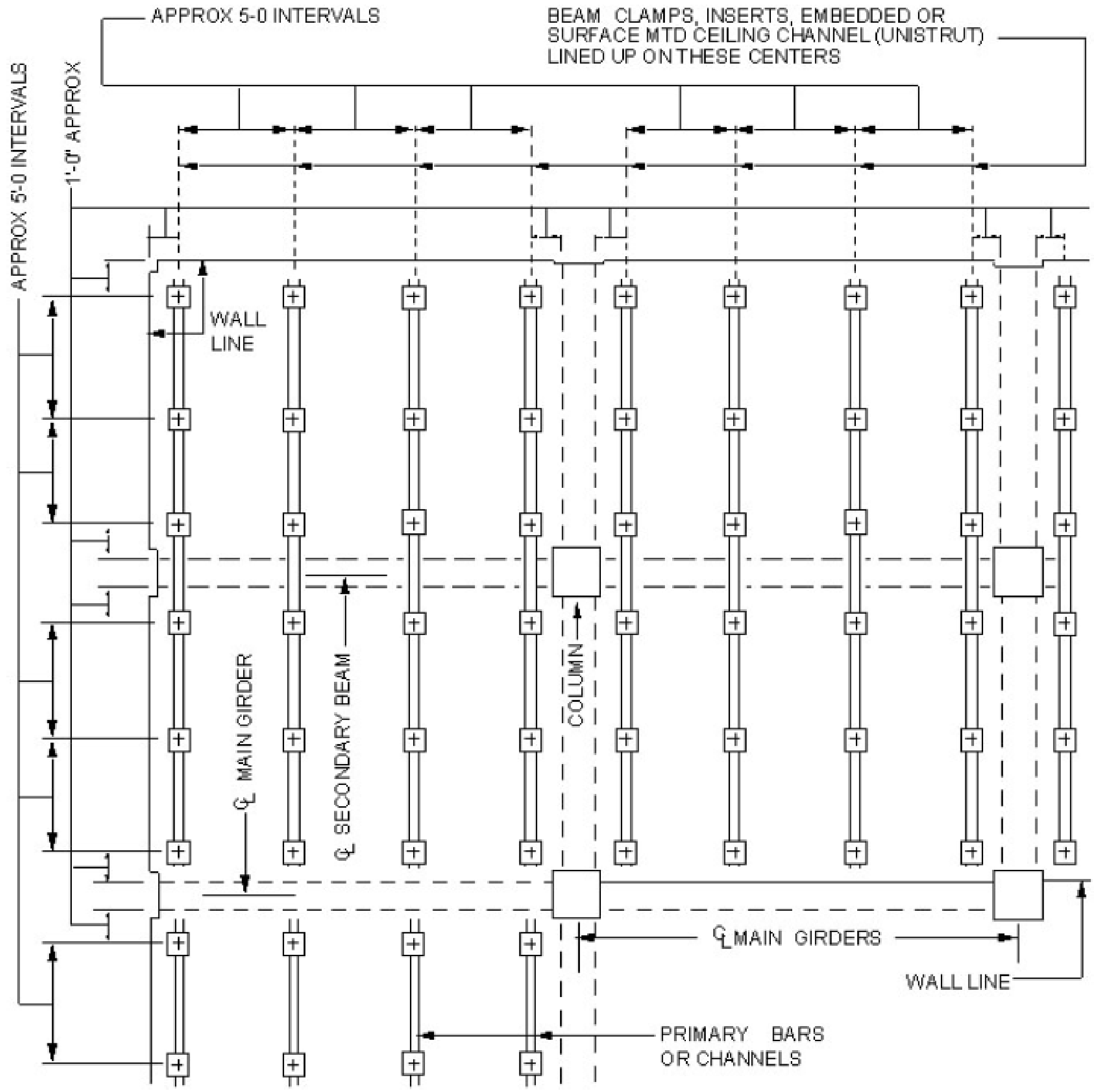


EXHIBIT 2-E3-5 (A&M)

2-E3-5 (A&M) TYPICAL LAYOUT OF BEAM CLAMPS, ATTACHMENT POINTS, OR INSERTS AND PRIMARY BARS OR CHANNELS

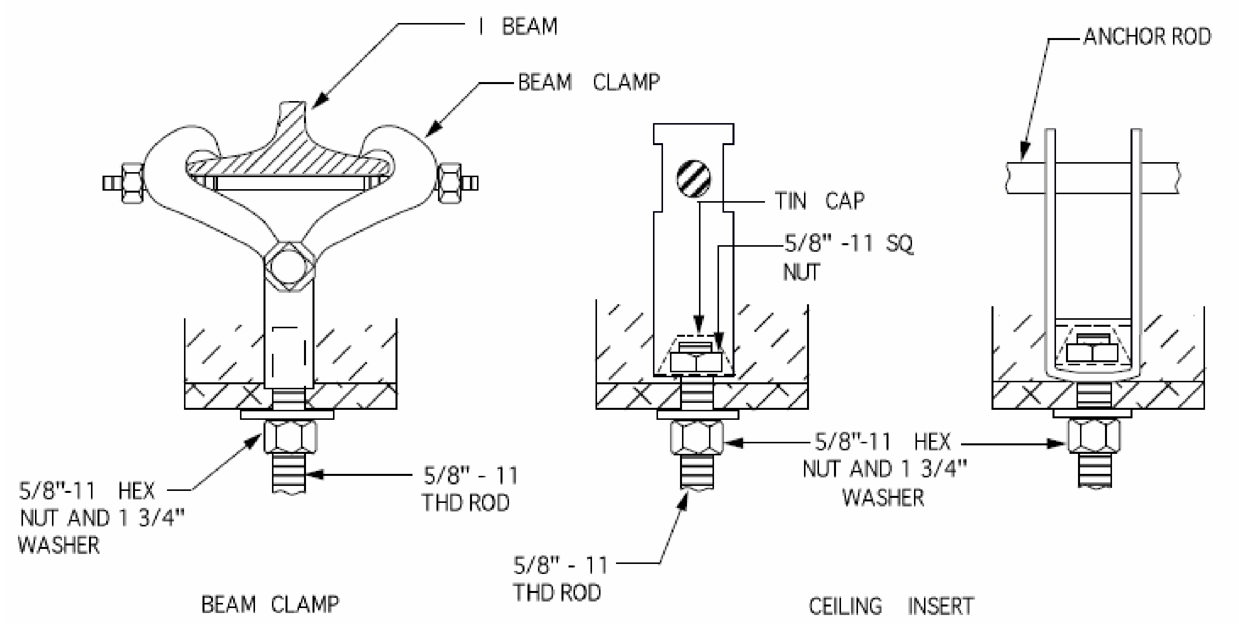


EXHIBIT 2-E3-6

2-E3-6 HANGER ROD ATTACHED TO BEAM CLAMP OR CEILING INSERT

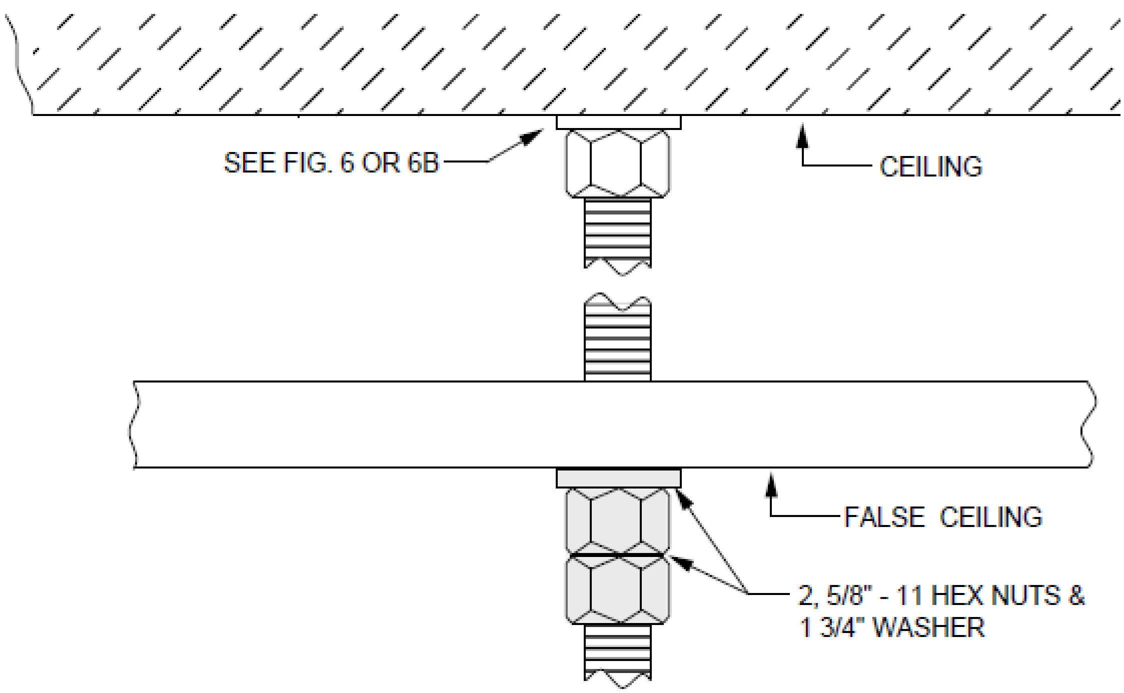
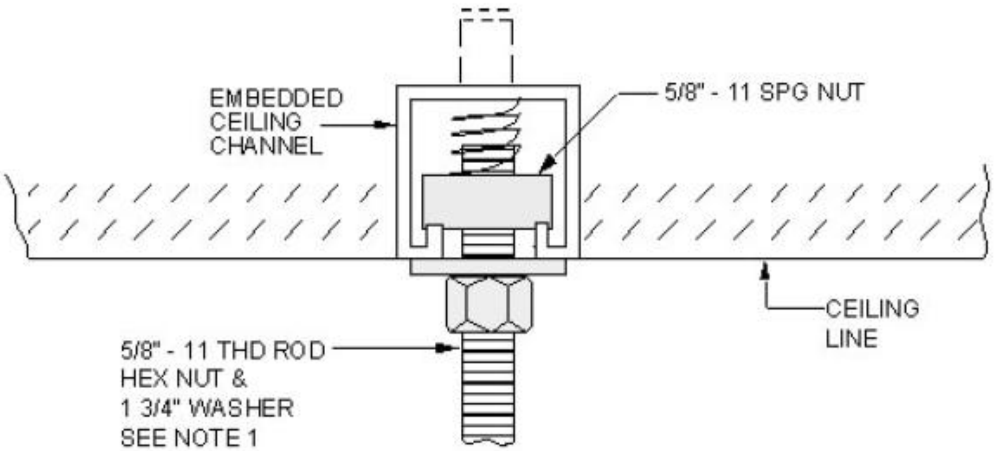


EXHIBIT 2-E3-6A

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
2-E3-6B FASTENING CEILING HANGER ROD TO EMBEDDED CEILING CHANNEL

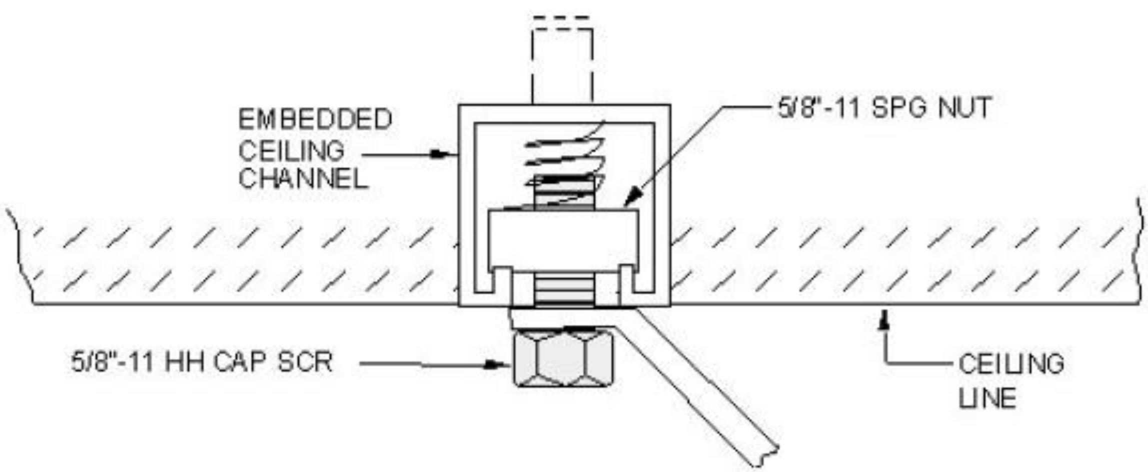
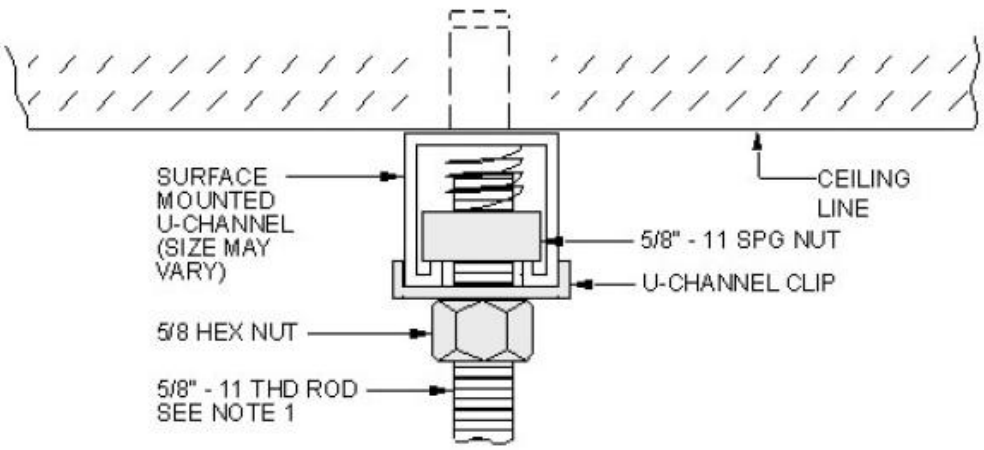


EXHIBIT 2-E3-6C
2-E3-6C FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL



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-E3-6D

2-E3-6D FASTENING CEILING HANGER ROD TO CEILING MOUNTED CHANNEL

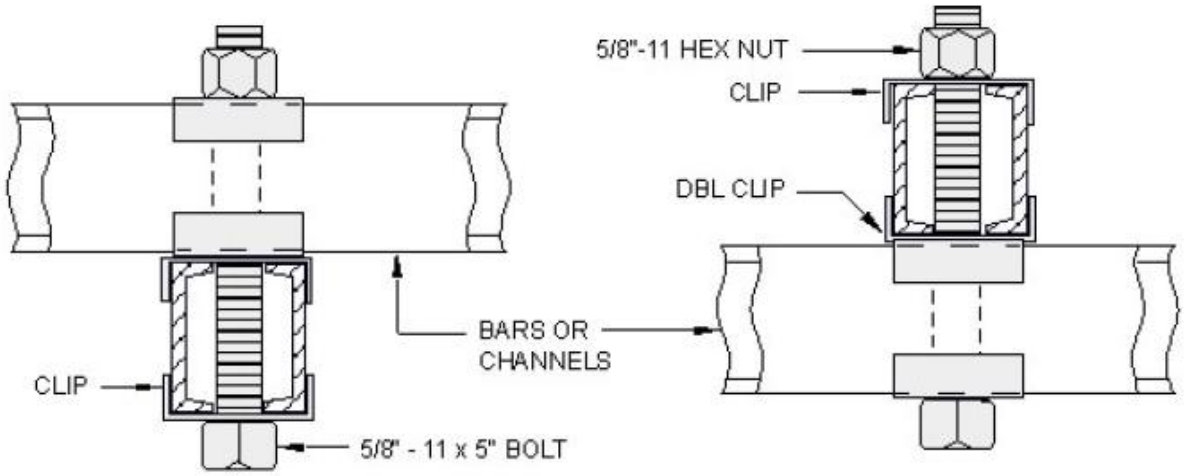


EXHIBIT 2-E3-7

2-E3-7 DOUBLE-LEVEL BARS OR CHANNELS ATTACHED WITH A BOLT ASSEMBLY

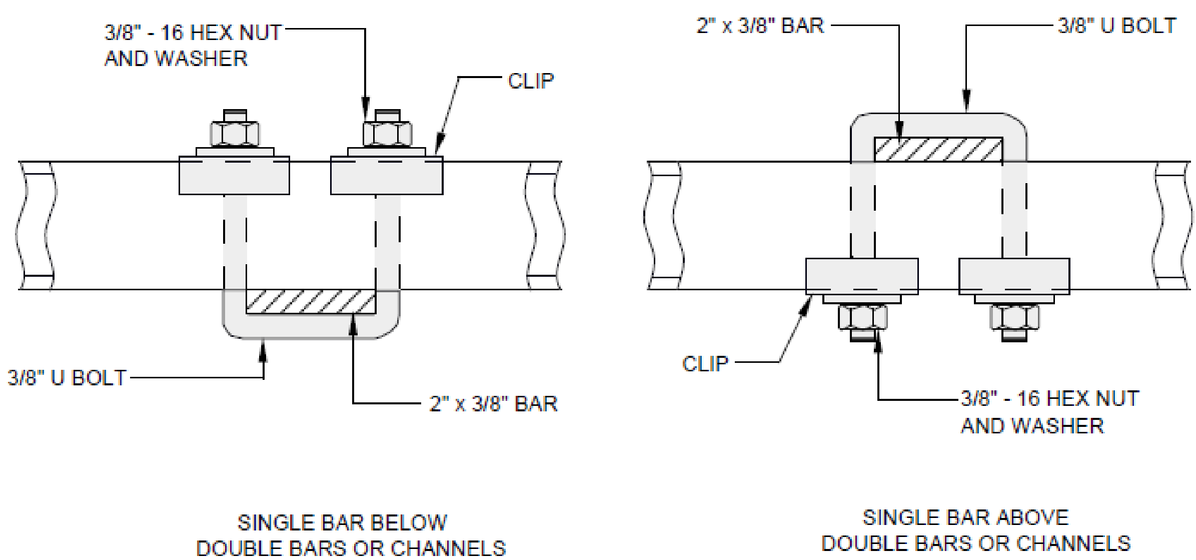
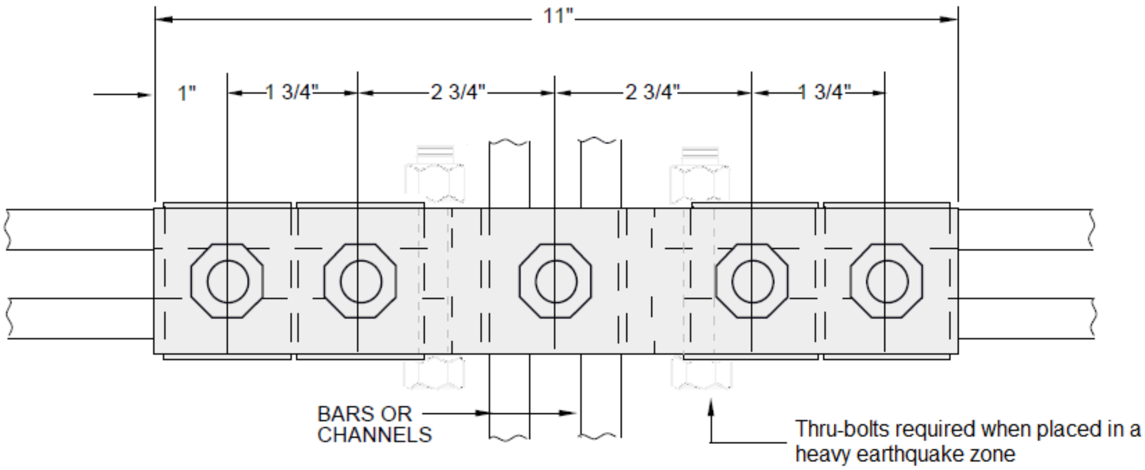


EXHIBIT 2-E3-8 (A&M)

2-E3-8 (A&M) DOUBLE-LEVEL AUXILIARY FRAMING-SINGLE BARS ATTACHED TO DOUBLE BARS OR CHANNELS



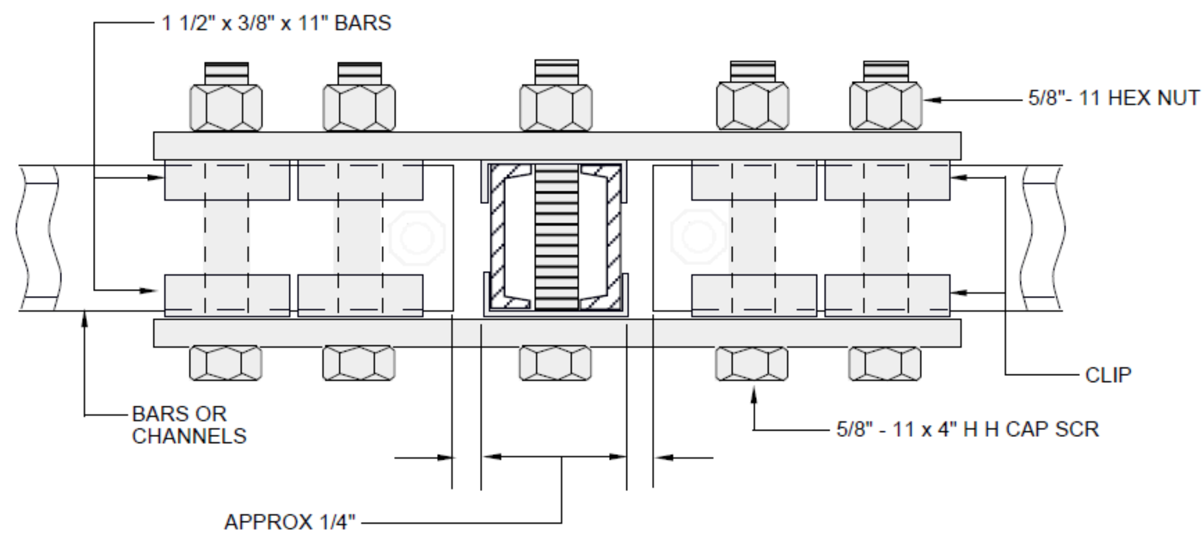


EXHIBIT 2-E3-9

2-E3-9 SINGLE-LEVEL AUXILIARY FRAMING INTERSECTION OF BARS OR CHANNELS

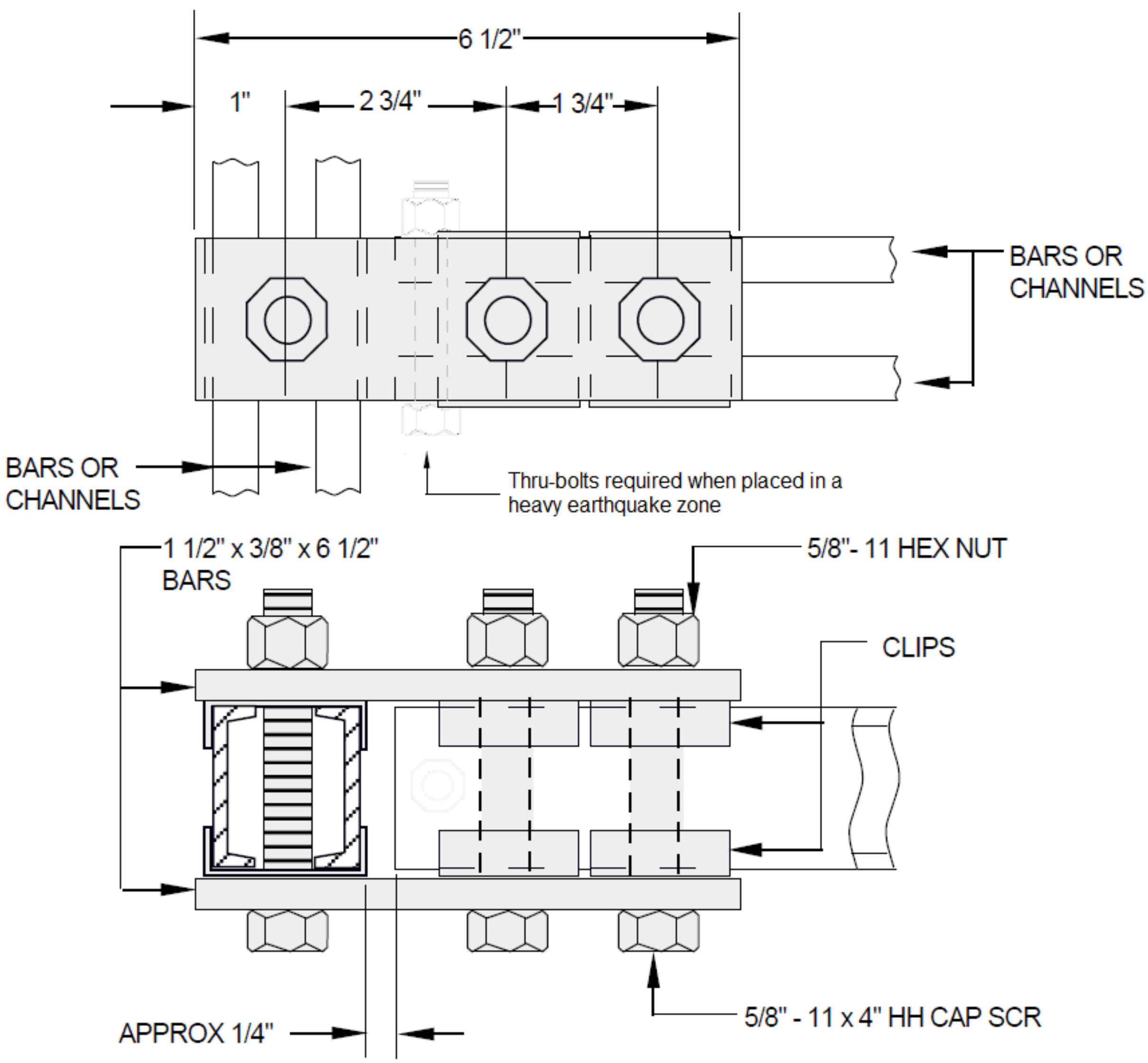


EXHIBIT 2-E3-10

2-E3-10 SINGLE-LEVEL AUXILIARY FRAMING JUNCTION OF BARS OR CHANNELS

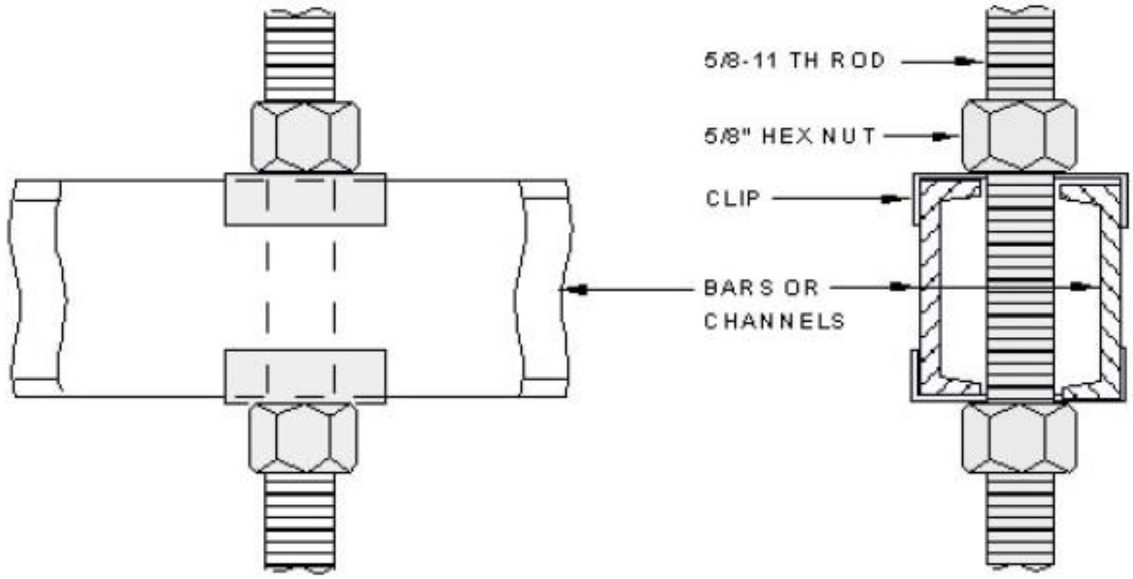


EXHIBIT 2-E3-11
2-E3-11 SINGLE LEVEL BARS OR CHANNELS ATTACHED TO HANGER RODS

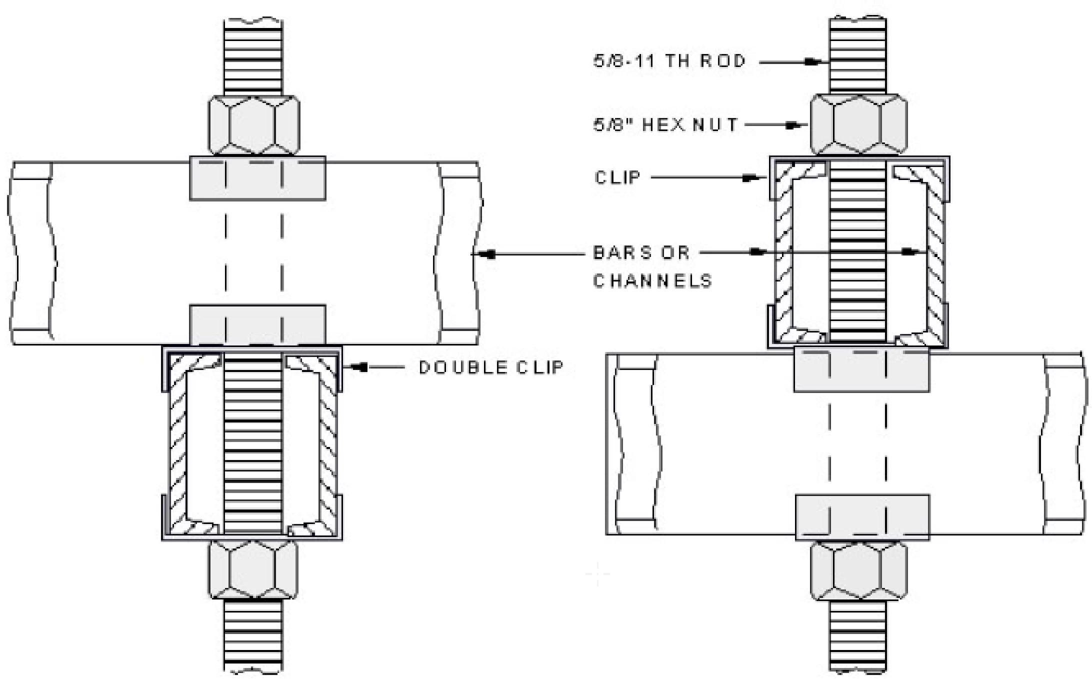


EXHIBIT 2-E3-11A
2-E3-11A DOUBLE LEVEL BARS OR CHANNELS ATTACHED TO HANGER RODS

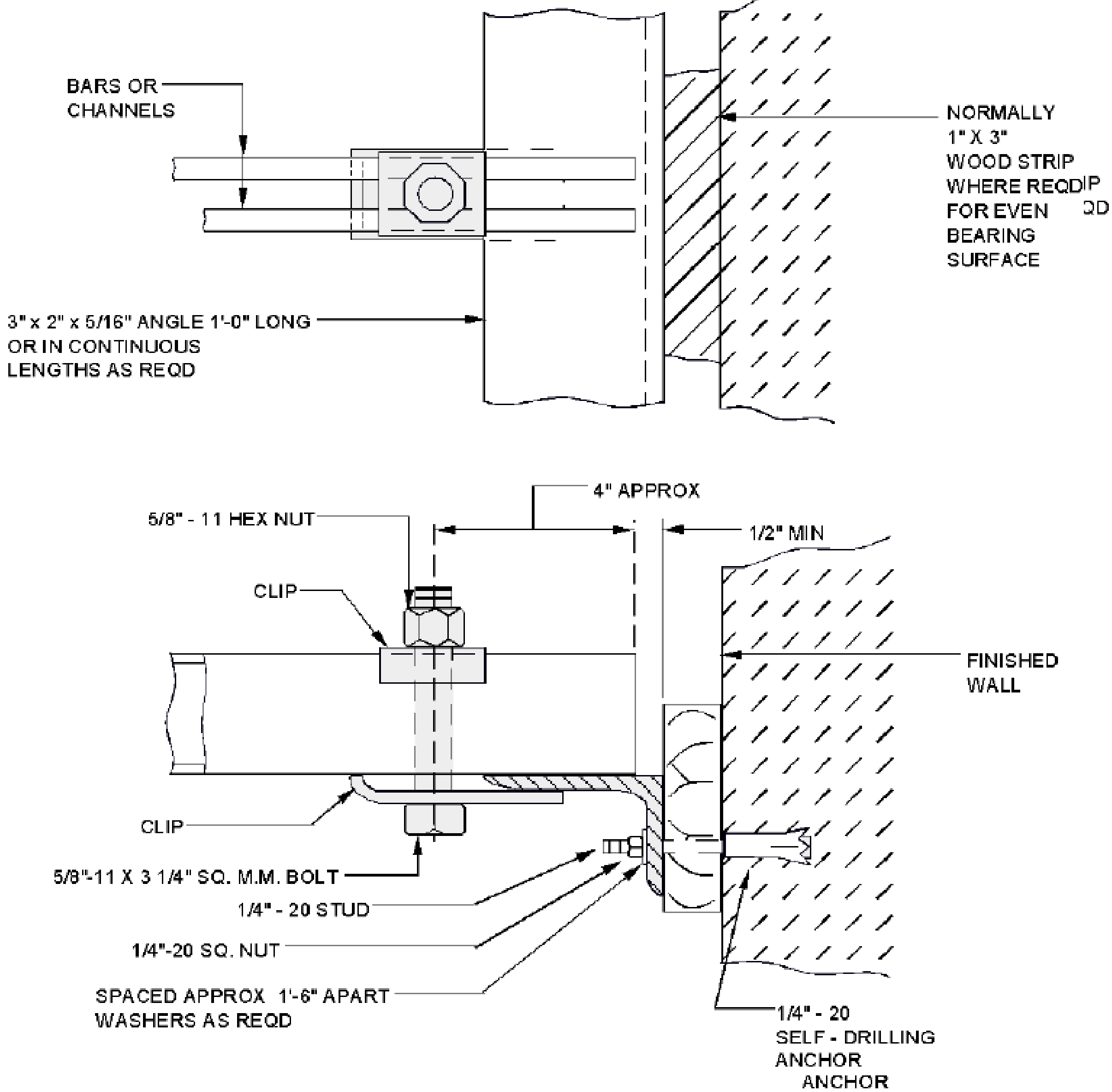


EXHIBIT 2-E3-12

2-E3-12 DOUBLE FRAMING ATTACHED TO WALLS WHERE IMPRACTICABLE TO DRILL WALL ANGLE

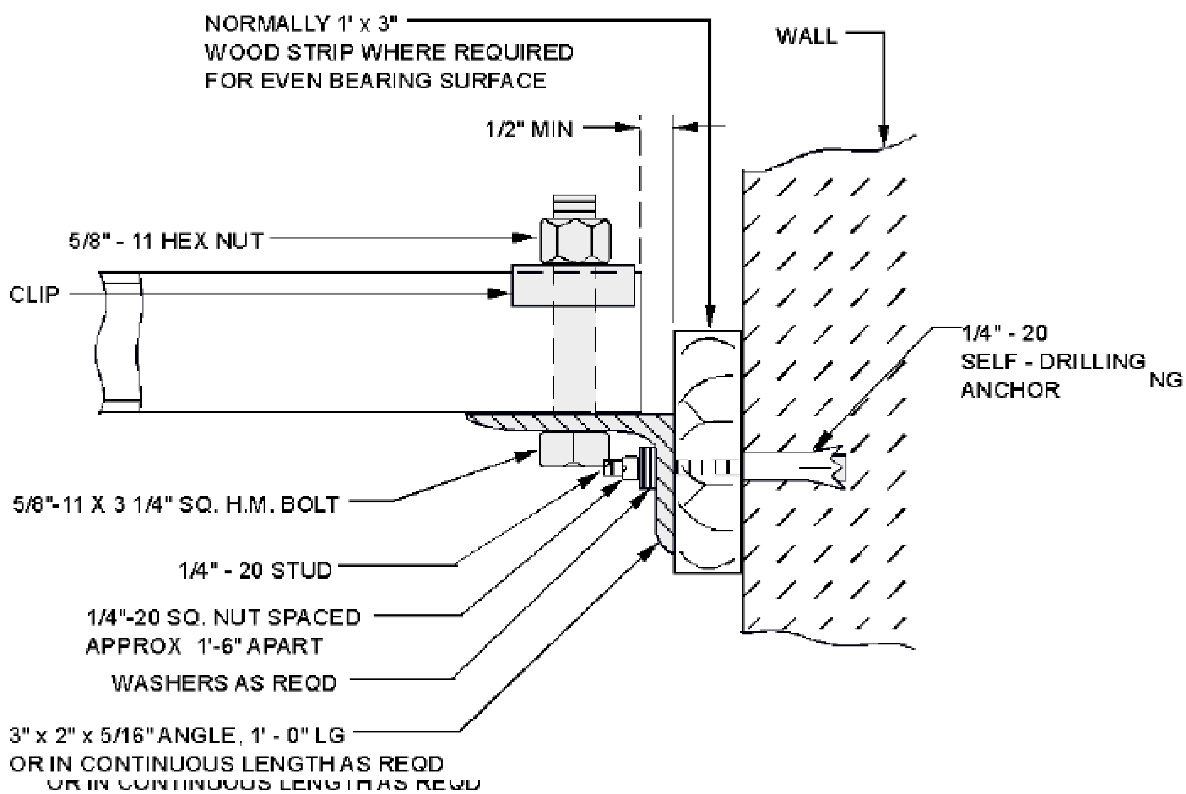


EXHIBIT 2-E3-12A (A&M) SEE 2-E2-8C

2-E3-12A **(A&M) SEE 2-E2-8C DOUBLE FRAMING ATTACHED TO WALLS WHERE ANGLE IS DRILLED**

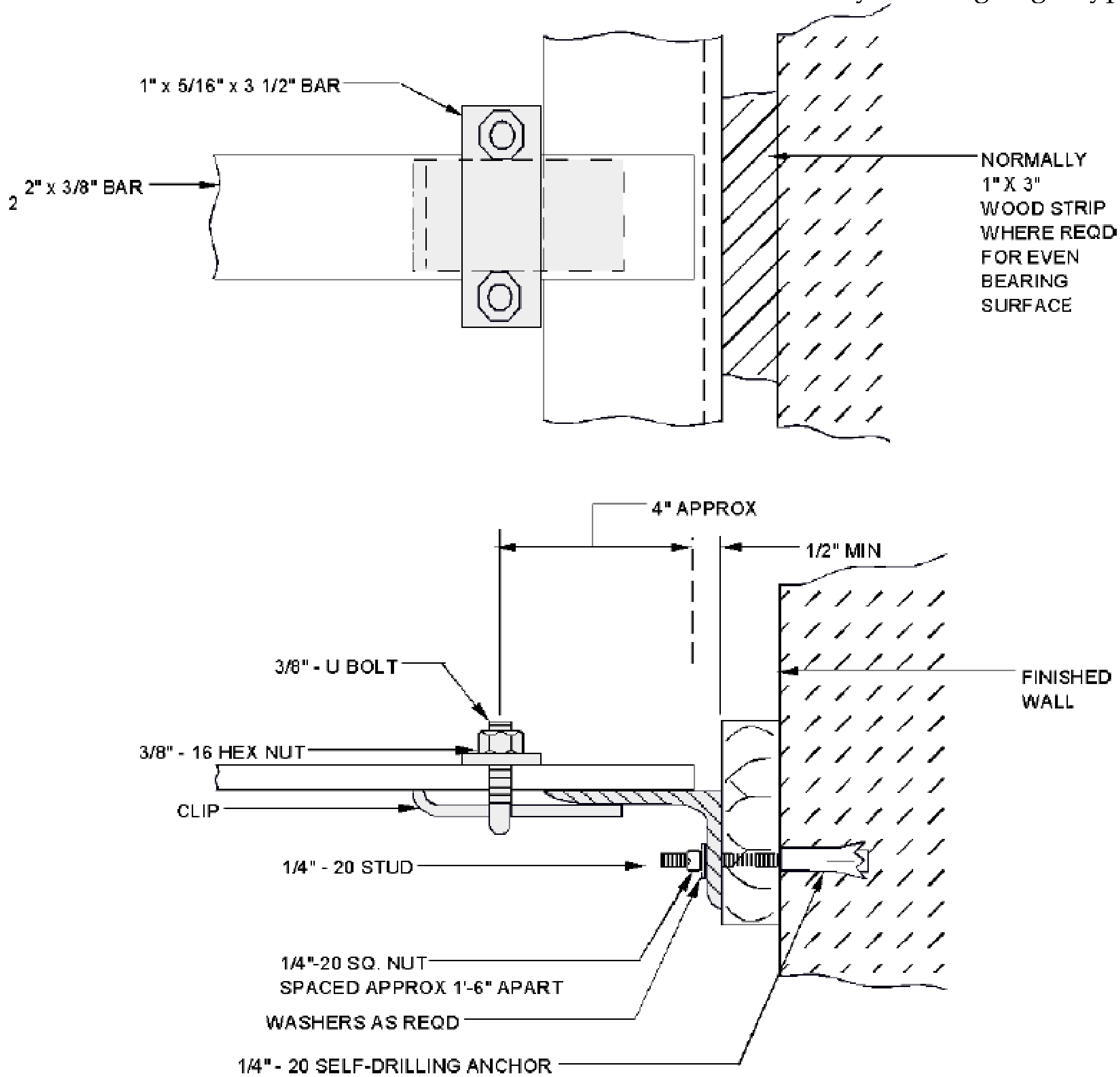


EXHIBIT 2-E3-13 (A&M)

2-E3-13 (A&M) SINGLE FRAMING ATTACHED TO WALLS

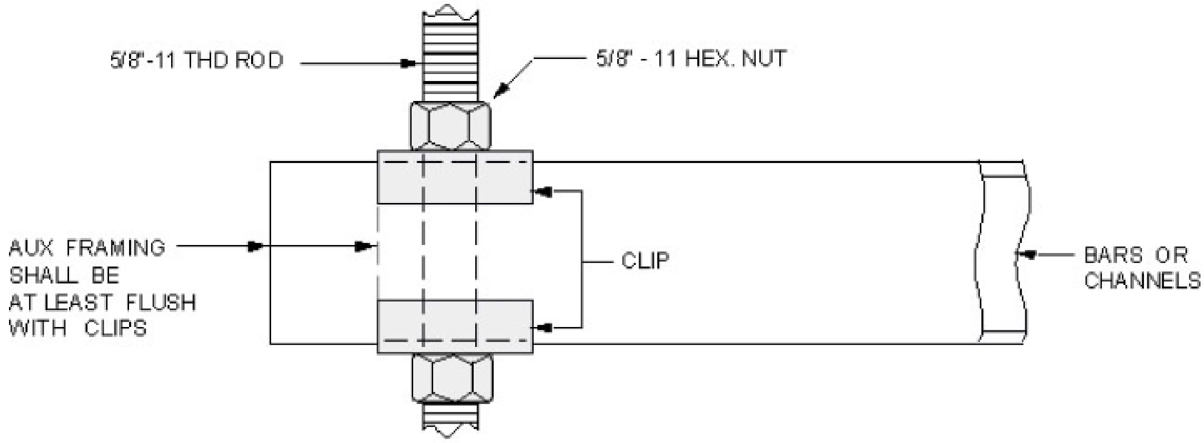


EXHIBIT 2-E3-14

2-E3-14 HANGER RODS OR BOLTS ATTACHED AT ENDS OF DOUBLE BARS OR CHANNELS

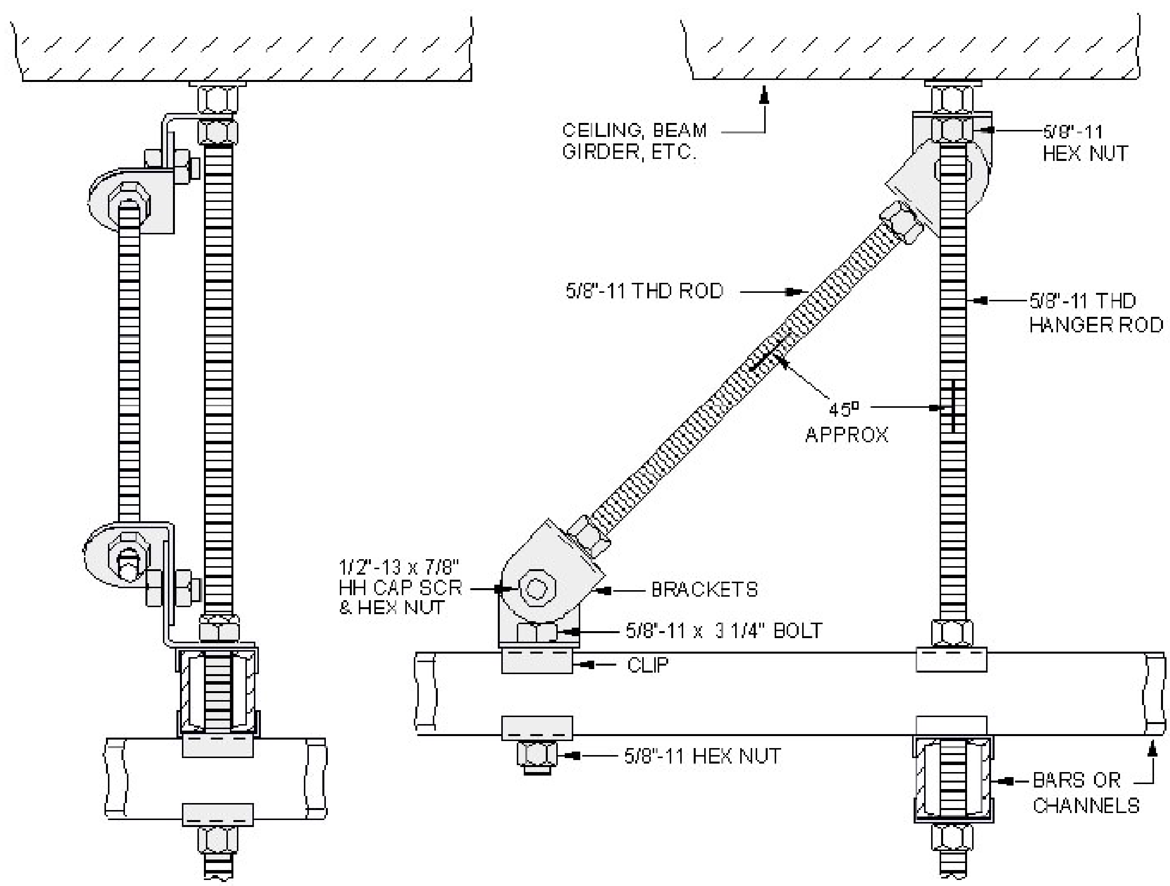


EXHIBIT 2-E3-15

2-E3-15 BRACING UPPER LEVEL FRAMING

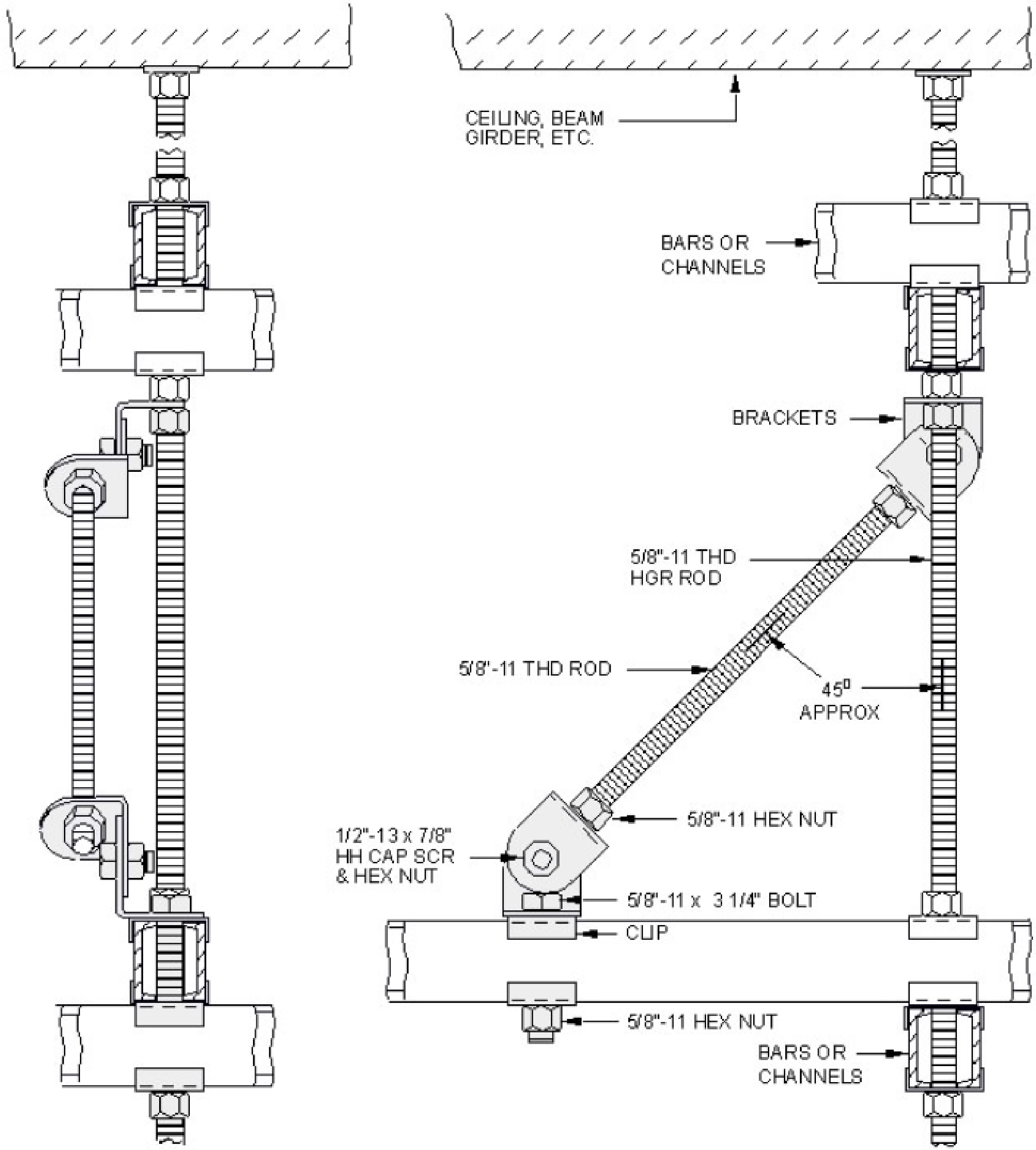


EXHIBIT 2-E3-16

2-E3-16 BRACING LOWER LEVEL FRAMING AT RIGHT ANGLES TO HIGHER LEVEL FRAMING

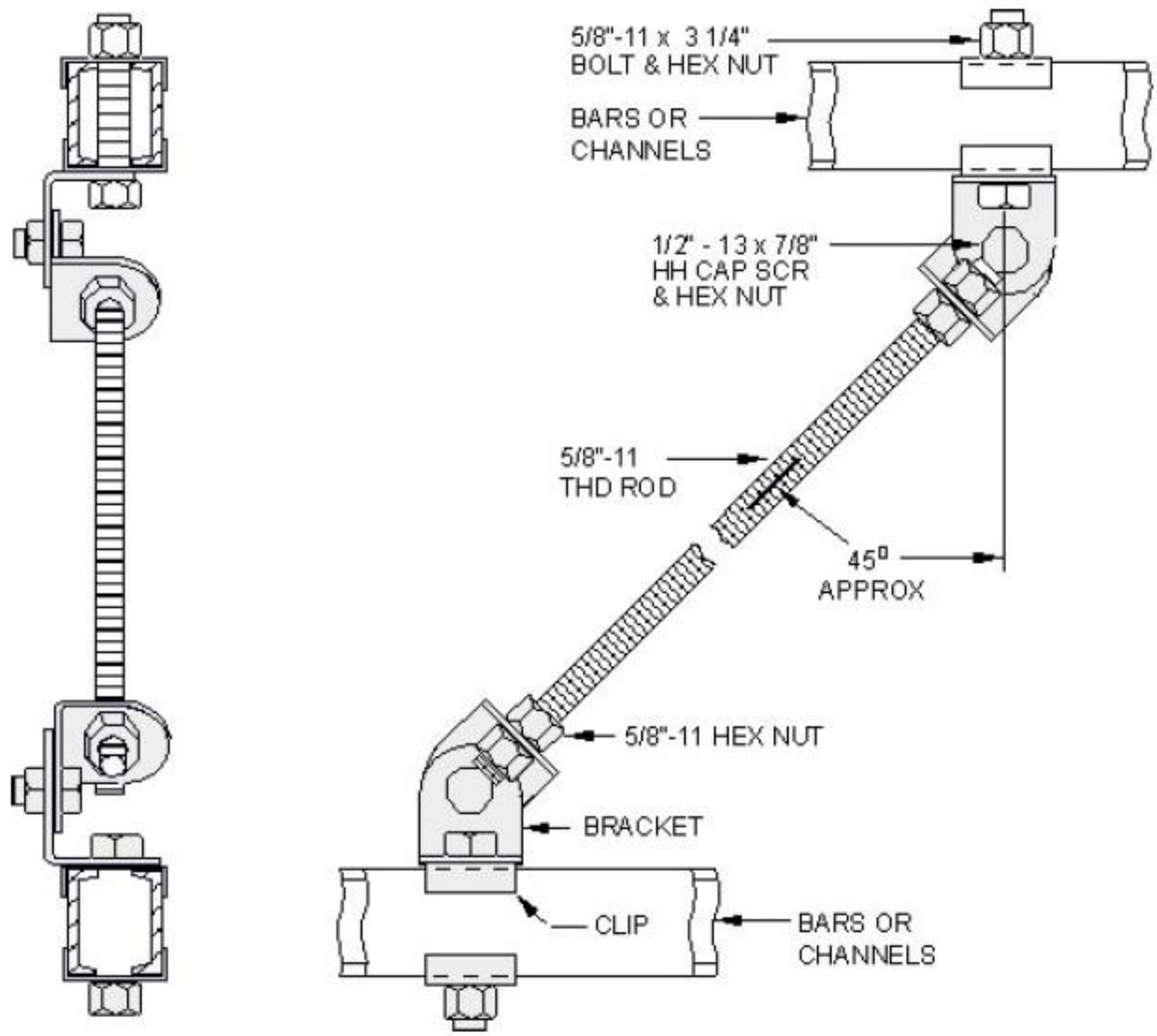


EXHIBIT 2-E3-16A

2-E3-16A BRACING LOWER LEVEL FRAMING PARALLEL TO HIGHER LEVEL FRAMING

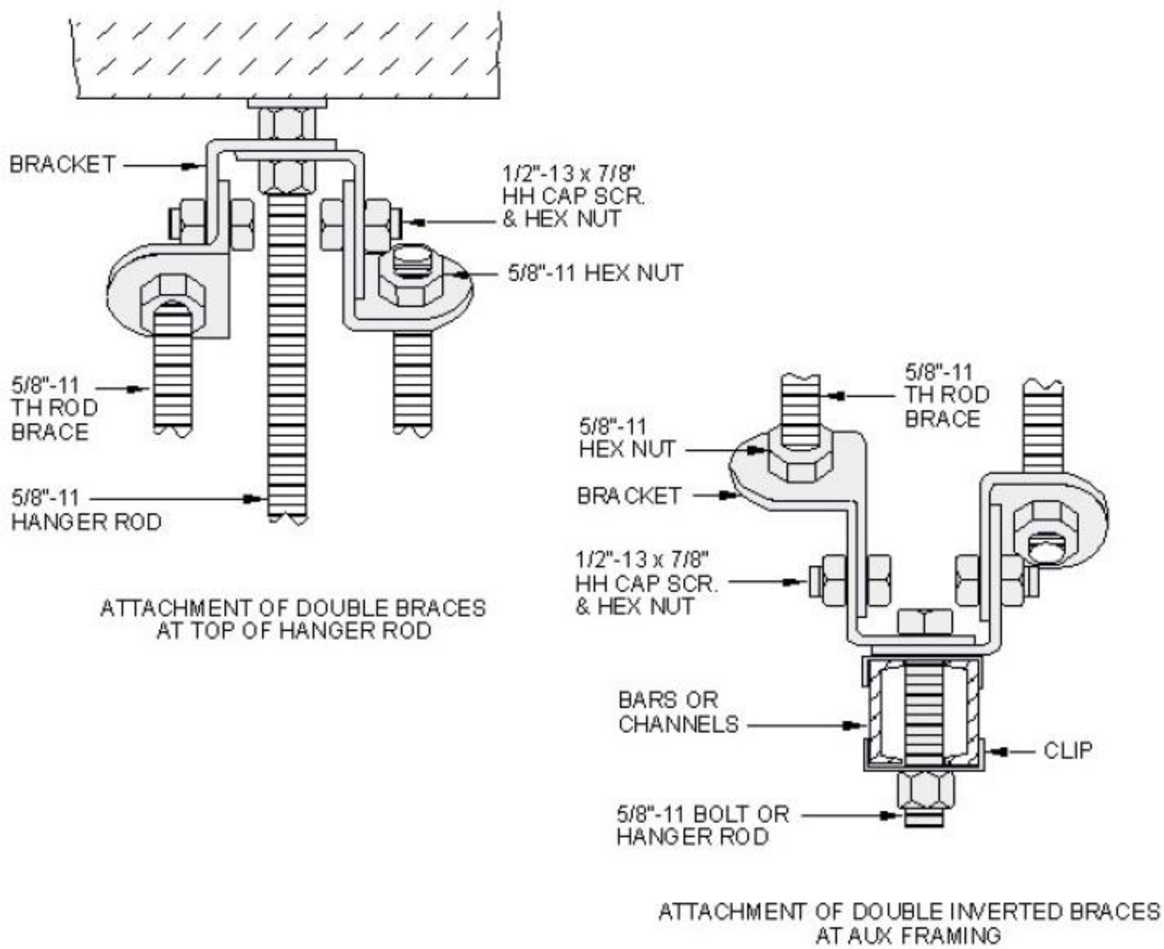


EXHIBIT 2-E3-17

2-E3-17 ATTACHING DOUBLE BRACING

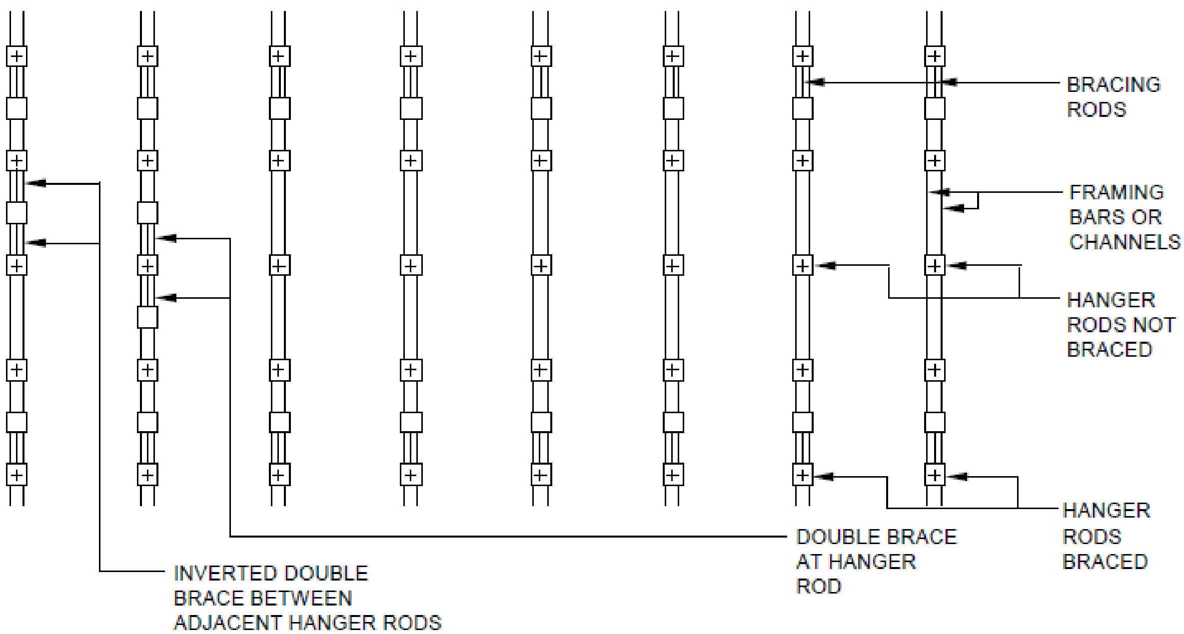


EXHIBIT 2-E3-18

2-E3-18 TYPICAL LAYOUT OF BRACING DETAILS FOR PRIMARY FRAMING BARS OR CHANNELS

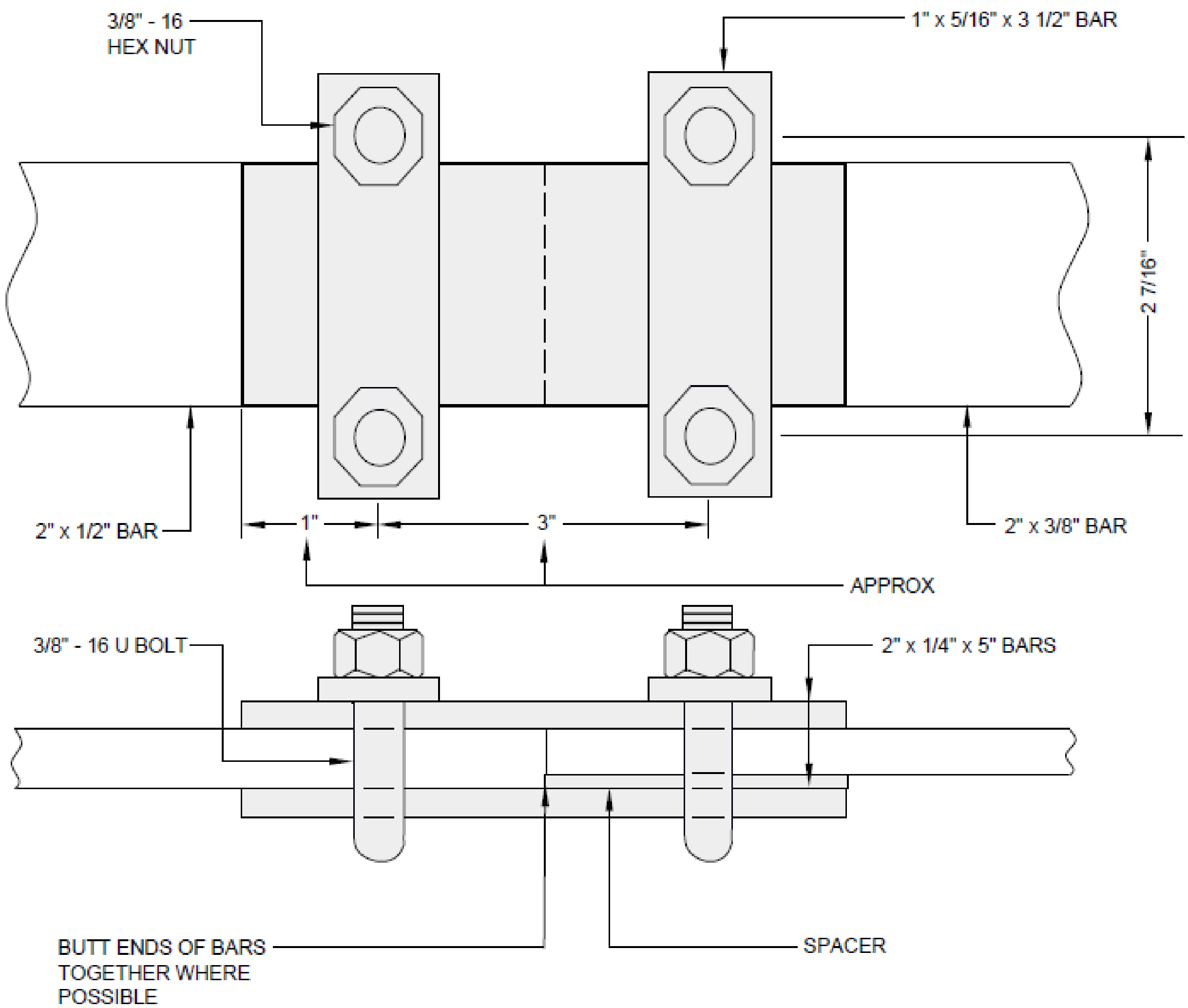


EXHIBIT 2-E3-19 (DISCONTINUED)

2-E3-19 (DISCONTINUED) SPLICING SINGLE 2 INCHES BY 3/8 OF AN INCH BARS TO 2 INCHES BY 1/2 OF AN INCH BARS

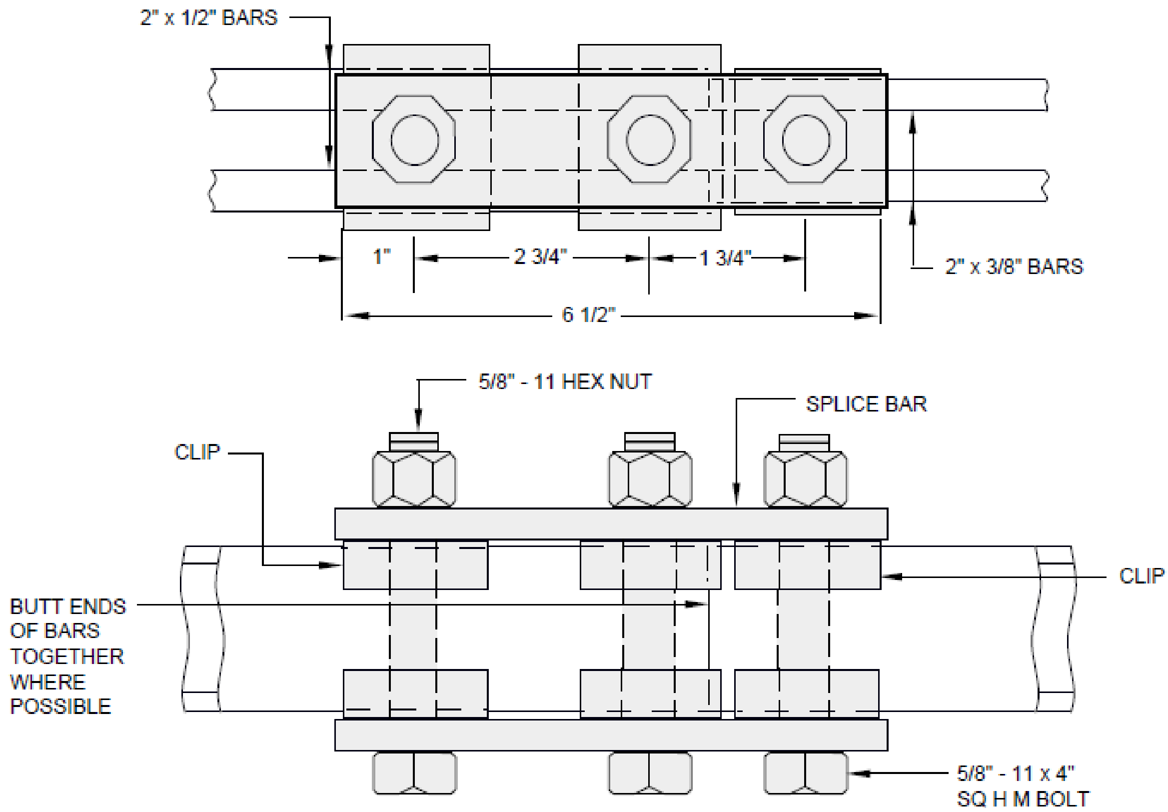


EXHIBIT 2-E3-20 (A&M)

2-E3-20 (A&M) SPLICING PAIRS OF 2 INCHES BY 3/8 OF AN INCH BARS TO 2 INCHES BY 1/2 OF AN INCH BARS

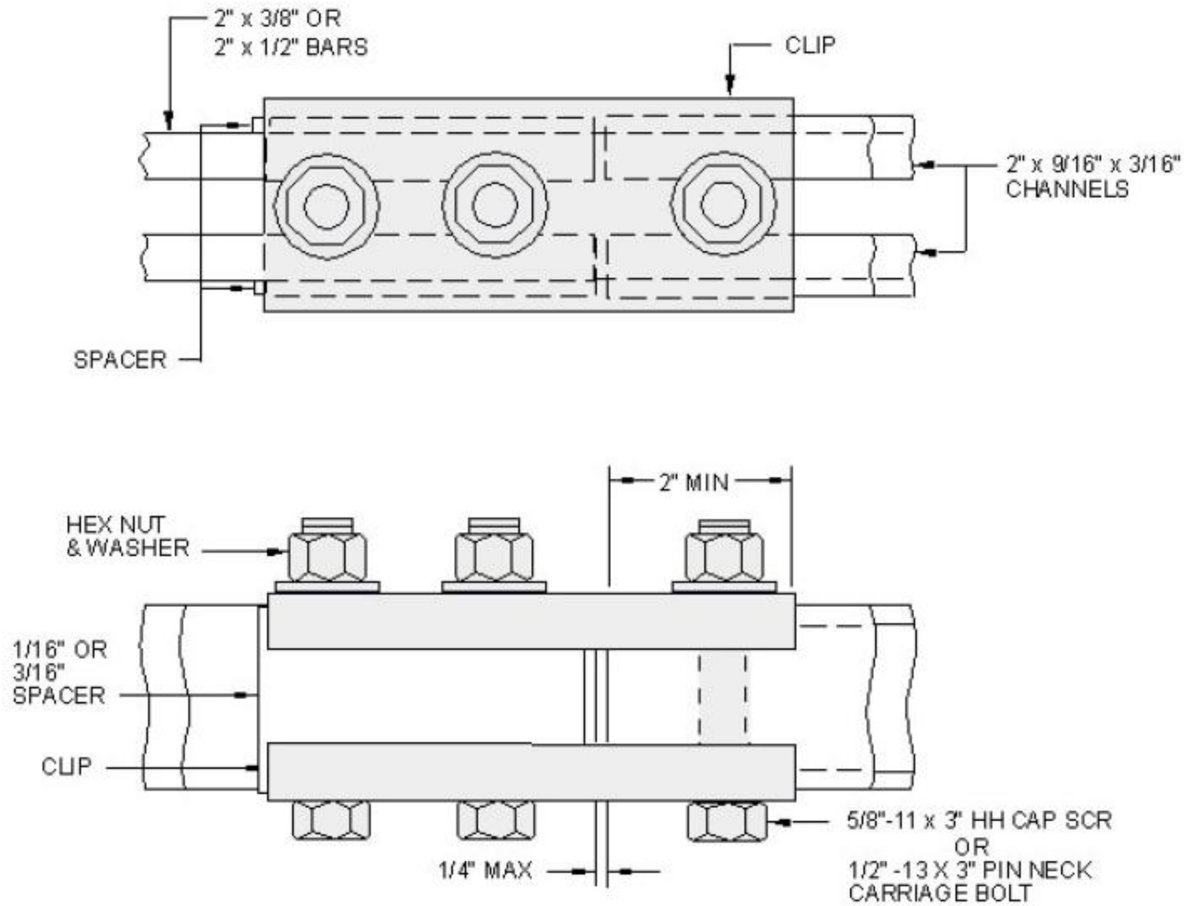


EXHIBIT 2-E3-20A (A&M)

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

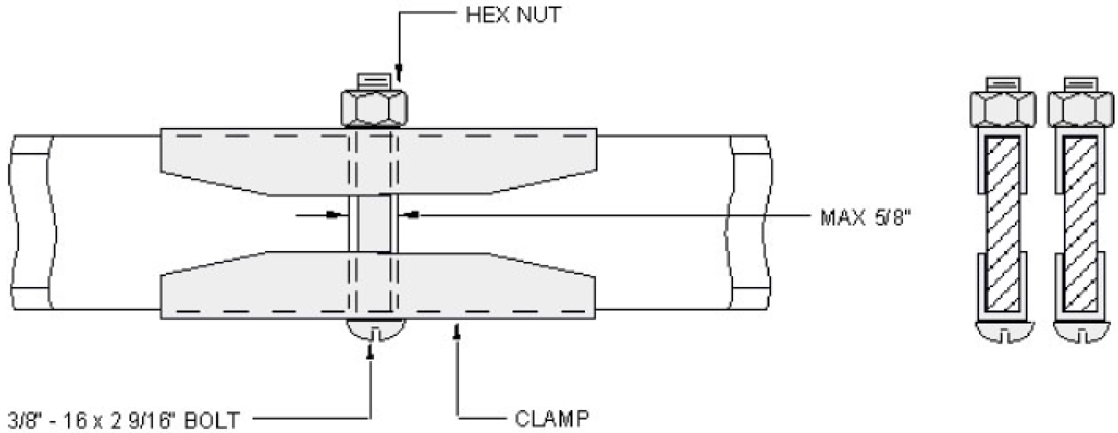
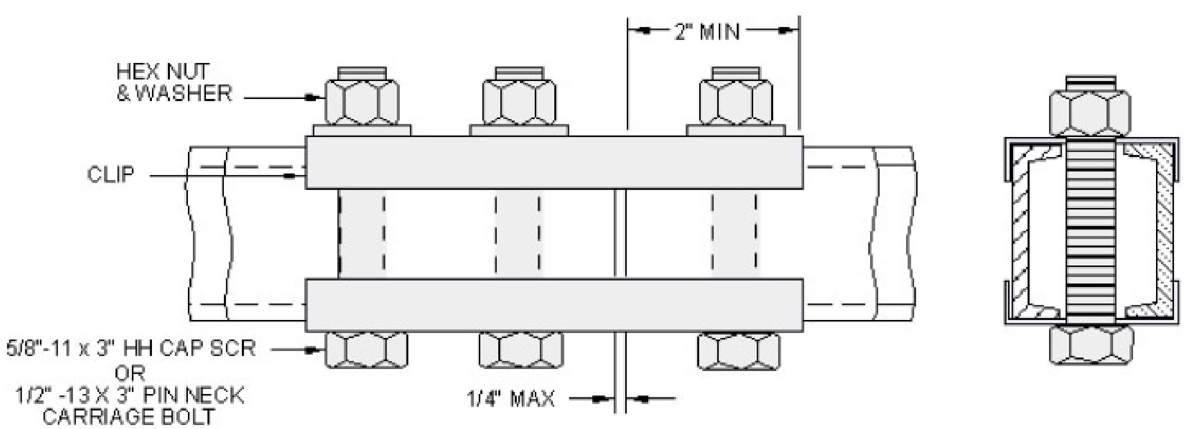


EXHIBIT 2-E3-21

2-E3-21 SPLICING PAIRS OF 2 INCHES BY 3/8 OF AN INCH BARS



NOTE: THIS EXHIBIT PREVIOUSLY SHOWED A 2-HOLE SPLICE

EXHIBIT 2-E3-21A ~~(A&M)~~

2-E3-21A SPLICING PAIRS OF 2 INCHES BY 9/16 OF AN INCH CHANNELS

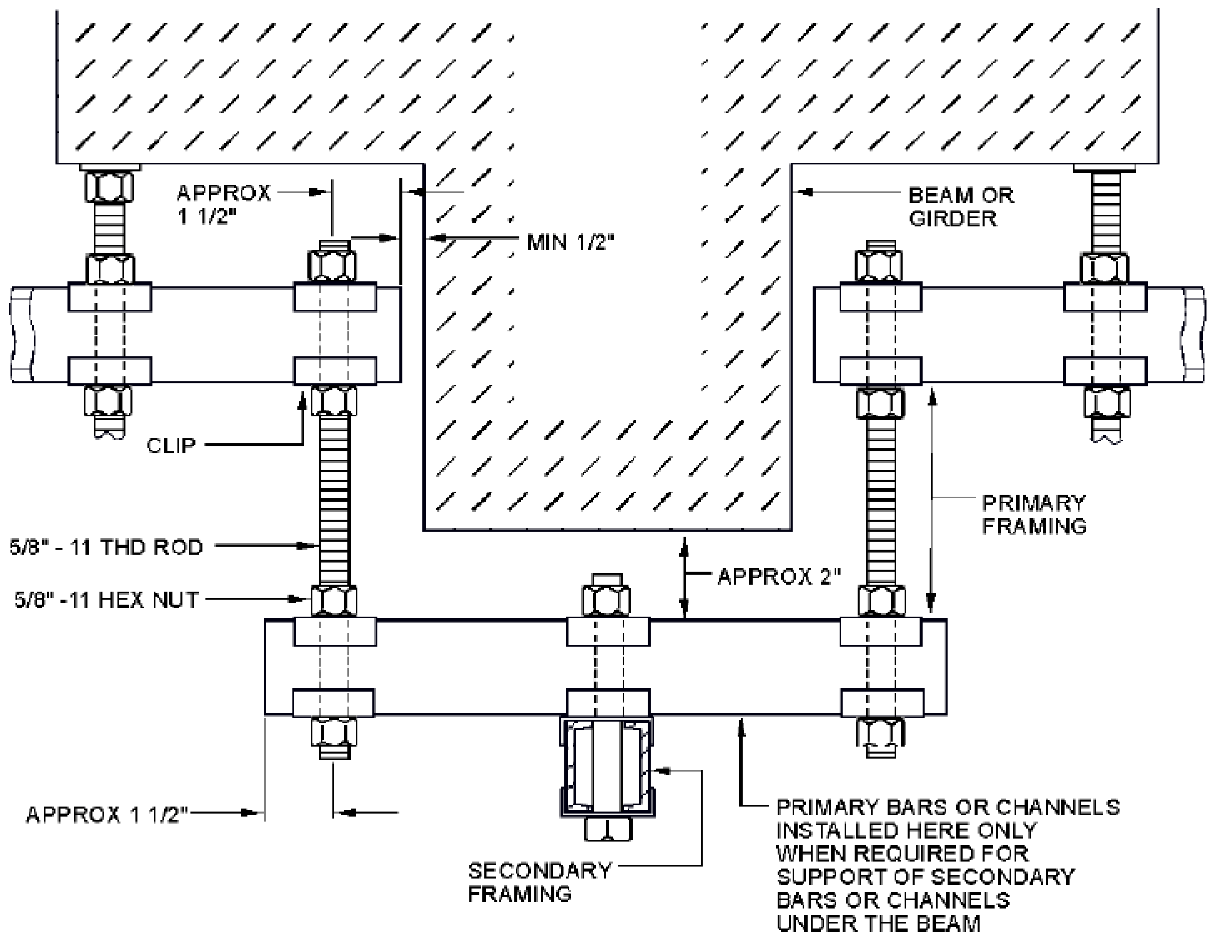
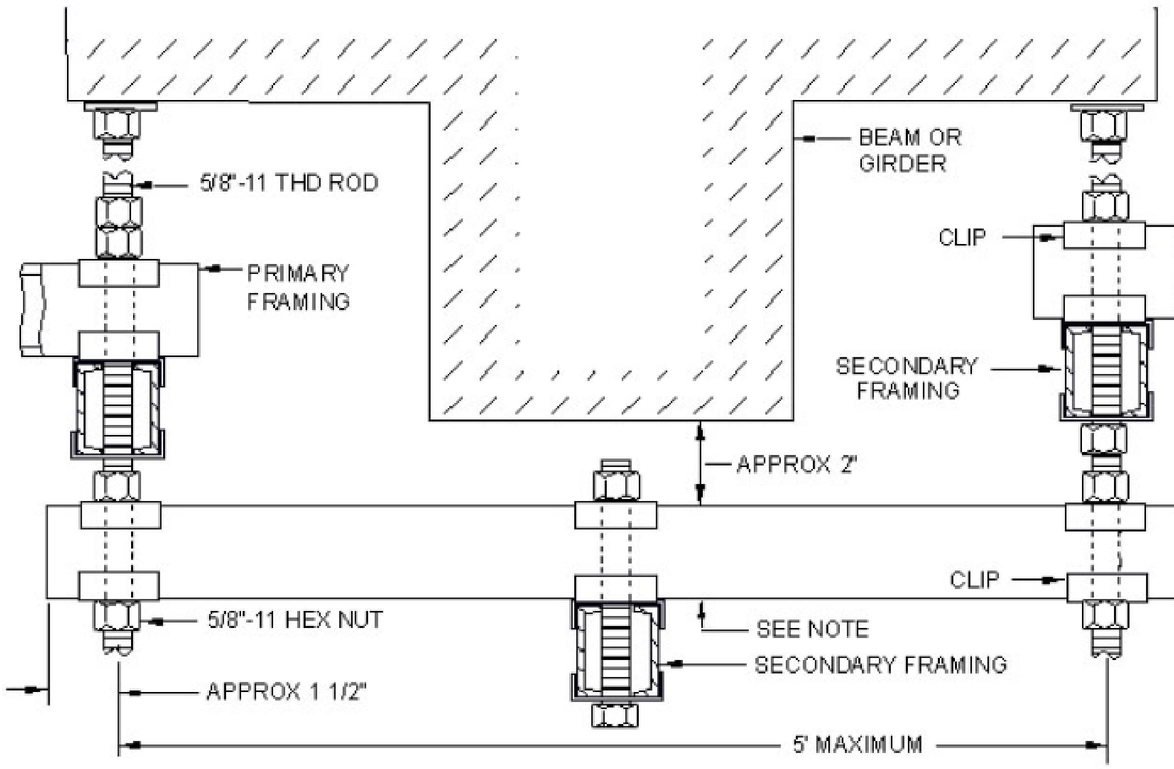


EXHIBIT 2-E3-22 (DISCONTINUED)

2-E3-22 (DISCONTINUED) DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS AT RIGHT ANGLES TO BEAMS OR GIRDERS



NOTE: PRIMARY BARS OR CHANNELS INSTALLED HERE ONLY WHEN REQUIRED FOR THE SUPPORT OF SECONDARY BARS OR CHANNELS UNDER THE BEAM.

EXHIBIT 2-E3-22A

2-E3-22A DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS AT RIGHT ANGLES TO BEAMS OR GIRDERS

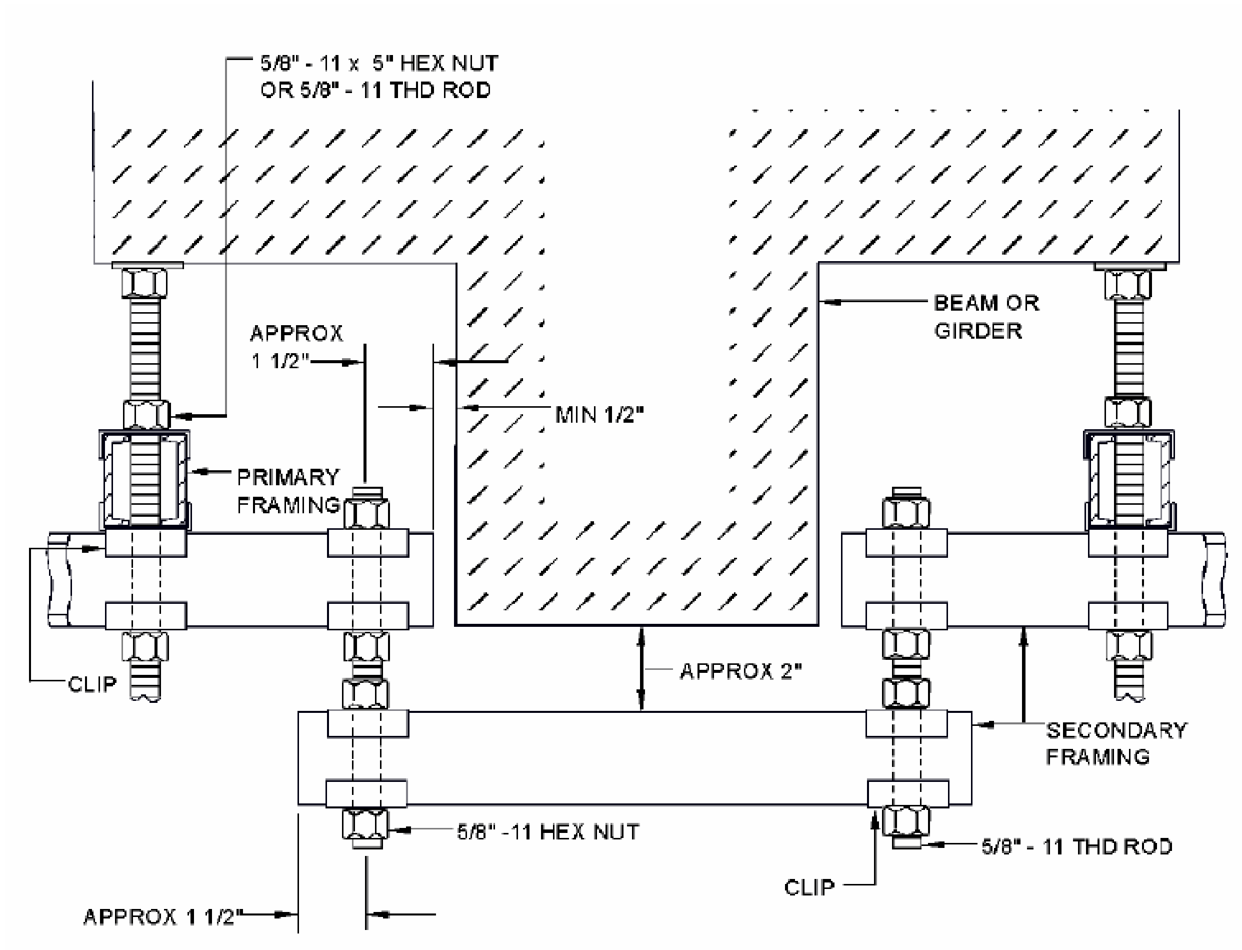


EXHIBIT 2-E3-23 (DISCONTINUED)

2-E3-23 (DISCONTINUED) DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS PARALLEL TO BEAMS OR GIRDERS

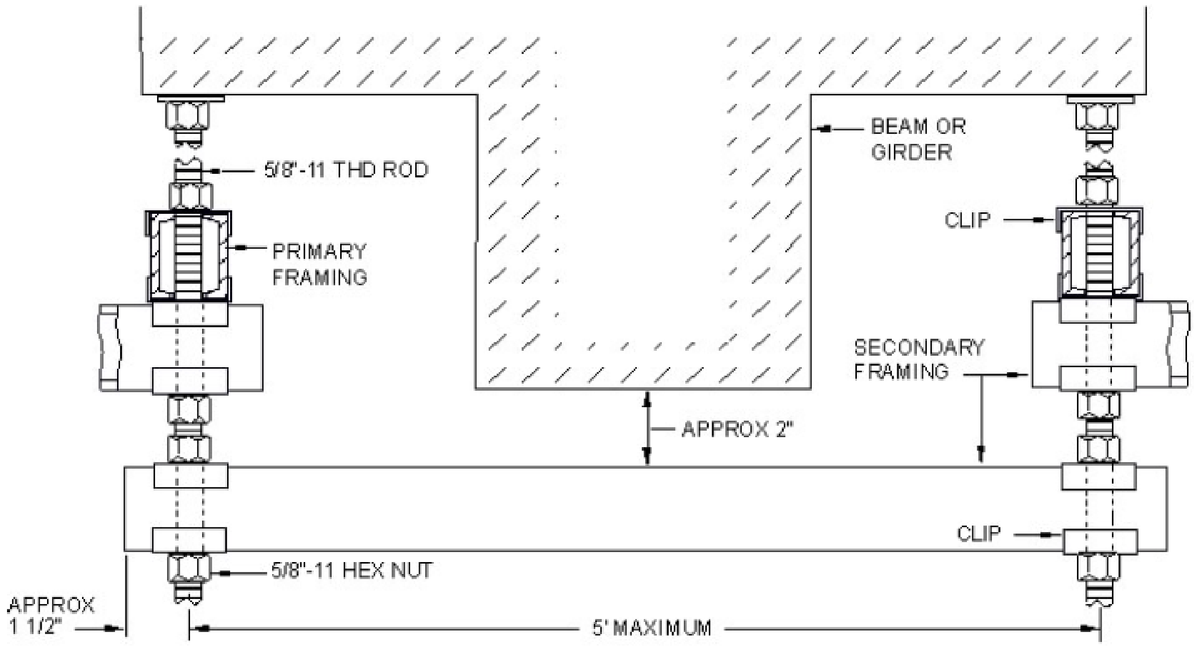


EXHIBIT 2-E3-23A

2-E3-23A DOUBLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS PARALLEL TO BEAMS OR GIRDERS

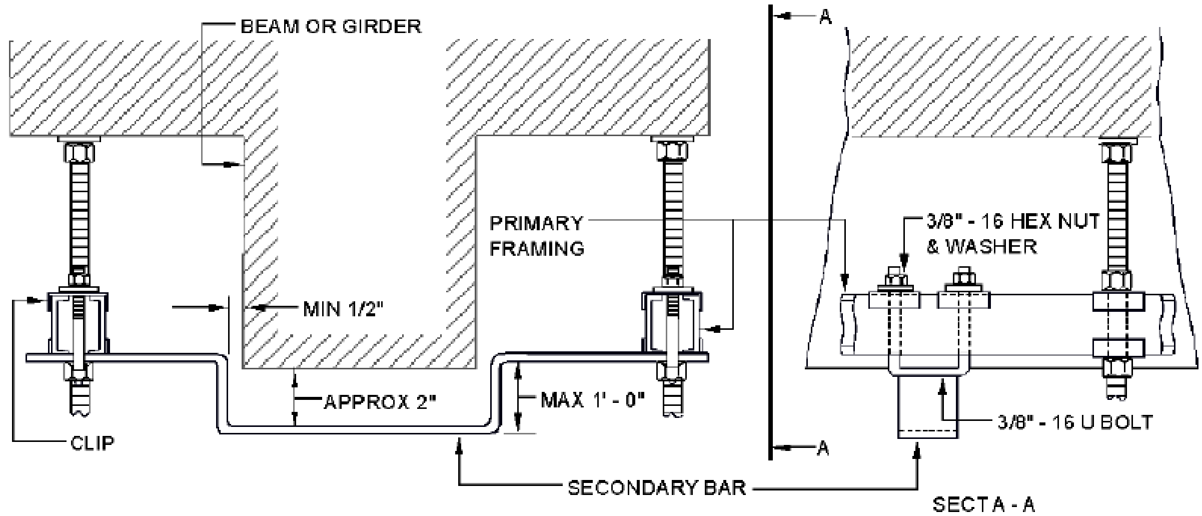


EXHIBIT 2-E3-24 (DISCONTINUED)

2-E3-24 (DISCONTINUED) SINGLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY

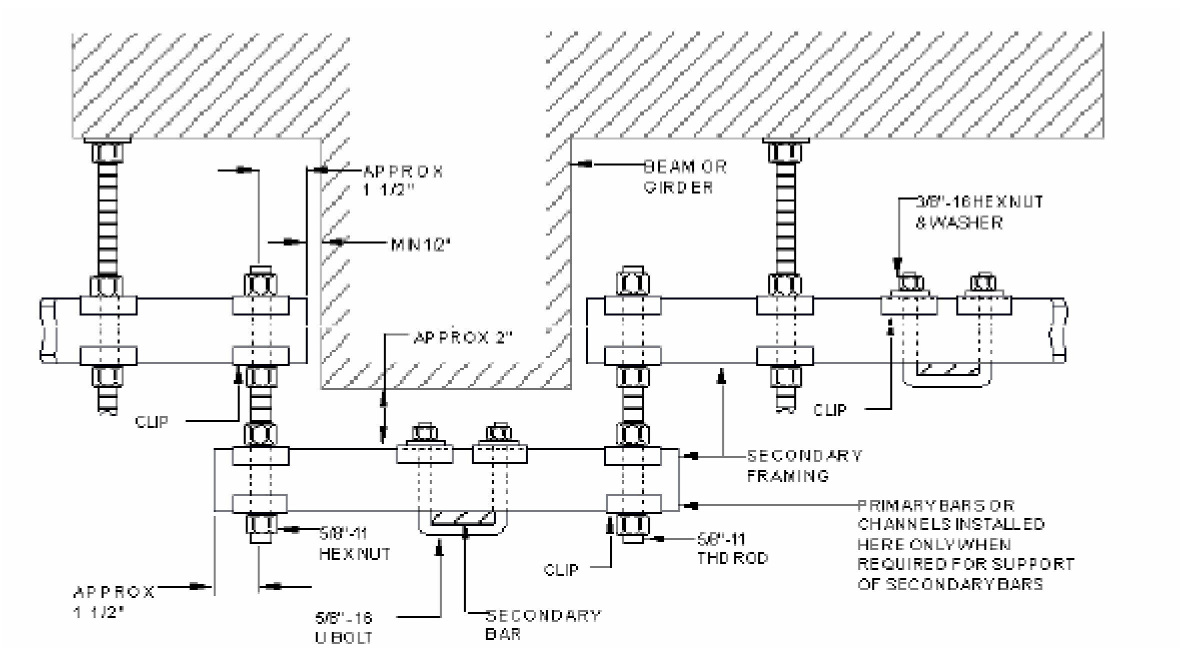


EXHIBIT 2-E3-25 (DISCONTINUED)

2-E3-25 (DISCONTINUED) SINGLE FRAMING UNDER BEAMS OR GIRDERS-PRIMARY BARS OR CHANNELS AT RIGHT ANGLES TO BEAMS OR GIRDERS

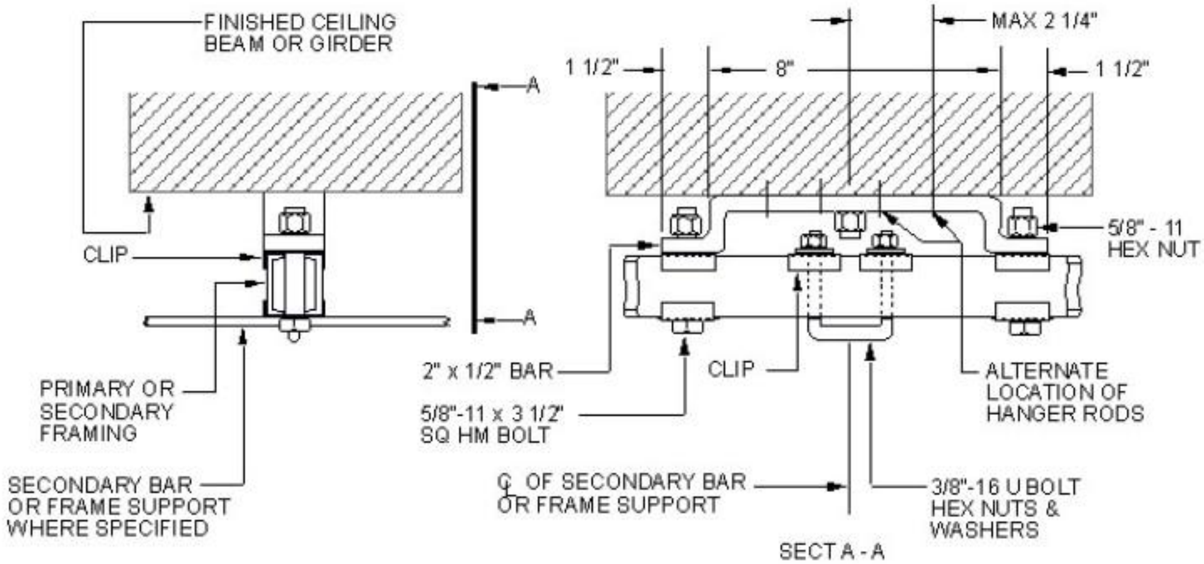


EXHIBIT 2-E3-26 (DISCONTINUED)
2-E3-26 (DISCONTINUED) SUPPORTING FRAMING WHERE HANGER RODS INTERFERE WITH OTHER ATTACHMENTS

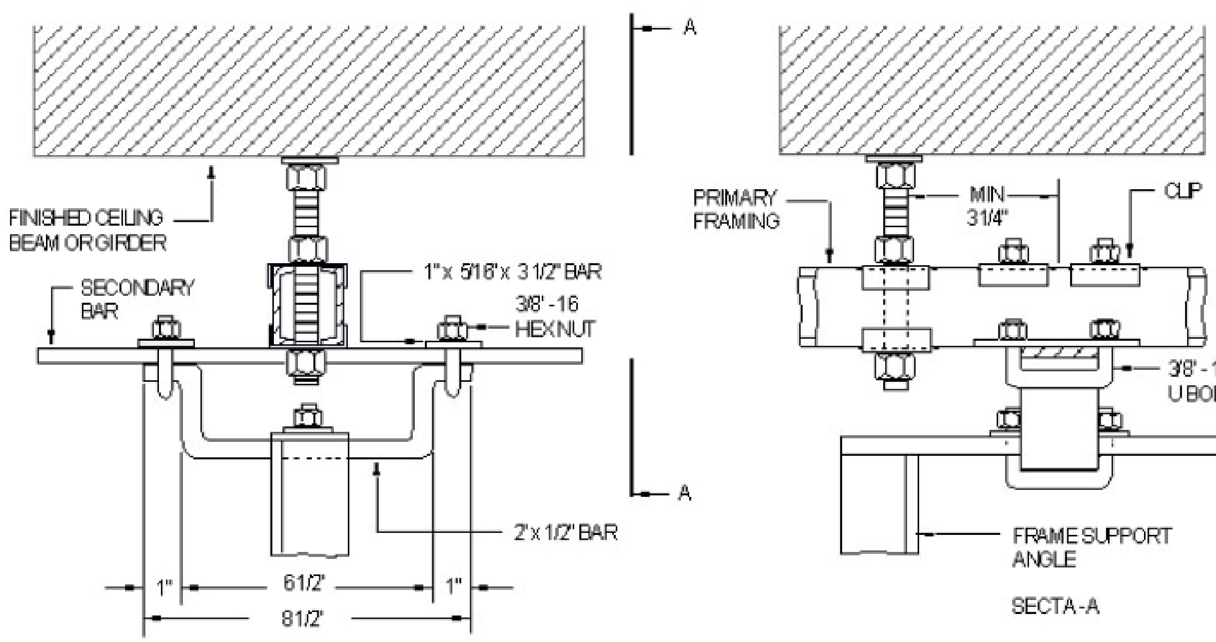


EXHIBIT 2-E3-27 (DISCONTINUED)
2-E3-27 (DISCONTINUED) FRAMING BARS OR CHANNELS ATTACHED AT FRAME SUPPORTS-MAIN HANGER ROD AT POINT OF SUPPORT

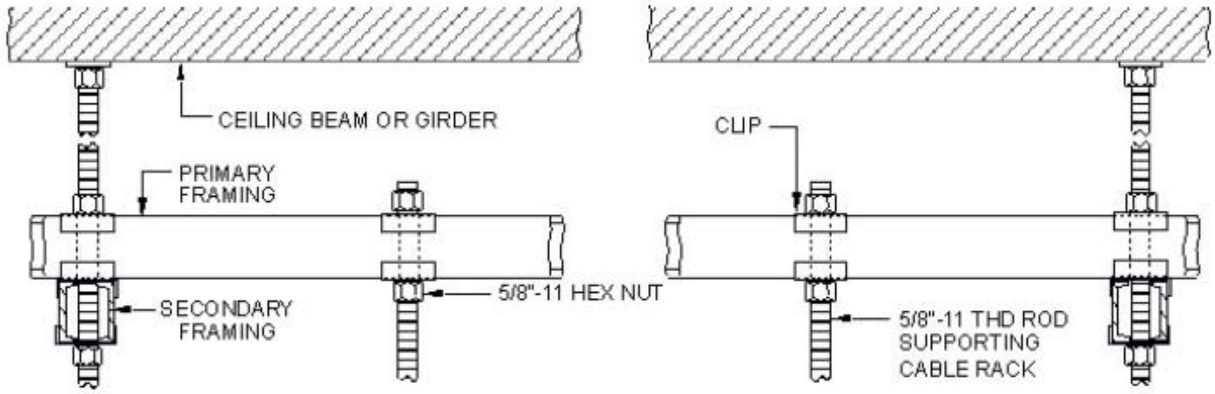


EXHIBIT 2-E3-28

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

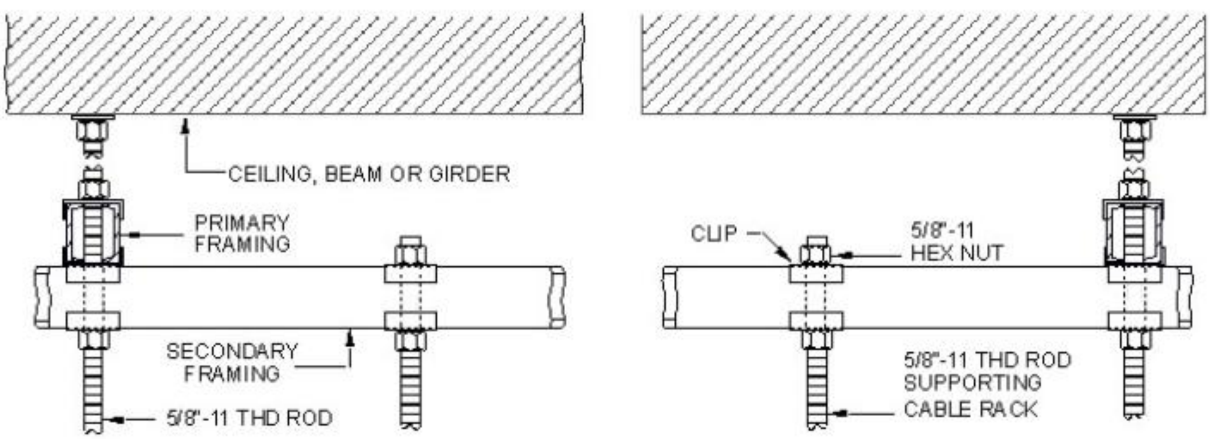


EXHIBIT 2-E3-29

2-E3-29 CABLE RACK OR CONDUIT HANGER RODS ATTACHED TO FRAMING - CABLE RACK OR CONDUIT RUN PARALLEL TO PRIMARY BARS OR CHANNELS

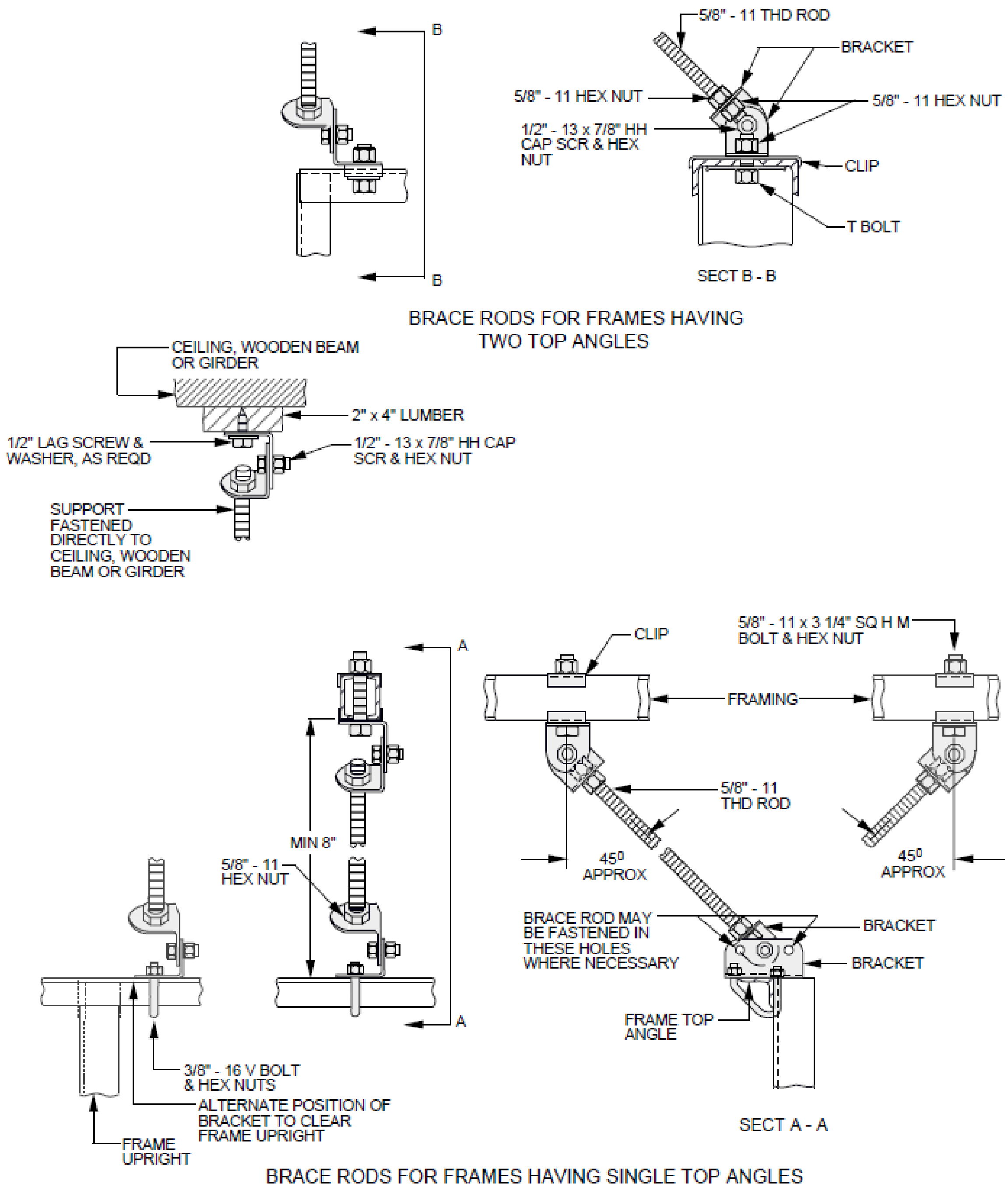
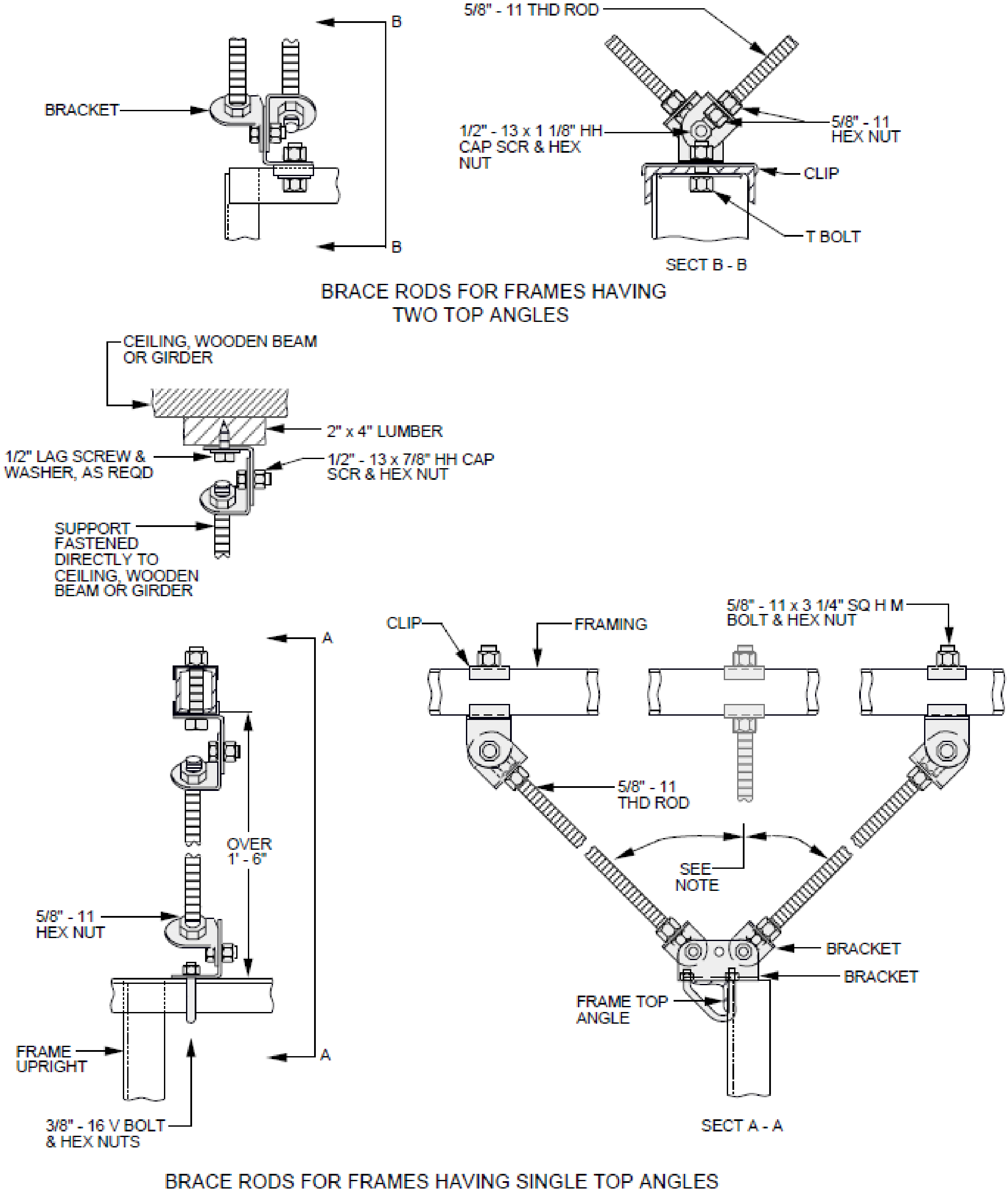


EXHIBIT 2-E3-35 (A&M)

2-E3-35 **(A&M) SINGLE BRACE FRAME SUPPORT**

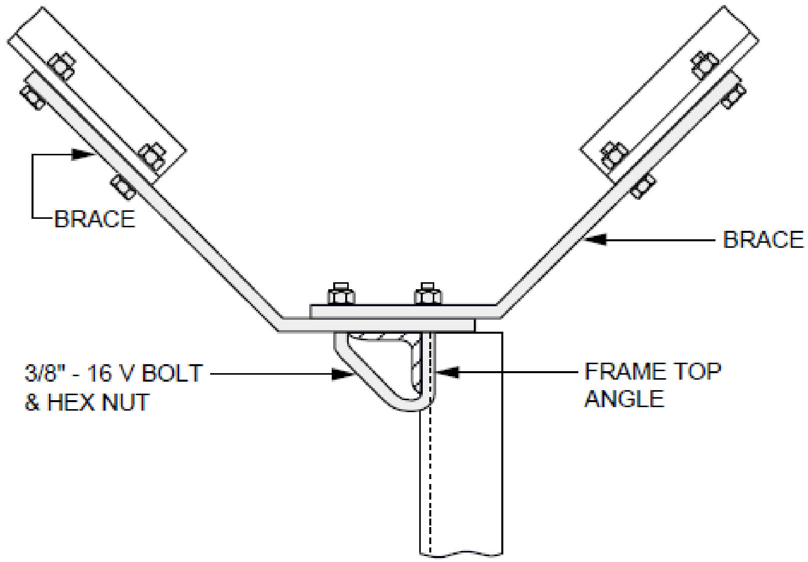


NOTE:

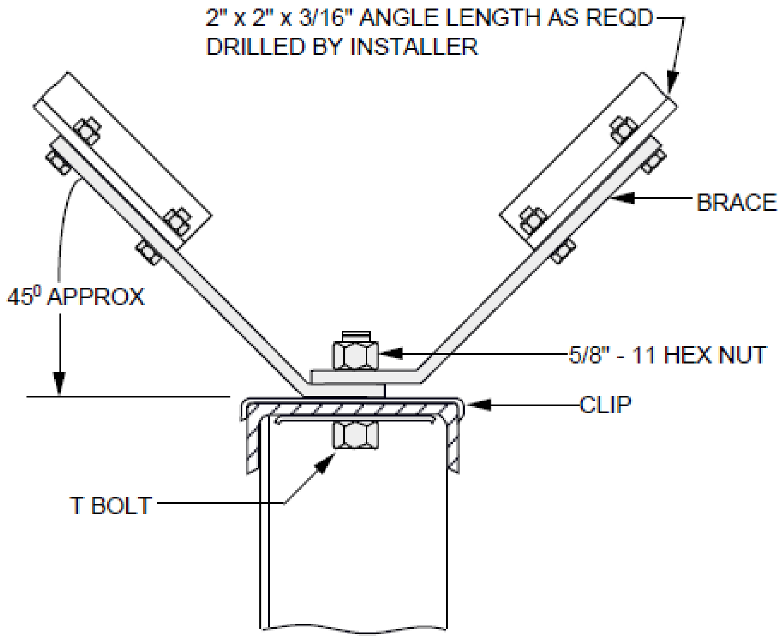
EITHER ROD MAY BE PLACED IN A VERTICAL POSITION WHERE NECESSARY TO CLEAR CABLE RACK OR OTHER EQUIPMENT.

EXHIBIT 2-E3-36 (A&M)

2-E3-36 (A&M) DOUBLE BRACE FRAME SUPPORT USING THREADED ROD BRACES



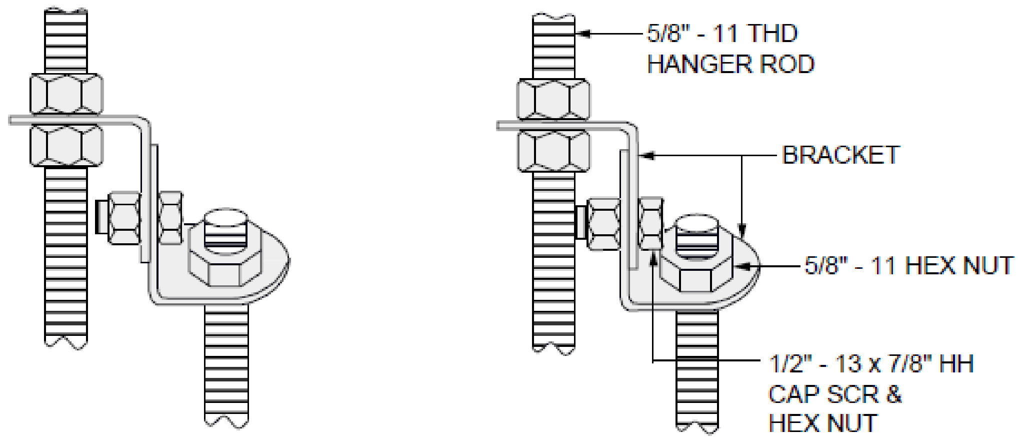
ANGLE BRACES FOR FRAMES HAVING
SINGLE TOP ANGLE



ANGLE BRACES FOR FRAMES HAVING
TWO TOP ANGLES

EXHIBIT 2-E3-36A (A&M)

2-E3-36A (A&M) DOUBLE BRACE FRAME SUPPORT USING ANGLE-TYPE BRACES



NOTE:
EITHER ASSEMBLY MAY BE USED.

EXHIBIT 2-E3-37 (DISCONTINUED)
2-E3-37 (DISCONTINUED) BRACE AT HANGER ROD

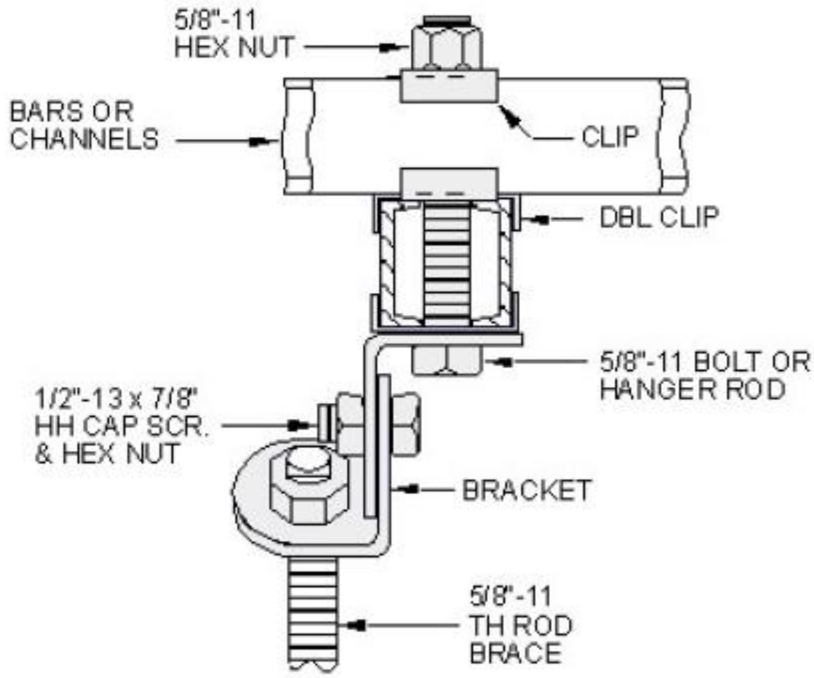


EXHIBIT 2-E3-38
2-E3-38 BRACE ATTACHED AT JUNCTION OF FRAMING BARS OR CHANNELS

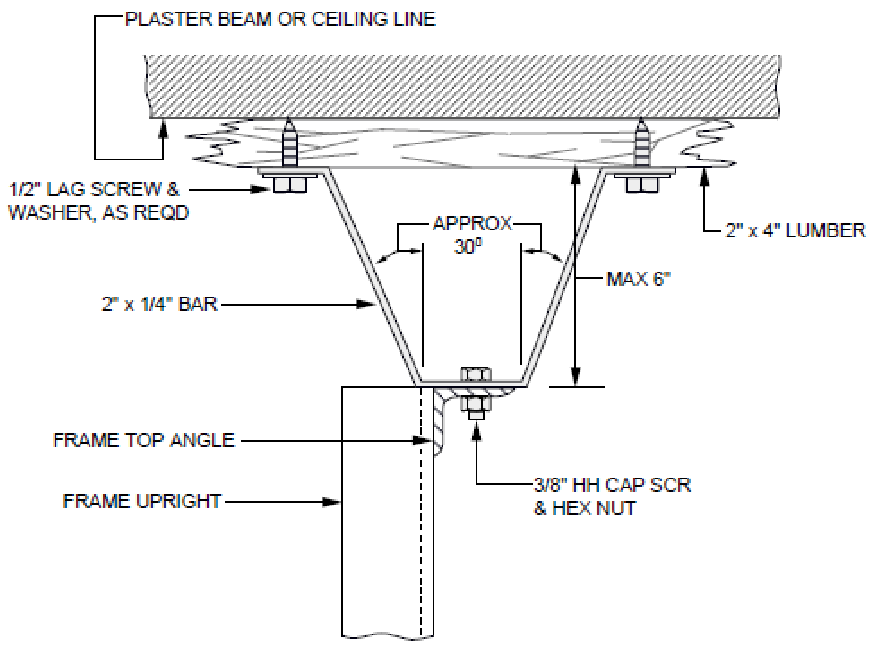


EXHIBIT 2-E3-44 (DISCONTINUED)

2-E3-44 (DISCONTINUED) V BAR FRAME SUPPORT FOR FRAMES WITH SINGLE TOP ANGLES

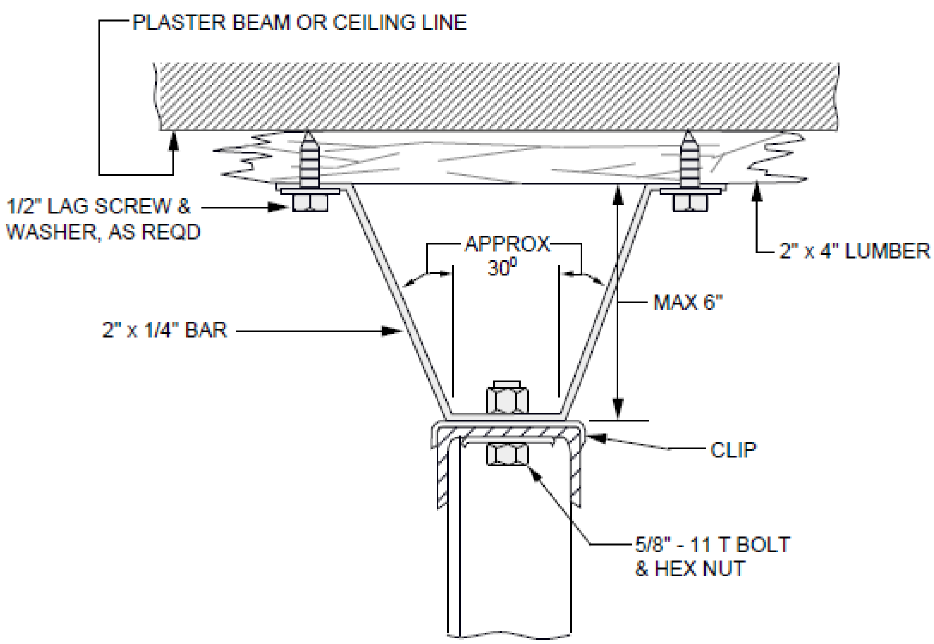


EXHIBIT 2-E3-44A (DISCONTINUED)

2-E3-44A (DISCONTINUED) V BAR FRAME SUPPORT FOR BULB ANGLE TYPE FRAMES

Contents

EXHIBITS

6. Cable Rack And Auxiliary Framing-

6D Rolling Ladders

6D.1 General

This unit covers the engineering requirements for rolling ladders and associated equipment such as ladder brakes and ladder track.

The availability of rolling ladders has been discontinued and parts may no longer be available from the manufacturer. References made in this chapter are for information only. It is recommended to utilize existing ladders, or have ladders relocated to the excess warehouse for future use if they are removed.

6D.2 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 CenturyLink Design 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 wheel-guards. Rolling ladders shall also be equipped with two wheel-guards in line-ups where frames with guardrails extending to the floor are installed. Ladders used at Distributing Frames (DFs) shall be equipped with one wheel-guard 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 CenturyLink Design 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.

6D.3 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 re-drill 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 the track 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 non-continuous 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.

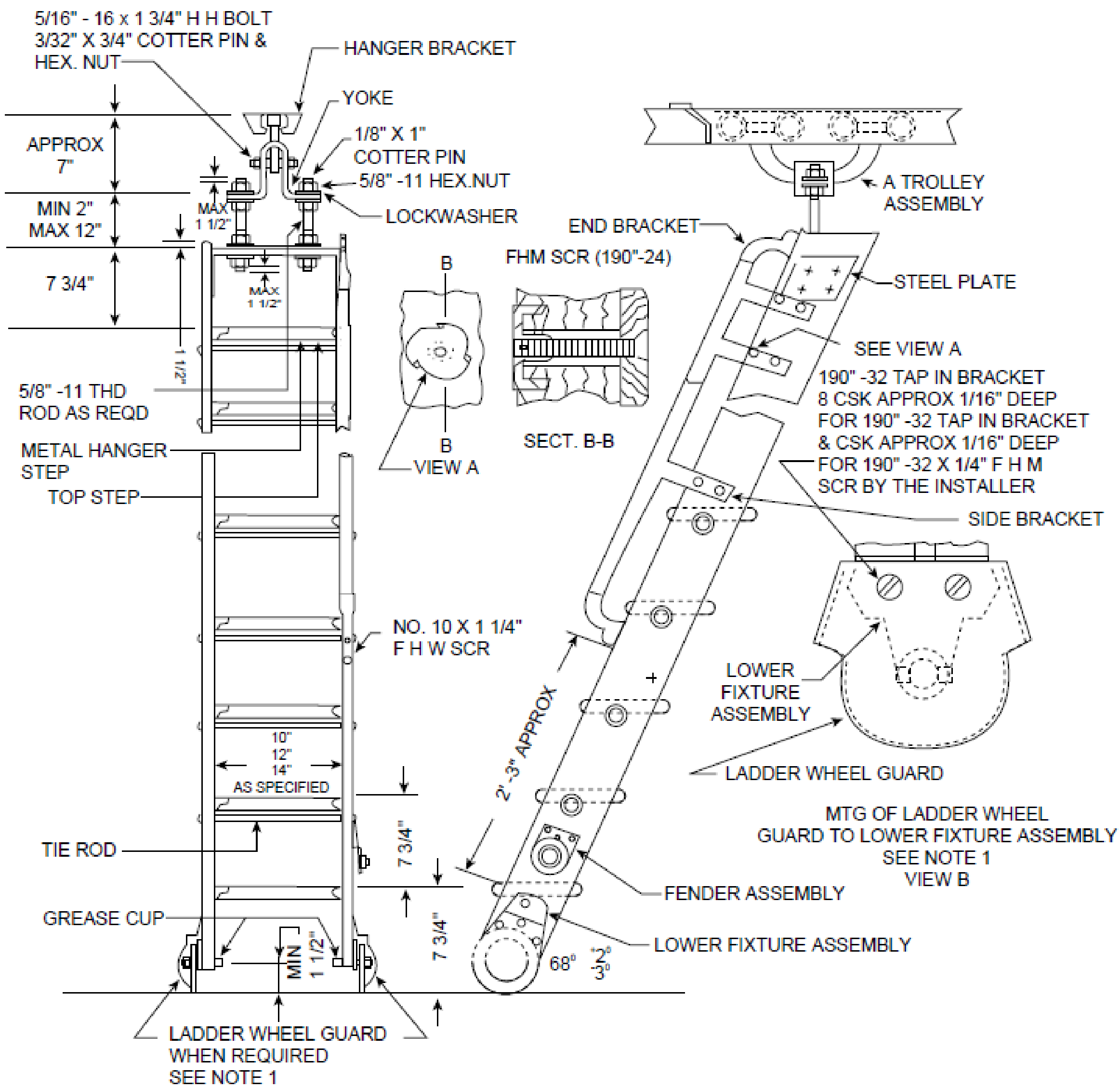


EXHIBIT 2-E4-1

2-E4-1 STRAIGHT-TYPE ROLLING LADDER ASSEMBLY WITHOUT BRAKE

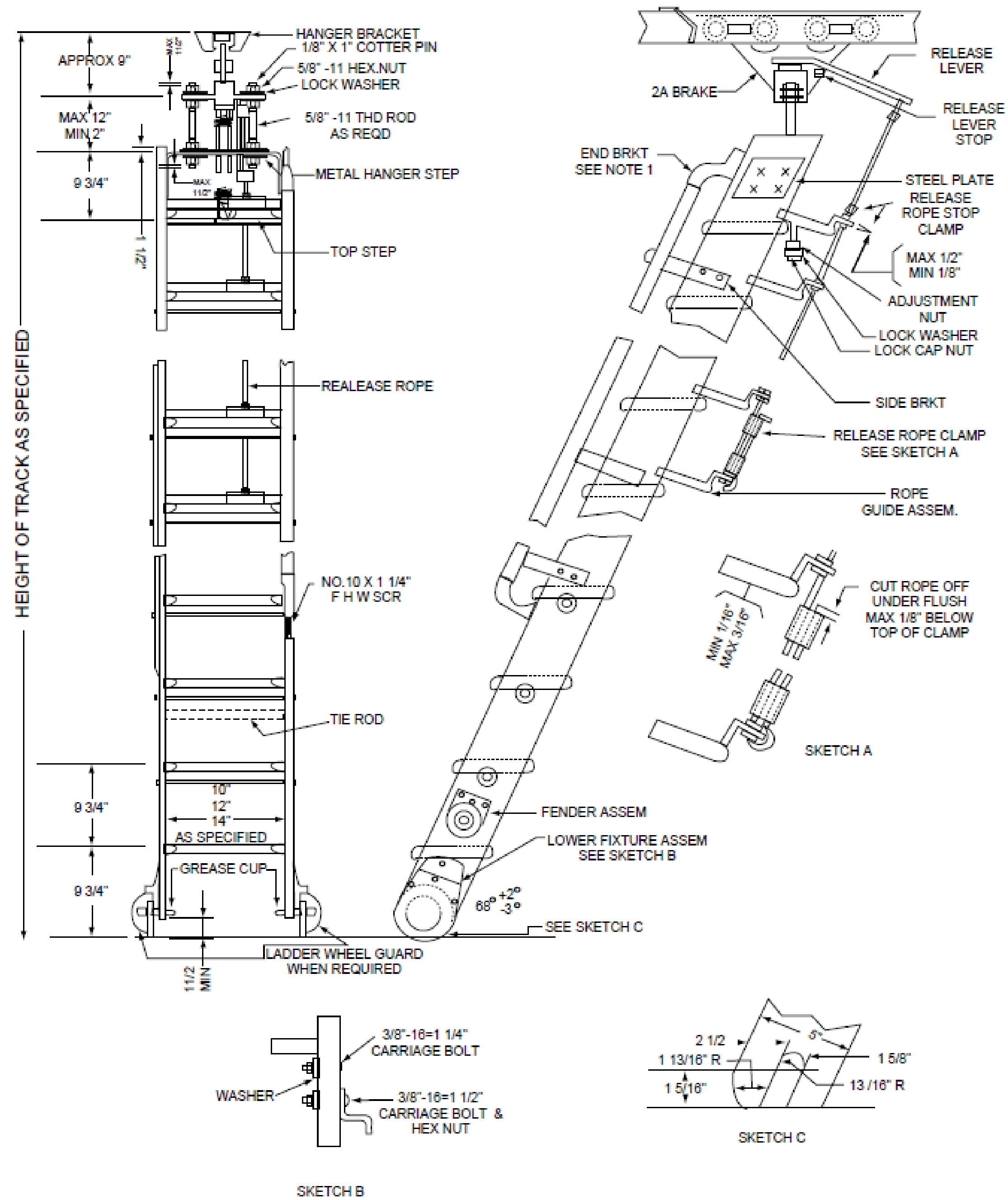
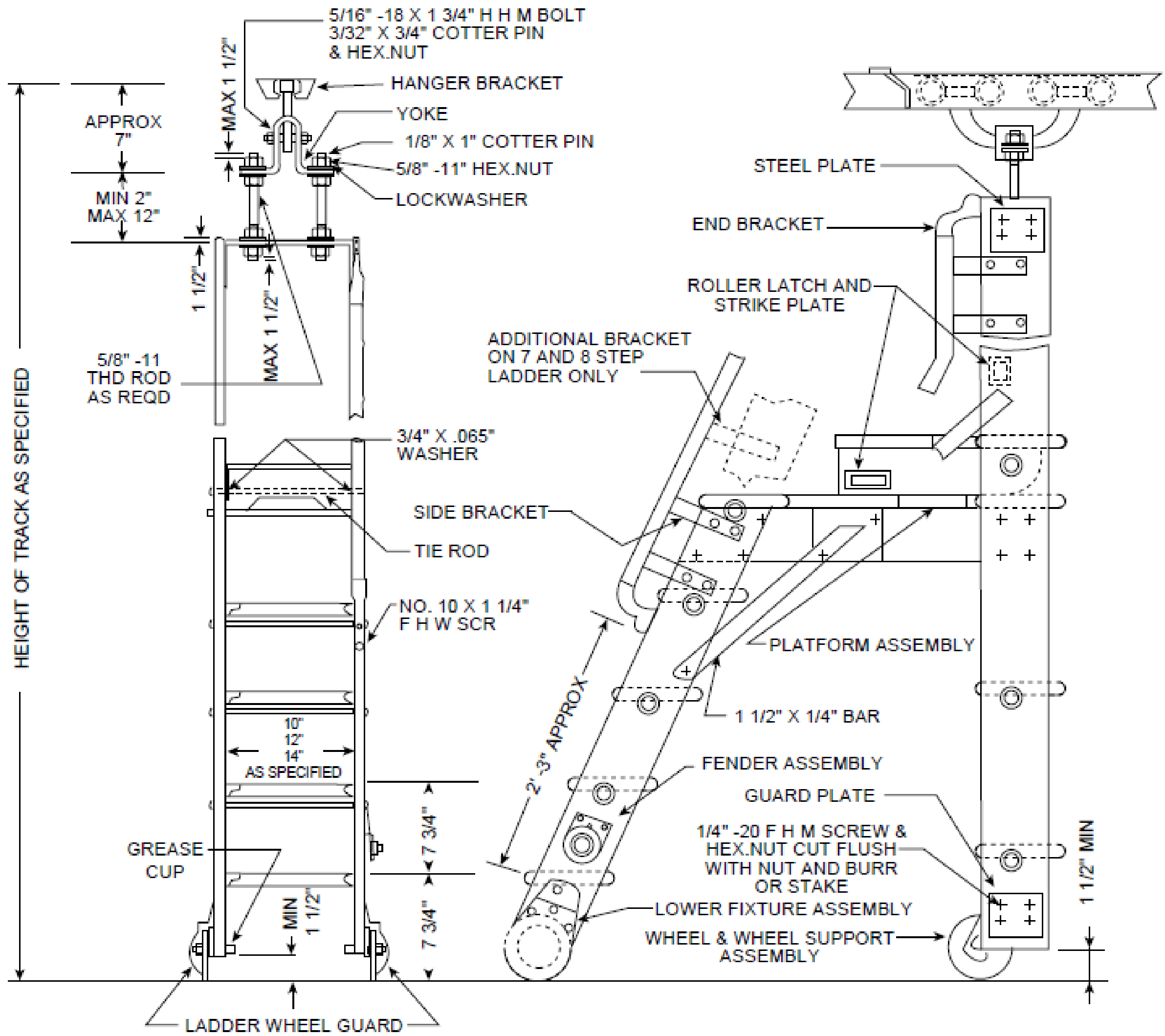


EXHIBIT 2-E4-2

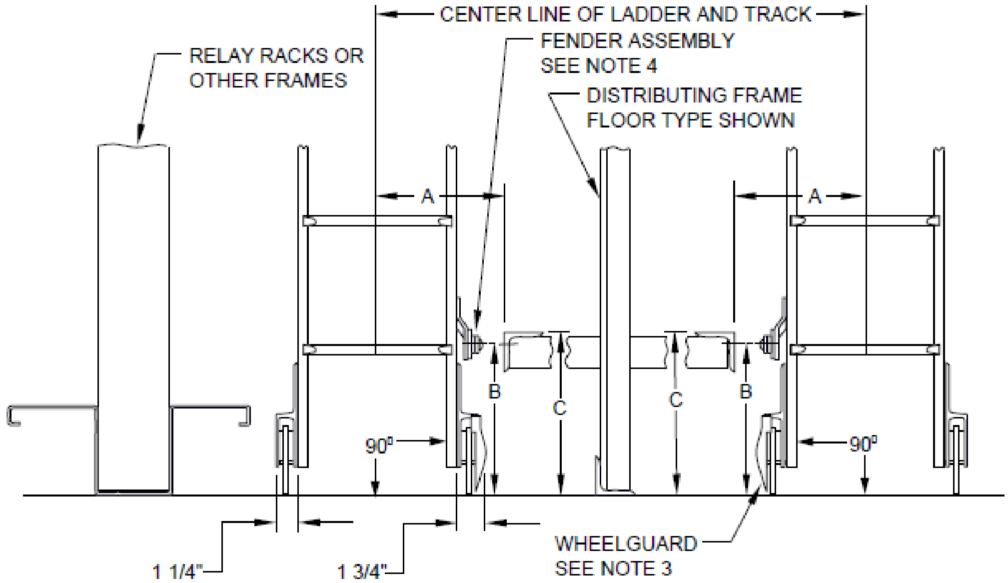
2-E4-2 STRAIGHT-TYPE ROLLING LADDER ASSEMBLY WITH BRAKE



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

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

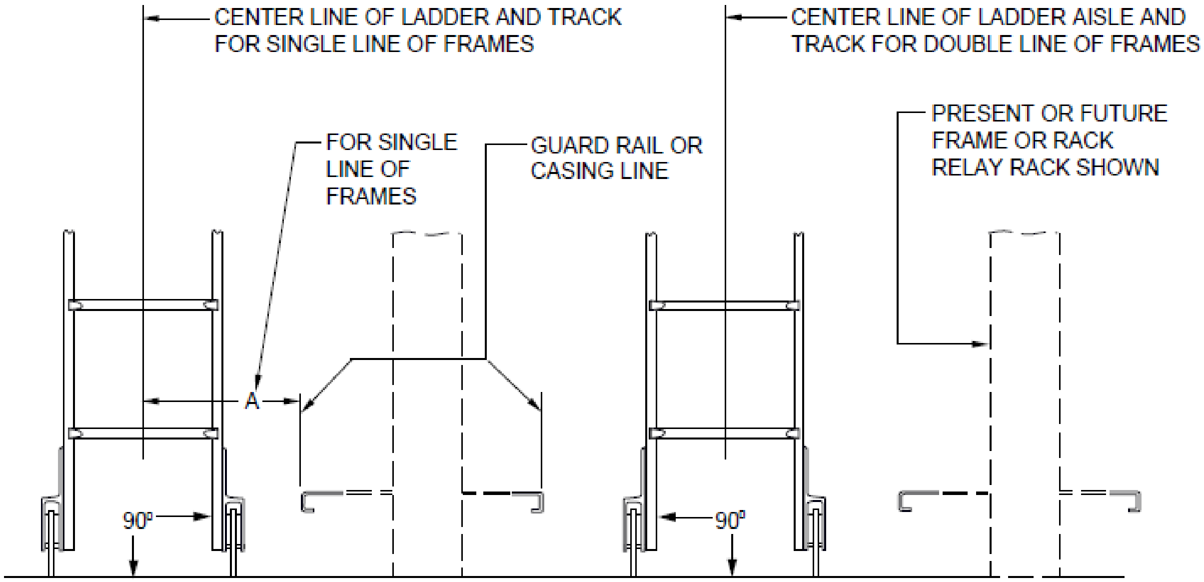
2. DIMENSION "A" FOR THE CROSSBAR LDF SHALL BE 12" BECAUSE OF 6 POINT BUNCHING BLOCKS LOCATED IN THE UPPER PORTION OF THE FRAME. A 14" LADDER WILL ALWAYS BE USED AT THE LDF. DIMENSTION "A" FOR ALL OF THE VARIOUS GROUPING FRAMES IN NO. 1 CROSSBAR AND NO. 4 TOLL SWITCHING OFFICES SHALL BE AS SHOWN WHERE 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 WHEEL GUARD 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 CONTACTING THE CENTER OF THE GUARD RAIL.

EXHIBIT 2-E4-4

2-E4-4 LOCATION AND CLEARANCE FOR LADDERS AT DISTRIBUTING FRAMES

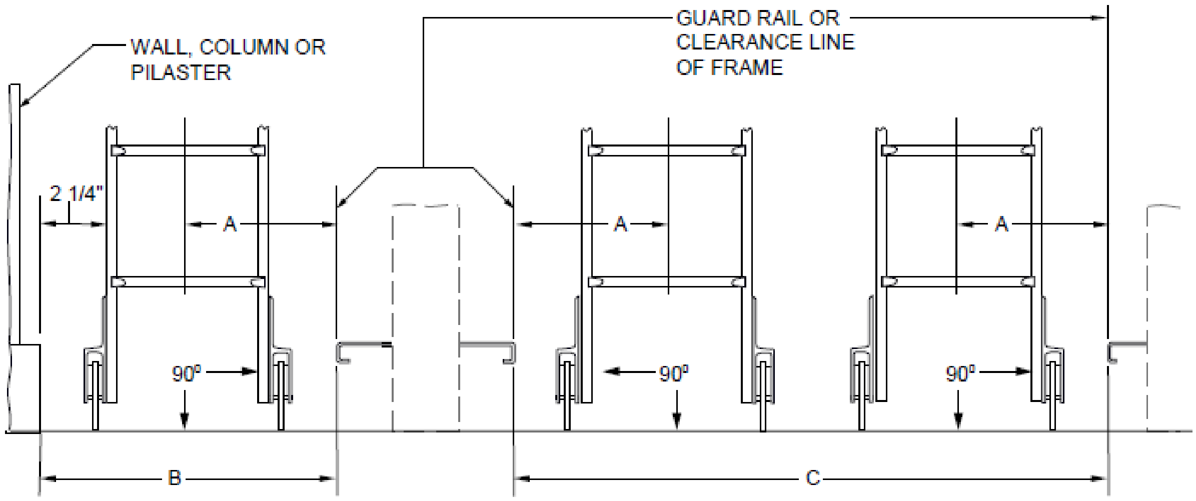


NOTES:
1. DIMENSION "A" FOR FUSE BOARDS HAVING A 12" GUARD RAIL SHALL BE 8 1/2", 9 1/2" OR 10 1/2" FOR 10", 12" & 14" LADDERS RESPECTIVELY.
2. WHEREVER IN CROSSBAR OFFICES (ALL TYPES) A 14" LADDER SERVES A SINGLE LINE OF FRAMES AND SPACE WILL PERMIT, THE TRACK SHALL BE LOCATED 13" FROM THE GUARD RAIL.

LADDER	A	
	USUAL	MIN
10"	8"	7 1/4"
12"	9"	8 1/4"
14"	10"	9 1/4"

EXHIBIT 2-E4-5

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 ℄ 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 ℄ OF THE COLUMN ROWS THIS 2 1/4" MINIMUM SHAL BE INCREASED TO 3" TO ALLOW A 5" CLEARANCE BETWEEN THE LADDER SIDE RAIL AND THE DIS-PLAY 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

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	
TOTAL FT	10' SECT	8' SECT	TOTAL FT	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 FRO THE LENGTH IN EXCESS OF 120' TO THE NUMBER REQUIRED FOR 120' AS LISTED IN ABOVE TABLE.

EXHIBIT 2-E4-7

2-E4-7 NUMBER OF SECTIONS OF TRACK REQURIED FOR VARIOUS LENGTHS OF TRACK

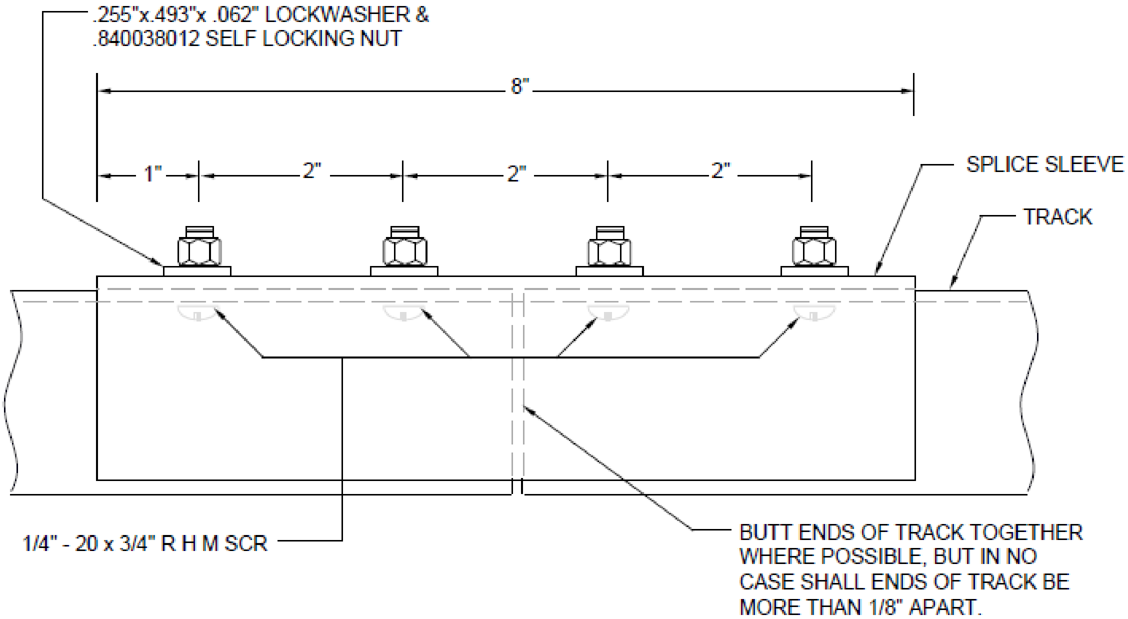


EXHIBIT 2-E4-8

2-E4-8 SPLICING SLEEVES FOR LADDER TRACK

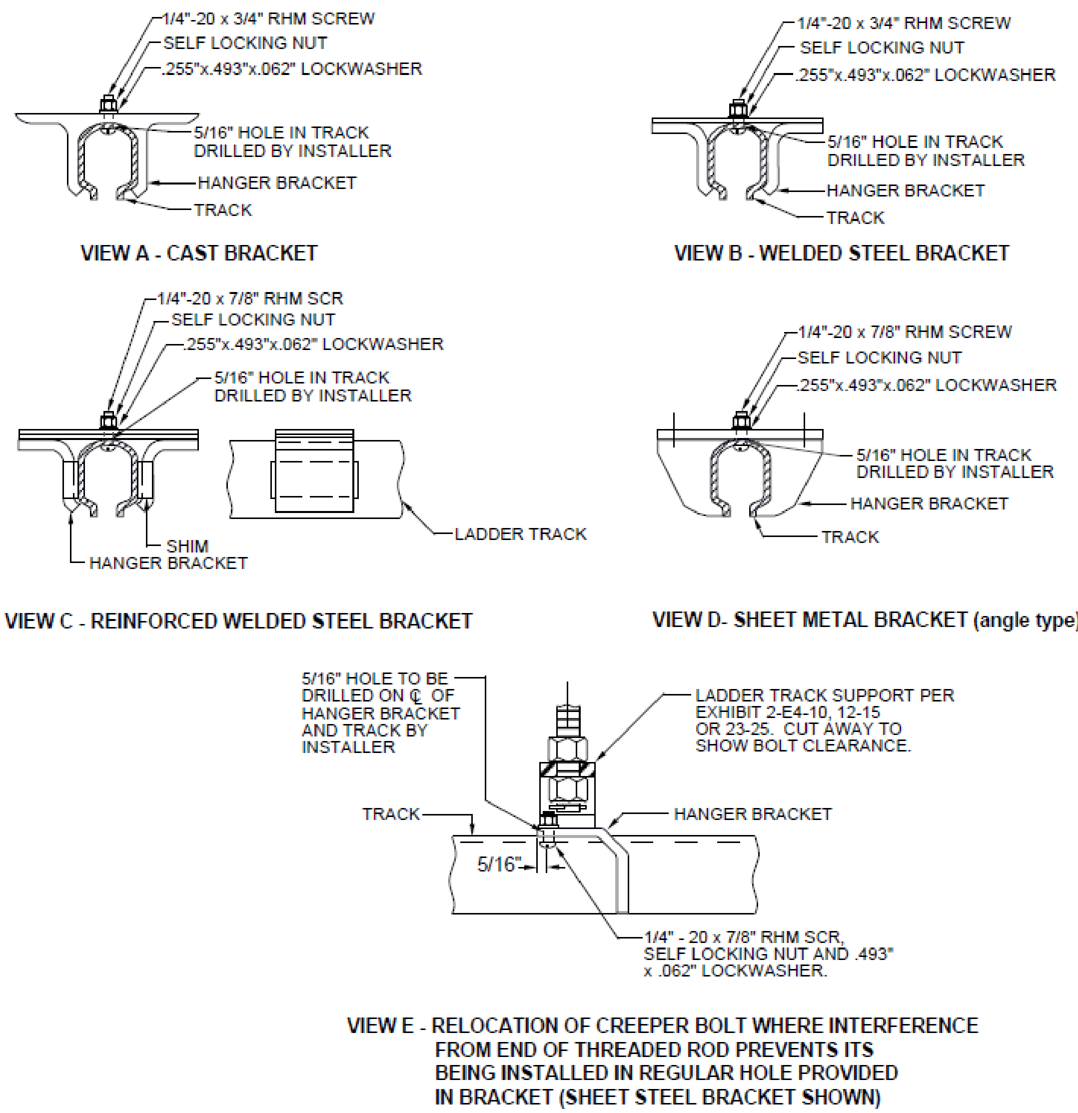


EXHIBIT 2-E4-9

2-E4-9 TRACK SUPPORT BRACKETS

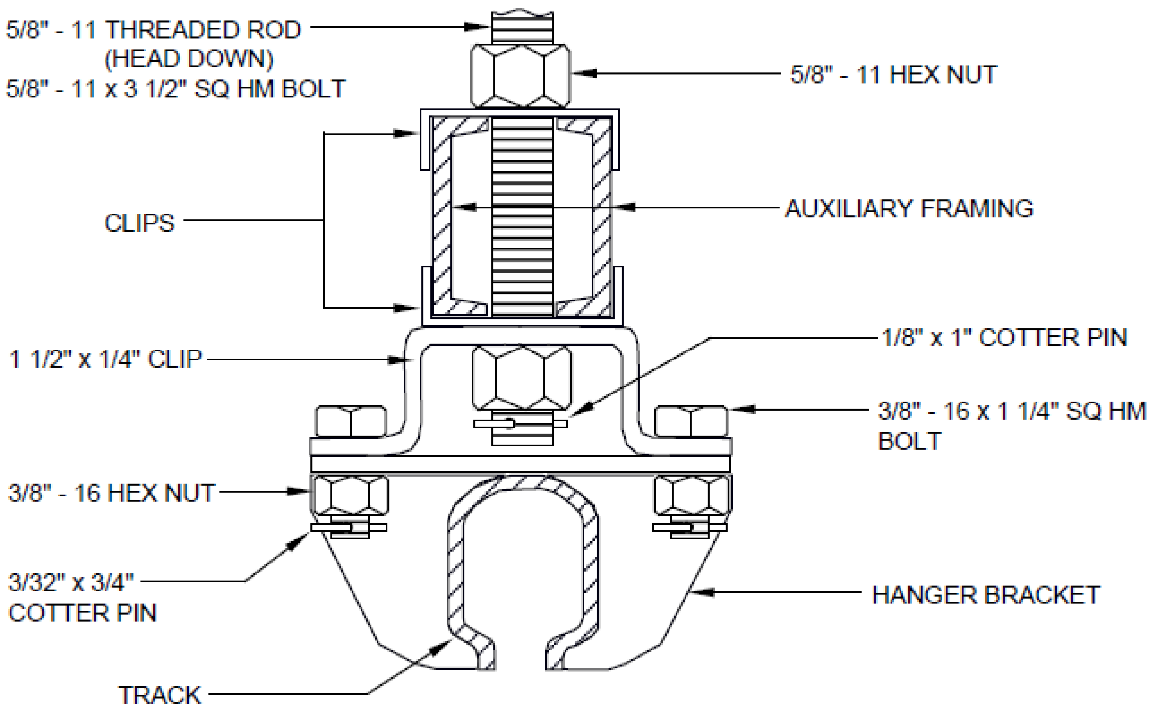


EXHIBIT 2-E4-10

2-E4-10 TRACK SUPPORTED PARALLEL TO/OR AT RIGHT ANGLES TO AUXILIARY FRAMING, PARALLEL SHOWN

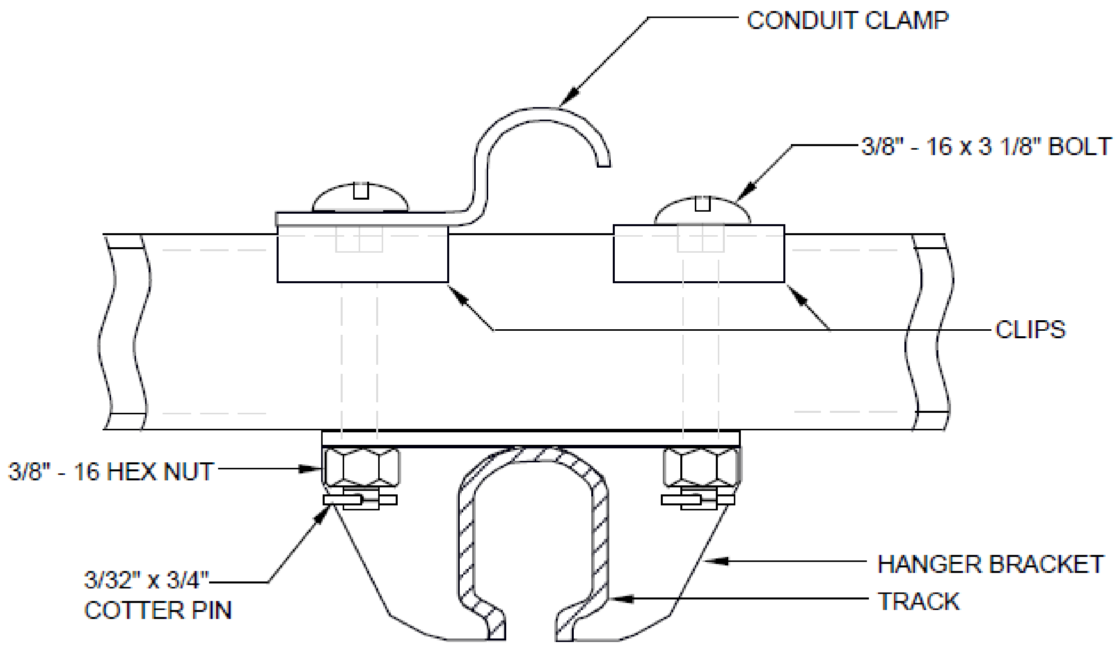


EXHIBIT 2-E4-11

2-E4-11 TRACK SUPPORTED DIRECTLY FROM AND AT RIGHT ANGLES TO AUXILIARY FRAMING

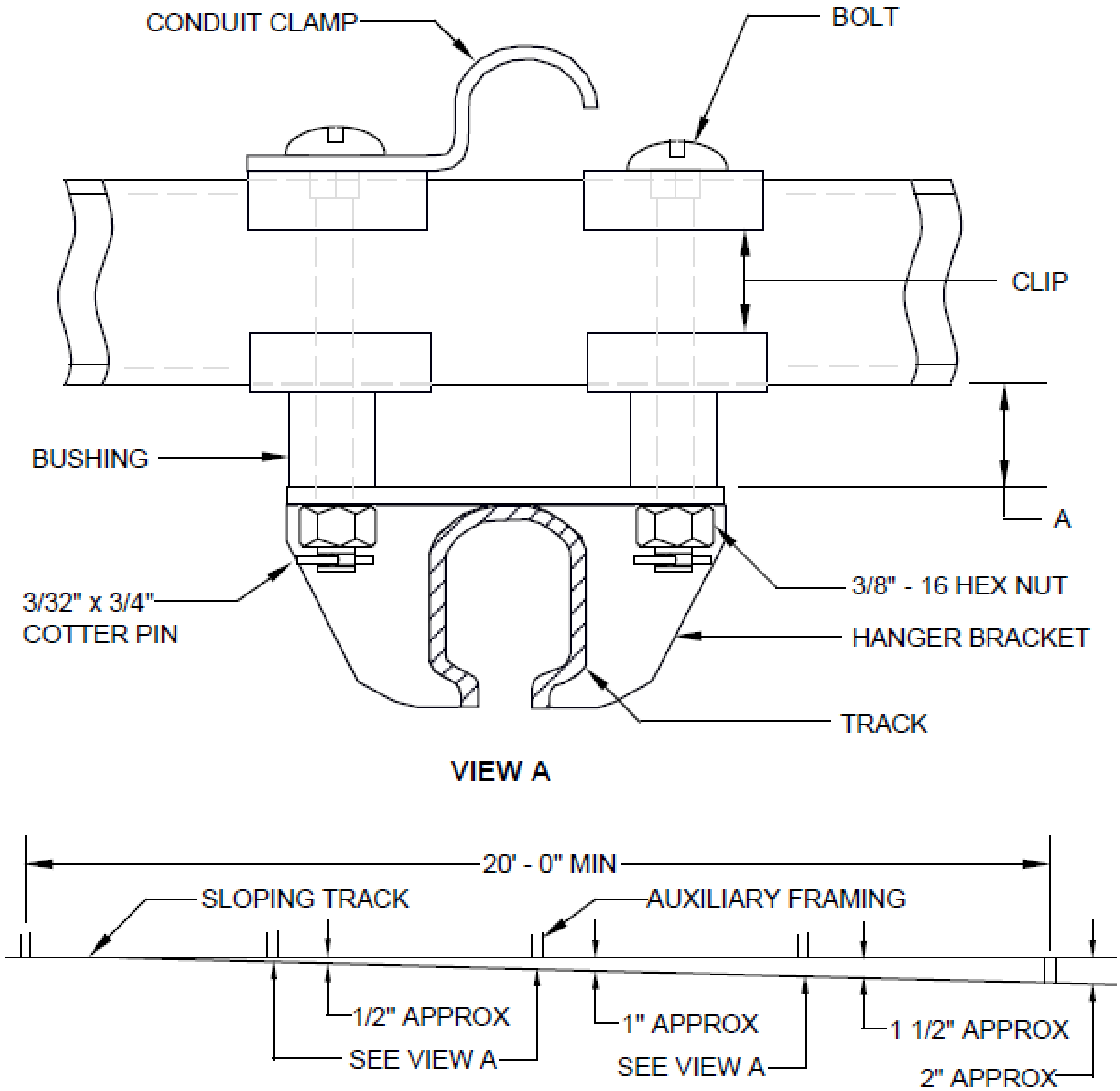


EXHIBIT 2-E4-11A

2-E4-11A TRACK SUPPORTED FROM AND AT RIGH ANGLES TO AUXILIARY FRAMING – SLOPING TRACK – 2 INCHES DIFFERENCE IN AUXILIARY FRAMING LEVEL

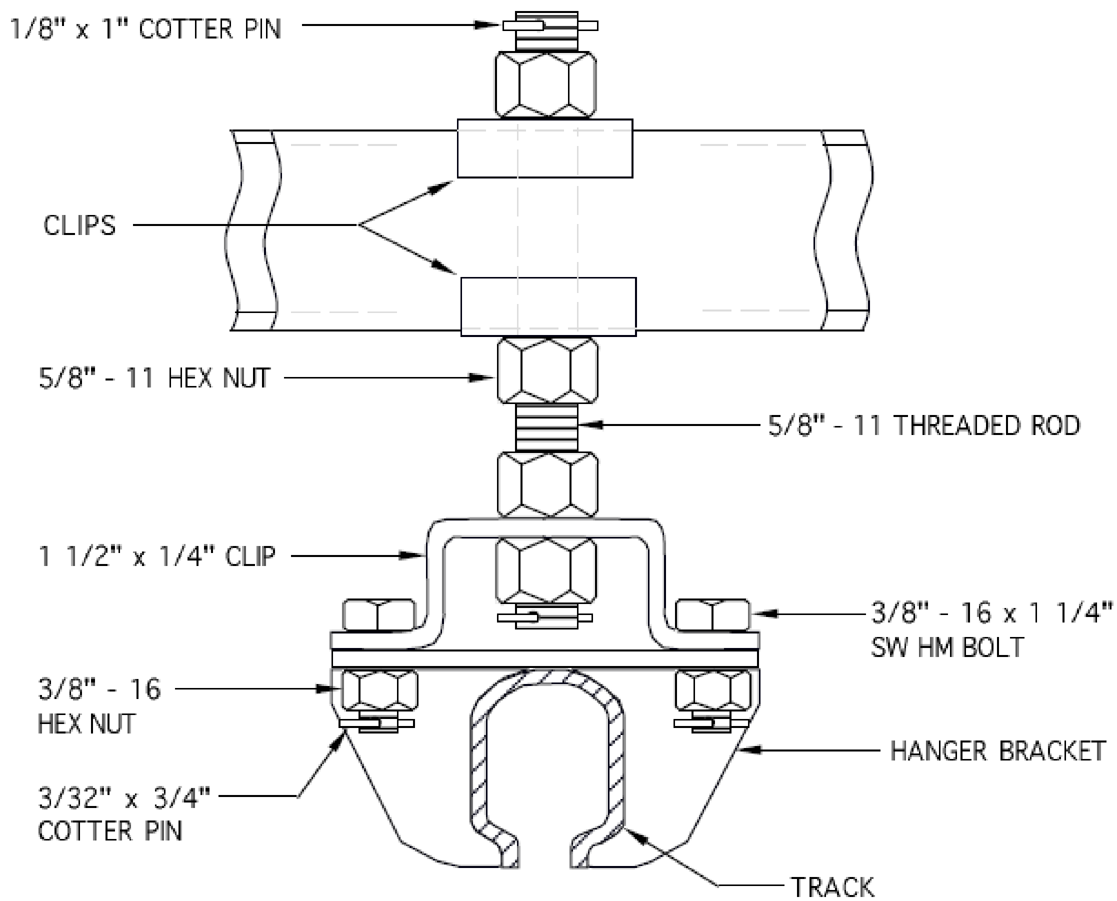


EXHIBIT 2-E4-12

2-E4-12 TRACK SUPPORTED FROM AUXILIARY FRAMING WITH EXTENSION ROD

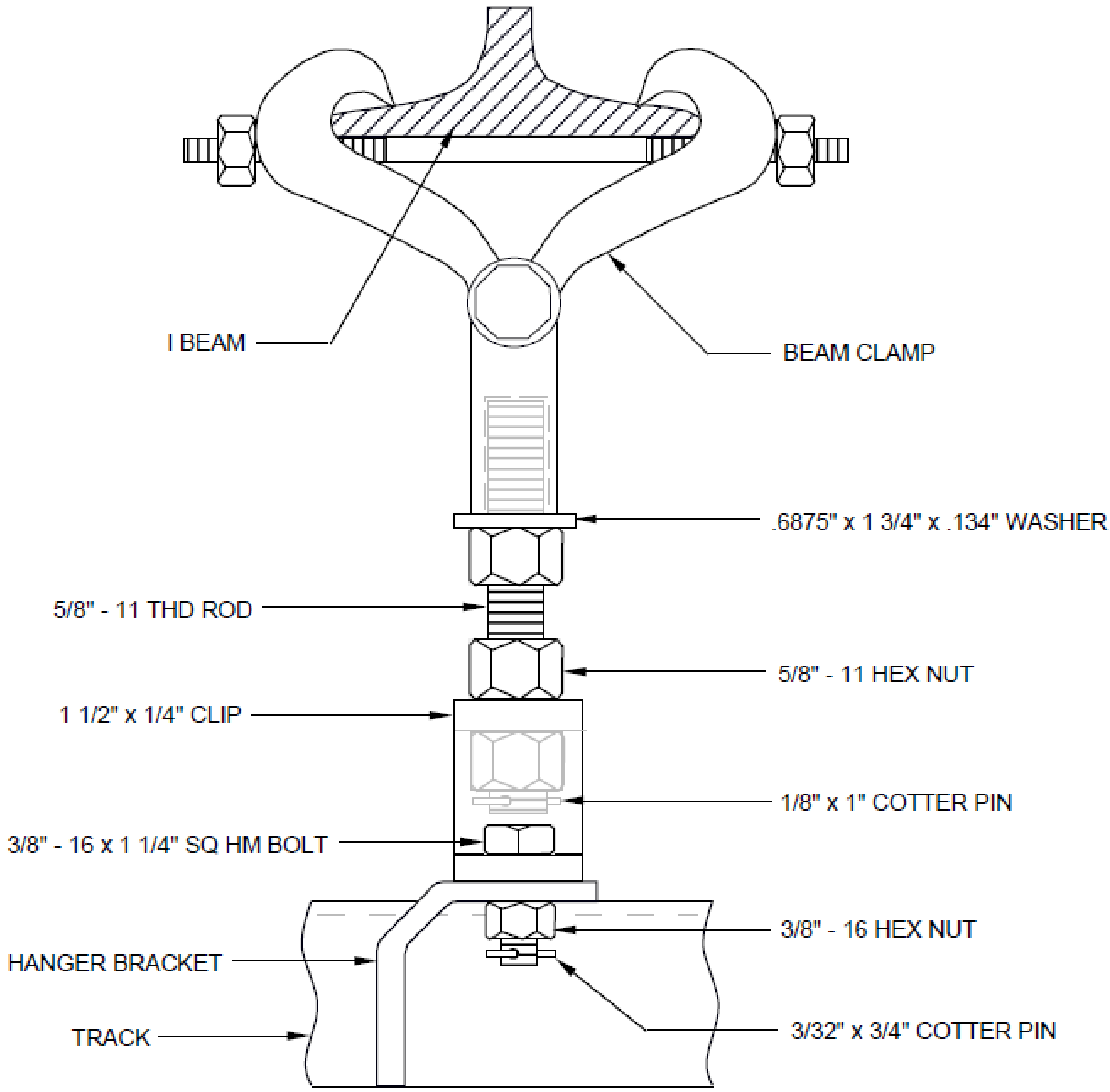


EXHIBIT 2-E4-13

2-E4-13 TRACK SUPPORTED DIRECTLY FROM CEILING

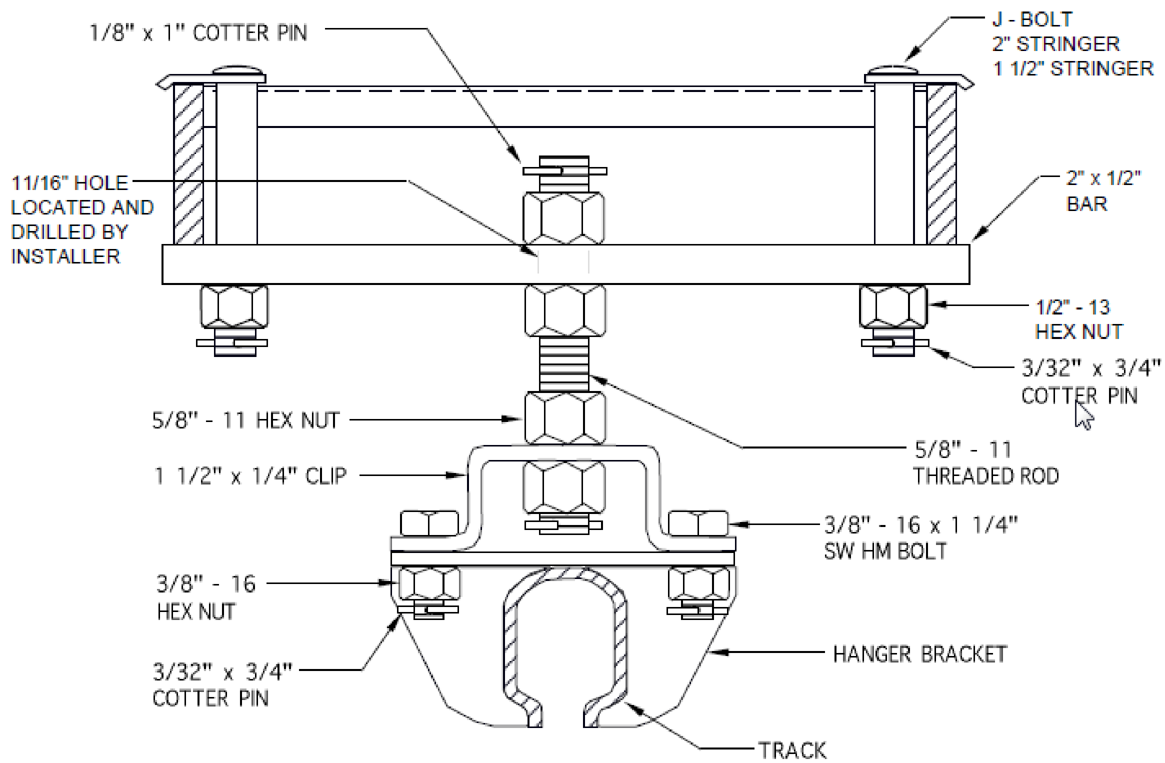


EXHIBIT 2-E4-14

2-E4-14 TRACK SUPPORTED WITH EXTENSION RODS FROM CABLE RACK 2 FEET 1 INCH OR LESS WIDE – TRACK AND PARALLEL WITH CABLE RACK

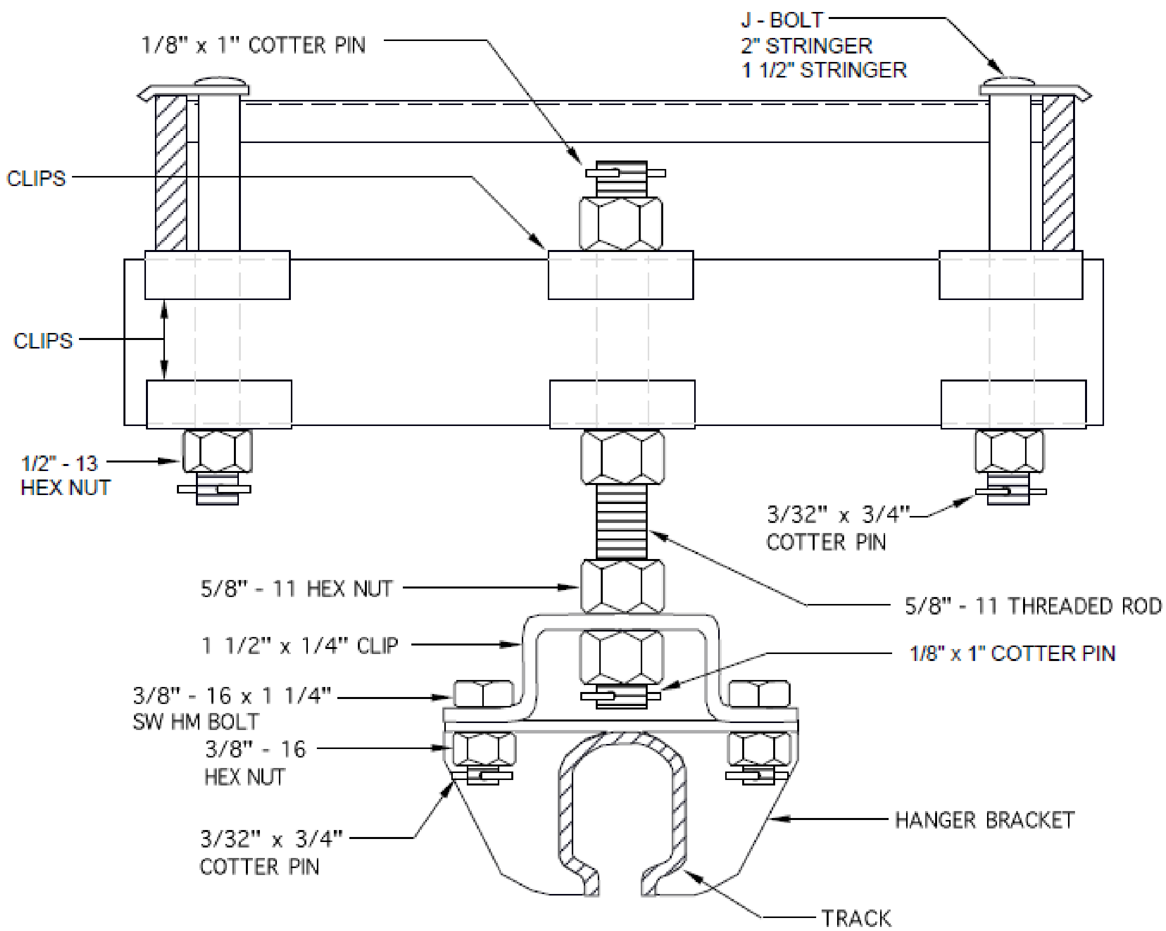


EXHIBIT 2-E4-15

2-E4-15 TRACK SUPPORTED WITH EXTENSION ROD AND CABLE RACK MORE THAN 2 FEET 1 INCH IN WIDTH

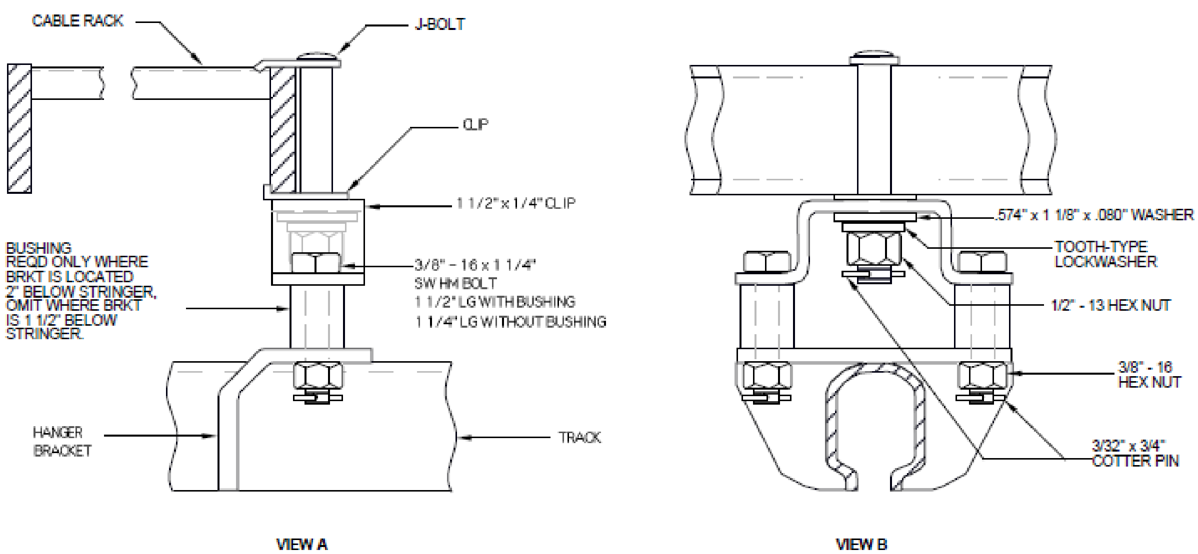


EXHIBIT 2-E4-16

2-E4-16 TRACK SUPPORTED BELOW AND AT RIGHT ANGLES TO CABLE RACK

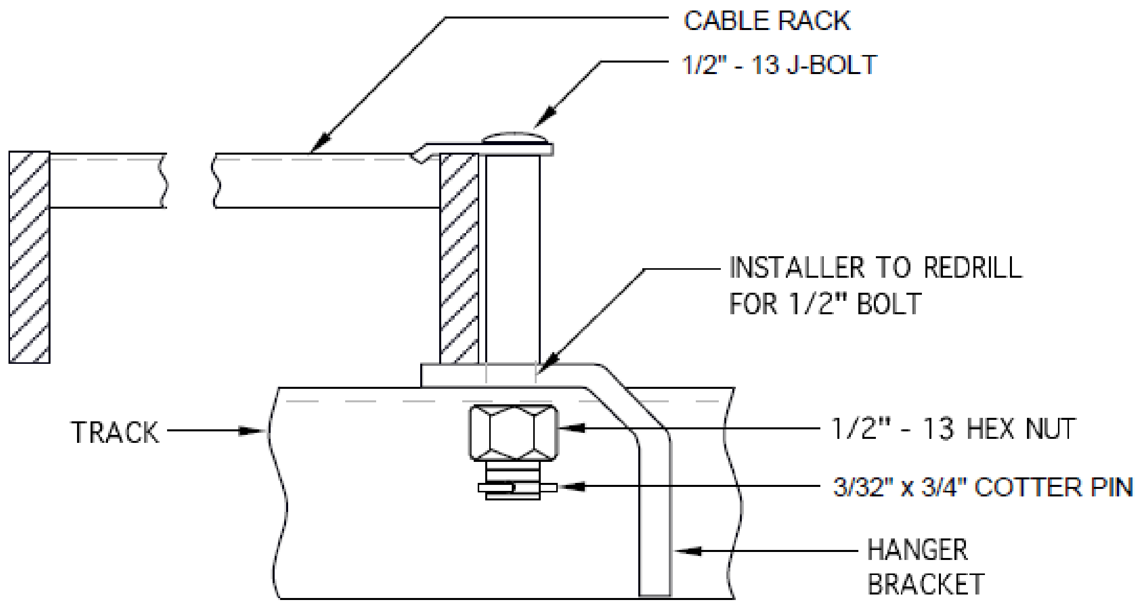


EXHIBIT 2-E4-17

2-E4-17 TRACK SUPPORTED DIRECTLY FROM AND AT RIGH ANGLES TO CABLE RACK

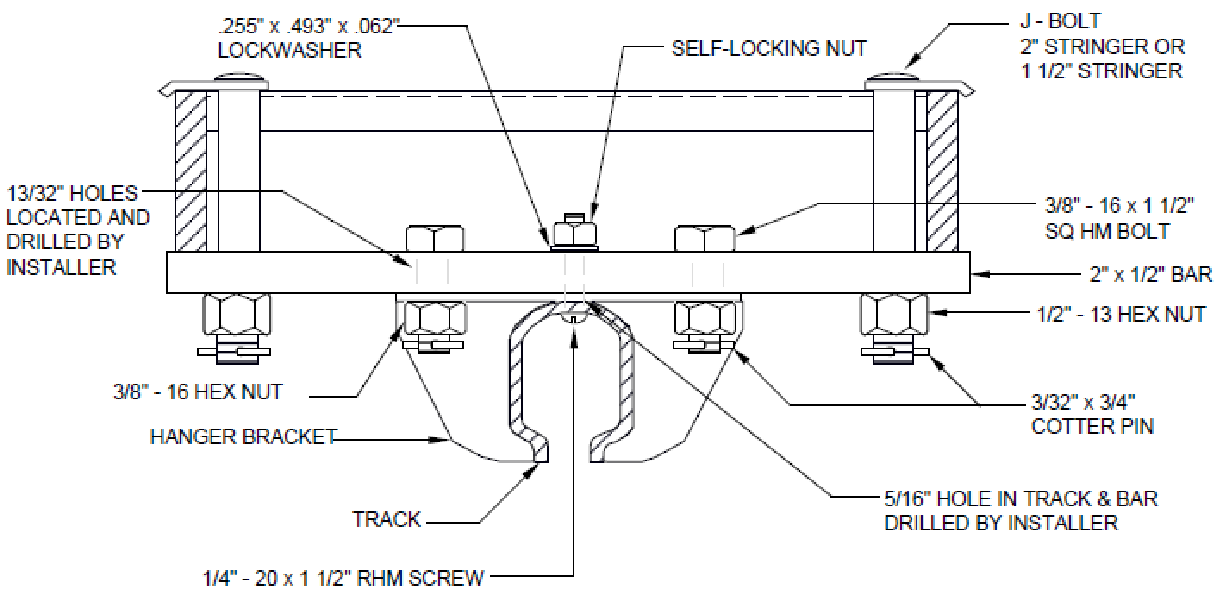


EXHIBIT 2-E4-18

2-E4-18 TRACK SUPPORTED WITH SINGLE BAR DIRECTLY FROM CABLE RACK 2 FEET 1 INCH OR LESS WIDE

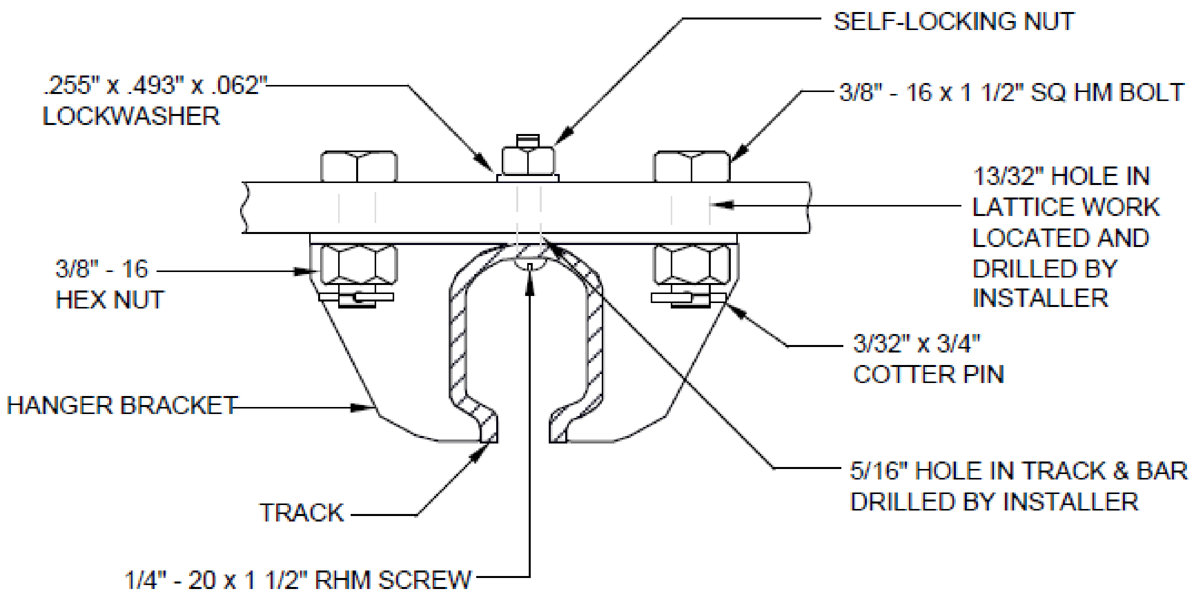


EXHIBIT 2-E4-19

2-E4-19 TRACK SUPPORTED FROM LATTICE WORK

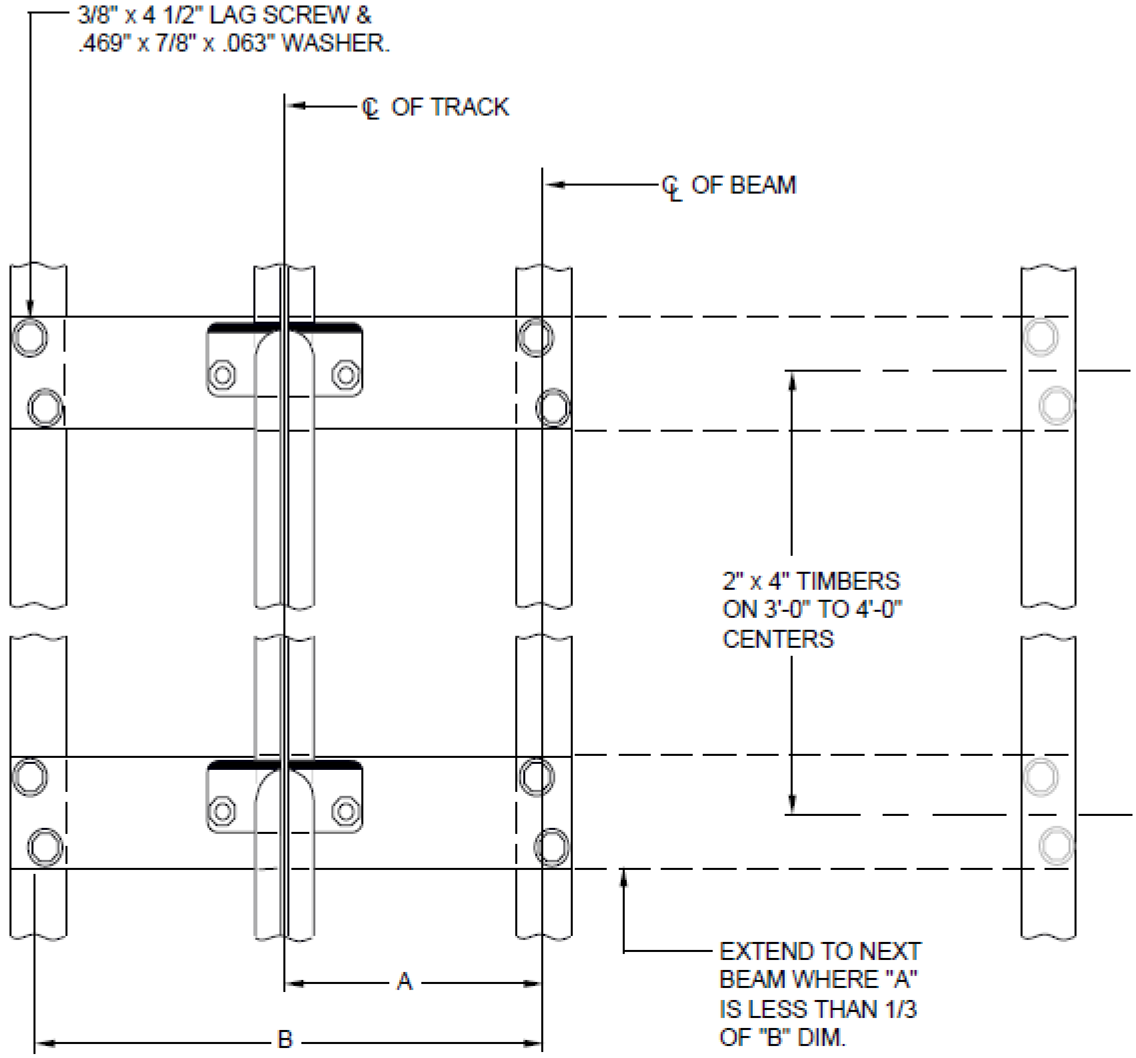


EXHIBIT 2-E4-20

2-E4-20 TRACK SUPPORTED PARALLEL TO WOOD JOISTS

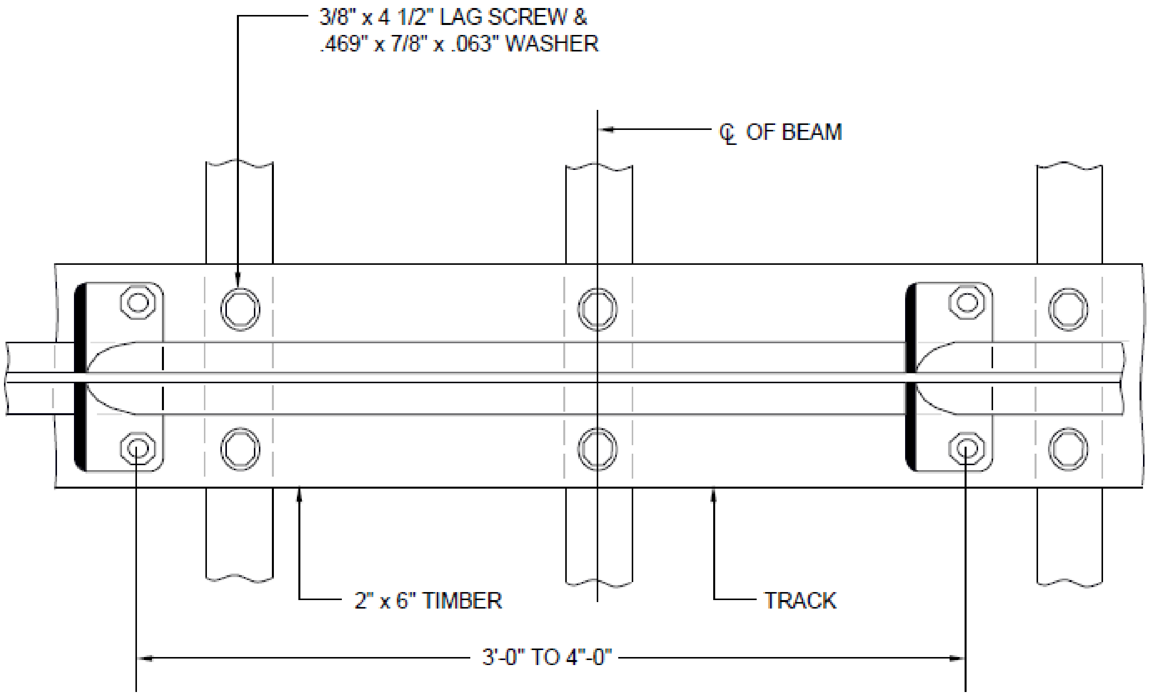


EXHIBIT 2-E4-21

2-E4-21 TRACK SUPPORTED AT RIGHT ANGLES TO WOOD JOISTS

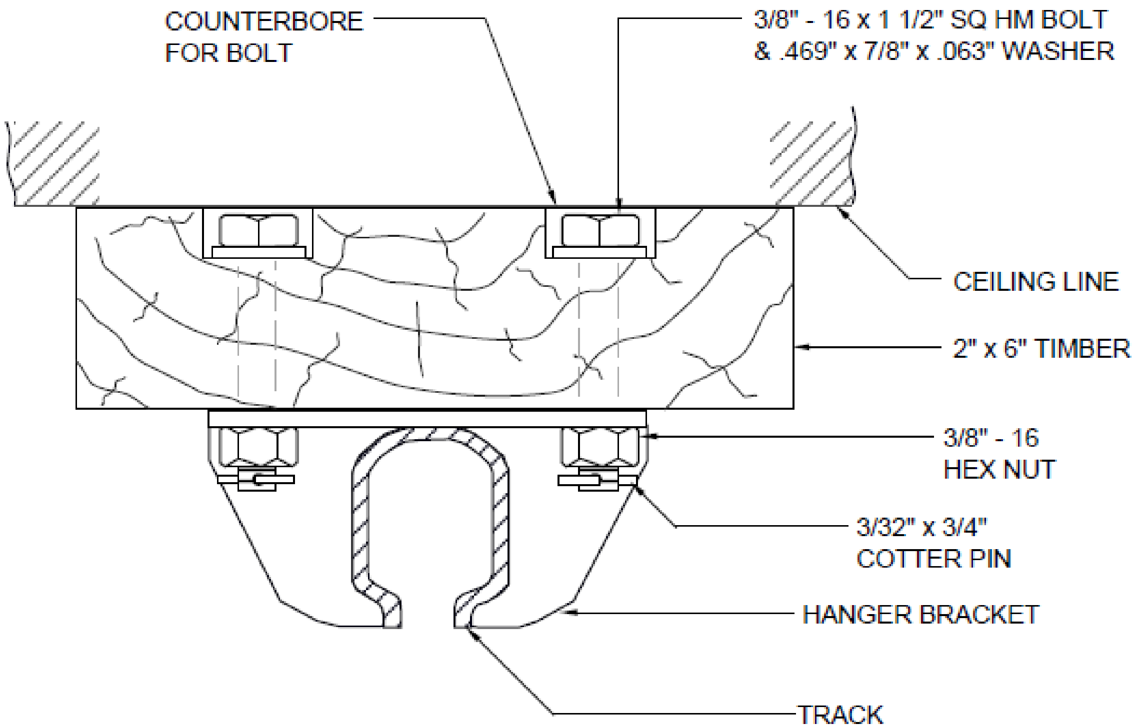


EXHIBIT 2-E4-22

2-E4-22 TRACK SUPPORTED DIRECTLY FROM TIMBERS

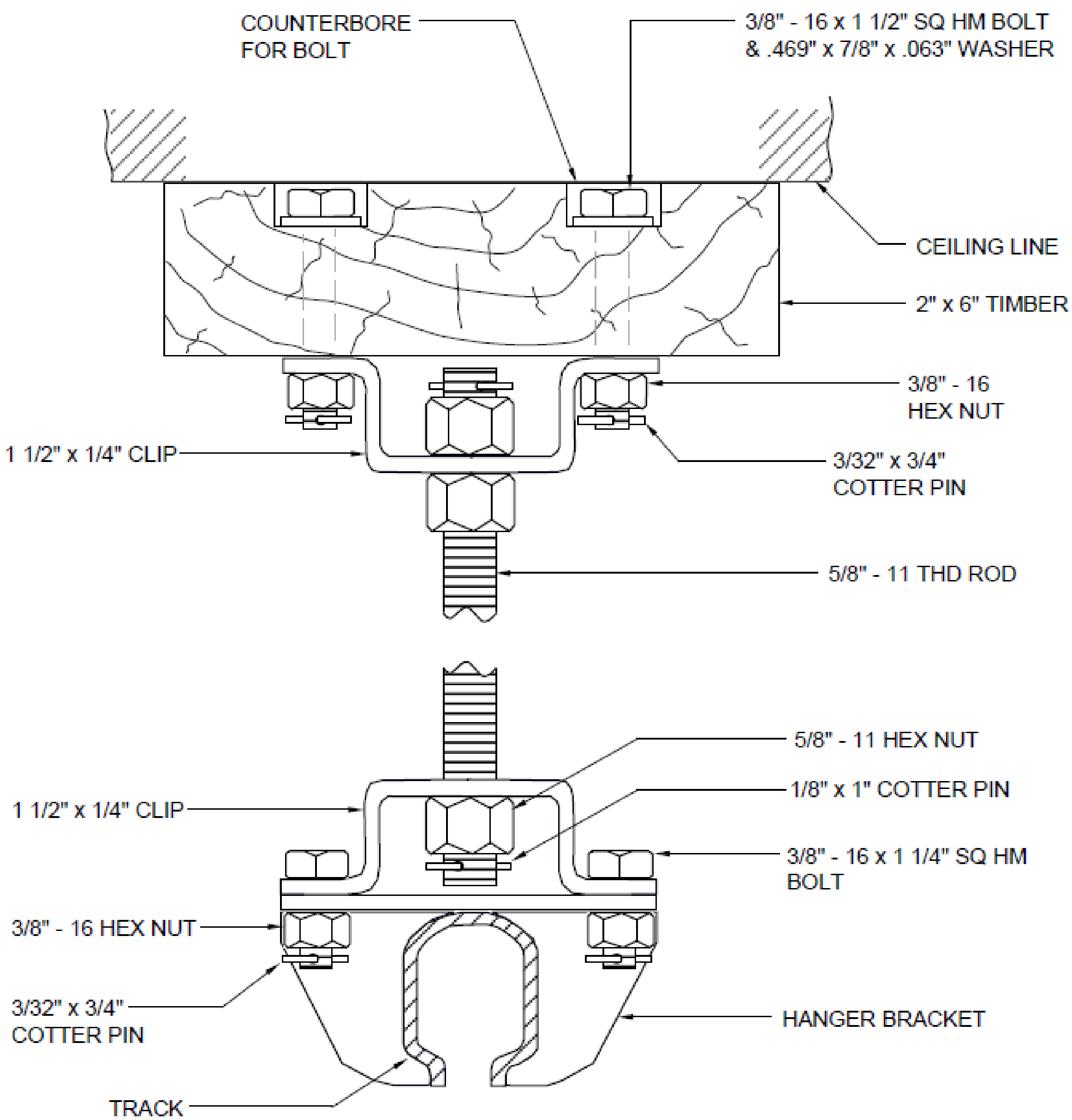


EXHIBIT 2-E4-23

2-E4-23 TRACK SUPPORTED FROM TIMBERS WITH EXTENSION RODS

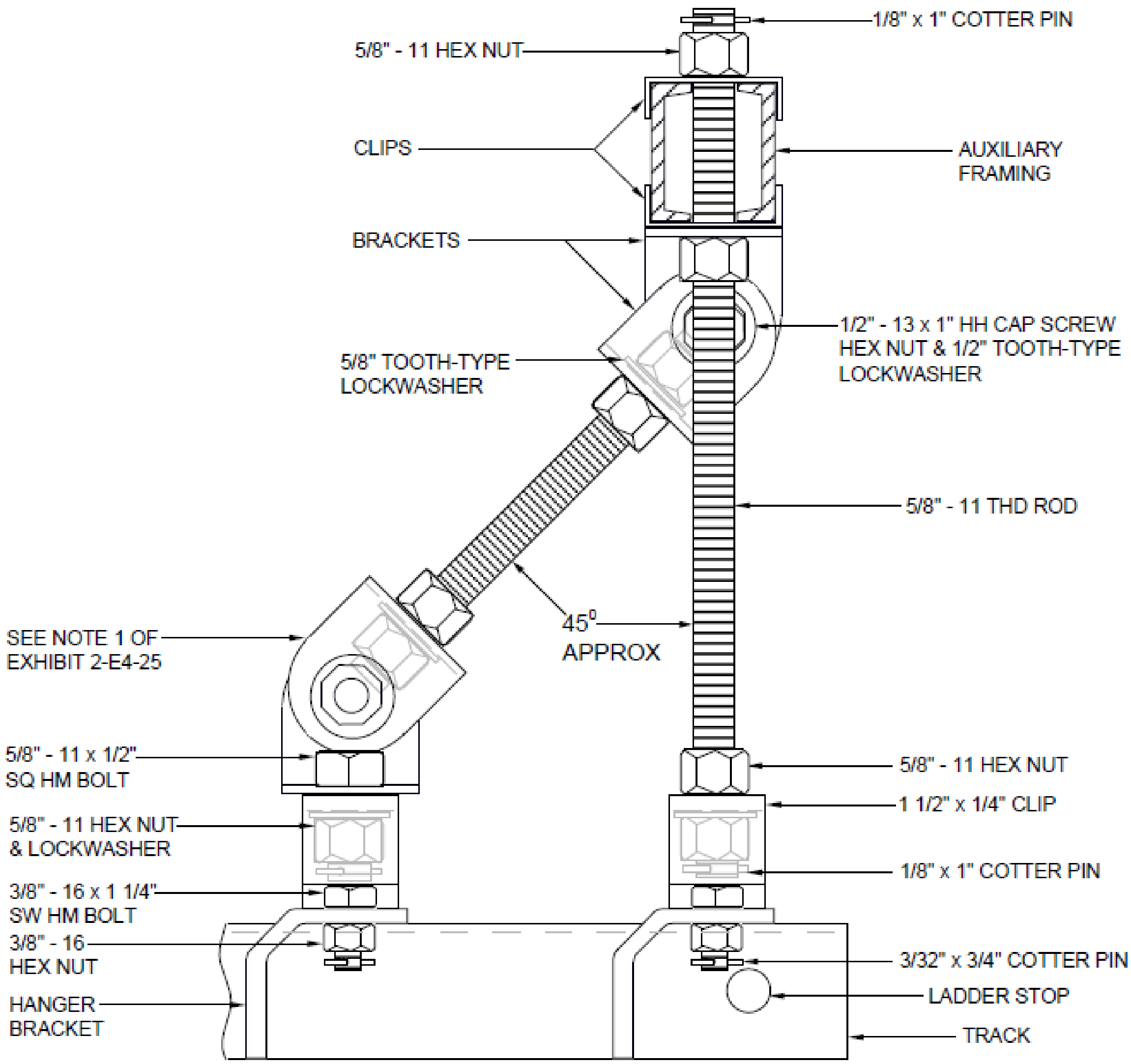
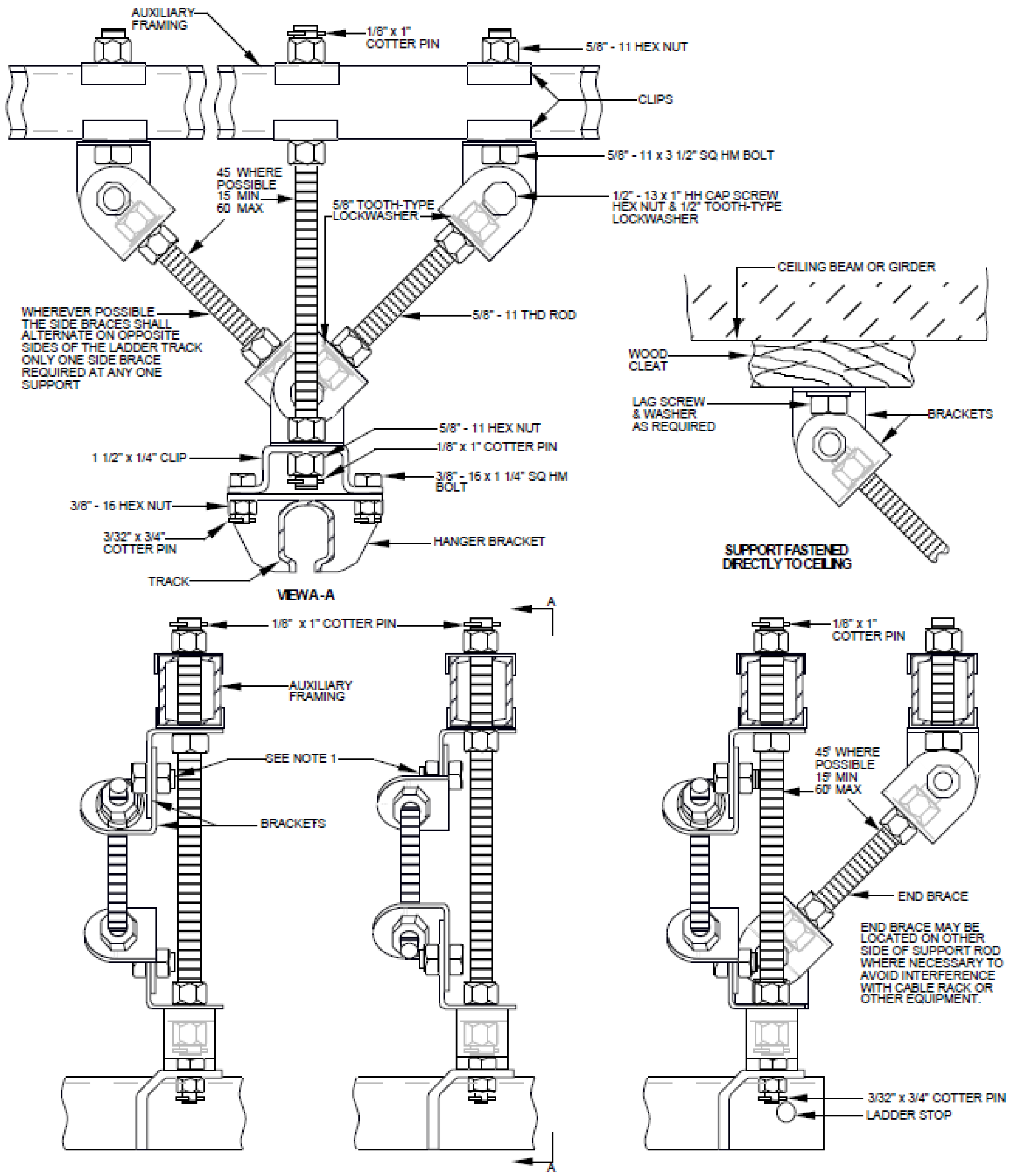


EXHIBIT 2-E4-24

2-E4-24 LADDER TRACK END BRACE WHERE AUXILIARY FRAMING BEYOND END OF TRACK CANNOT BE USED



NOTE:
1. BRACKETS AND BRACKET BOLTS MAY BE ASSEMBLED AS NECESSARY TO MEET JOB CONDITIONS. THE ARRANGEMENTS SHOWN ARE TYPICAL.

EXHIBIT 2-E4-25

2-E4-25 LADDER TRACK SIDE BRACES AND PREFERRED LOCATION FOR END BRACES

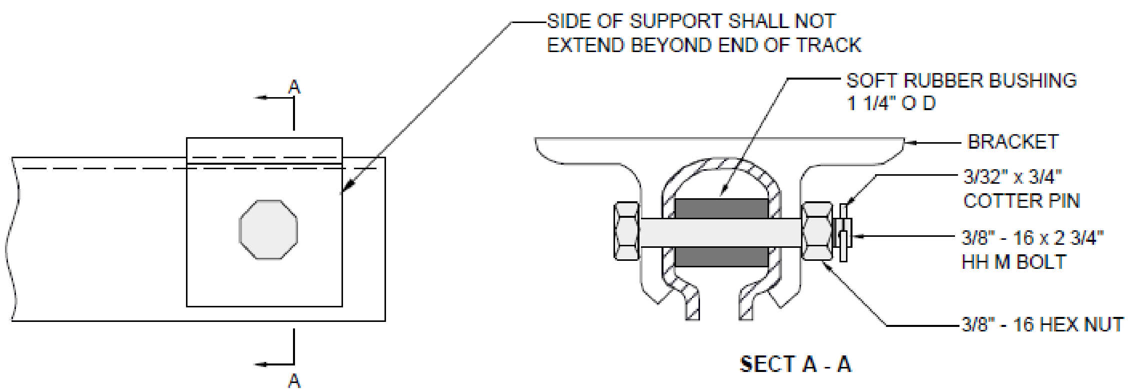
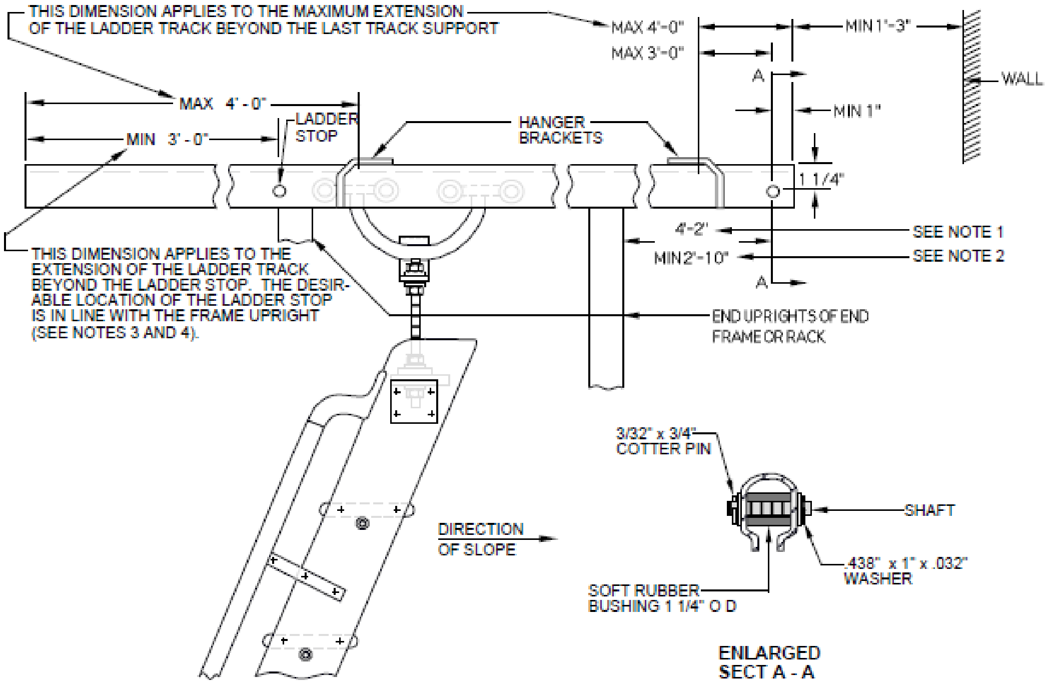


EXHIBIT 2-E4-26

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

2-E4-27 LOCATION OF END SUPPORTS AND LADDER STOPS IN TRACK

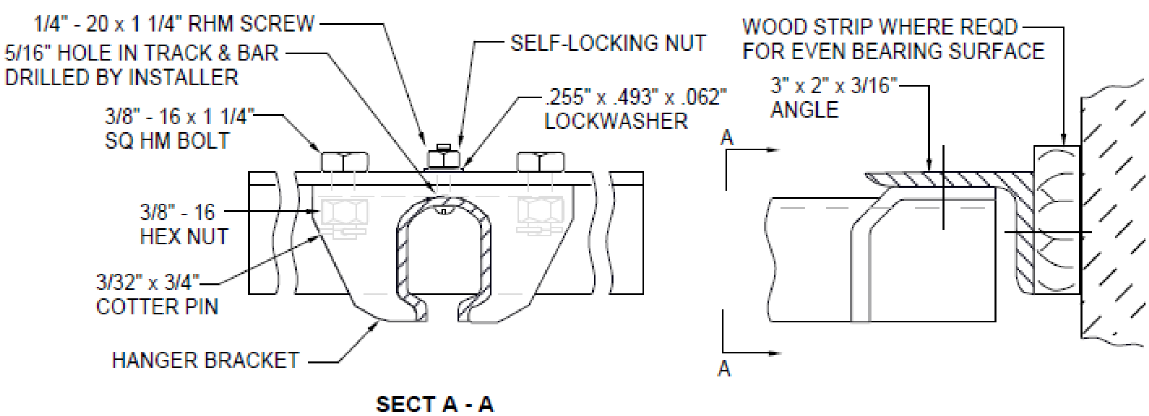


EXHIBIT 2-E4-28

2-E4-28 LADDER TRACK SUPPORTED FROM WALL

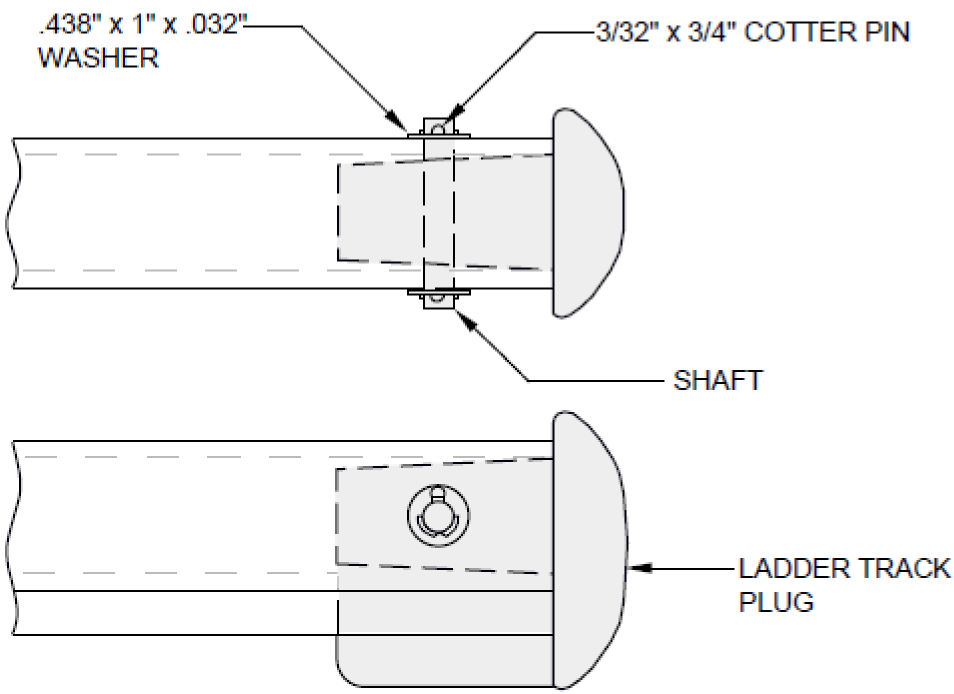


EXHIBIT 2-E4-29

2-E4-29 LADDER TRACK PLUG

Contents

EXHIBITS

FIGURES

TABLES

6. Cable Rack and Auxiliary Framing-

6E 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 CenturyLink Engineering Representative 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 CenturyLink Standard Configurations for additional information.
Standard Configurations may include essential information, specific arrangements, approved products, or direction on applying engineering requirements.

SEISMIC ZONES: Telecommunications equipment is installed according to the Telcordia rating system. The following chart illustrates the zone rating system outlined by Telcordia.

TABLE 6E.1 TELCORDIA SEISMIC ZONE RATING SYSTEM

Telcordia
0
1
2

3
4

- Telecommunications equipment installed by and for CenturyLink 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
- Framework Top Support

ANCHORING: A 1/2 inches (12mm) expansion type torque indicating anchor shall be used in all CenturyLink 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 CenturyLink Engineering representative for resolution.

- In these cases the CenturyLink Engineering representative will contact the CenturyLink Real Estate organization managing building projects for assistance in determining the best solution

SPLIT NUTS: Split type nuts and assemblies are prohibited.

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.
- Junctioning assemblies 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.

TABLE 6E.2 AUXILIARY FRAMING JUNCTIONS

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.

<u>STIFFENING CLIPS</u>: 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.

<u>FINISHING DETAILS</u>: 3/8 or 1/2 inch through bolts equipped with external tooth lock washers shall be added to the ends of the auxiliary framing per Exhibit 2-E5-2D

- The size of the 3/8 or 1/2 inch bolt kit will be matched to the size of the bolt hole that the manufacturer included in the auxiliary framing.
- A 1 and 1/2 inch spacer shall be placed between the framing channels to maintain separation.
- Finishing clips shall be added where the end of framing channels is more than 3 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 20 foot intervals 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.

TABLE 6E.3 BRACING BETWEEN AUXILIARY FRAMING LEVELS

DISTANCE TO CEILING OR BETWEEN AUXILIARY FRAMING LEVELS	TYPE OF BRACE
Over 5 inches to 10 inches	5/8-11 Threaded Rod
Over 10 inches to 1 foot 6 inches	2 by 3/8 inch Bar
Over 1 foot 6 inches	2 by 2 by 3/16 inch Angle

<u>BRACING TO THE CEILING</u>: A 3 inch, 5 pound per lineage foot U-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 CenturyLink Real Estate building project manager.
- Where ceiling inserts are not available, 5/8 inch ceiling expansion anchors are preferred for fastening the braces to the ceiling and shall be provided by CenturyLink Real Estate.
- U-Channel can be provided by CenturyLink Real Estate in areas where there is no existing embedded U-channel or ceiling inserts. U-channel provided must meet the loading requirements outlined in Section 6A.3.
- 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.

<u>DOUBLE BRACES</u>: 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.

<u>BRACING SUPPLEMENTARY FRAMING</u>: Bars or channels of supplementary framing must be braced at each end with threaded rod braces, as shown in Exhibit 2-E2-2E and 2-E5-7 where a row of frames is omitted.

- 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.

6E.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 as a primary support of the grid structure.

- 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 the safe load table in Chapter 6 unit A section 6.4 must be observed.

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.

6E.3.1 Cable Rack Support

The following practices for cable rack support shall be used for locations within heavy earthquake zones.

- Cable rack stilted above or below auxiliary framing or other cable rack shall be supported by C-Clip brackets. The use of C-Clips is not permitted for dedicated power rack.
- 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 thru 9N. Cast in or expansion anchors shall be used for ceiling support. Self drilling anchors shall not be used.
- 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 existing ladder-type cable racks are supported by 5/8-11 threaded rods and G-Clips 2 inches or more above the auxiliary framing or cable rack stringers, they shall be tied together with a flat steel bar as shown in Exhibit 2-E5-9L. This is not required when C-Clips are used for support.

6E.3.2 Bracing Cable Rack

Hanger-rod supported racks shall be braced to prevent movement in both sidewise and endwise directions.

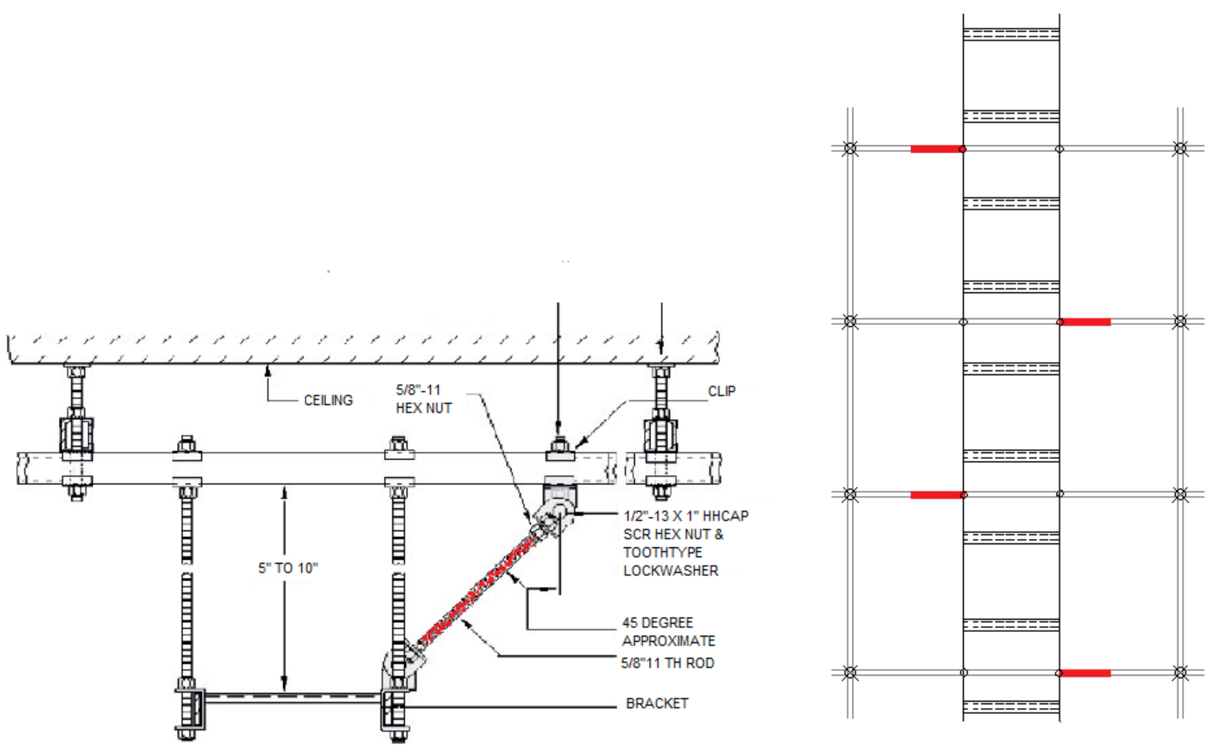
- Threaded rod, flat-bar or angle-type braces may be used. Specific bracing types and distances are identified in applicable Exhibits.

- 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 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 each set of supports.

<u>SIDE BRACING</u>: 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 an alternating arrangement, slanted in opposite directions, and staggered on opposite stringers of the cable rack as shown in Figure 6E.1

FIGURE 6E.1 SIDE BRACING



- In the case of ceiling supported main aisle racks, sidewise bracing is unnecessary where they junction with ceiling supported lineup cable racks.
- End-aisle racks require bracing on the outside stringer only.
- 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.
- Where perpendicular bracing is required, the braces shall be fastened as shown in Exhibit 2-E5-9D, 9E, and 9F.

END BRACING: End braces are required for each hanger rod supported cable rack.

- 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.
- Braces shall be installed on opposite stringers and slanted in opposite directions

6E.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 external tooth-type lock-washers.

- 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, 7,8, 9,10 and11-6 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).

6E.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. Four anchor bolts are required, one on each corner, of the framework stanchion in a heavy earthquake zone.
- 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 column stanchion. Exceptions may occur where a lineup requires a framework stanchion in support of a light switch
- Stanchions in compartment cableway environments shall be provided per system assembly requirements.

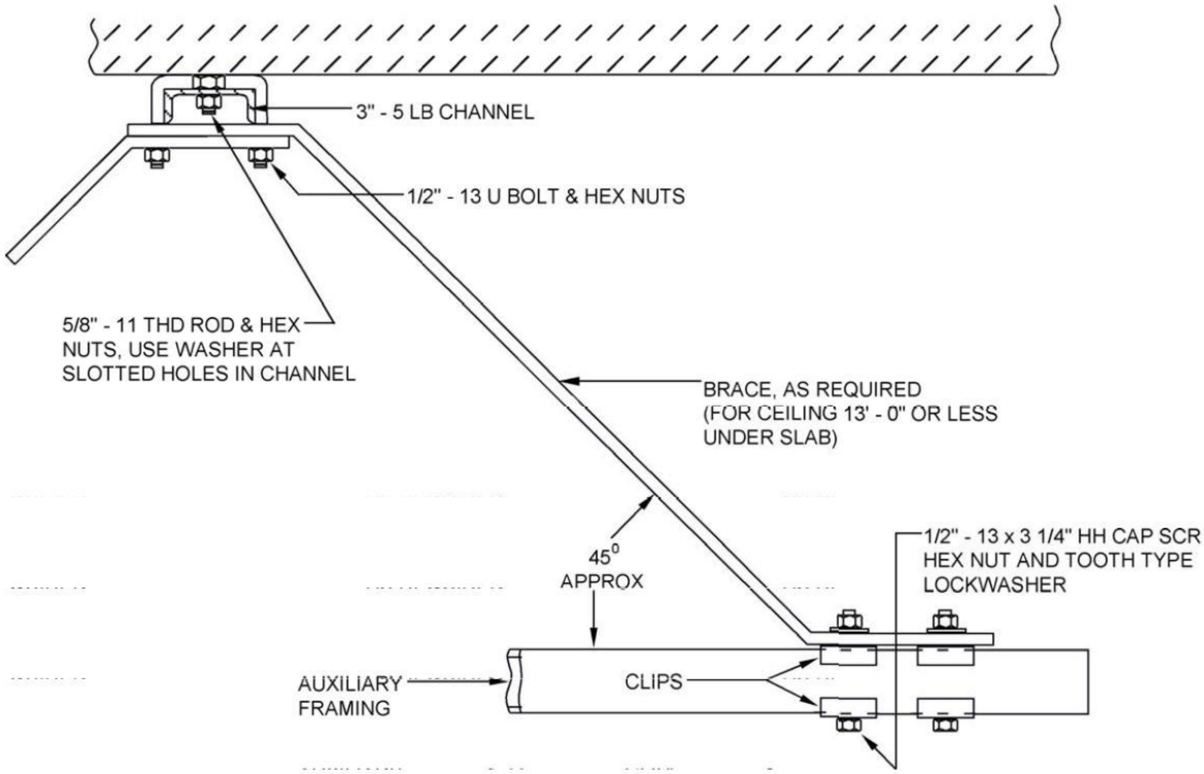


EXHIBIT 2-E5-1

2-E5-1 AUXILIARY FRAMING BRACE FOR USE IN LOW-CEILING AREAS

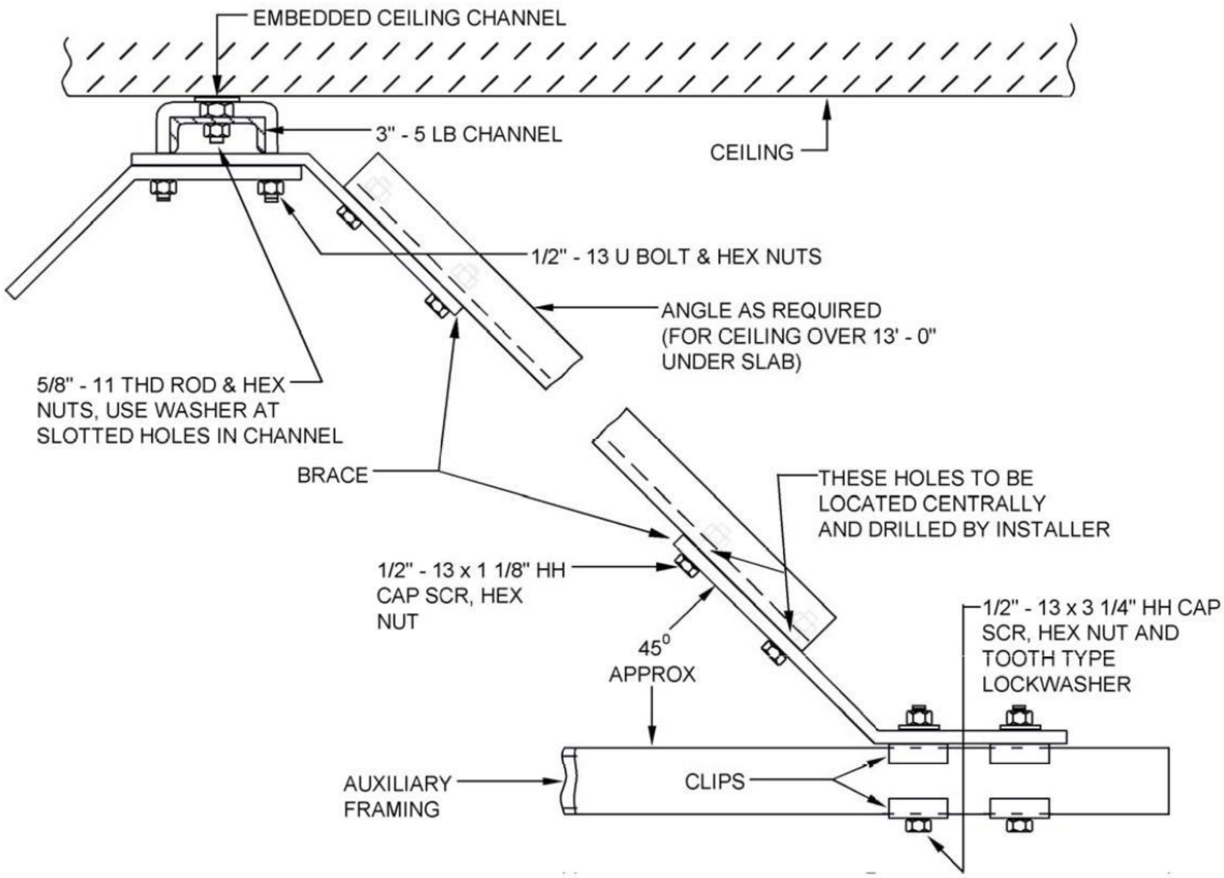


EXHIBIT 2-E5-2

2-E5-2 AUXILIARY FRAMING BRACE FOR USE IN HIGH CEILING AREAS

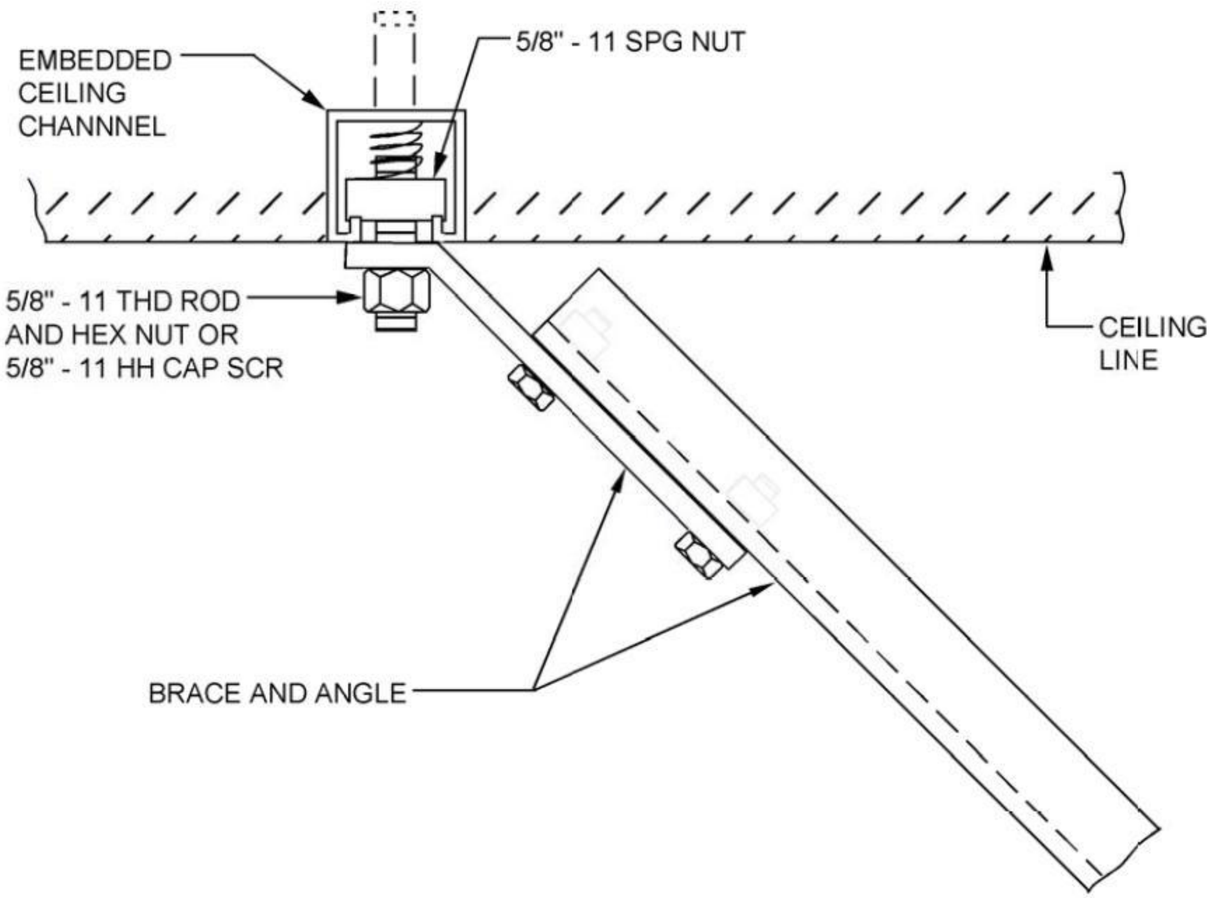
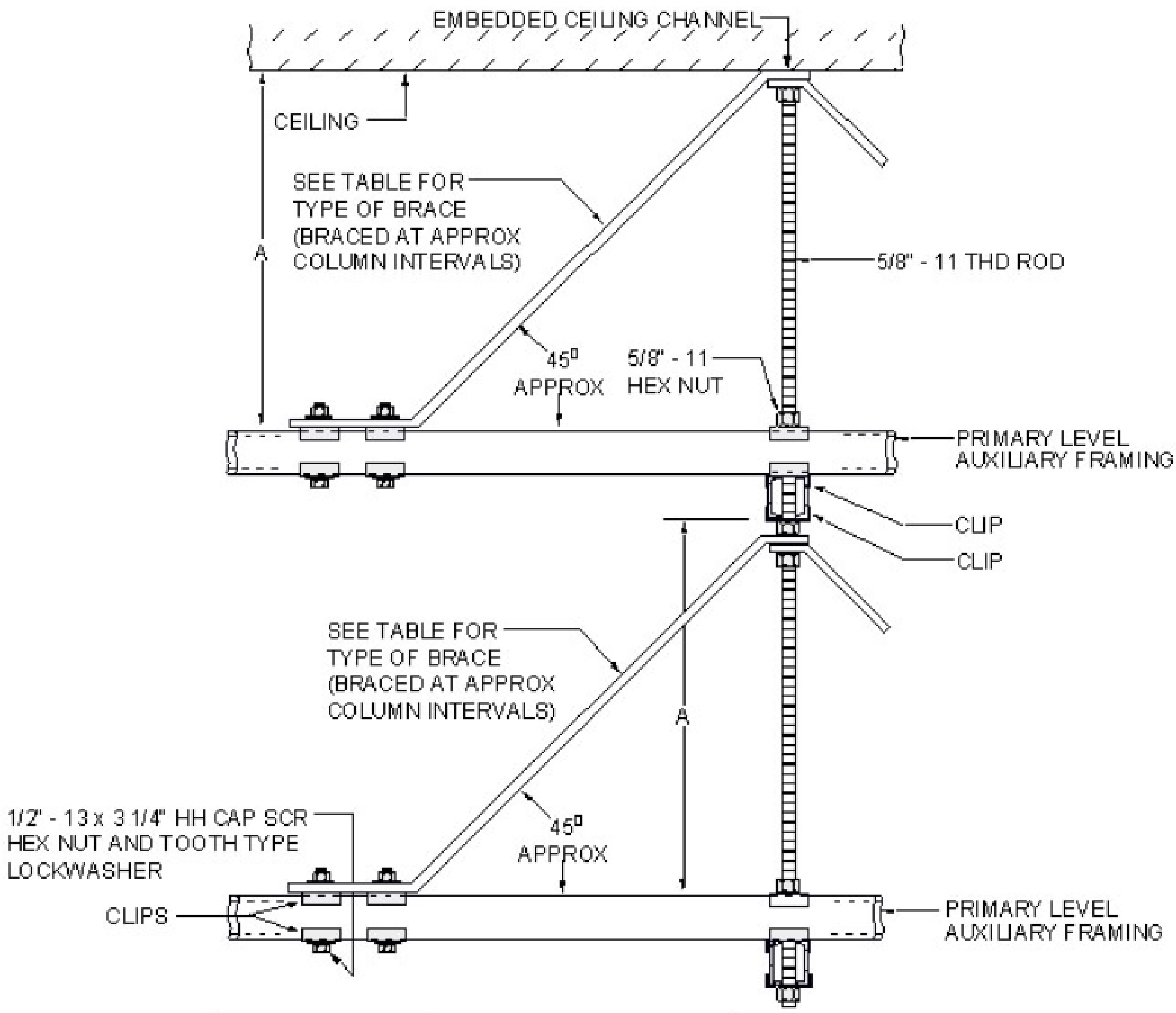


EXHIBIT 2-E5-2A

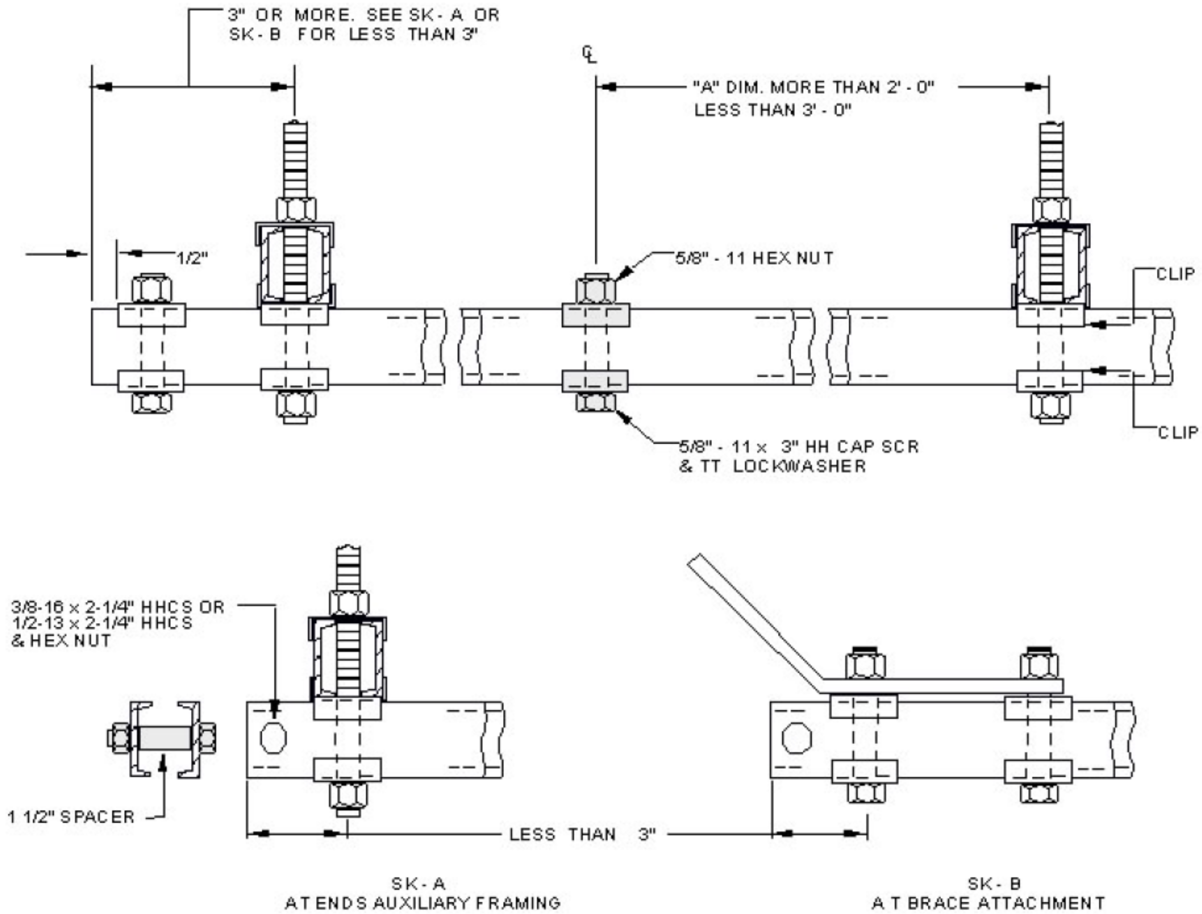
2-E5-2A FASTENING AUXILIARY FRAMING BRACE TO EMBEDDED CEILING CHANNEL



A	TYPE OF BRACE
OVER 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

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

2-E5-2D APPLICATION OF STIFFENING CLIPS AND END BOLTS IN AUXILIARY FRAMING EQ HEAVY

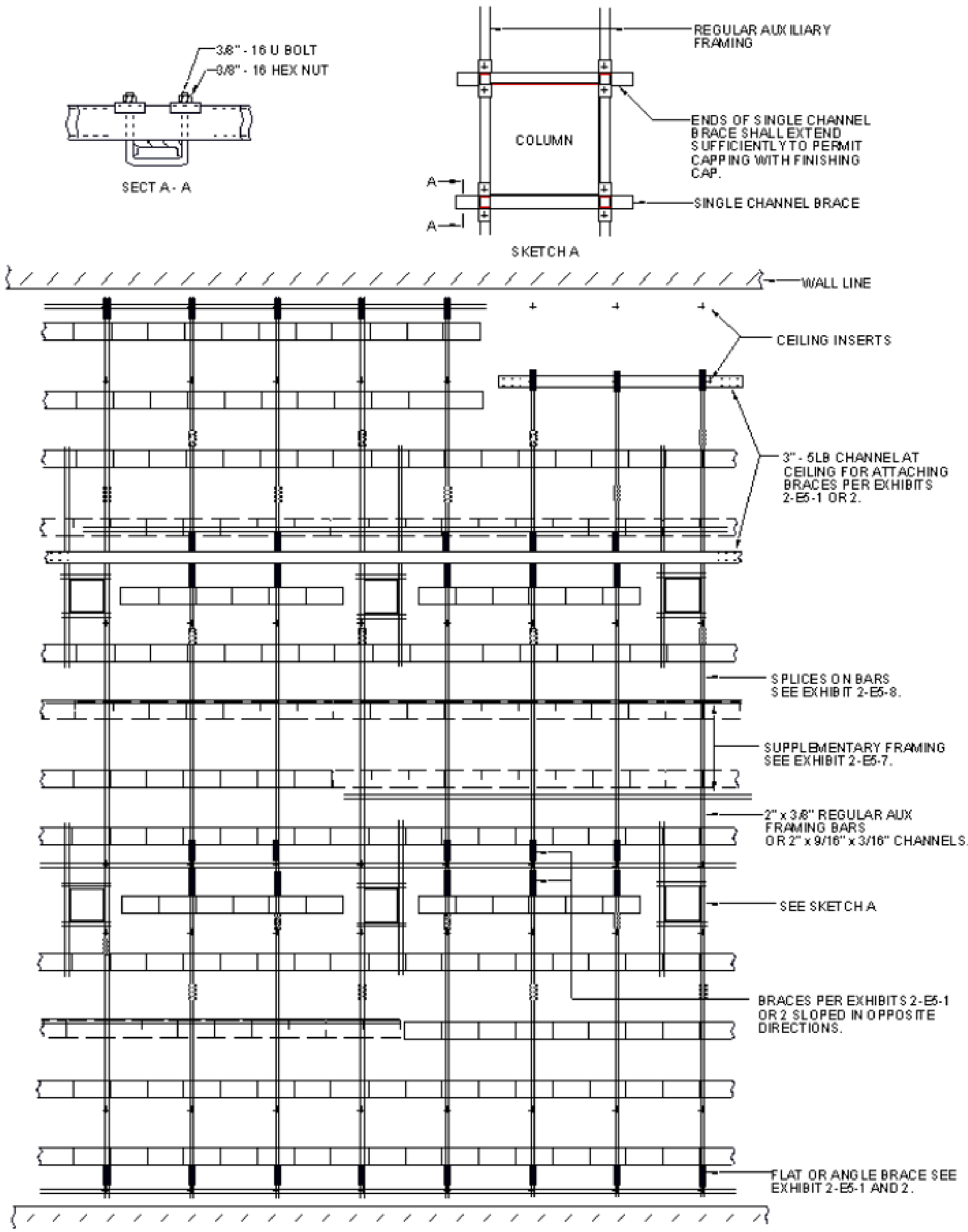


EXHIBIT 2-E5-3 (DISCONTINUED)

2-E5-3 (DISCONTINUED) TYPICAL AUXILIARY FRAMING ARRANGEMENT

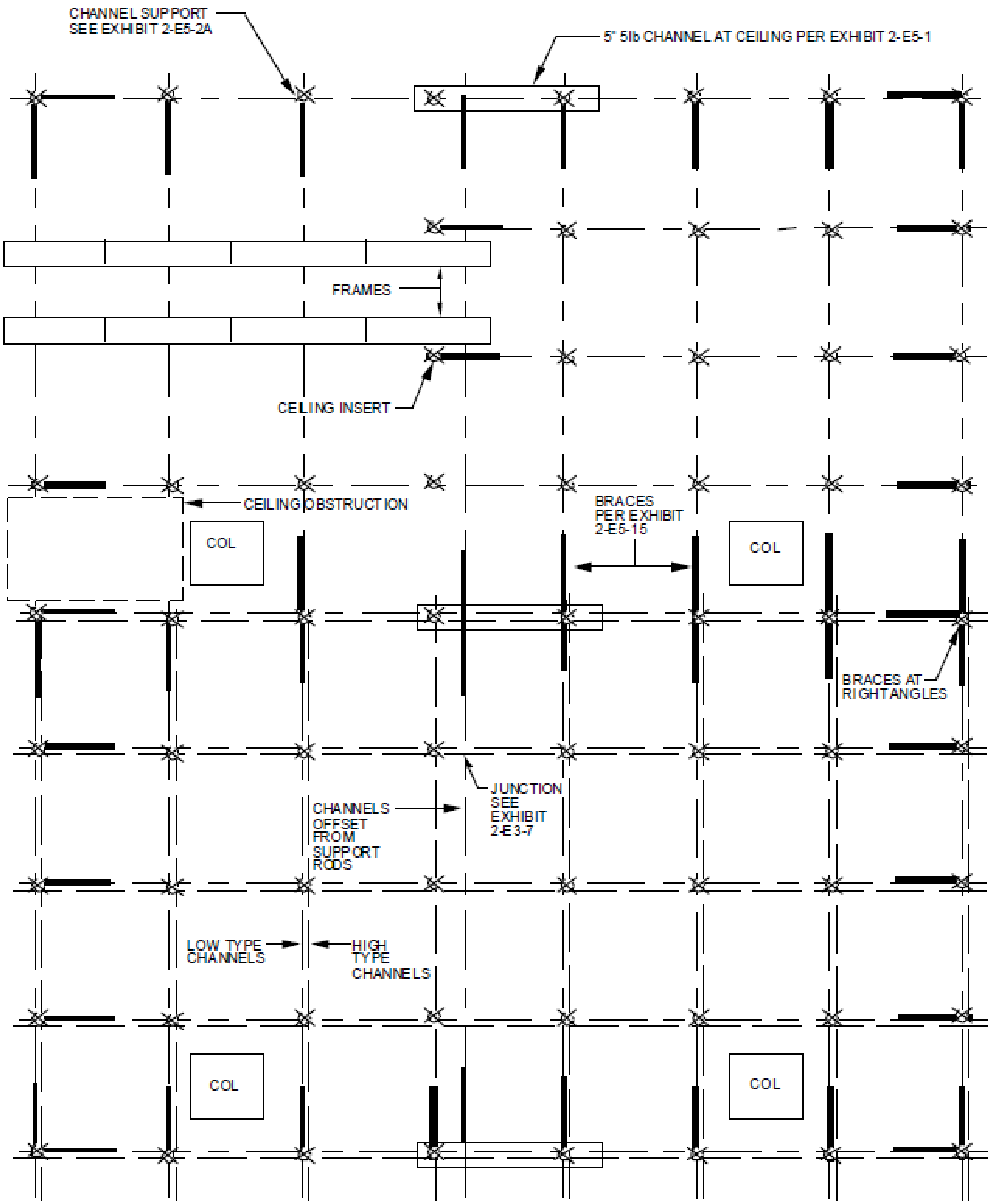
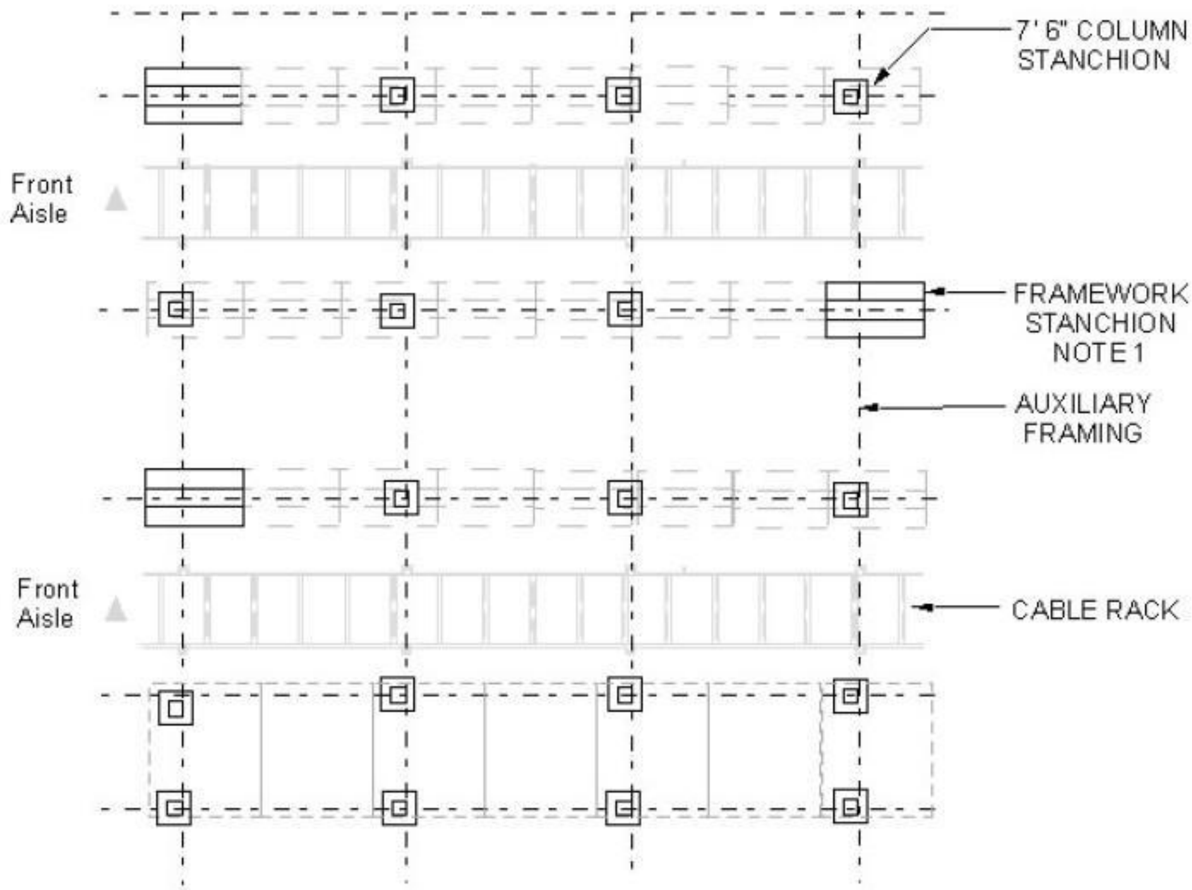


EXHIBIT 2-E5-3A

2-E5-3A TYPICAL EARTHQUAKE BRACING SCHEME – HEAVY



NOTE:
1) FRAMEWORK STANCHIONS ARE ONLY REQUIRED WHEN A LIGHT SWITCH WILL BE ENGINEERED FOR THAT LOCATION

EXHIBIT 2-E5-4

2-E5-4 TYPICAL STANCHION ARRANGEMENT – HEAVY

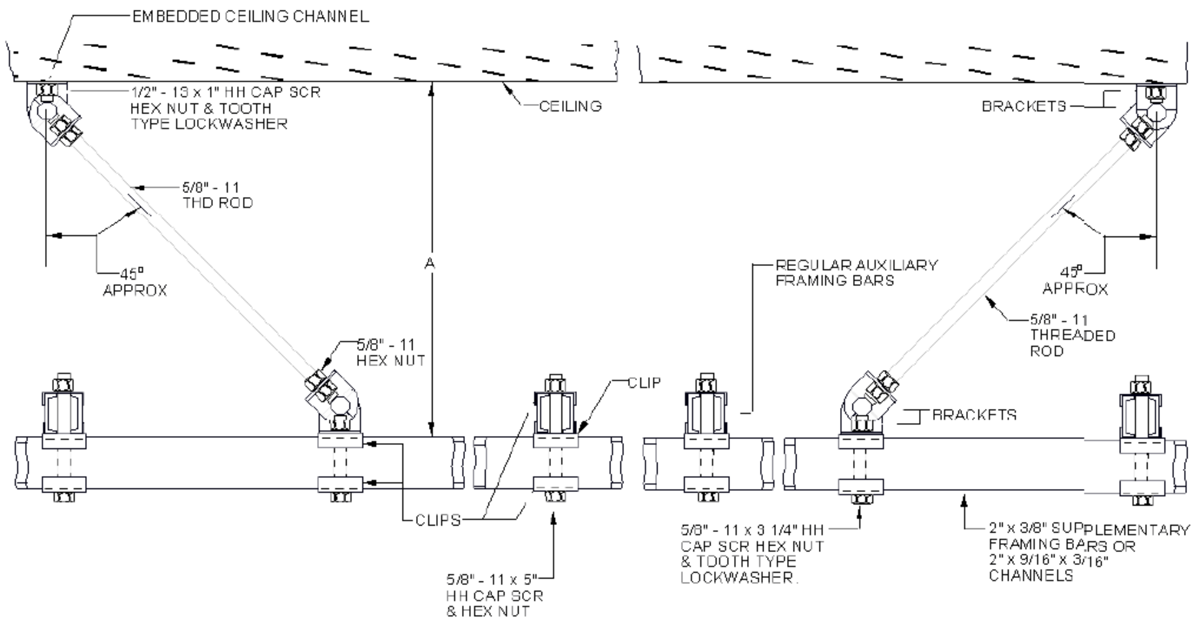


EXHIBIT 2-E5-7

2-E5-7 SUPPLEMENTARY FRAMING AND BRACES AT UNEQUIPPED ROWS OF FRAMES

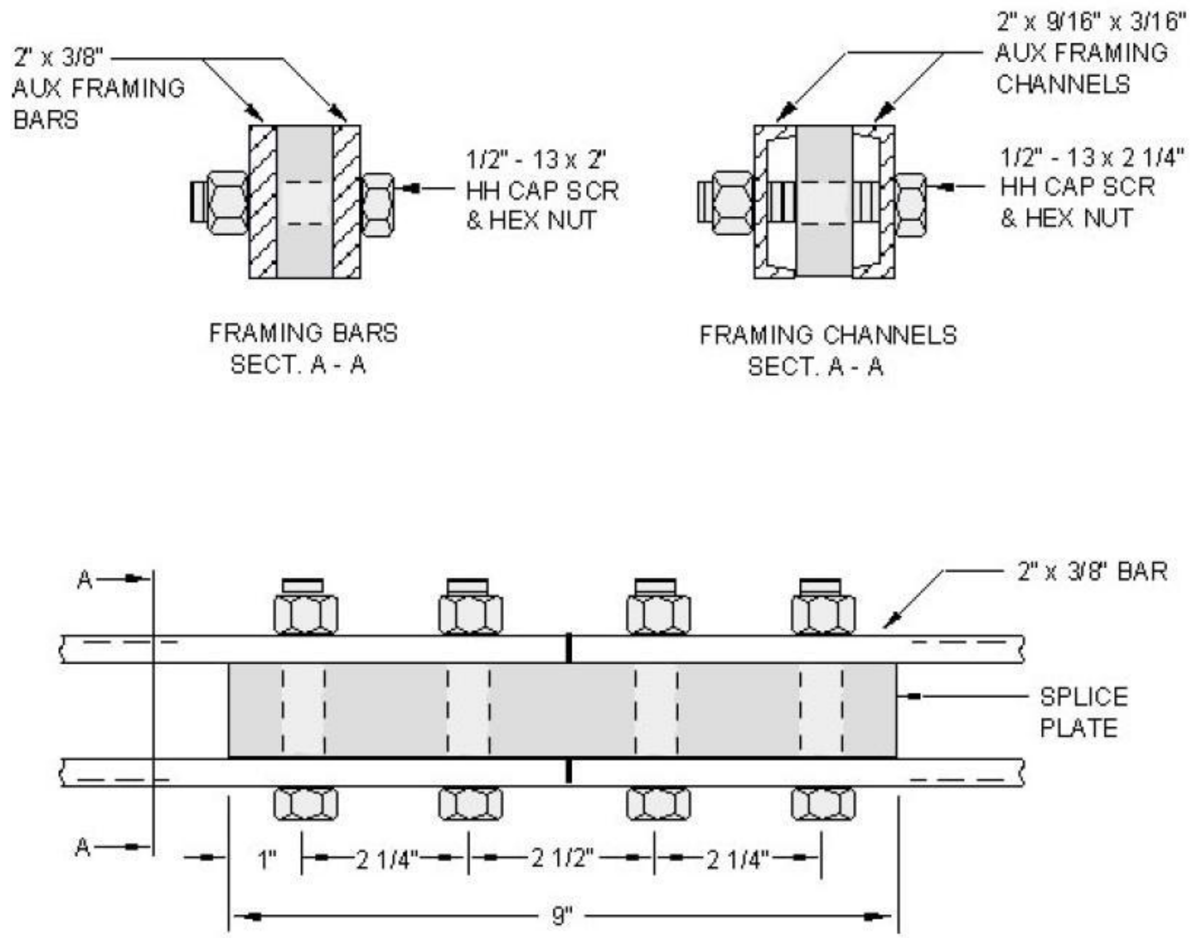


EXHIBIT 2-E5-8

2-E5-8 AUXILIARY FRAMING SPLICES – SAME LEVEL

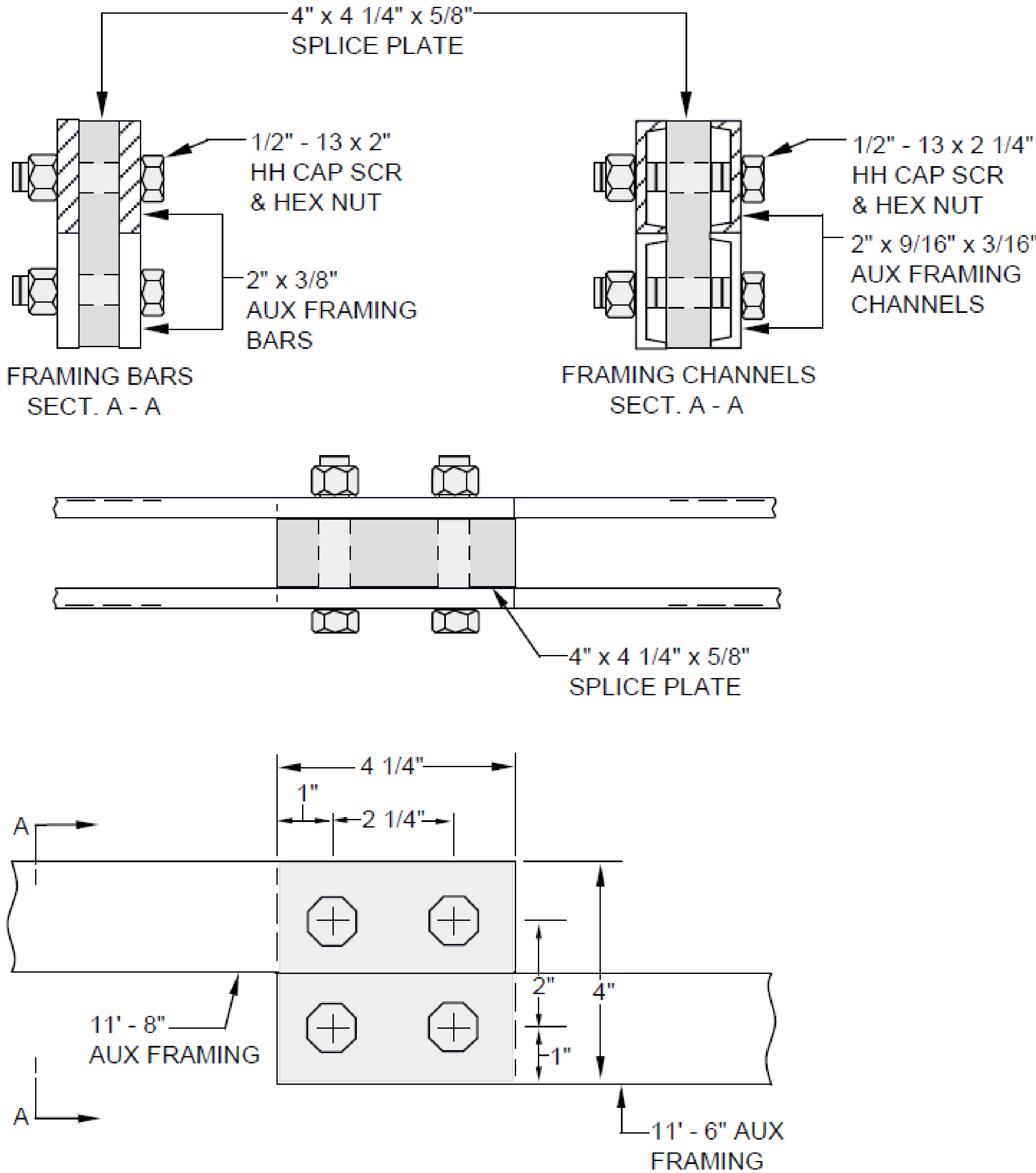


EXHIBIT 2-E5-8B

2-E5-8B AUXILIARY FRAMING SPLICES – 11 FOOT 6 INCH AND 11 FOOT 8 INCH FRAMING

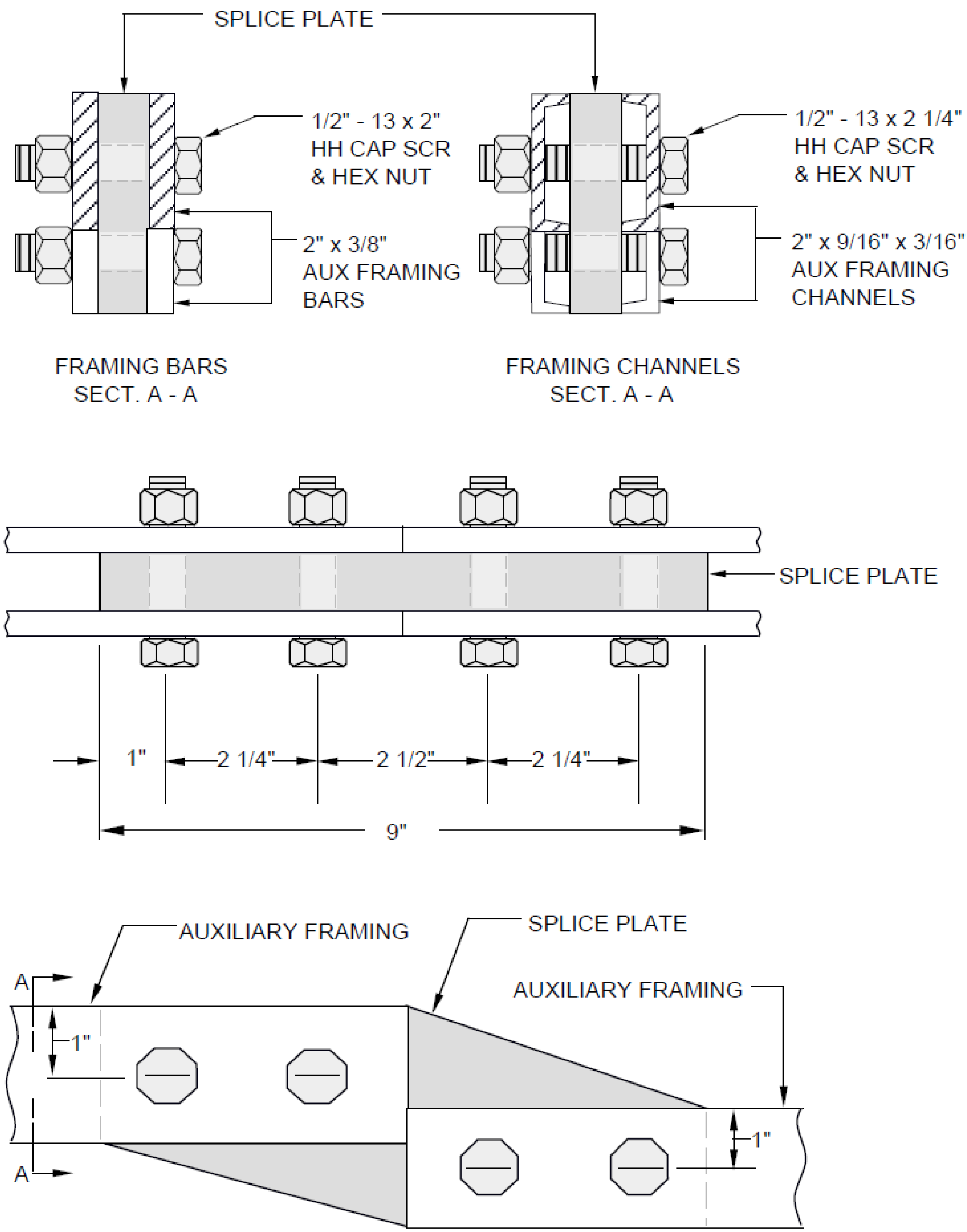


EXHIBIT 2-E5-8C

2-E5-8C AUXILIARY FRAMING SPLICES – 1 INCH DIFFERENCE IN FRAMING LEVELS

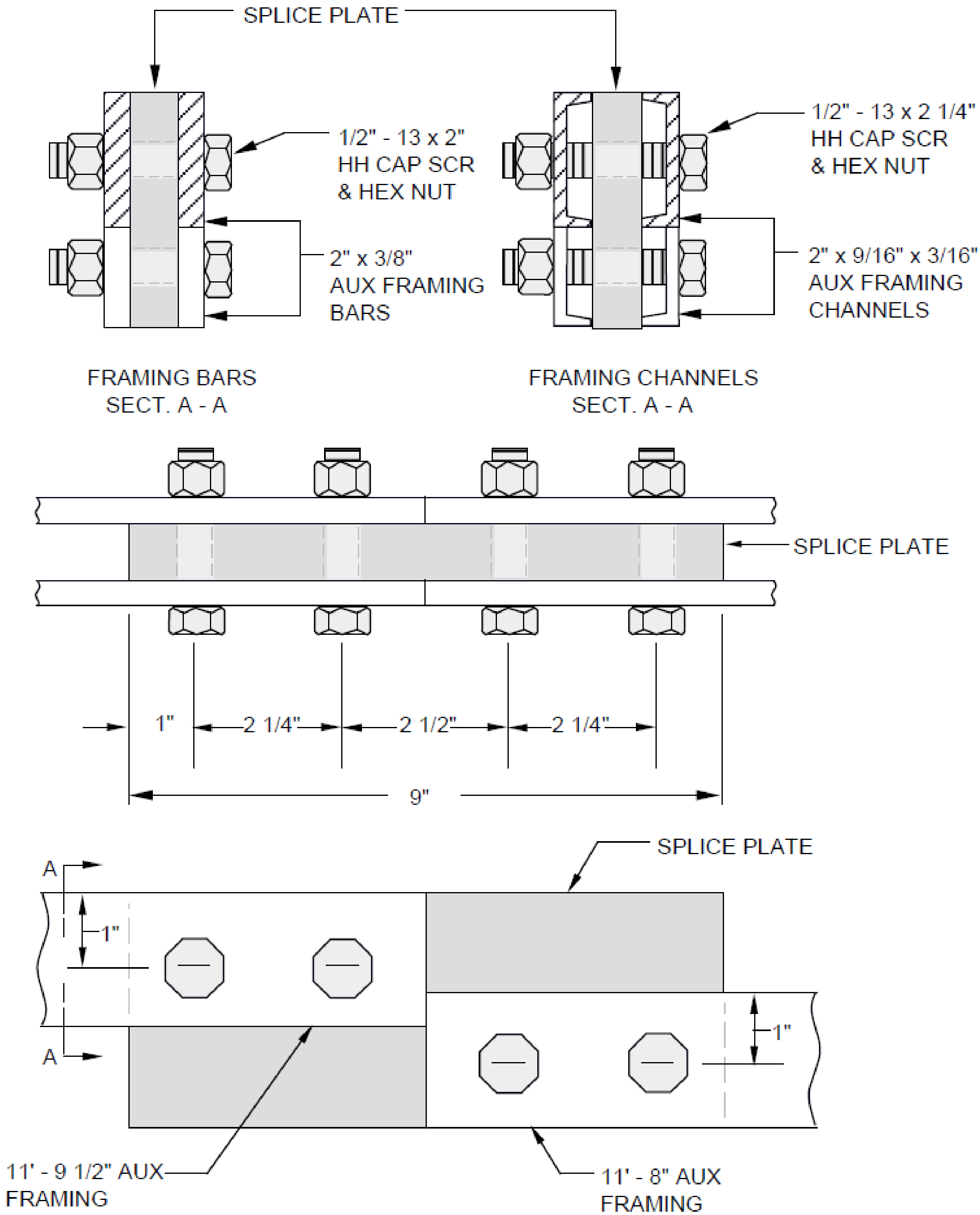


EXHIBIT 2-E5-8D

2-E5-8D AUXILIARY FRAMING SPLICES – 11 FOOT 6 INCH AND 11 FOOT 8 INCH FRAMING

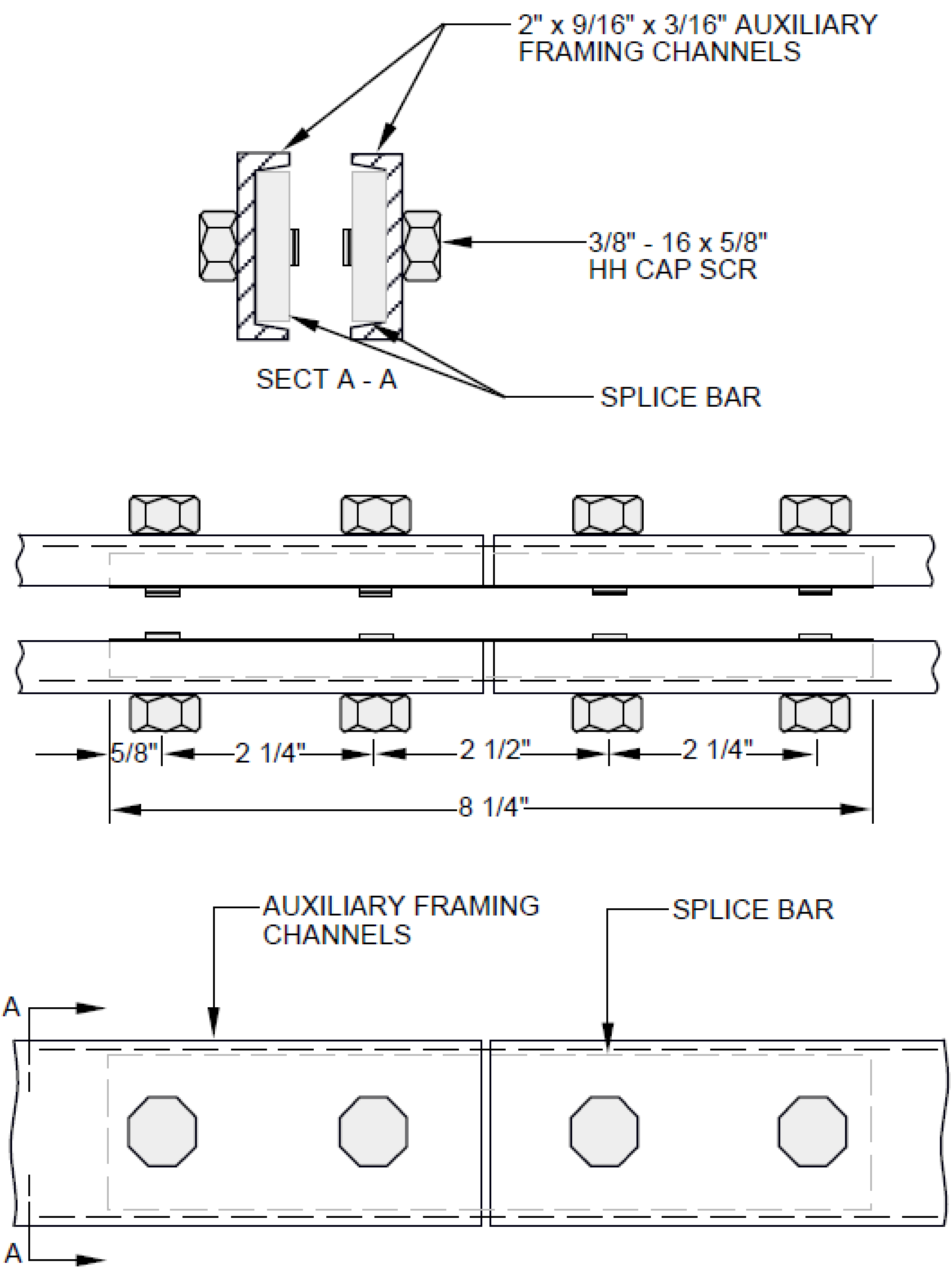


EXHIBIT 2-E5-8E

2-E5-8E AUXILIARY FRAMING SPLICES –S AME LEVEL

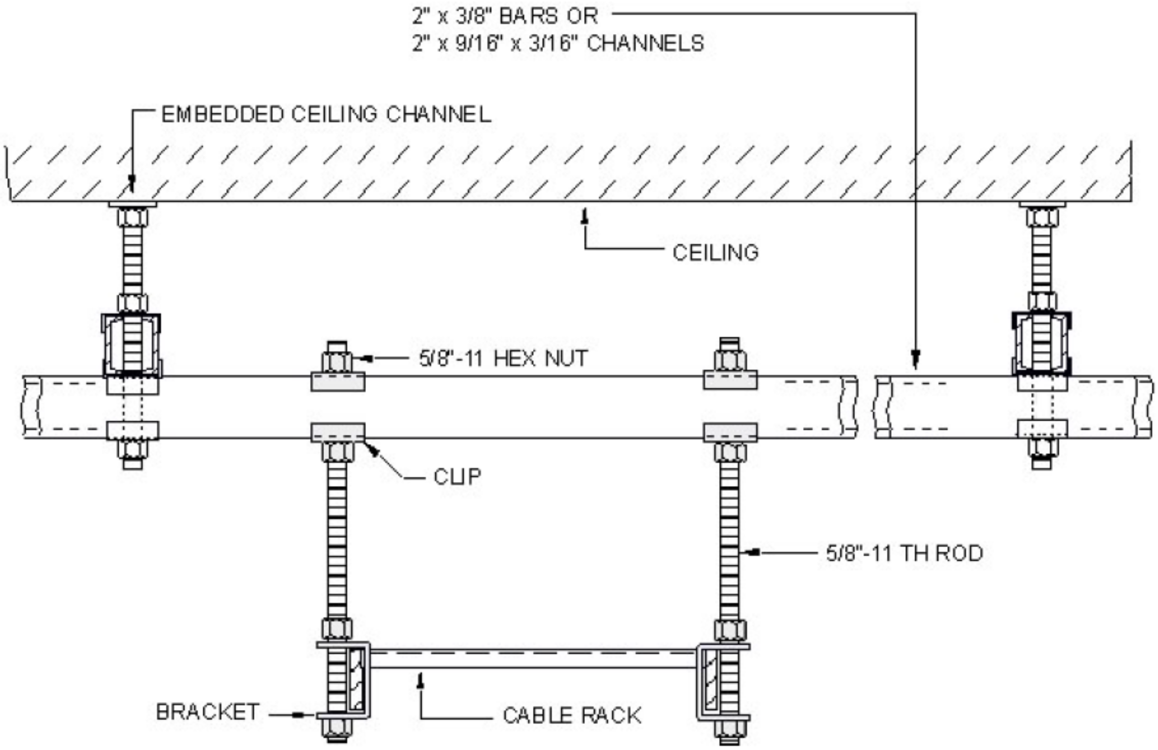


EXHIBIT 2-E5-9

2-E5-9 SUPPORT OF LADDER – OR BAR – TYPE CABLE RACKS NOT ATTACHED DIRECTLY TO AUXILIARY FRAMING – LADDER-TYPE SHOWN

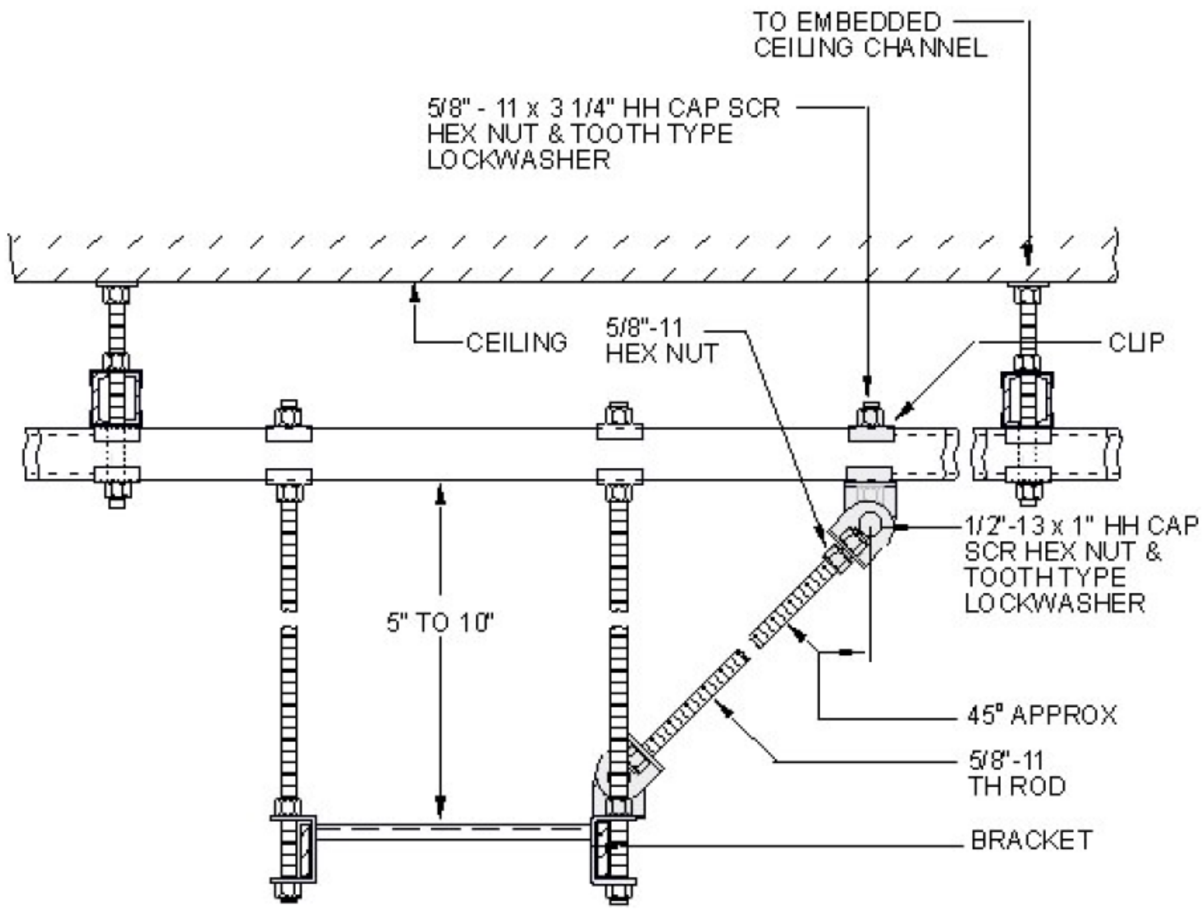


EXHIBIT 2-E5-9A

2-E5-9A SIDEWISE BRACING OF LADDER – OR BAR – TYPE CABLE RACK WITH THREADED ROD BRACES – LADDER-TYPE SHOWN

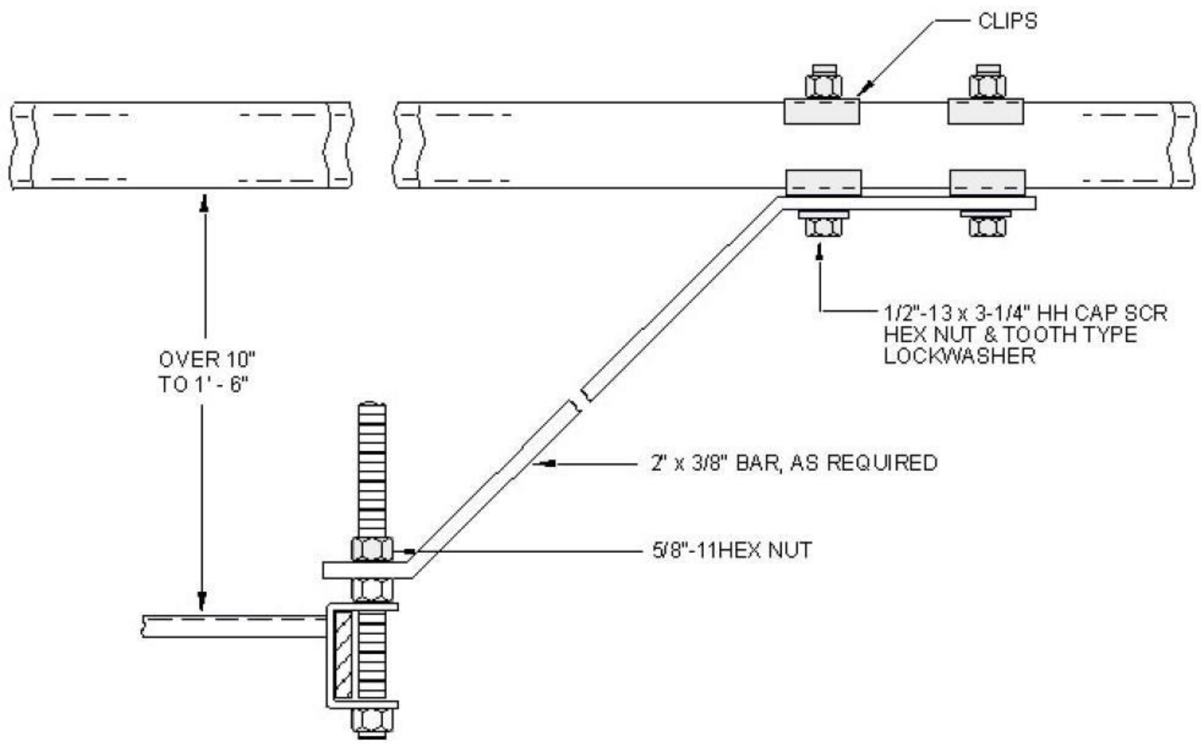


EXHIBIT 2-E5-9B
2-E5-9B SIDEWISE BRACING OF LADDER-OR BAR-TYPE CROSS-AISLE CABLE RACK WITH FLAT BAR BRACES – LADDER-TYPE SHOWN

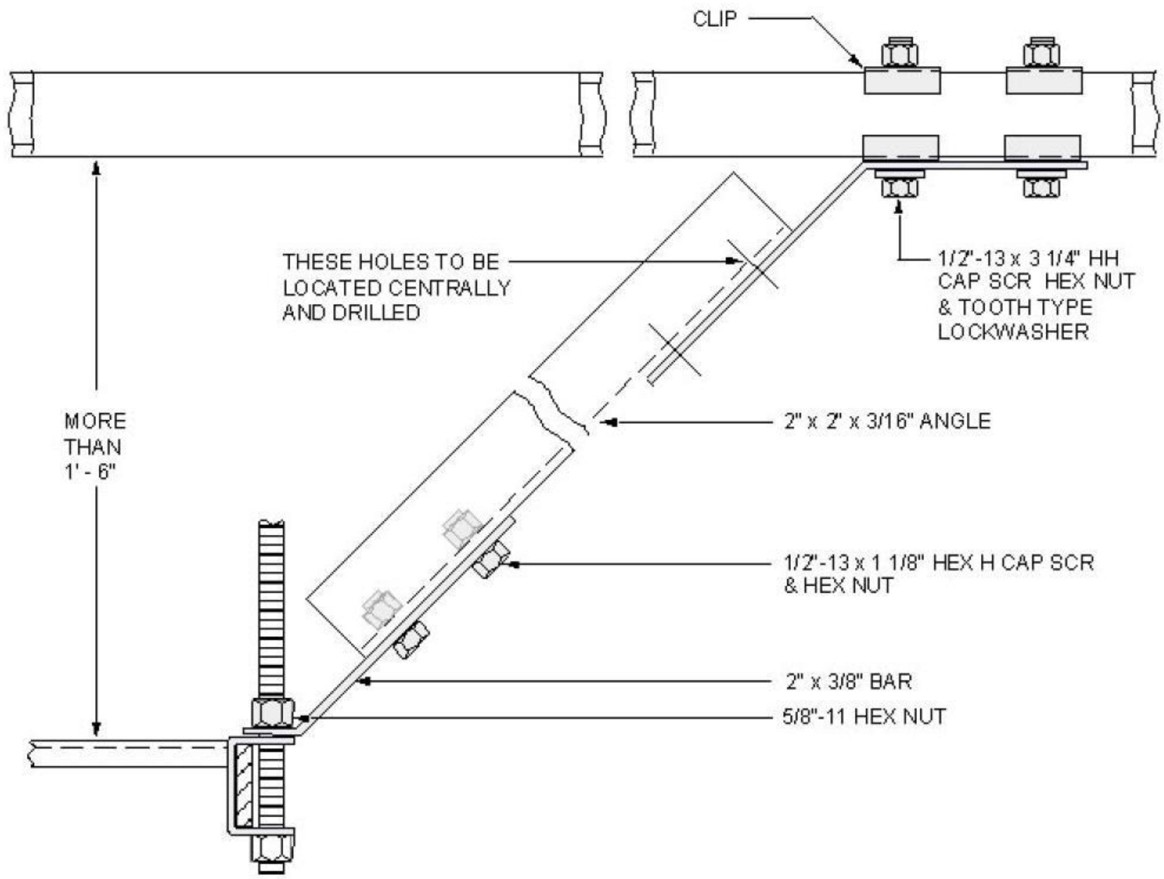


EXHIBIT 2-E5-9C

2-E5-9C SIDEWISE BRACING OF LADDER-OR BAR-TYPE CABLE RACK WITH ANGLE BRACES – LADDER-TYPE SHOWN

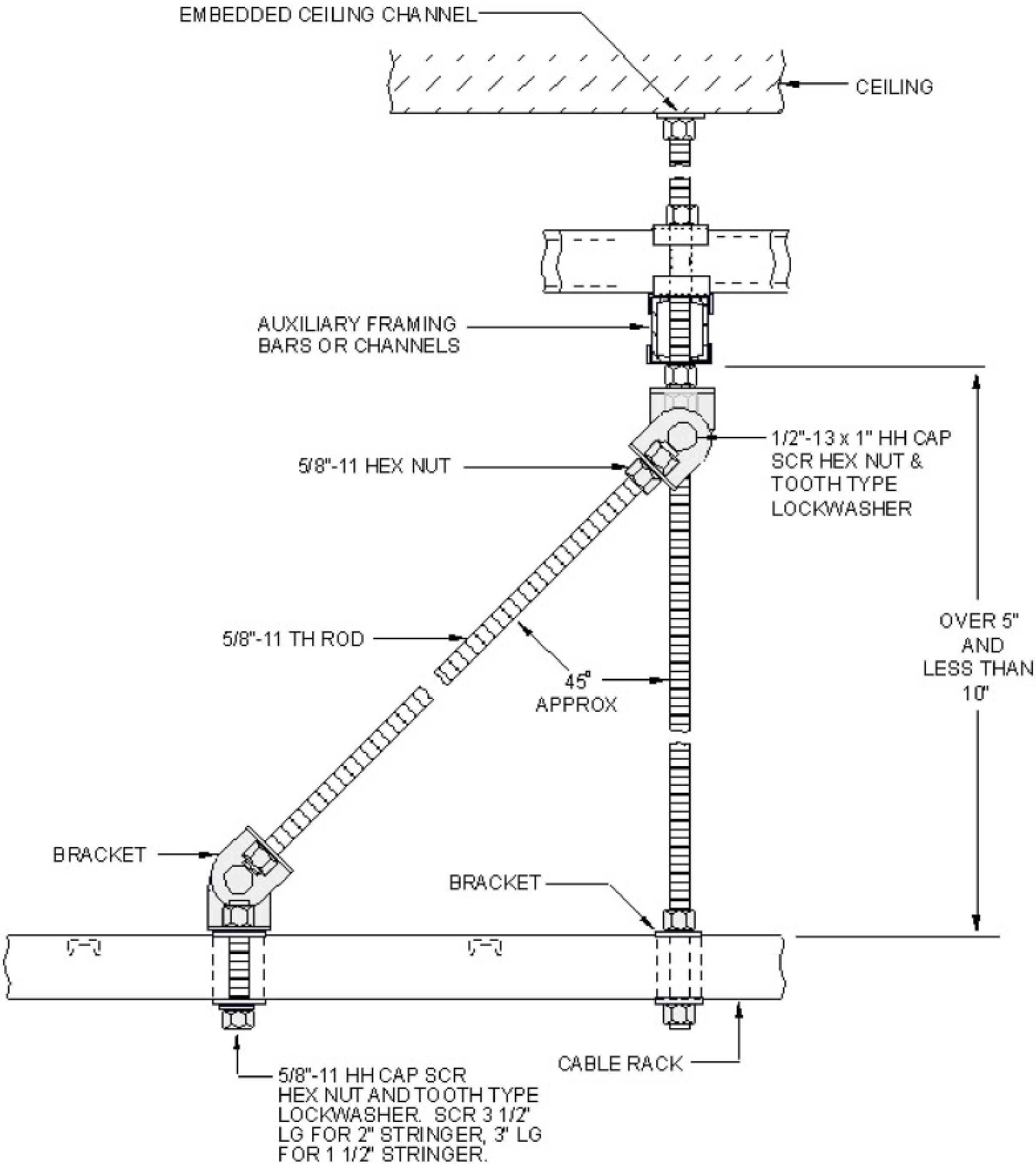


EXHIBIT 2-E5-9D

2-E5-9D ENDWISE BRACING OF LADDER-OR BAR-TYPE CABLE RACK WITH THREADED ROD BRACES – LADDER-TYPE SHOWN

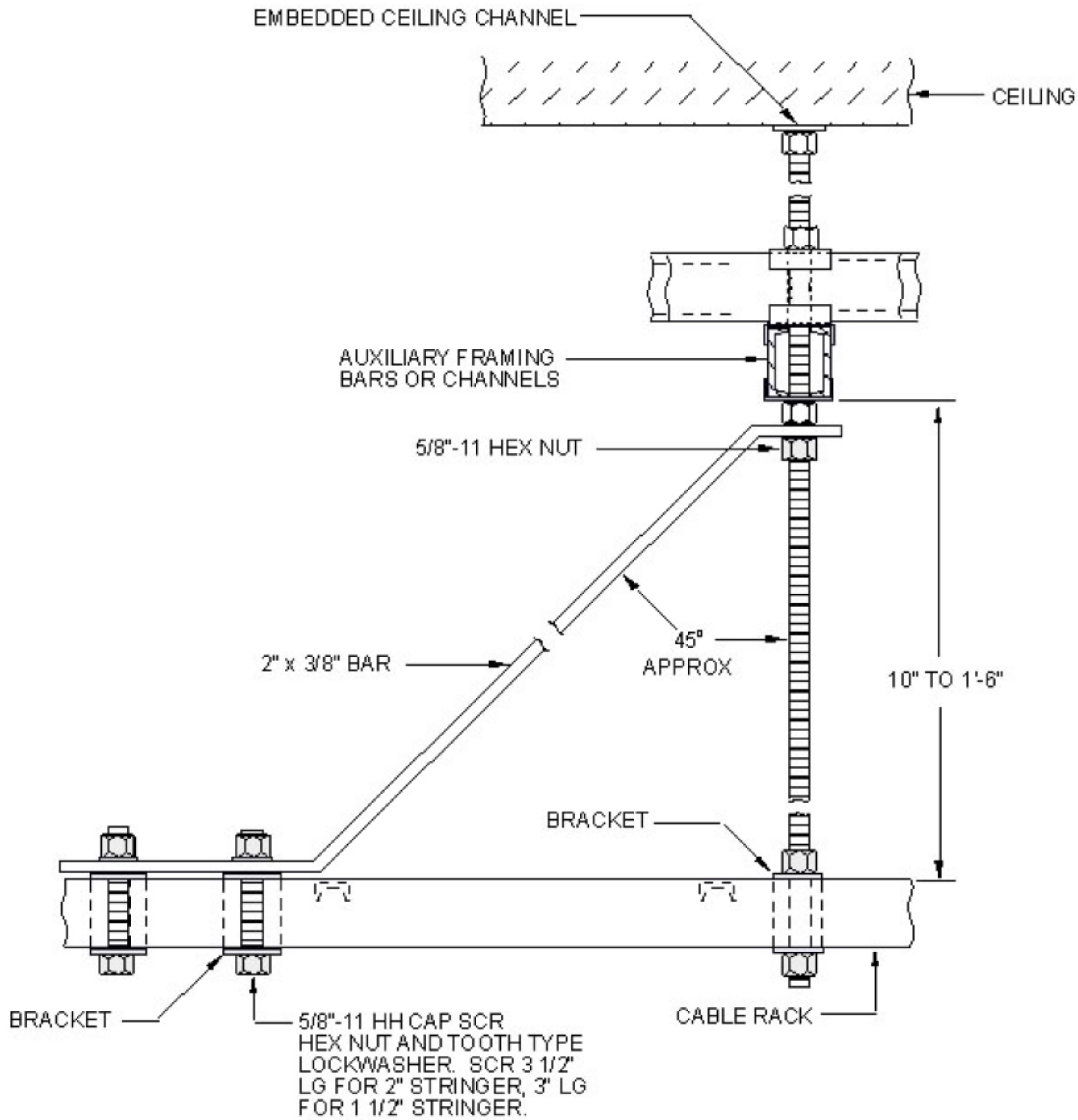


EXHIBIT 2-E5-9E

2-E5-9E ENDWISE BRACING OF LADDER- OR BAR-TYPE RACK WITH FLAT BAR BRACES– LADDER-TYPE SHOWN

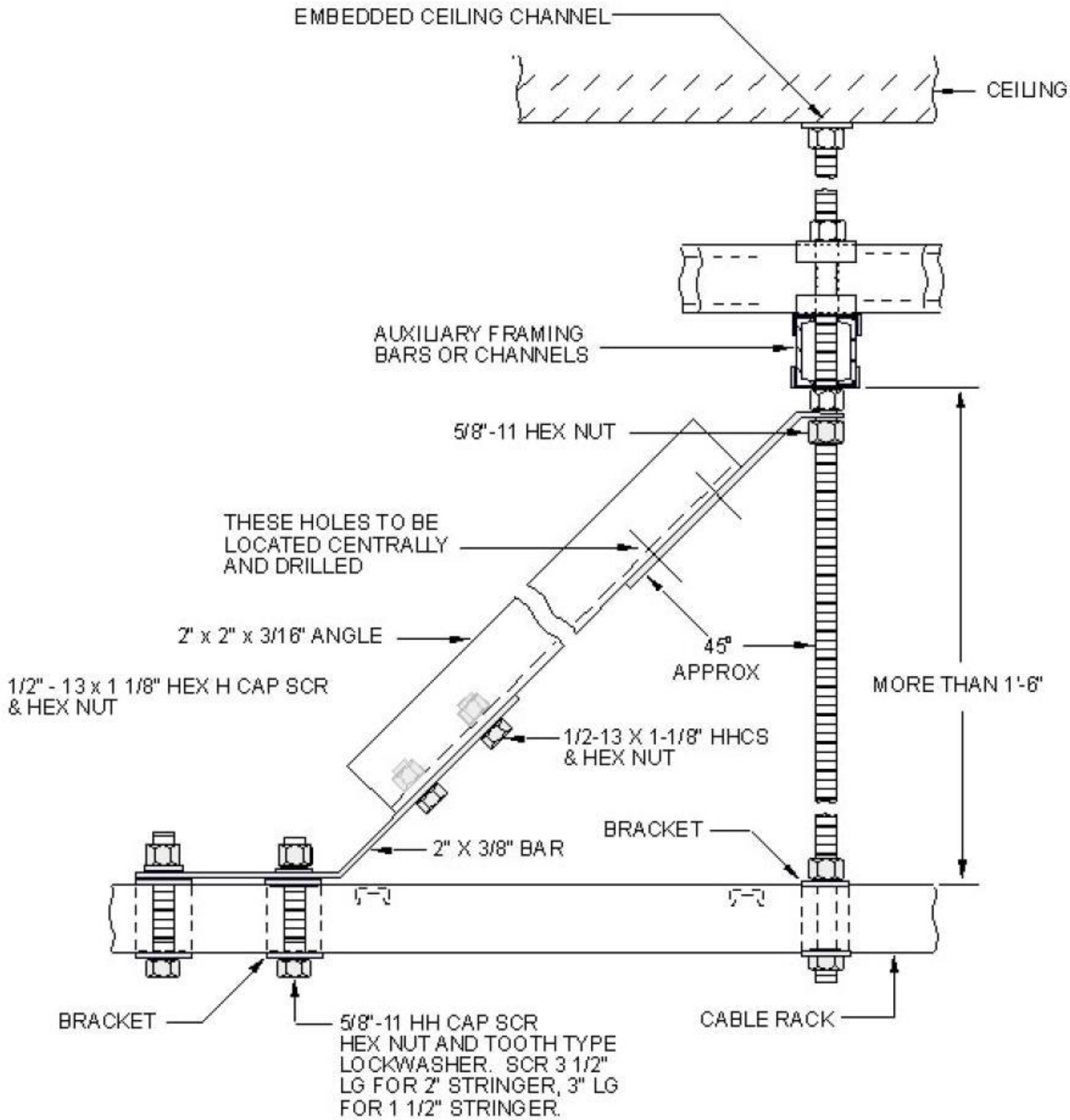


EXHIBIT 2-E5-9F

2-E5-9F ENDWISE BRACING OF LADDER-OR BAR-TYPE RACK WITH ANGLE BRACES – LADDER-TYPE SHOWN

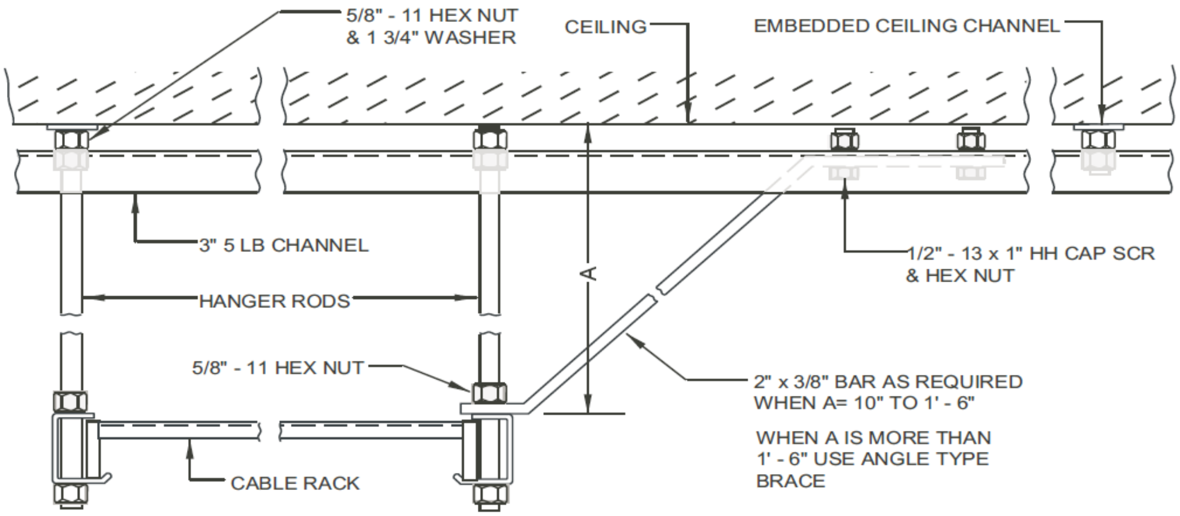
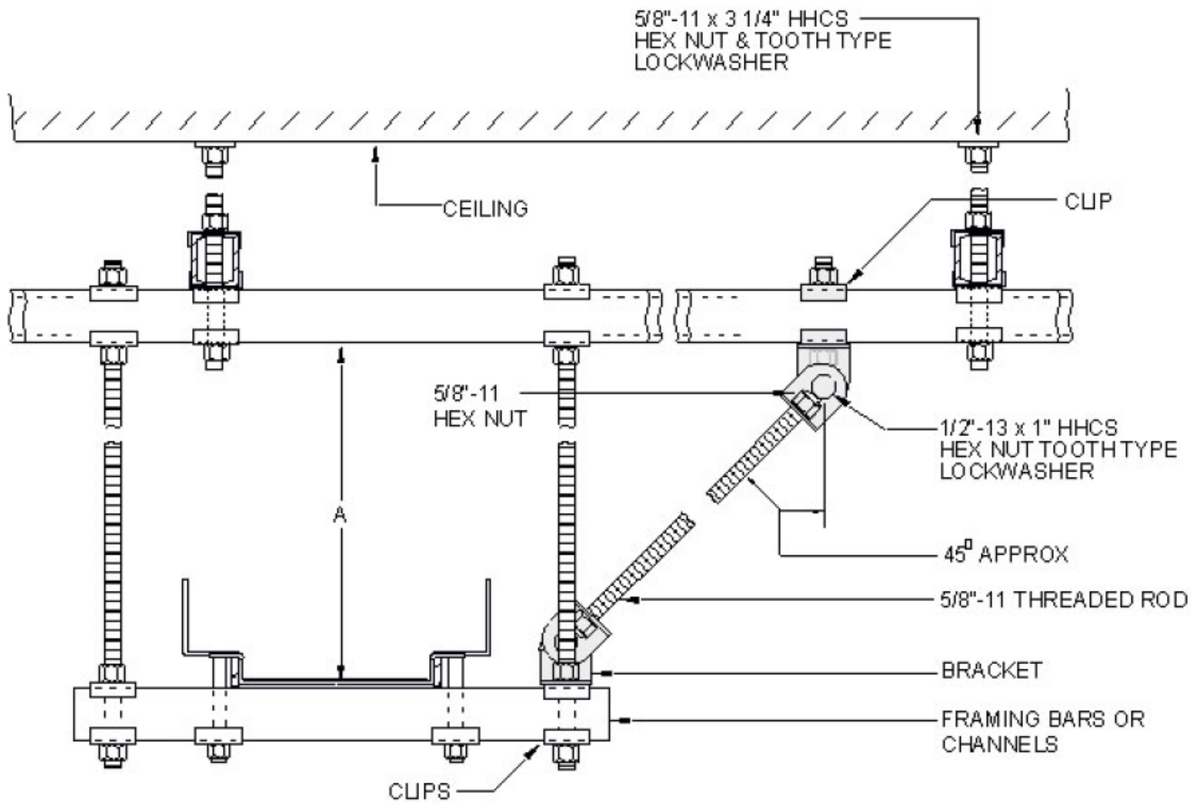


EXHIBIT 2-E5-9G

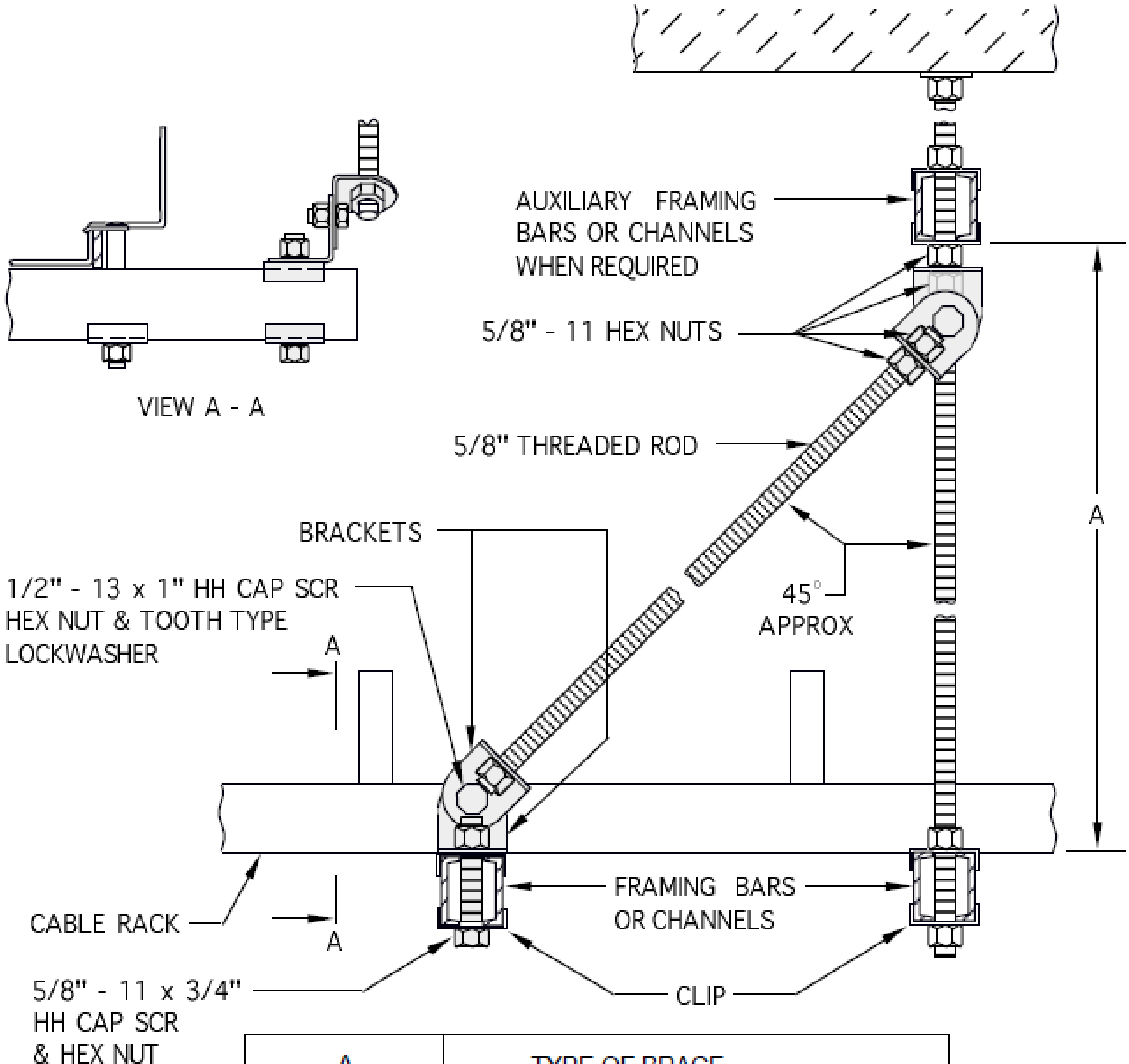
2-E5-9G SIDWISE BRACING OF LADDER-TYPE CABLE RACKS IN POWER AND OPERATING ROOMS



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

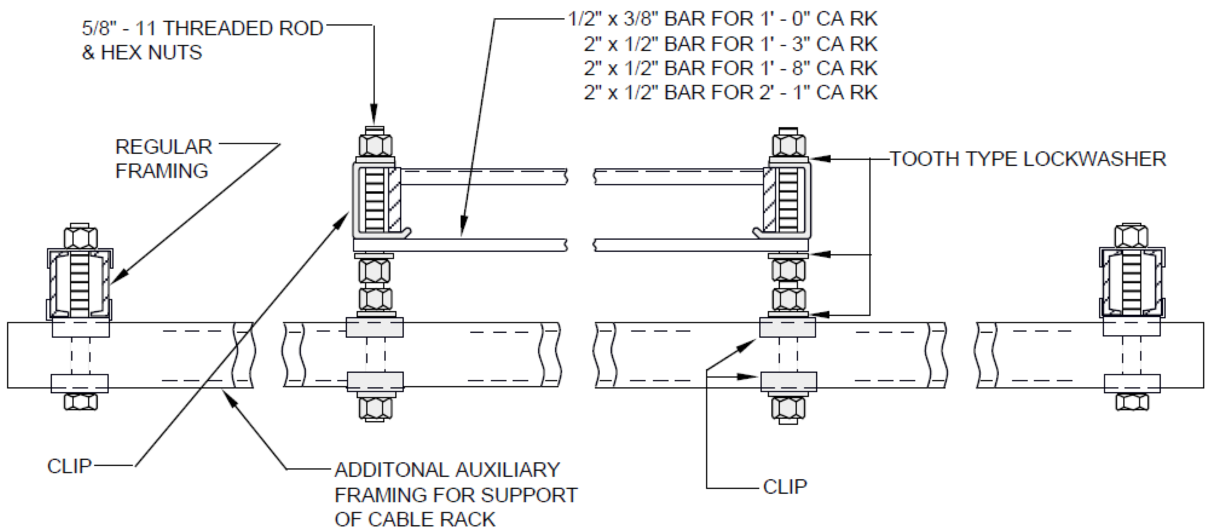
2-E5-9H SIDWISE BRACING OF BAR-TYPE OVER-AISLE CABLE RACKS



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 AT EACH END

EXHIBIT 2-E5-9J

2-E5-9J ENDWISE BRACING OF BAR-TYPE OVER-AISLE CABLE RACKS



NOTE: THE 3/8 OR 1/2 INCH BAR BELOW THE CABLE RACK IS NOT REQUIRED WHEN C-CLIP BRACKETS ARE USED.

EXHIBIT 2-E5-9L

2-E5-9L SUPPORTING LADDER-TYPE OR BAR-TYPE CROSS AISLE CABLE RACKS 2 INCHES ABOVE AUXILIARY FRAMING – LADDER-TYPE SHOWN

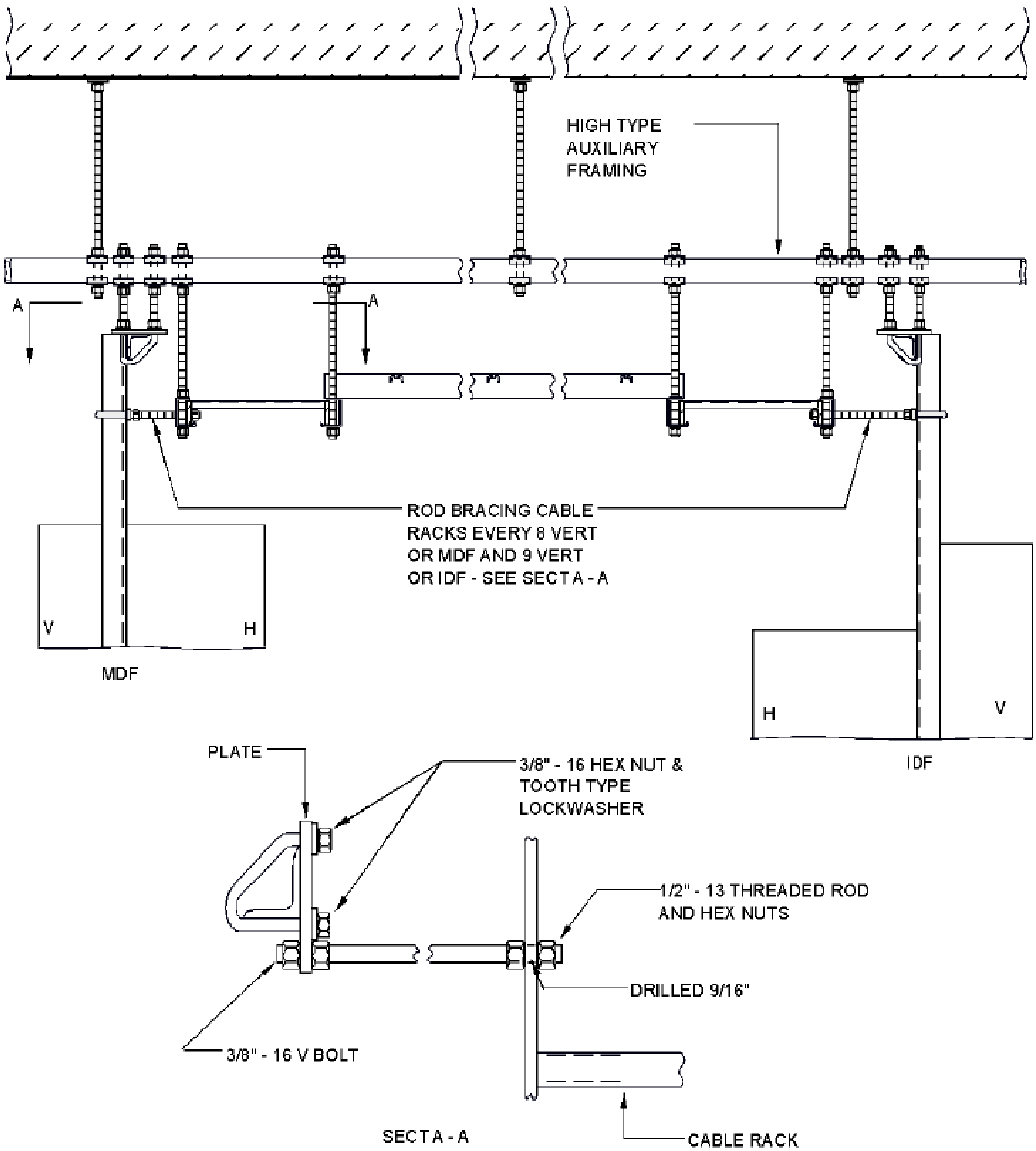


EXHIBIT 2-E5-9M

2-E5-9M BRACING CABLE RACKS TO DISTRIBUTING FRAME VERTICALS

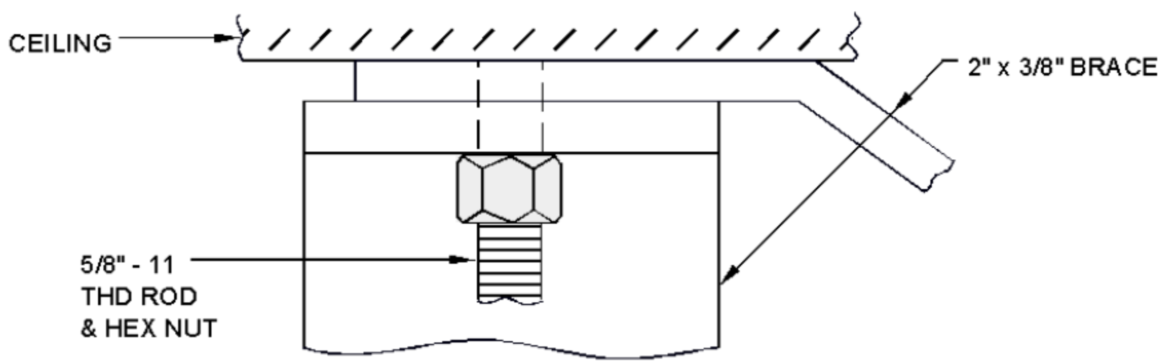


EXHIBIT 2-E5-9N

2-E5-9N PERPENDICULAR BRACING

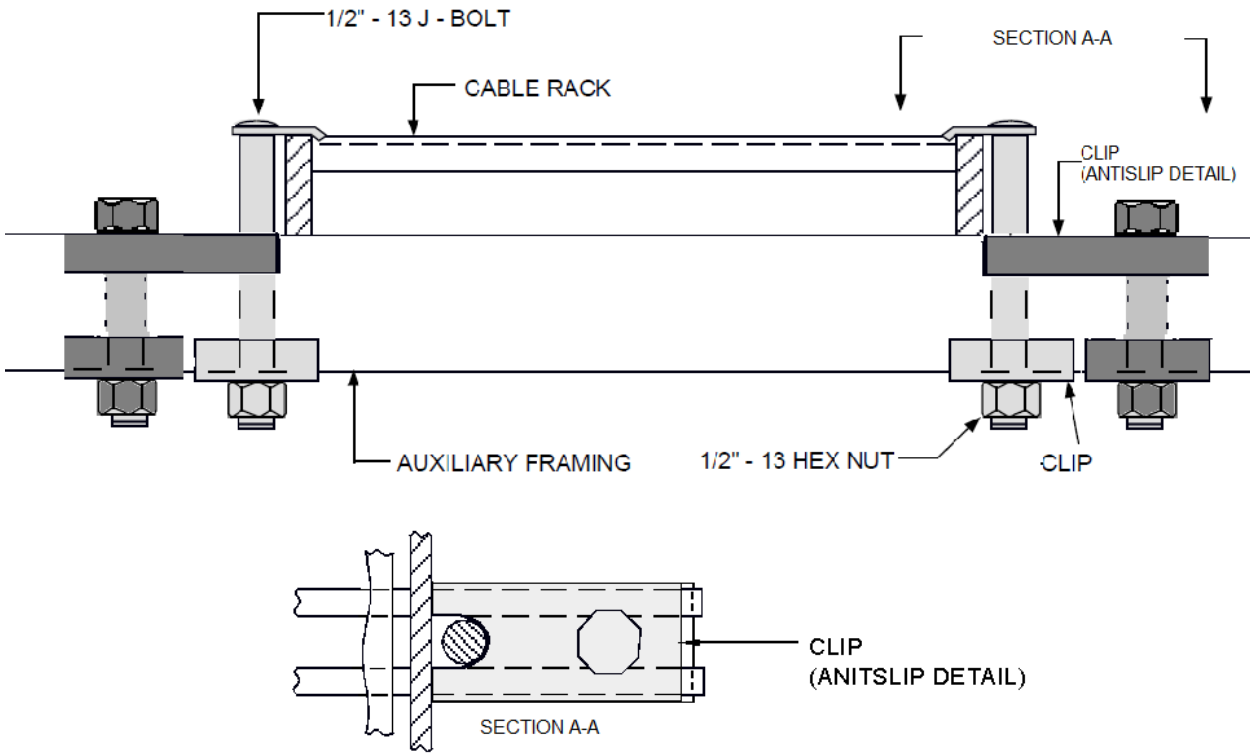


EXHIBIT 2-E5-10A

2-E5-10A FASTENING OF LADDER OR BAR-TYPE CABLE RACKS TO AUXILIARY FRAMING WHERE CABLE RACKS SUPPORT FRAMES – USE OF ANTISLIP DETAILS – LADDER-TYPE CABLE RACK SHOWN

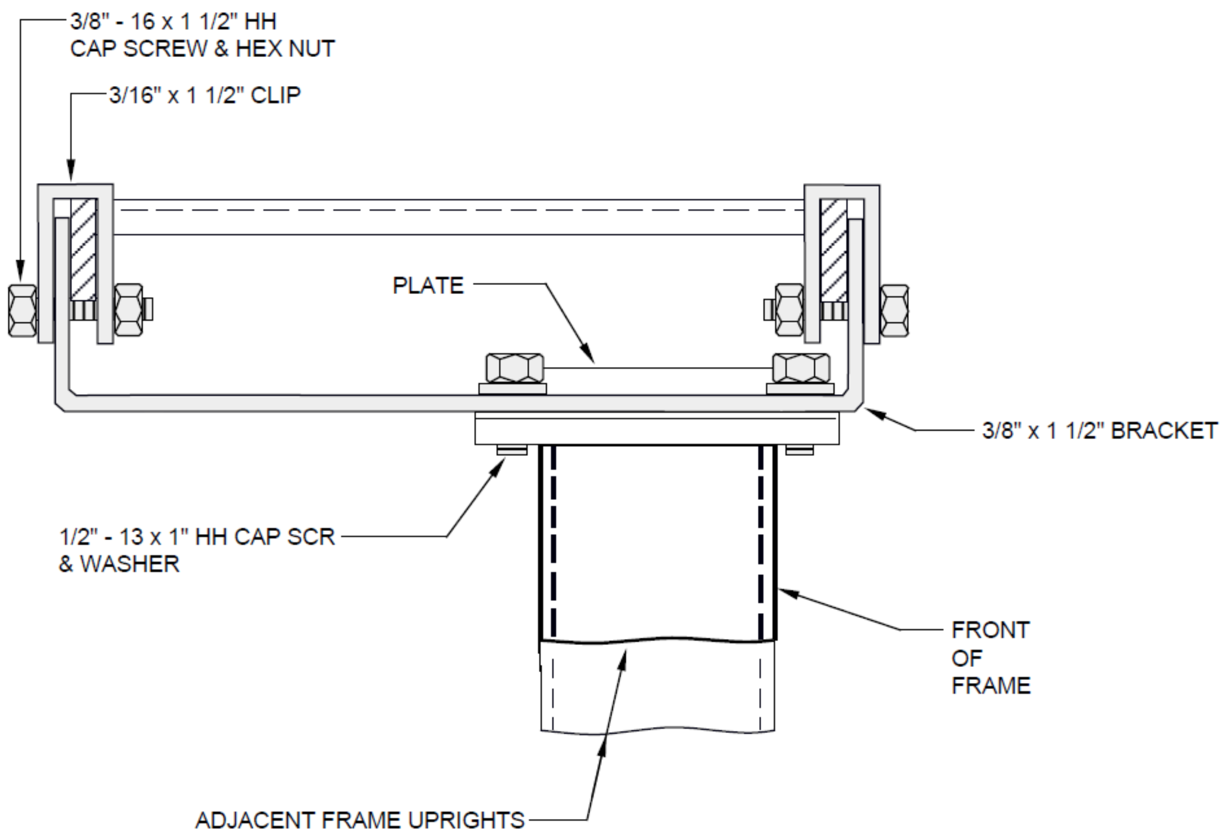


EXHIBIT 2-E5-11 (DISCONTINUED)

2-E5-11 (DISCONTINUED) FASTENING OR LADDER-TYPE CABLE RACKS TO FRAMES IN STEP-BY-STEP OFFICES WITH 11 FOOT 6 INCH AUXILIARY FRAMING

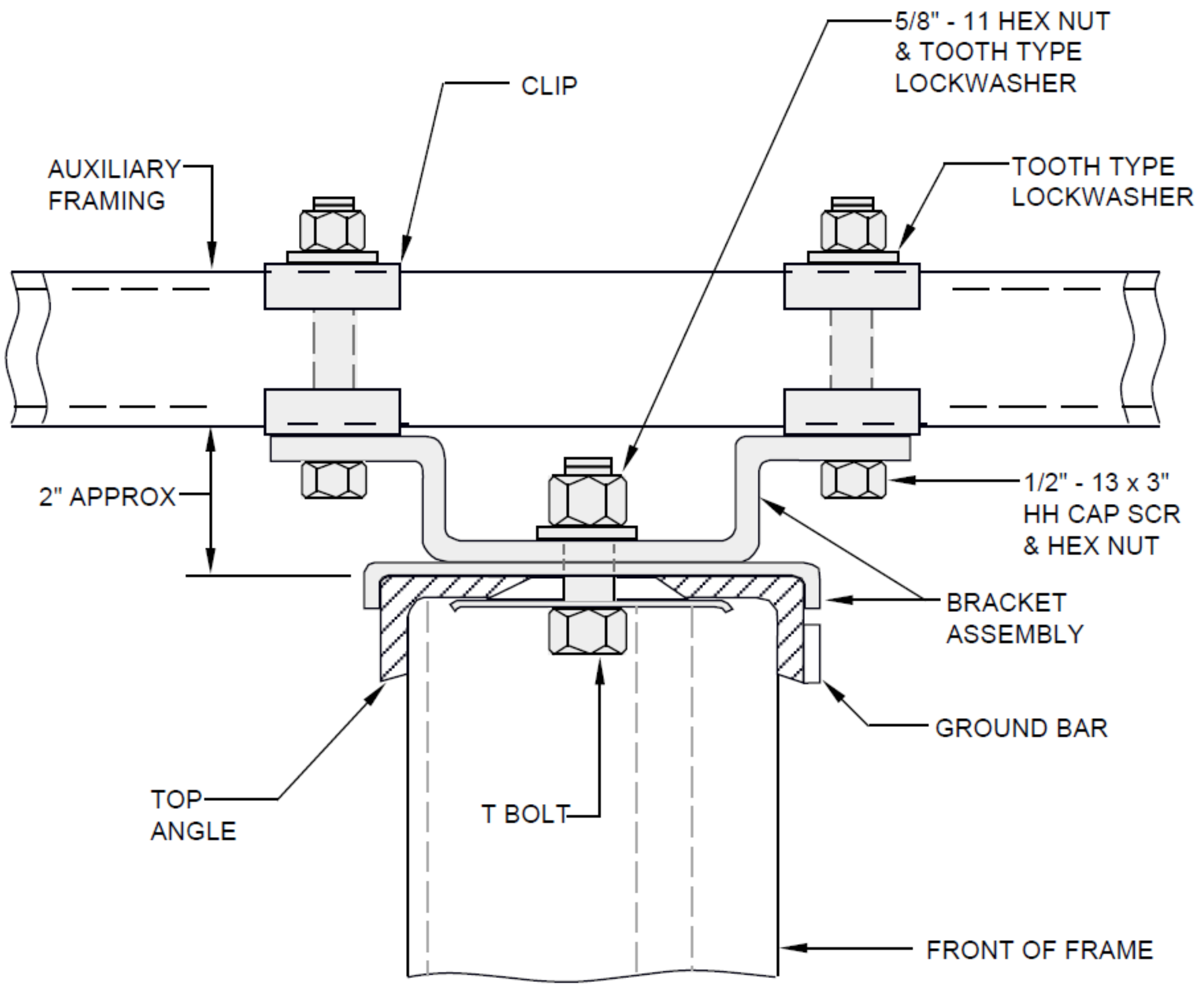


EXHIBIT 2-E5-12A (A&M)

2-E5-12A (A&M) AUXILIARY FRAMING FASTENED TO THE TOPS OF BULB-ANGLE FRAME

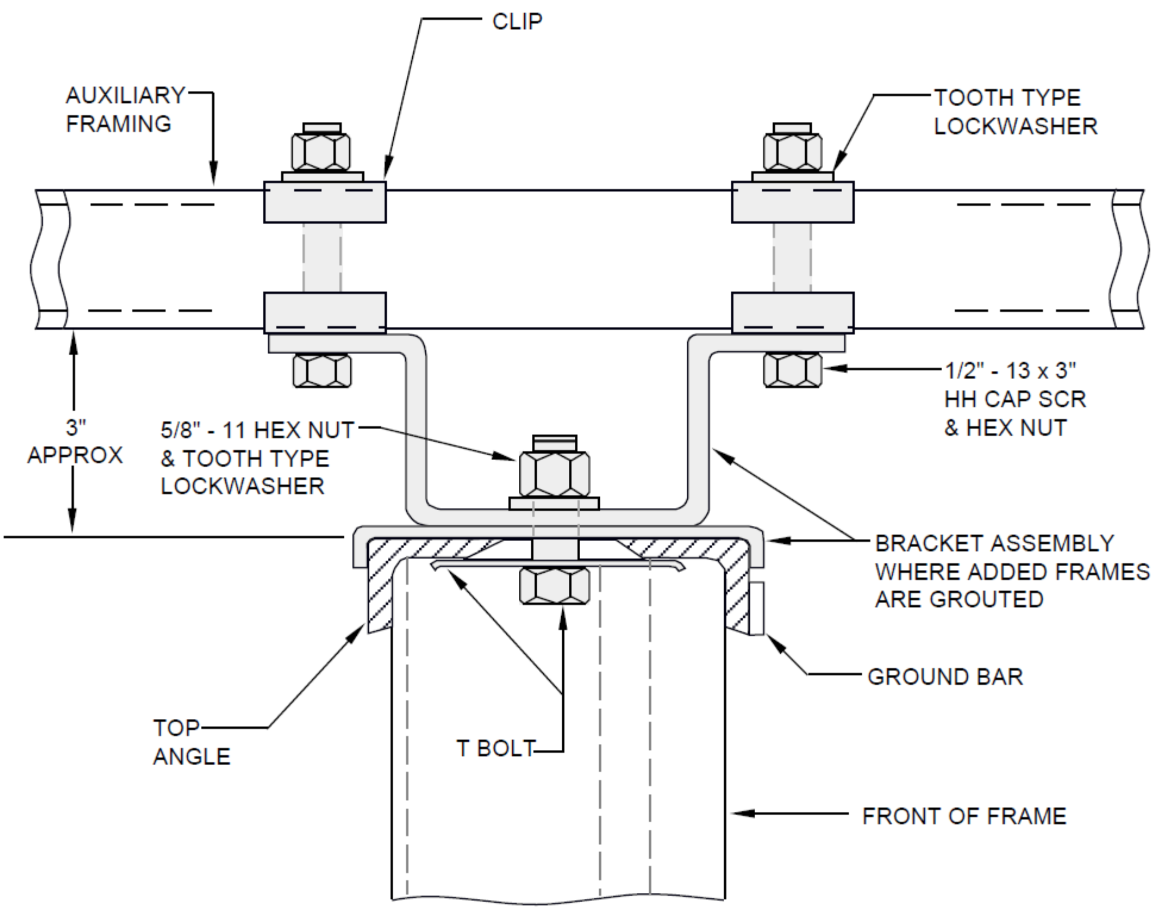


EXHIBIT 2-E5-12B (A&M)

2-E5-12B (A&M) ADDITIONS WHERE AUXILIARY FRAMING IS FASTENED 3 INCHES ABOVE TOP-ANGLES OF EXISTING BULB-ANGLE FRAMES

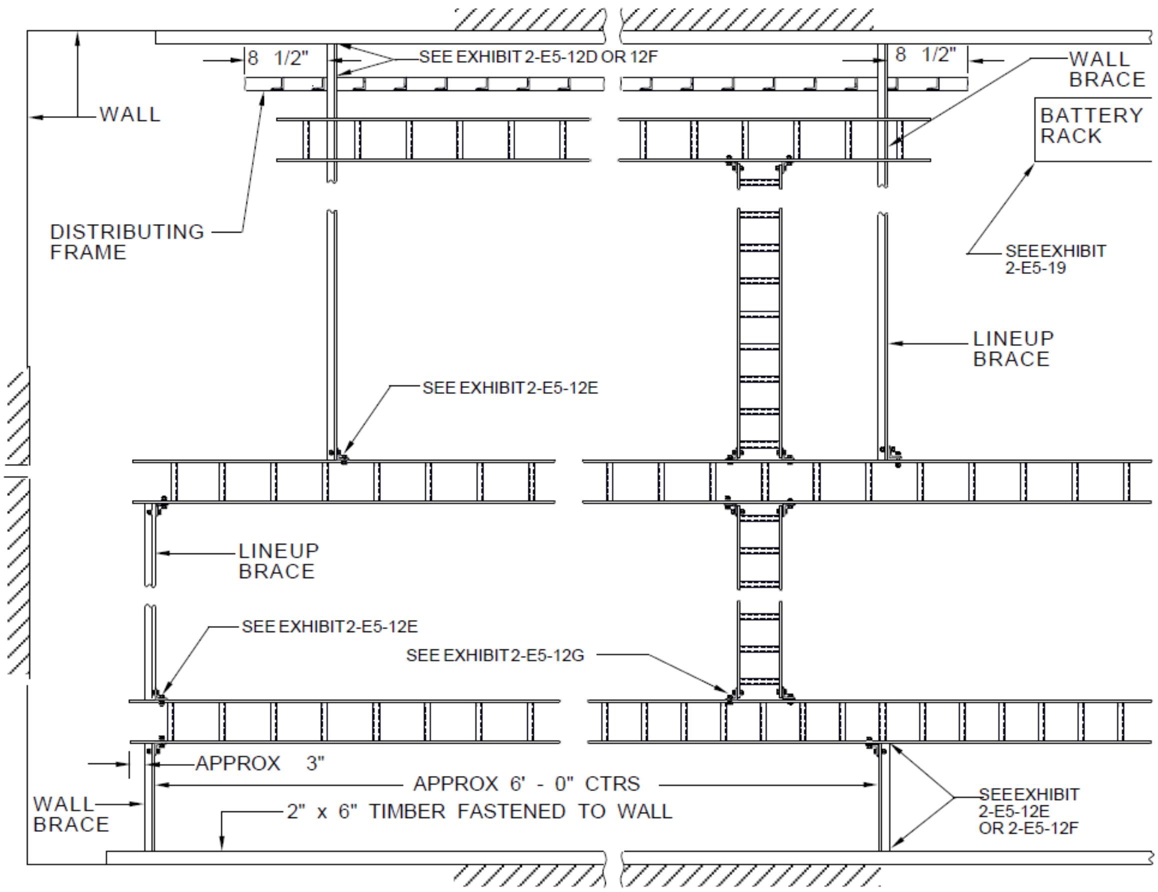


EXHIBIT 2-E5-12C (A&M)

2-E5-12C (A&M) TYPICAL ARRANGEMENT OF LADDER-TYPE CABLE RACKS AND BRACES FOR A COMMUNITY DIAL OFFICE

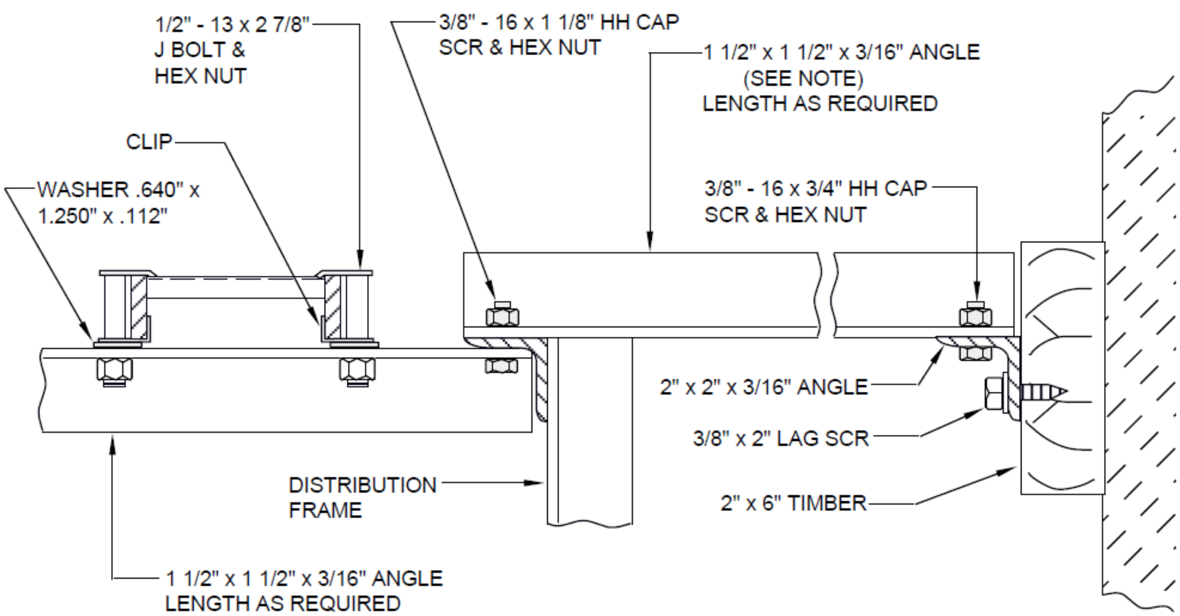


EXHIBIT 2-E5-12D (A&M)

2-E5-12D (A&M) WALL BRACES FOR COMMUNITY DIAL OFFICE DISTRIBUTING FRAME

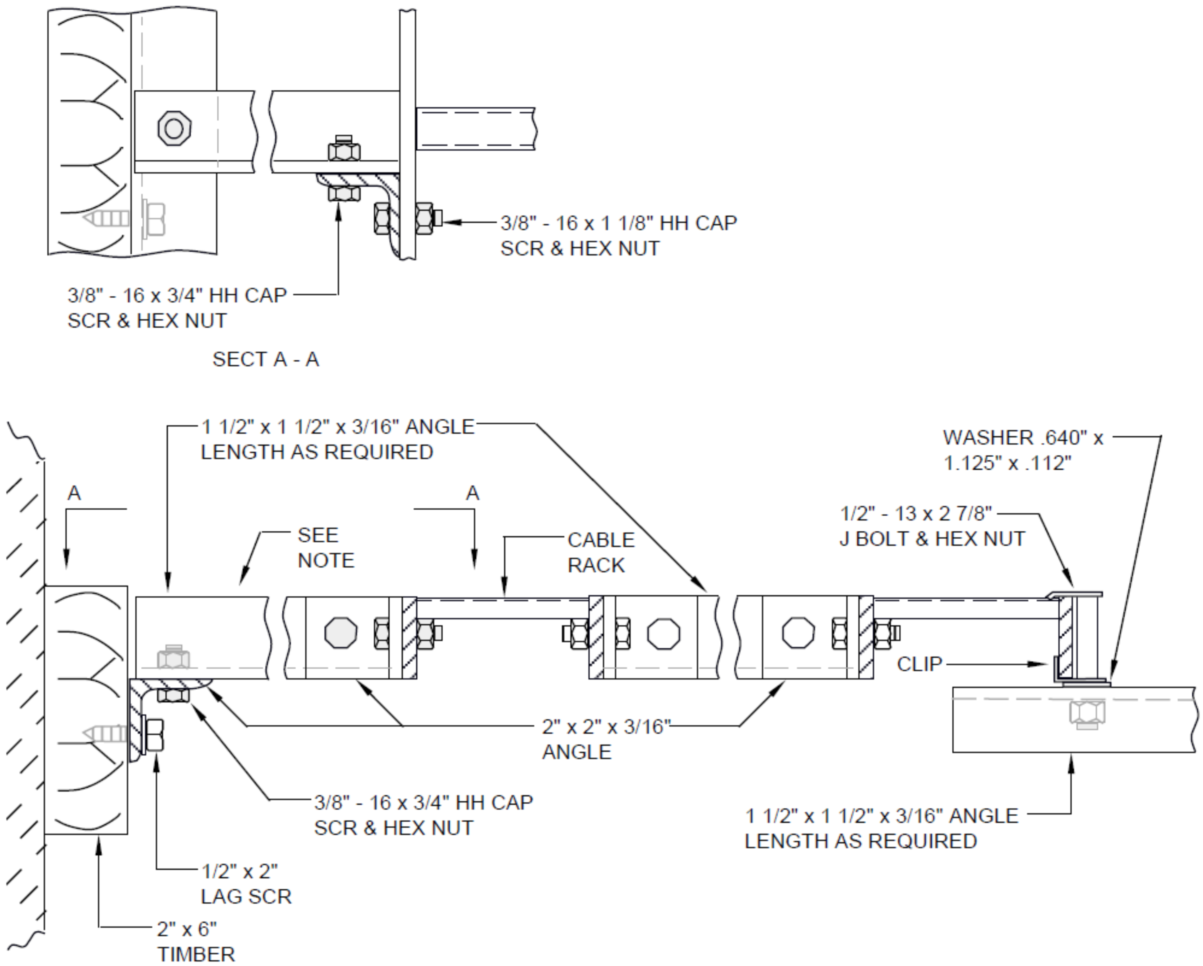


EXHIBIT 2-E5-12E (A&M)

2-E5-12E (A&M) WALL BRACES FOR COMMUNITY DIAL OFFICE FRAME CABLE RACKS

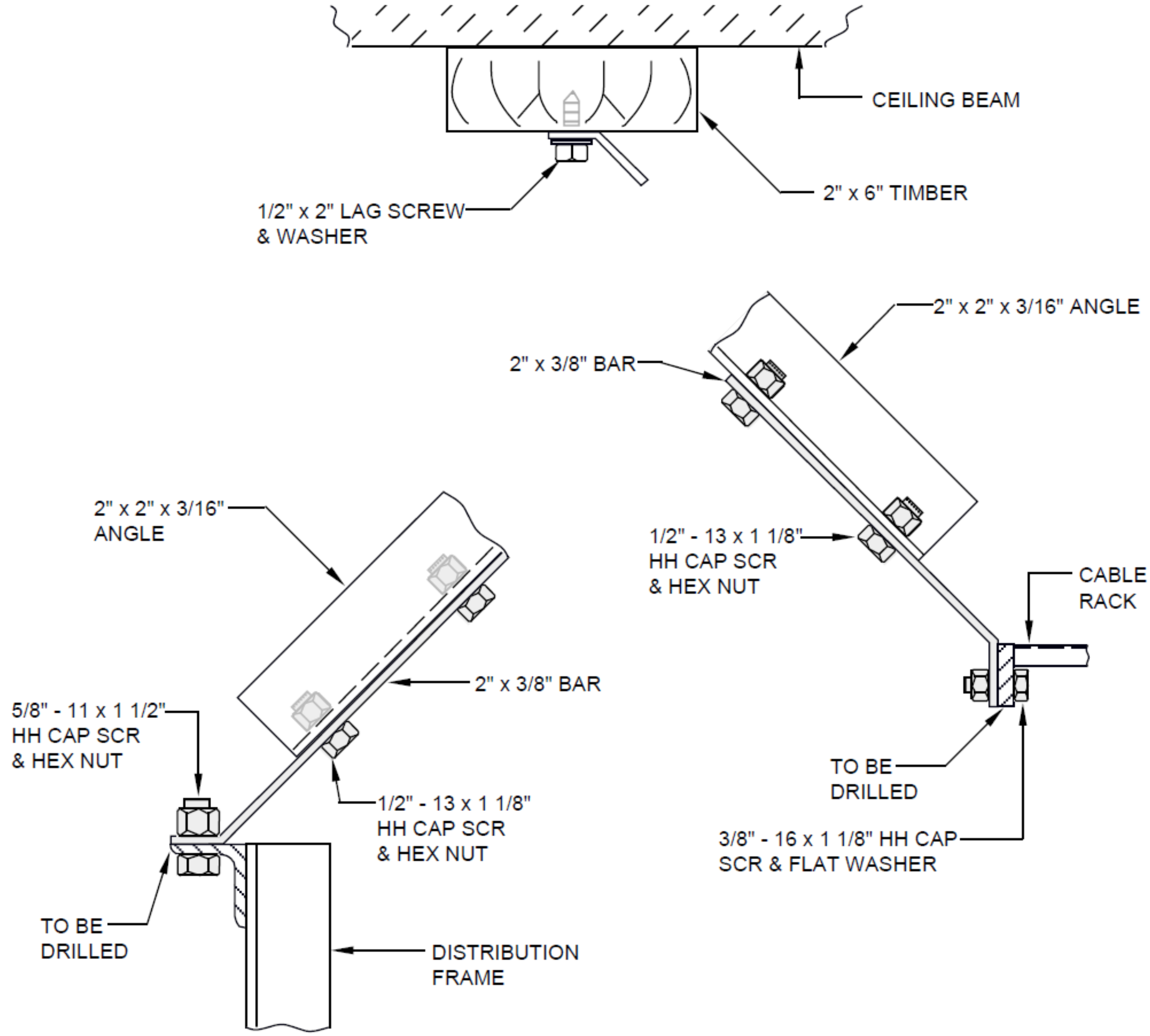


EXHIBIT 2-E5-12F
2-E2-12F CEILING BRACES FOR COMMUNITY DIAL OFFICE DISTRIBUTING FRAME AND CABLE RACKS

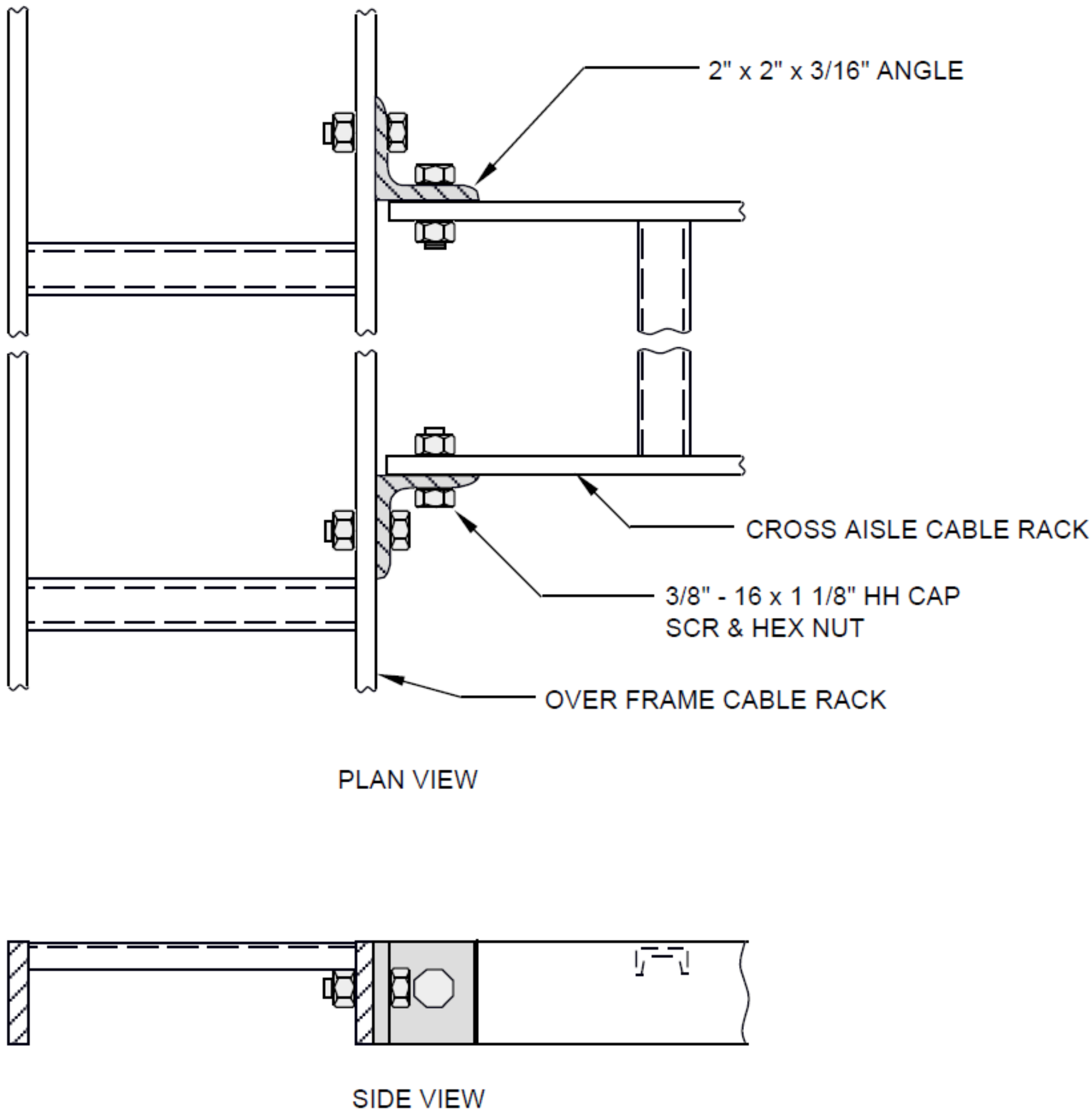
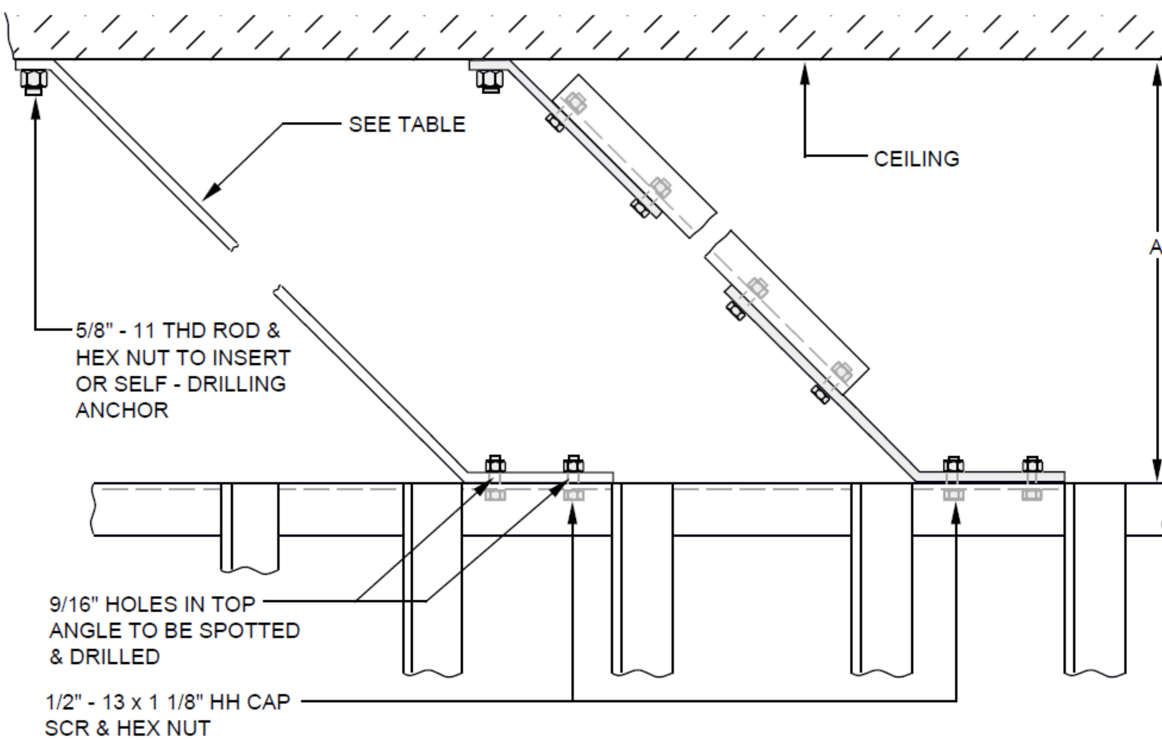


EXHIBIT 2-E5-12G

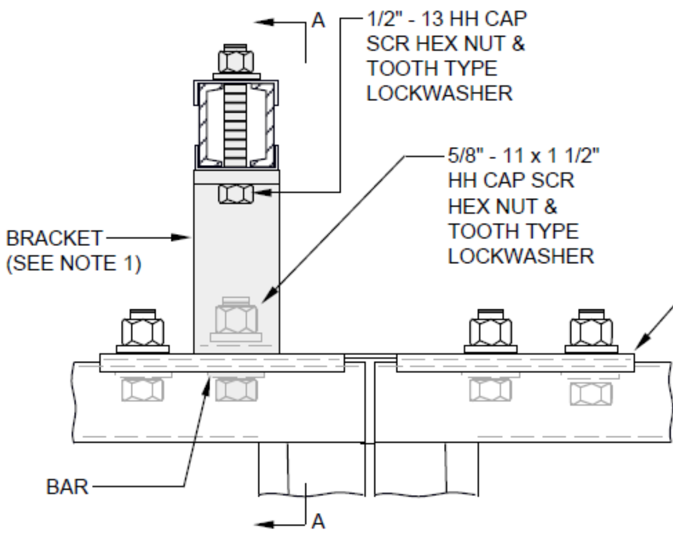
2-E5-12G FASTENING LADDER-TYPE CROSS-AISLE CABLE RACK TO OVER-FRAME CABLE RACK COMMUNITY DIAL OFFICES



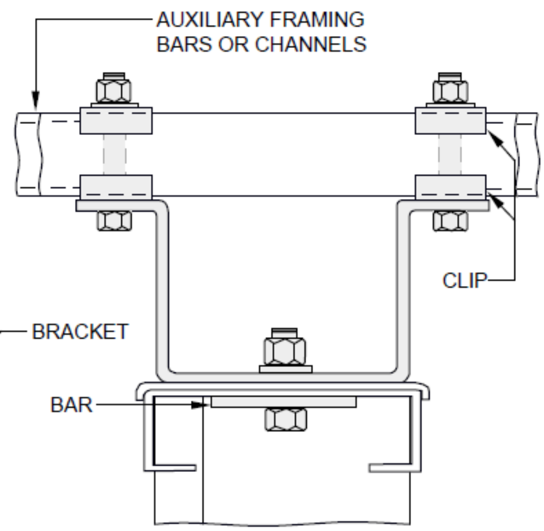
A	TYPE OF BRACE
5" TO 10"	2" x 3/16" BAR
10" TO 1' - 6"	2" x 3/8" BAR
OVER 1' - 6"	2" x 2" x 3/16" ANGLE AS REQUIRED WITH 2" x 3/8" BAR AT TOP AND BOTTOM RESPECTIVELY

EXHIBIT 2-E5-12J

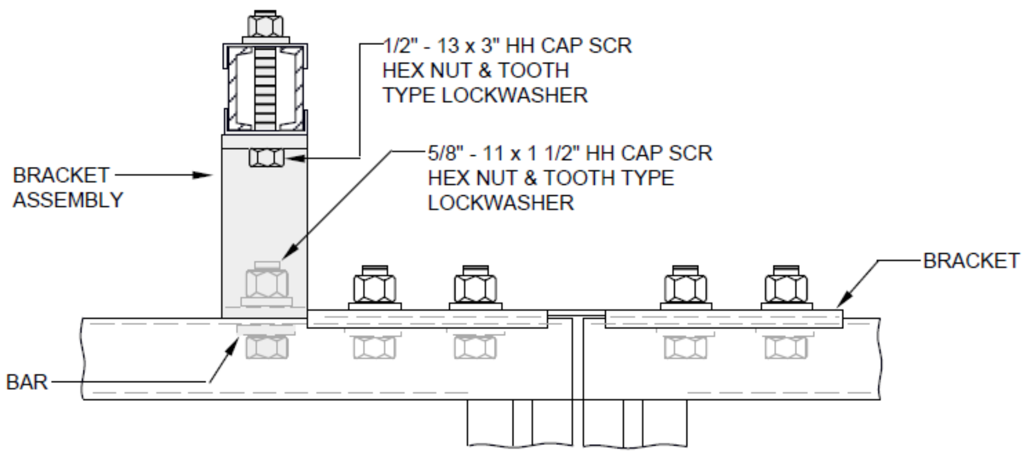
2-E5-12J ENDWISE BRACING OF DISTRIBUTING FRAMES AND PROTECTOR FRAMES



FRONT VIEW
AUXILIARY FRAMING ATTACHED
TO JUNCTION PLATE
VIEW A



SECT A - A



FRONT VIEW
AUXILIARY FRAMING ATTACHED
TO FRAME TOP CHANNEL
VIEW B

EXHIBIT 2-E5-12K (A&M)

2-E5-12K (A&M) FASTENING OF TOPS OF CROSSBAR FRAMES

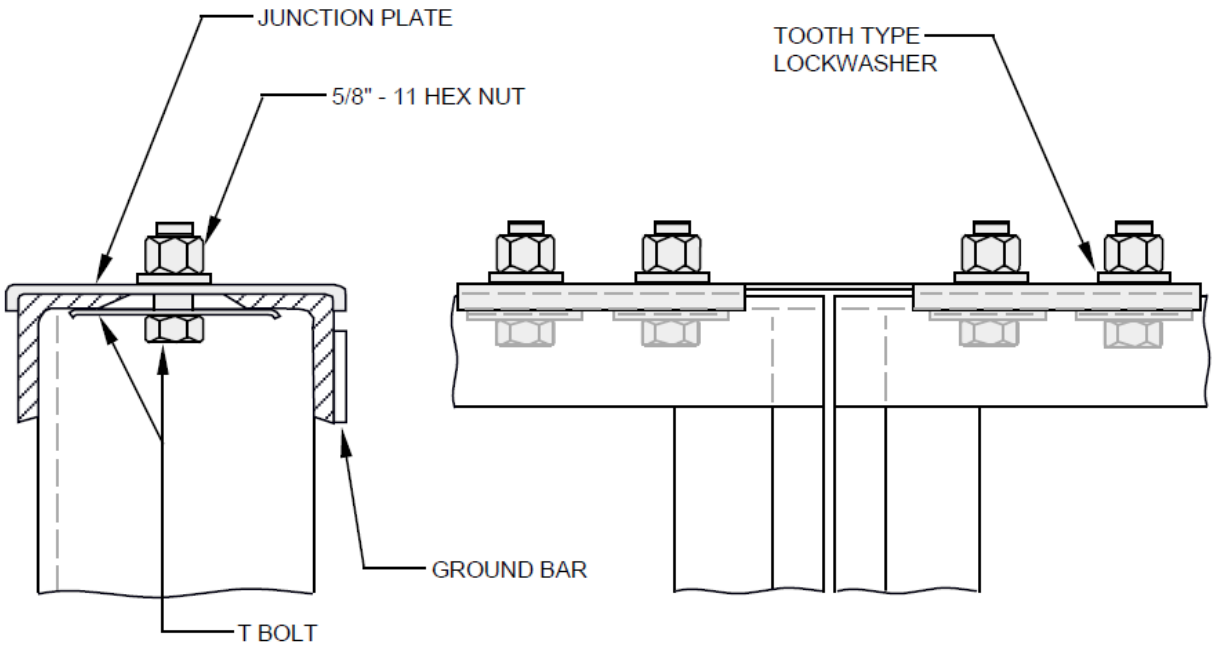


EXHIBIT 2-E5-12L (A&M)

2-E5-12L (A&M) JUNCTIONING TOP-ANGLES OF ADJACENT BULB-ANGLE FRAMES

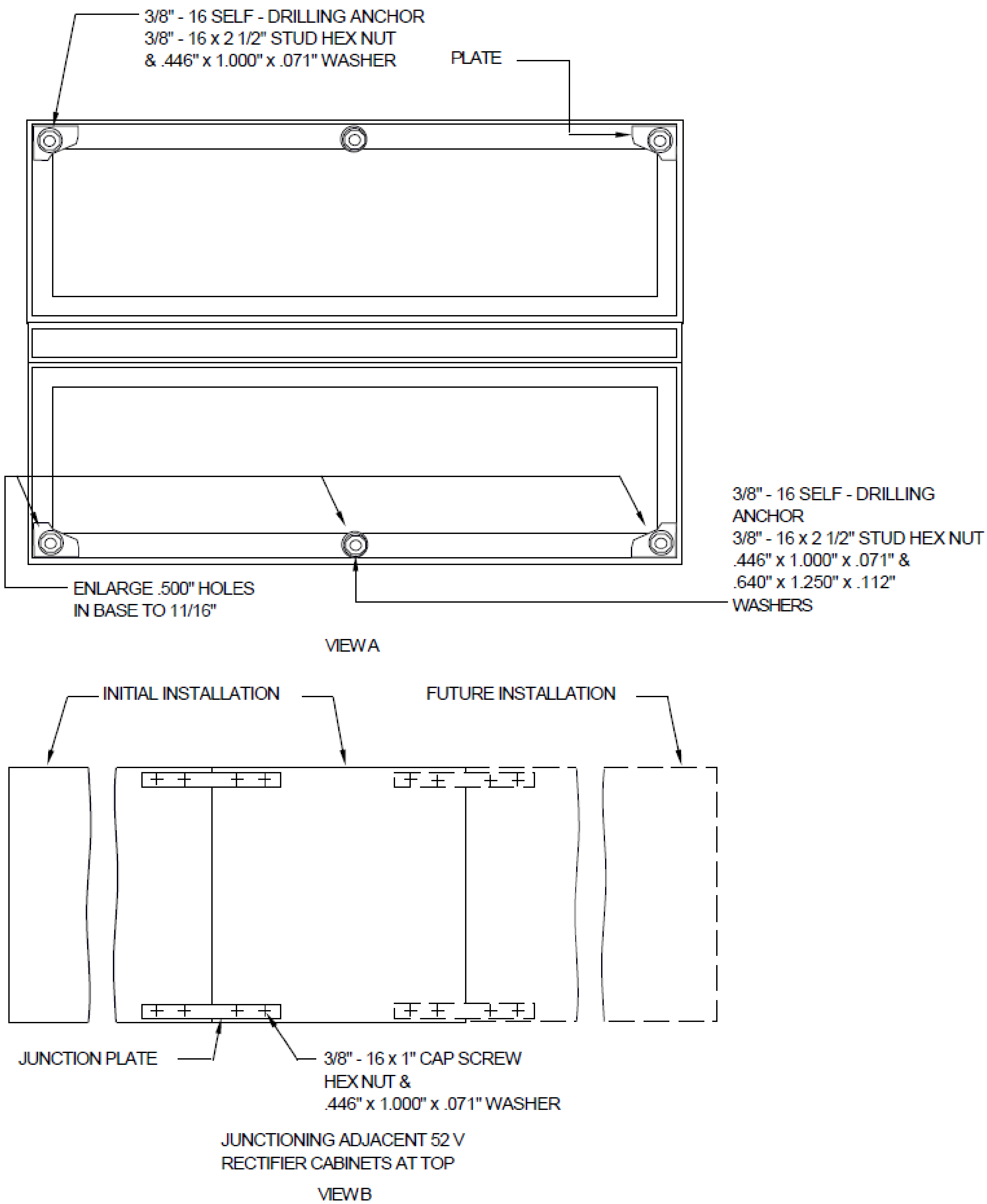


EXHIBIT 2-E5-12P

2-E5-12P FLOOR-SUPPORTED RECTIFIER CABINETS – FLOOR AND TOP FASTENINGS

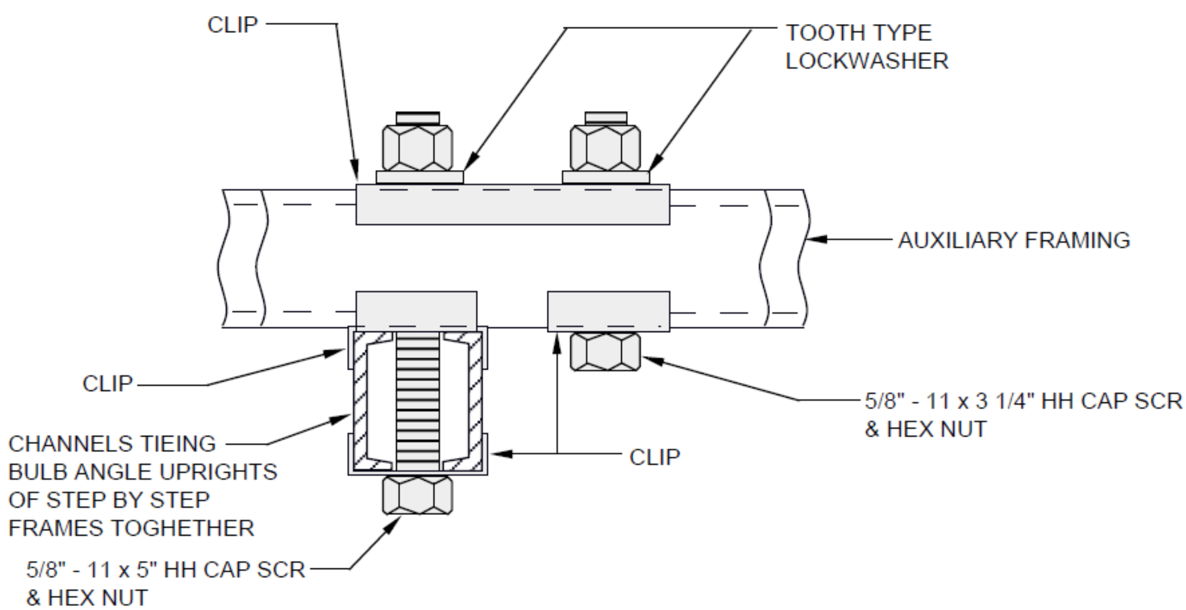


EXHIBIT 2-E5-12Q (A&M)

2-E5-12Q (A&M) JUNCTIONING OF TOP MEMBER CHANNELS OF STEP-BY-STEP FRAMES WITH AUXILIARY FRAMING

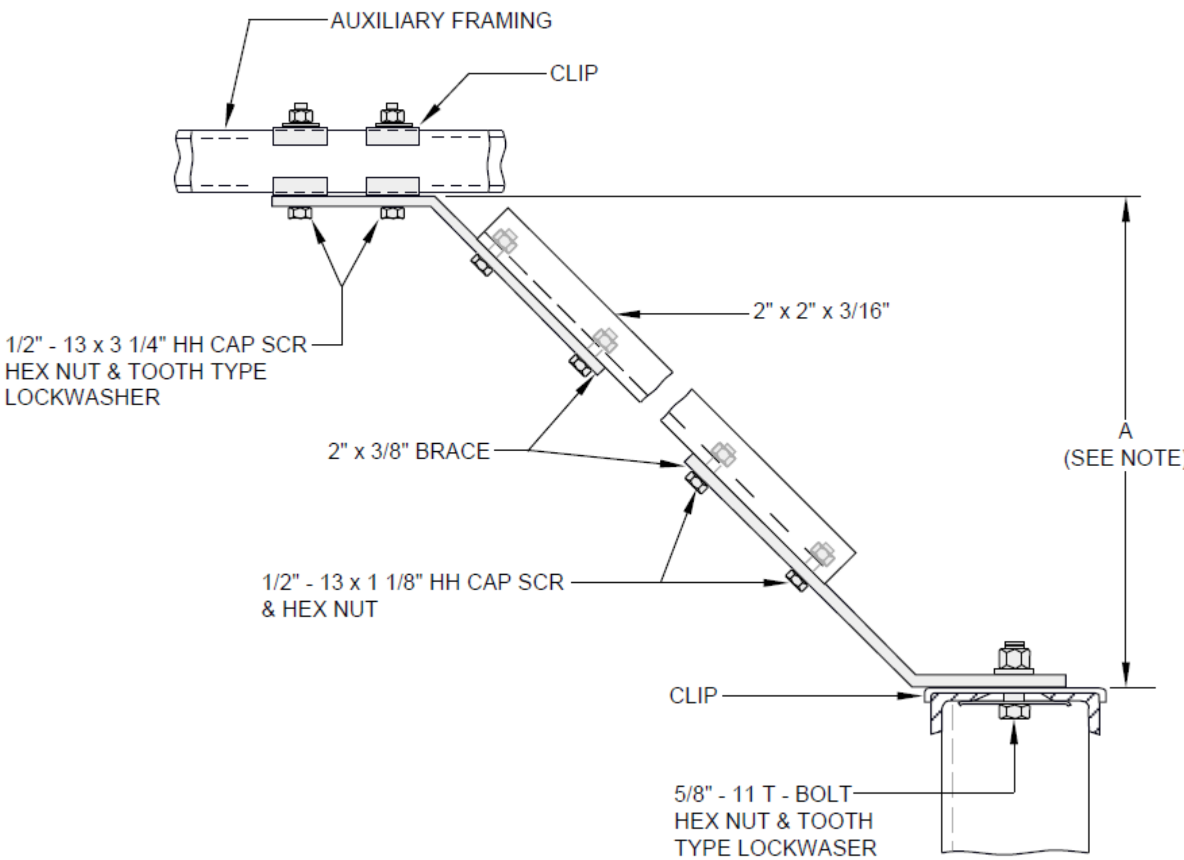


EXHIBIT 2-E5-12R (A&M)
2-E5-12R (A&M) FASTENING BULB-ANGLE-TYPE FRAMES TO HIGH-TYPE AUXILIARY FRAMING WHERE "A" IS OVER 1 FOOT 6 INCHES

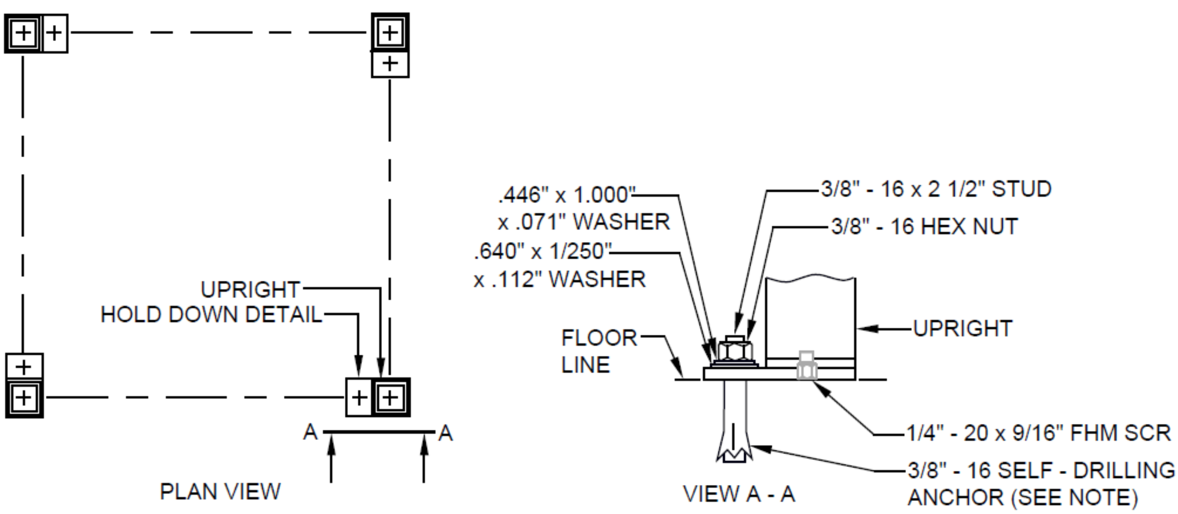


EXHIBIT 2-E5-13

2-E5-13 FLOOR FASTENINGS FOR MACHING TABLES WITH WELDED BEARING PLATES

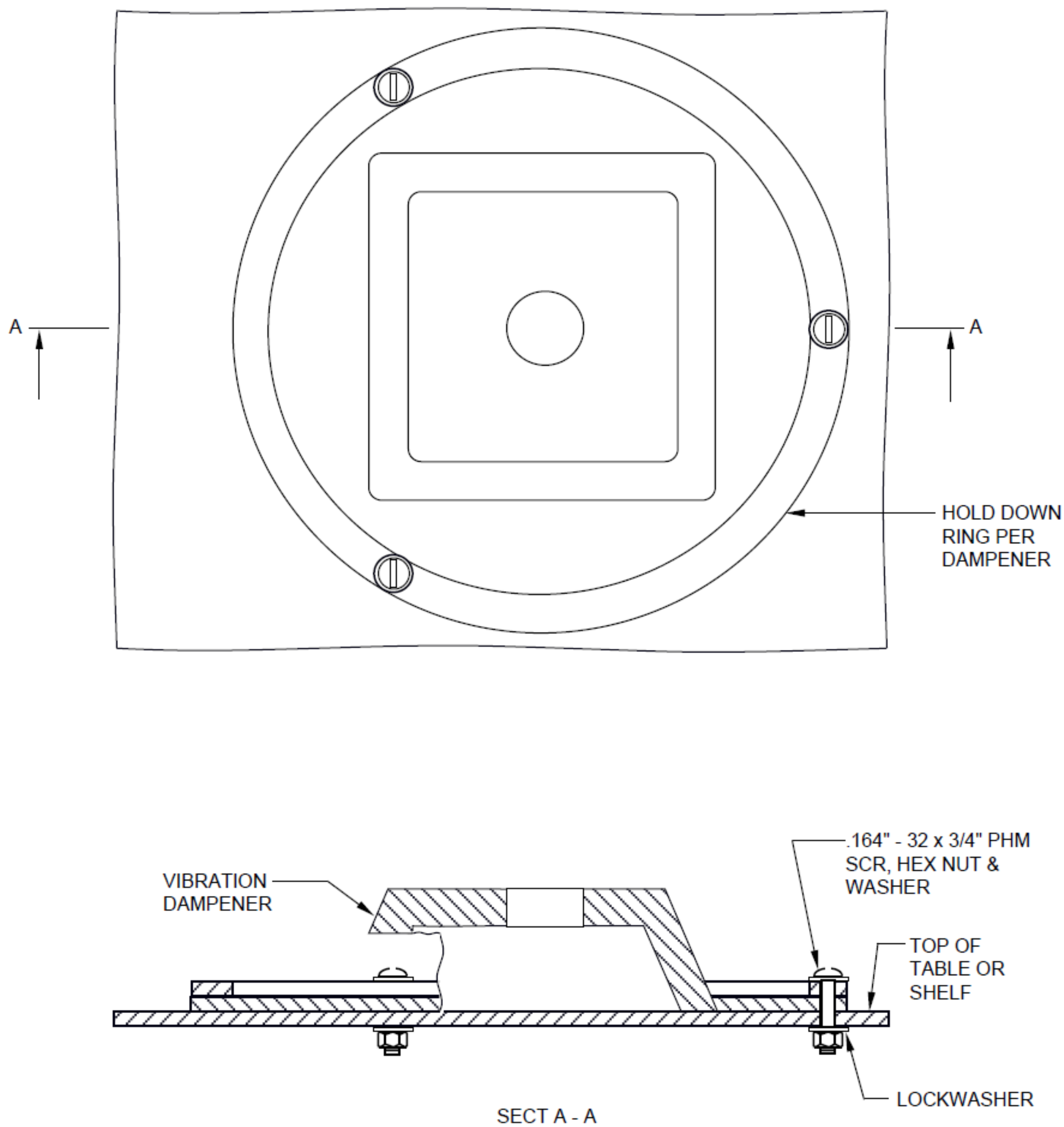


EXHIBIT 2-E5-14

2-E5-14 FASTENING MACHINES MOUNTED ON VIBRATION DAMPENERS

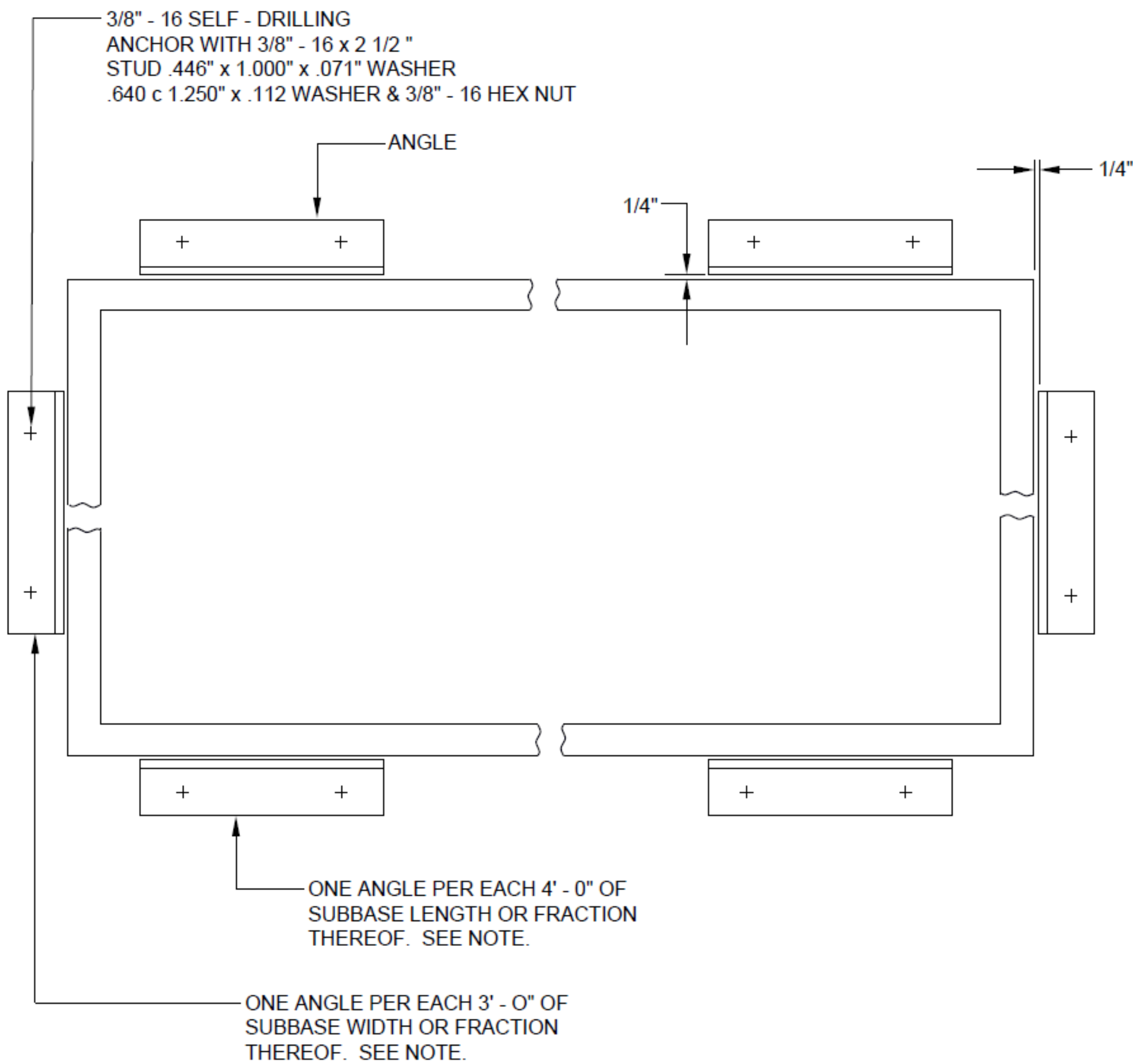


EXHIBIT 2-E5-15C

2-E5-15C FASTENING ENGINE-GENERATOR SETS, MOTOR-GENERATOR SETS OR SEPARATE RADIATOR UNITS TO FLOOR

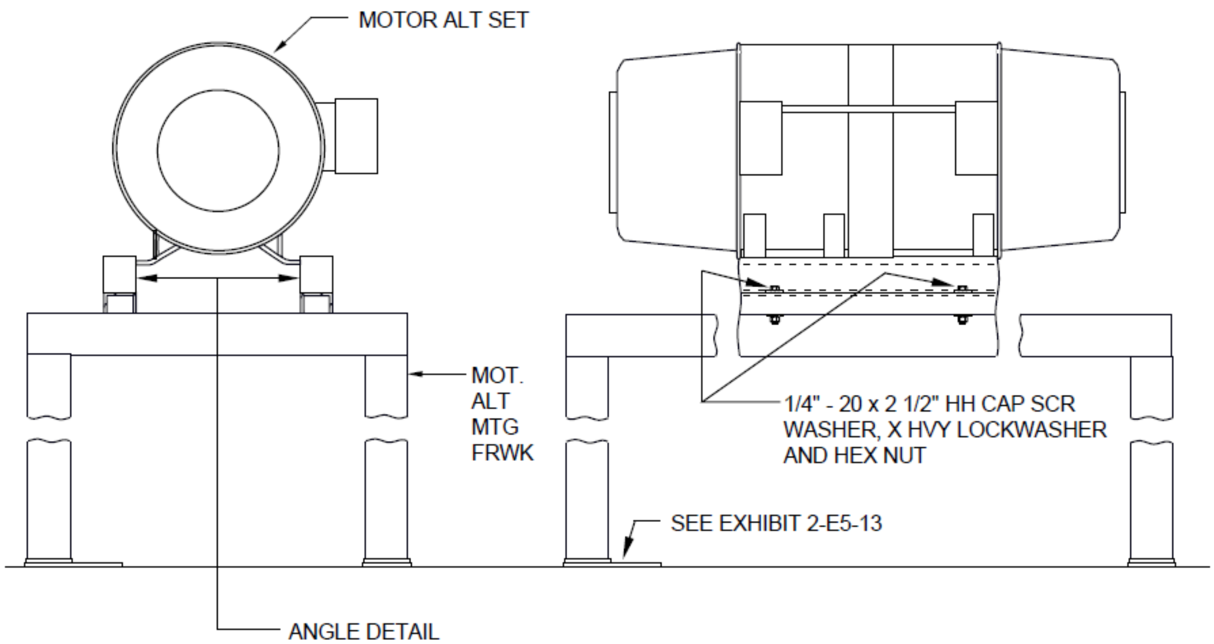


EXHIBIT 2-E5-15D

2-E5-15D ALTERNATORS FASTENED TO TABLES

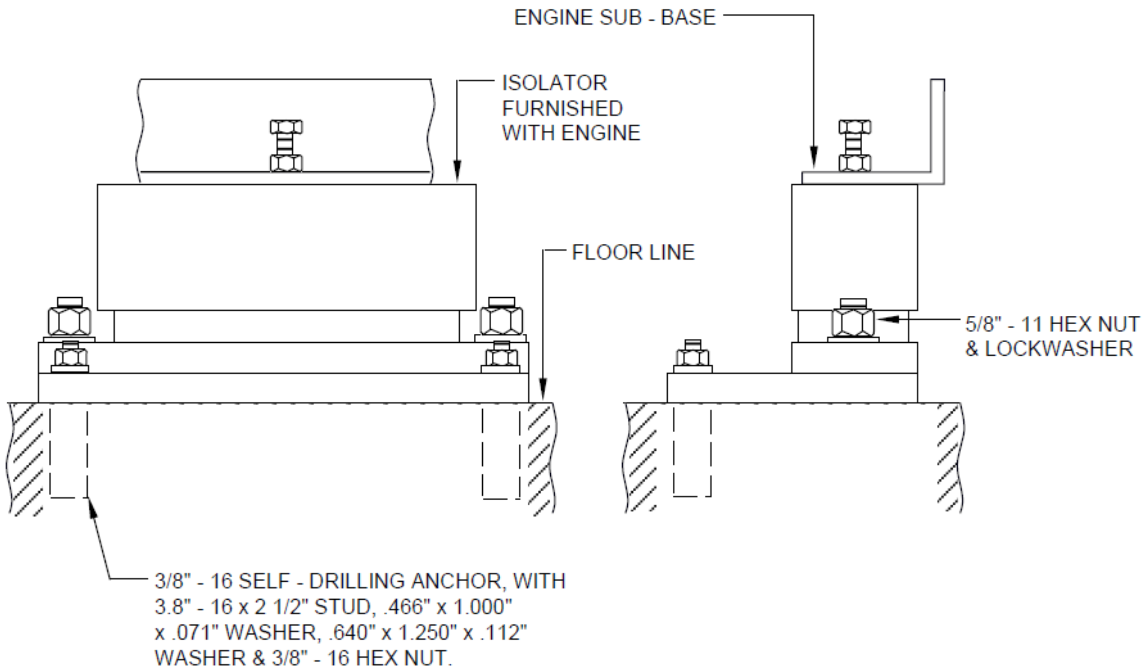


EXHIBIT 2-E5-15E

2-E5-15E FLOOR FASTENINGS FOR ENGINE-ALTERNATORS MOUNTED ON SPRING ISOLATORS

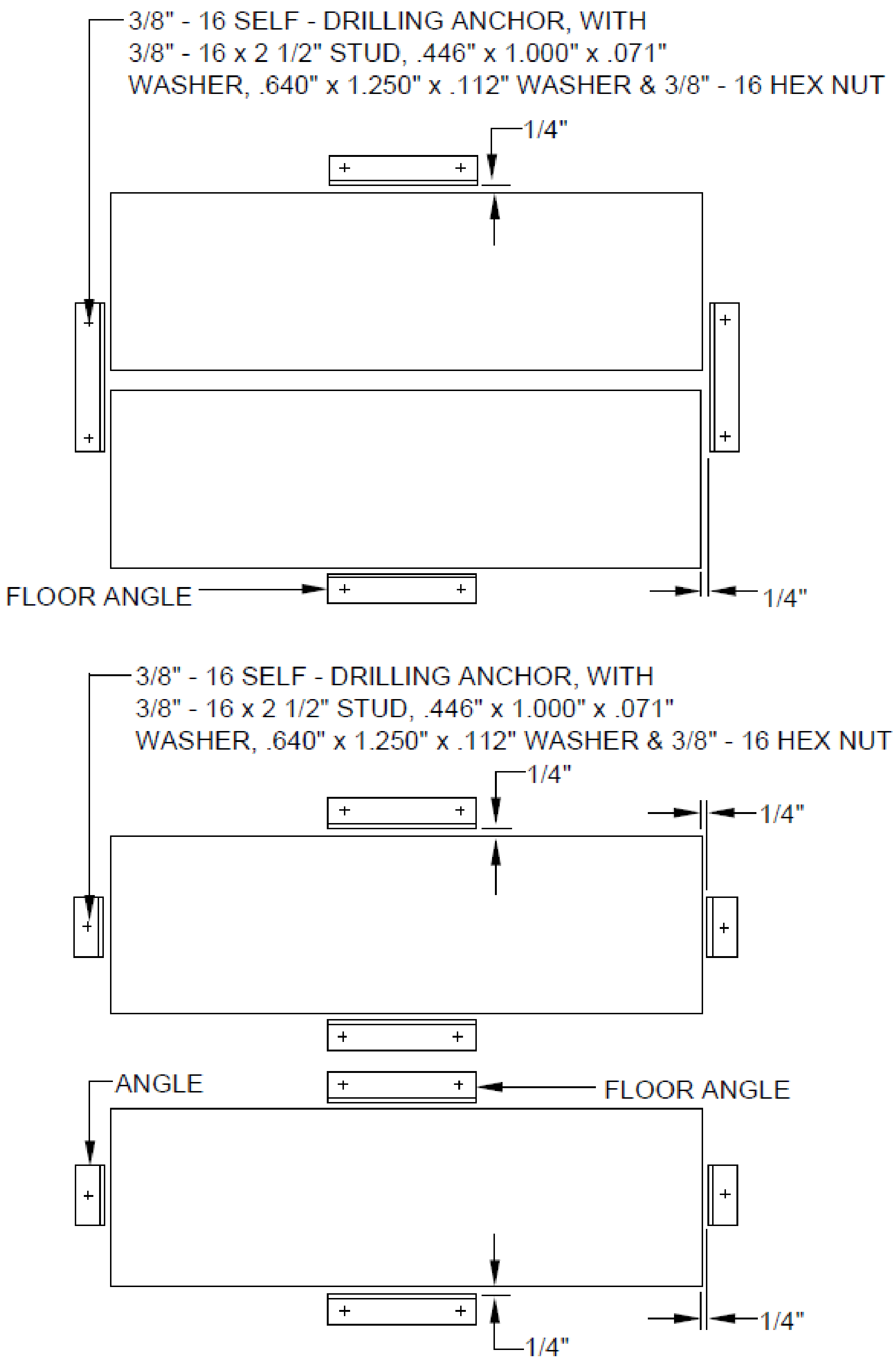


EXHIBIT 2-E5-16B
2-E5-16B SECURING BATTERIES MOUNTED ON FLOOR

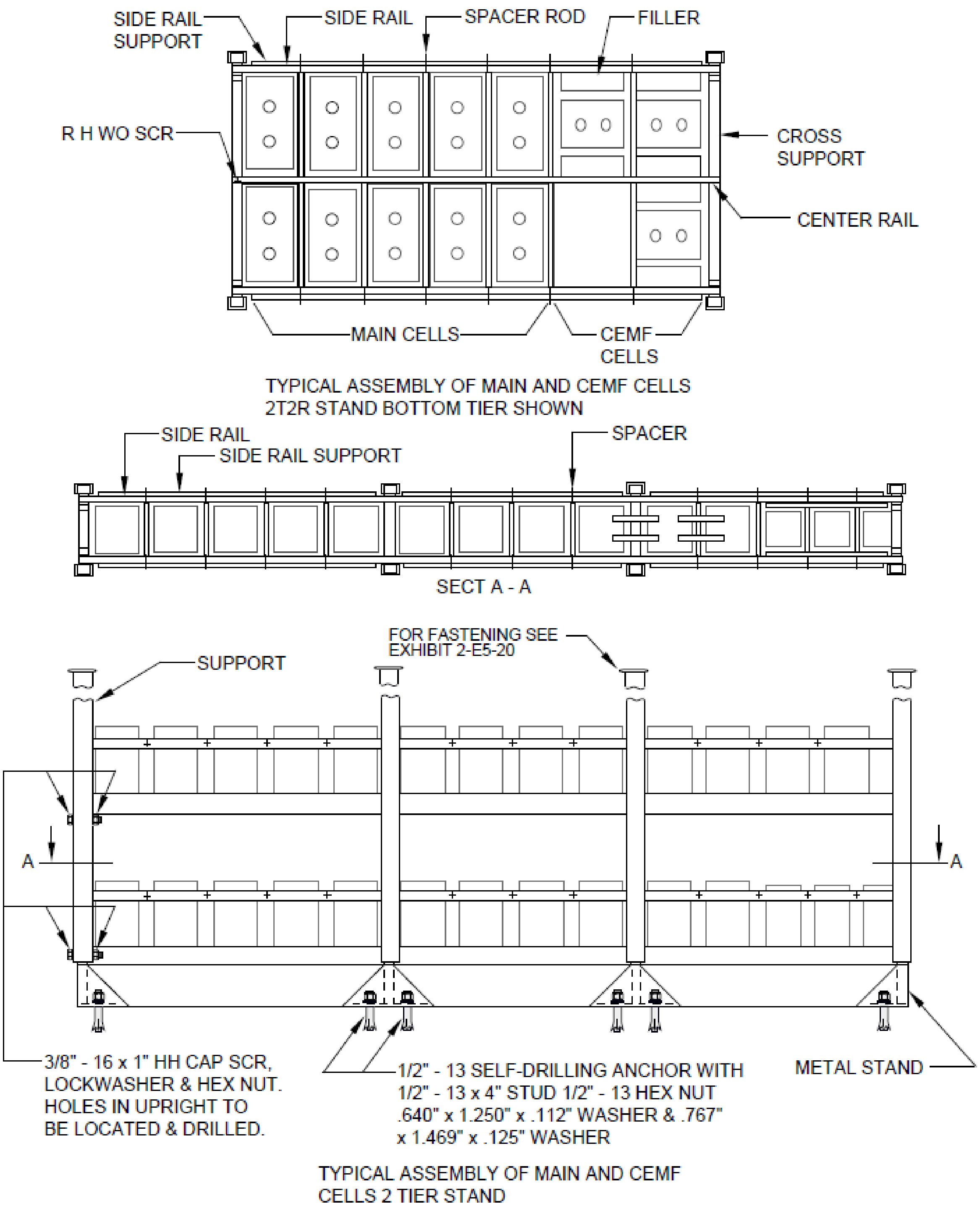
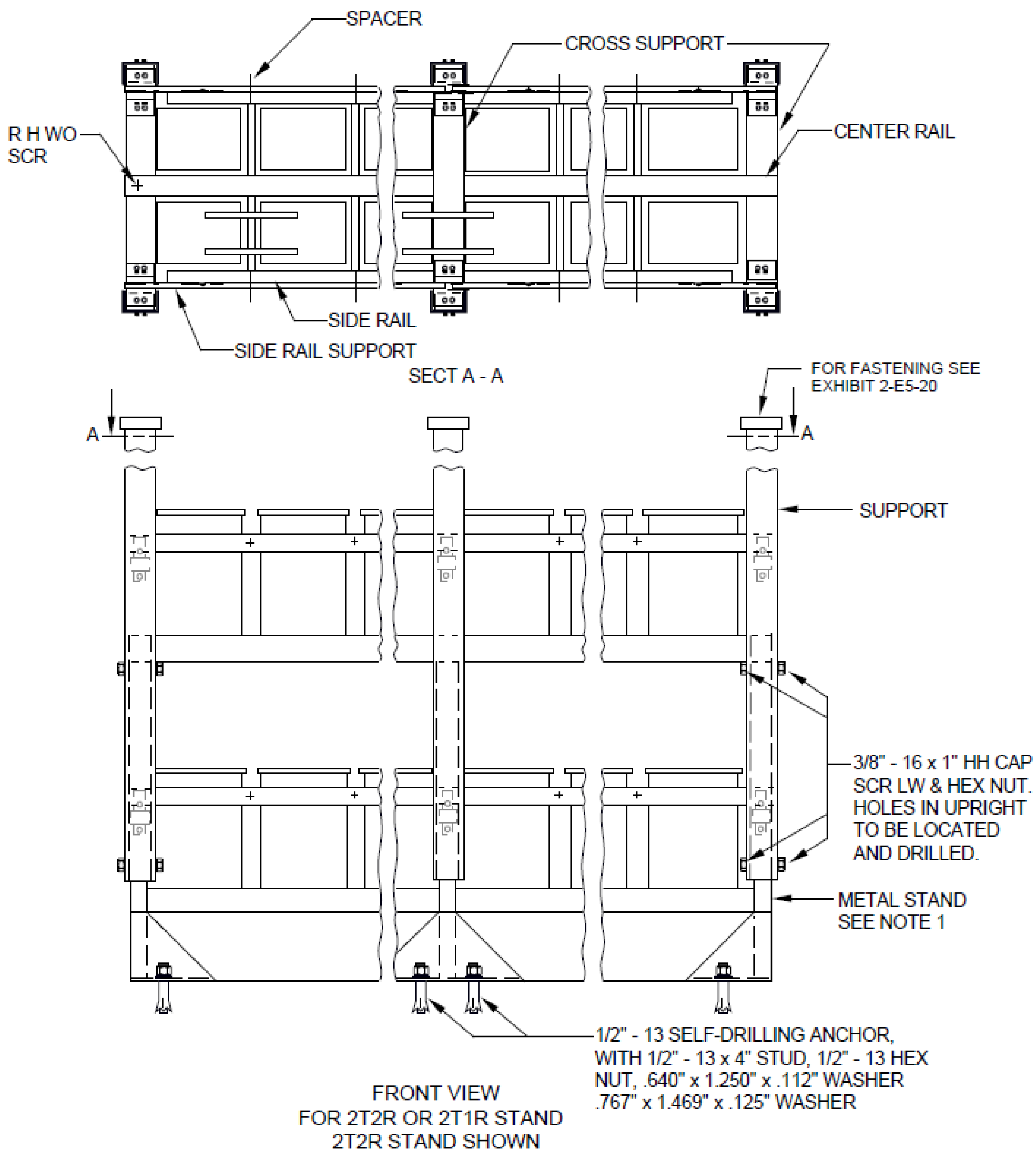


EXHIBIT 2-E5-17A

2-E5-17A SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUSBARS 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

2-E5-17B SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUS BARS OR CABLE RACKS ARE SUPPORTED DIRECTLY FROM THE STAND

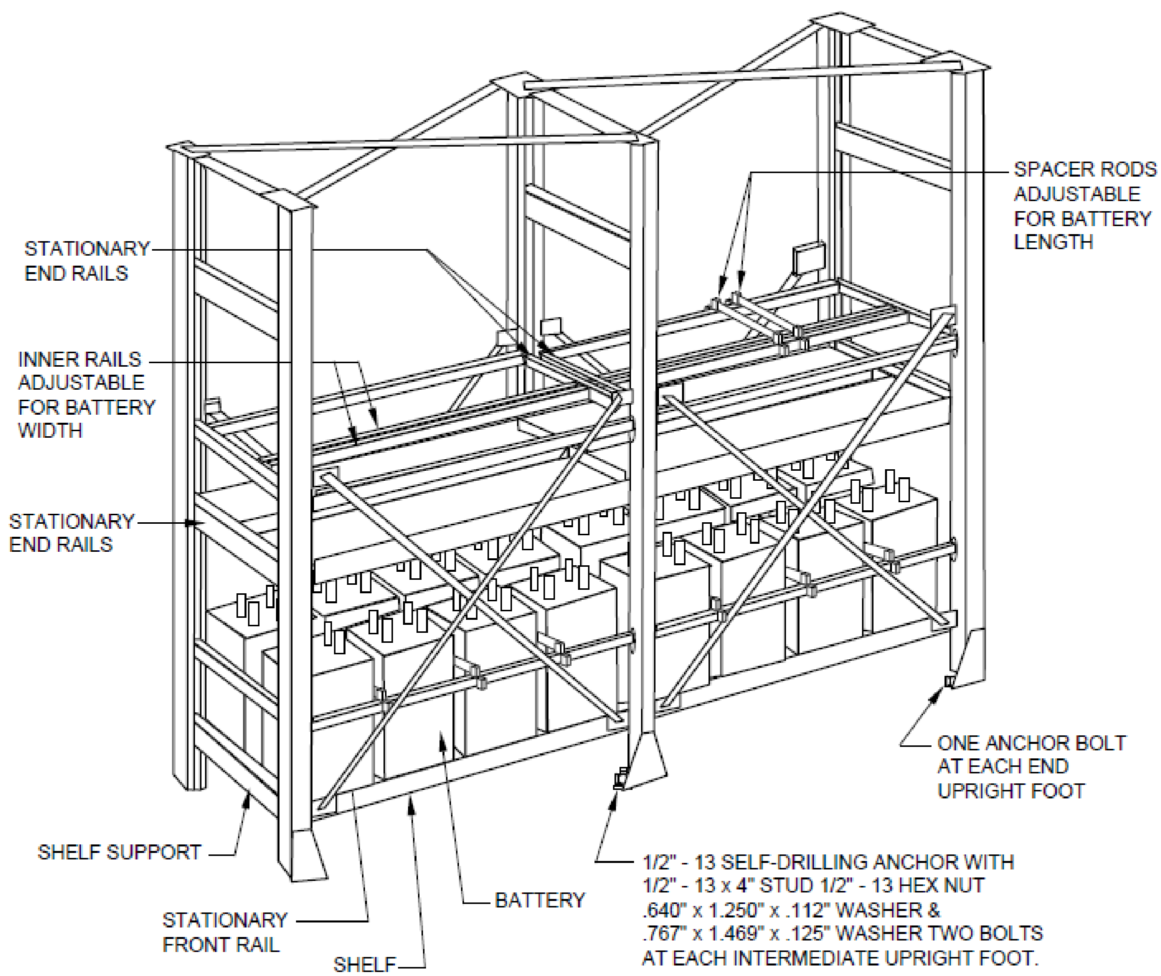


EXHIBIT 2-E5-17D

2-E5-17D FLOOR FASTENINGS FOR METAL BATTERY STAND

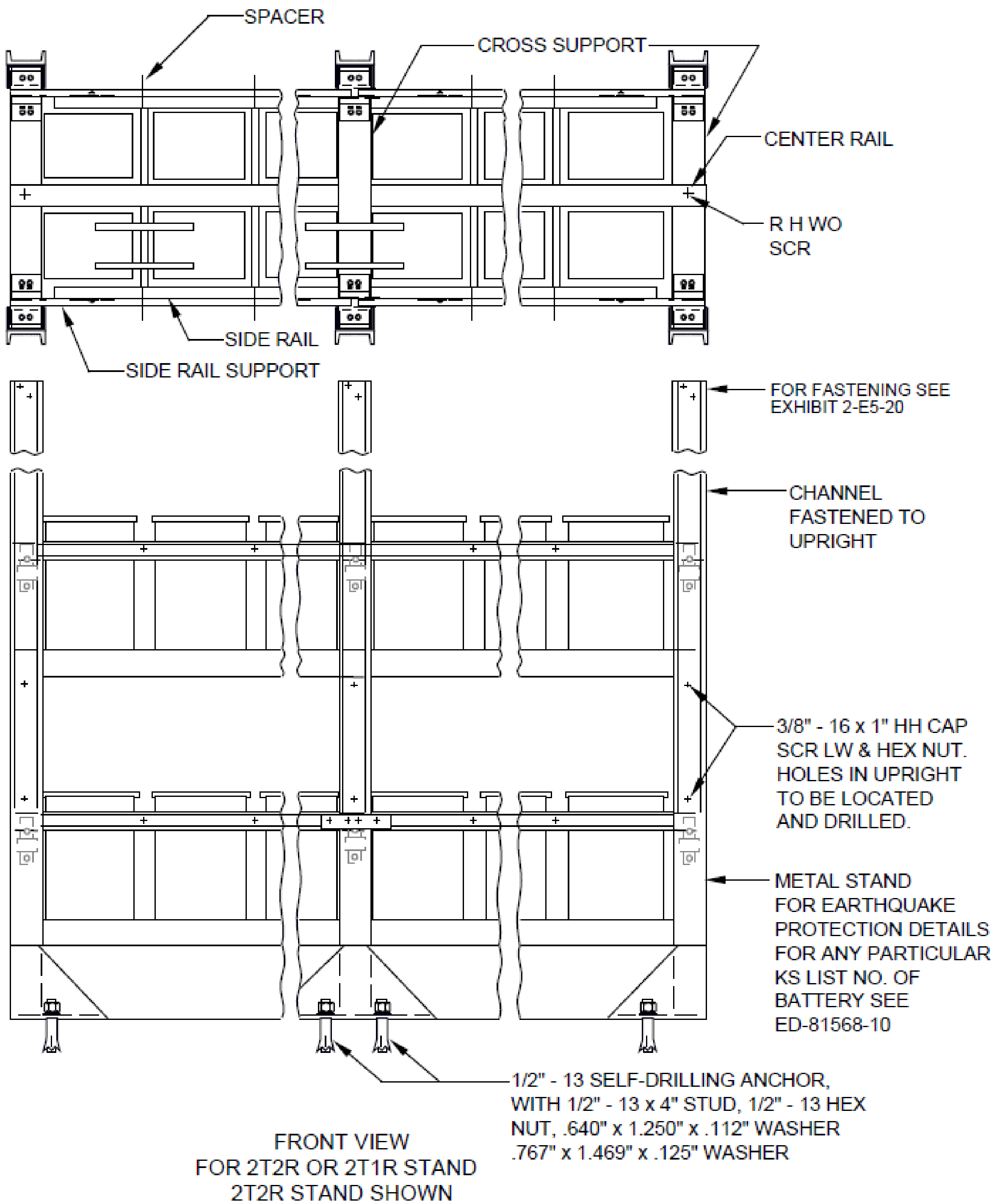


EXHIBIT 2-E5-18A

2-E5-18A SUPPORTS AND FLOOR FASTENINGS FOR METAL BATTERY STANDS WHERE BUS BARS OR CABLE RACKS ARE SUPPORTED FROM THE CEILING

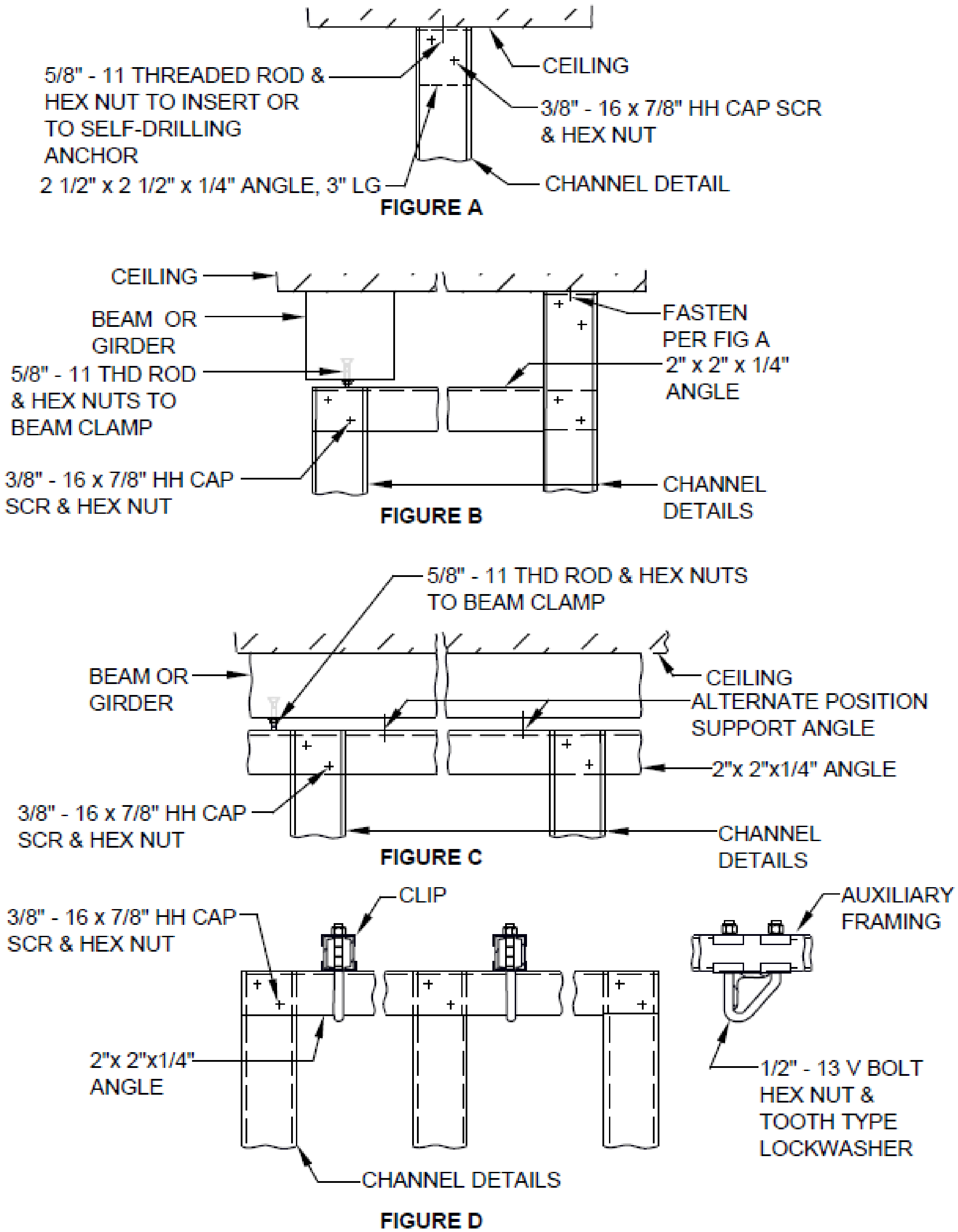


EXHIBIT 2-E5-19

2-E5-19 CEILING FASTENING FOR ISOLATED BATTERY RACKS

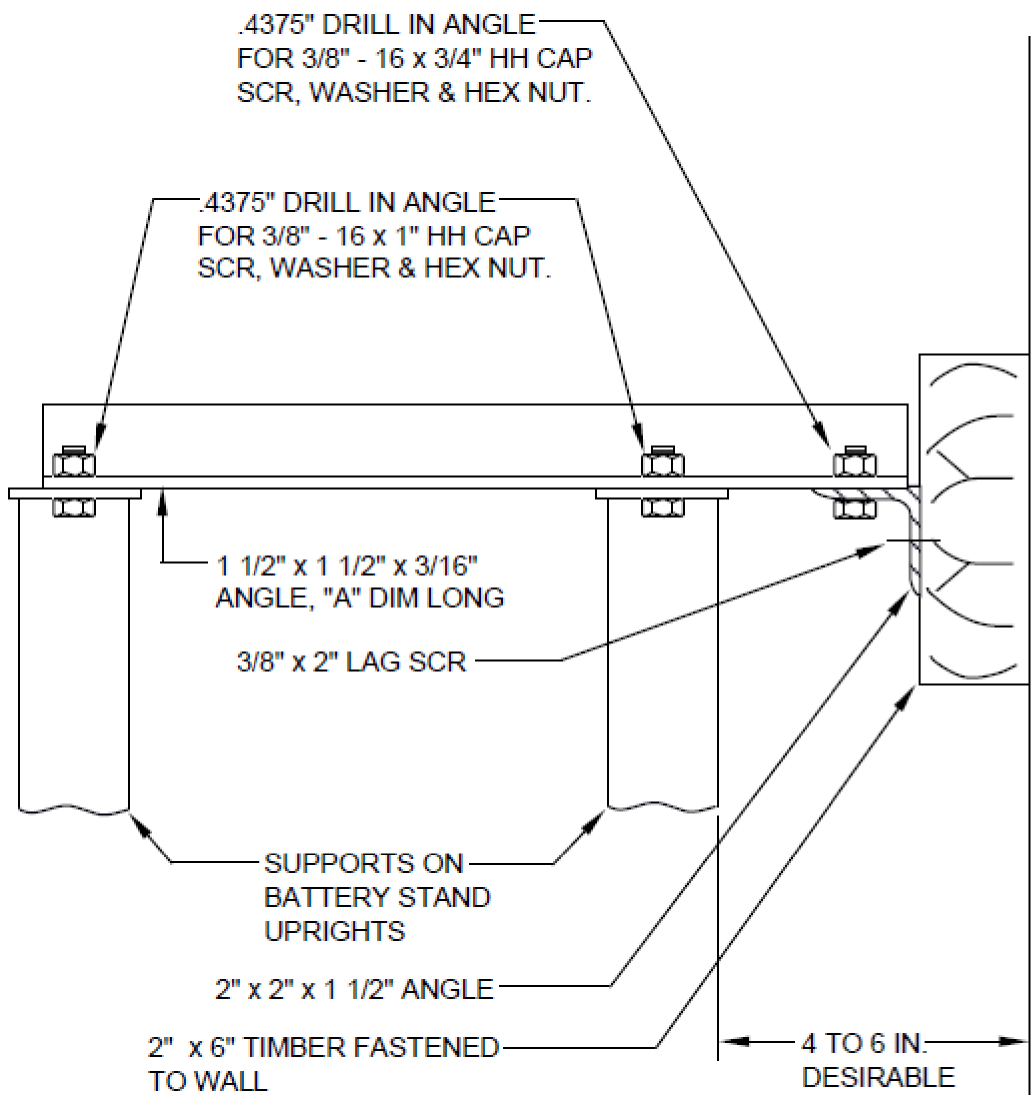


EXHIBIT 2-E5-19F

2-E5-19F BRACING BATTERY STAND PARARLLEL TO WALL

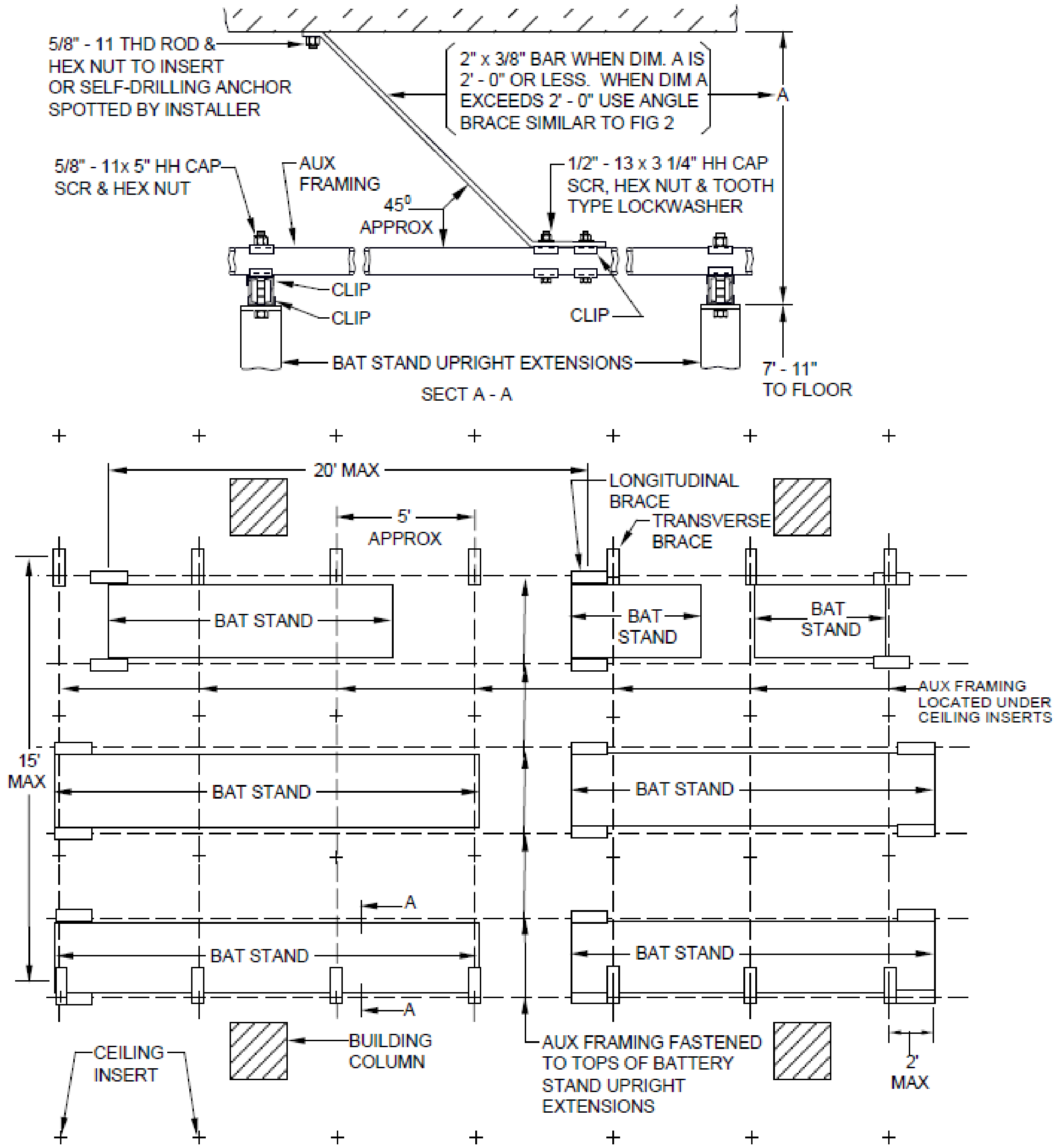


EXHIBIT 2-E5-20

2-E5-20 ARRANGEMENT OF CEILING BRACES FOR METAL BATTERY STANDS ARRANGED IN PARALLEL LINES

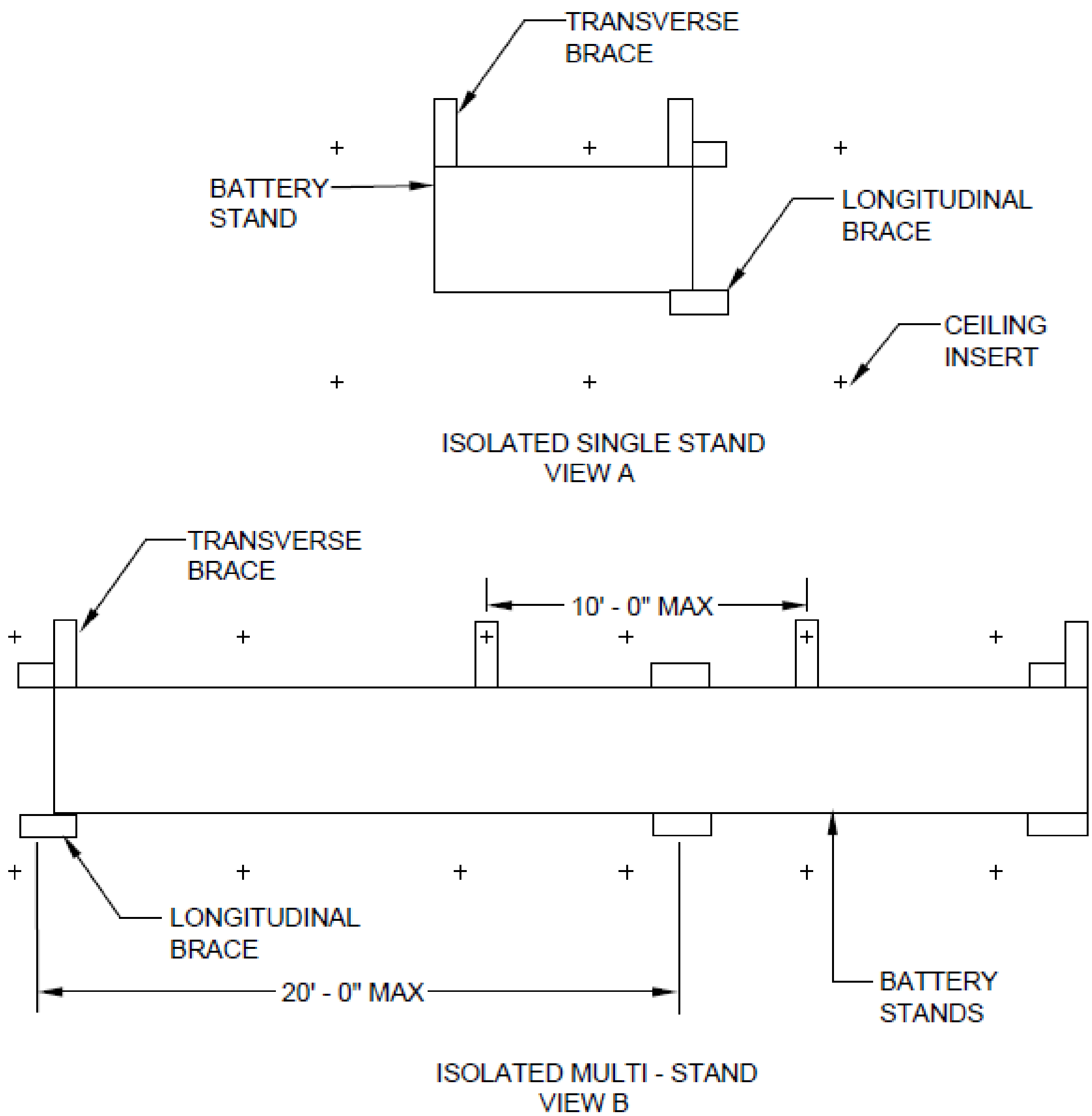


EXHIBIT 2-E5-20A

2-E5-20A ISOLATED SINGLE AND MULTI-BATTERY STANDS

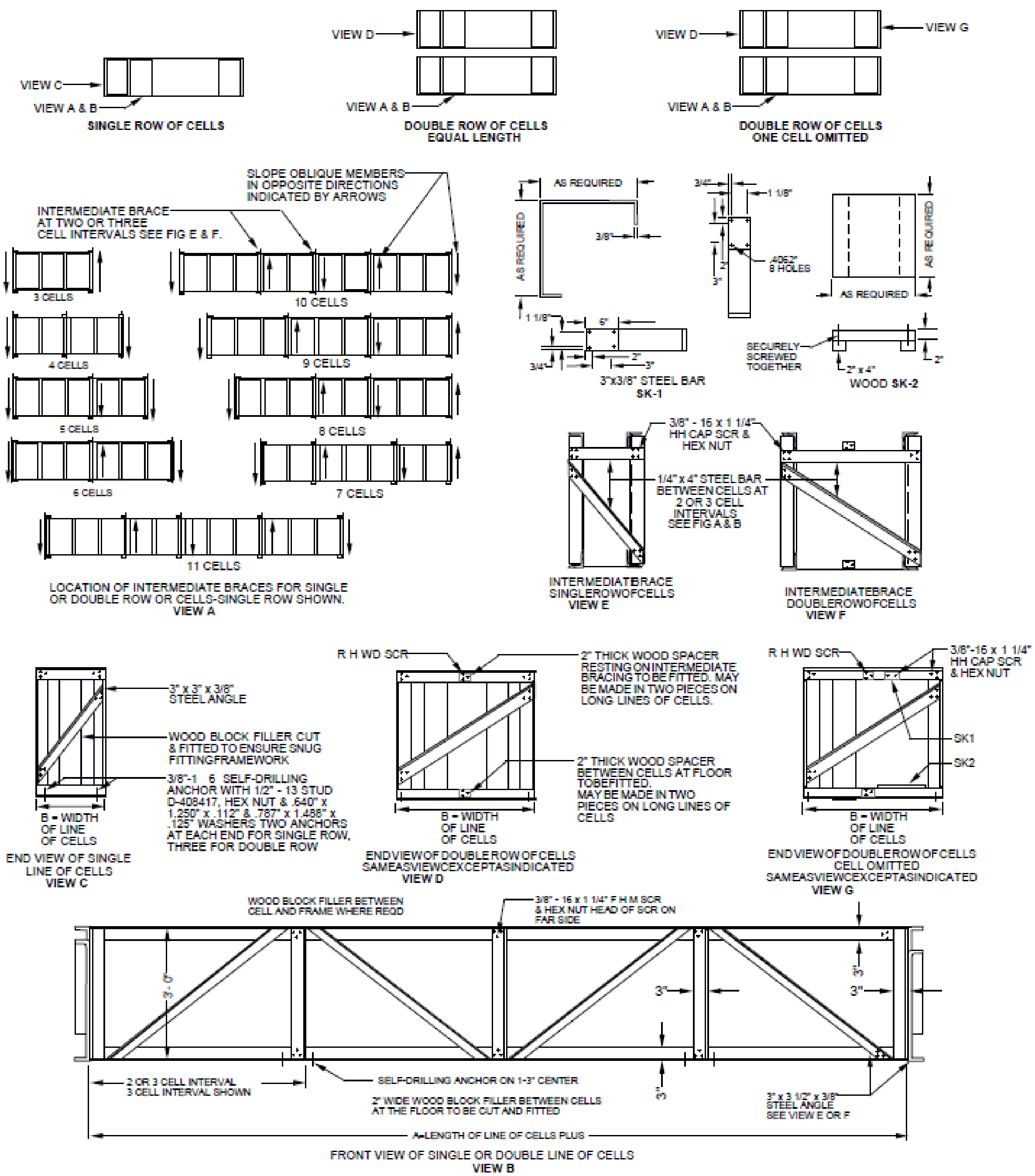


EXHIBIT 2-E5-21B

2-E5-21B SUPPLEMENTARY SUPPORTS FOR LARGE SEALED BATTERIES

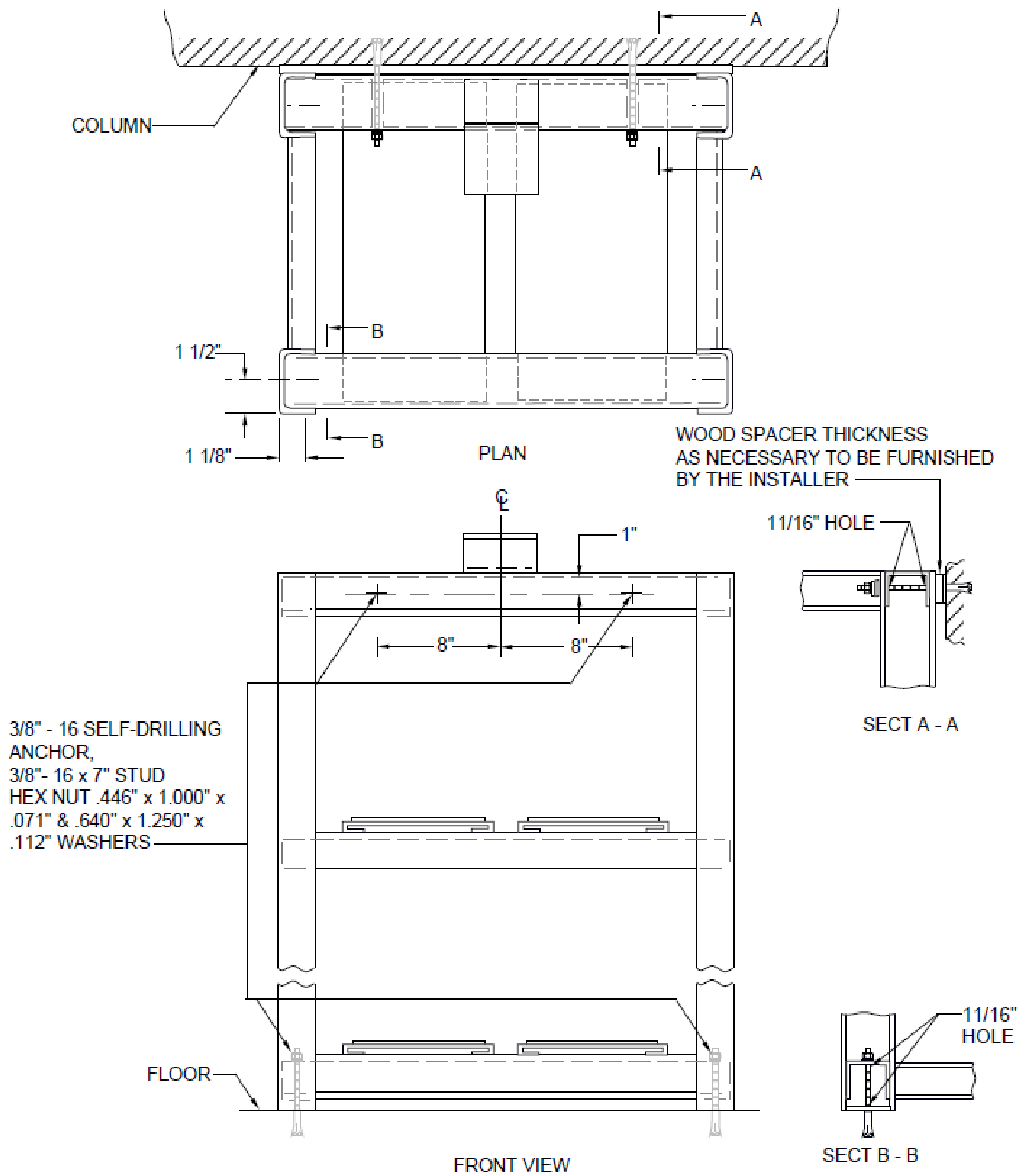
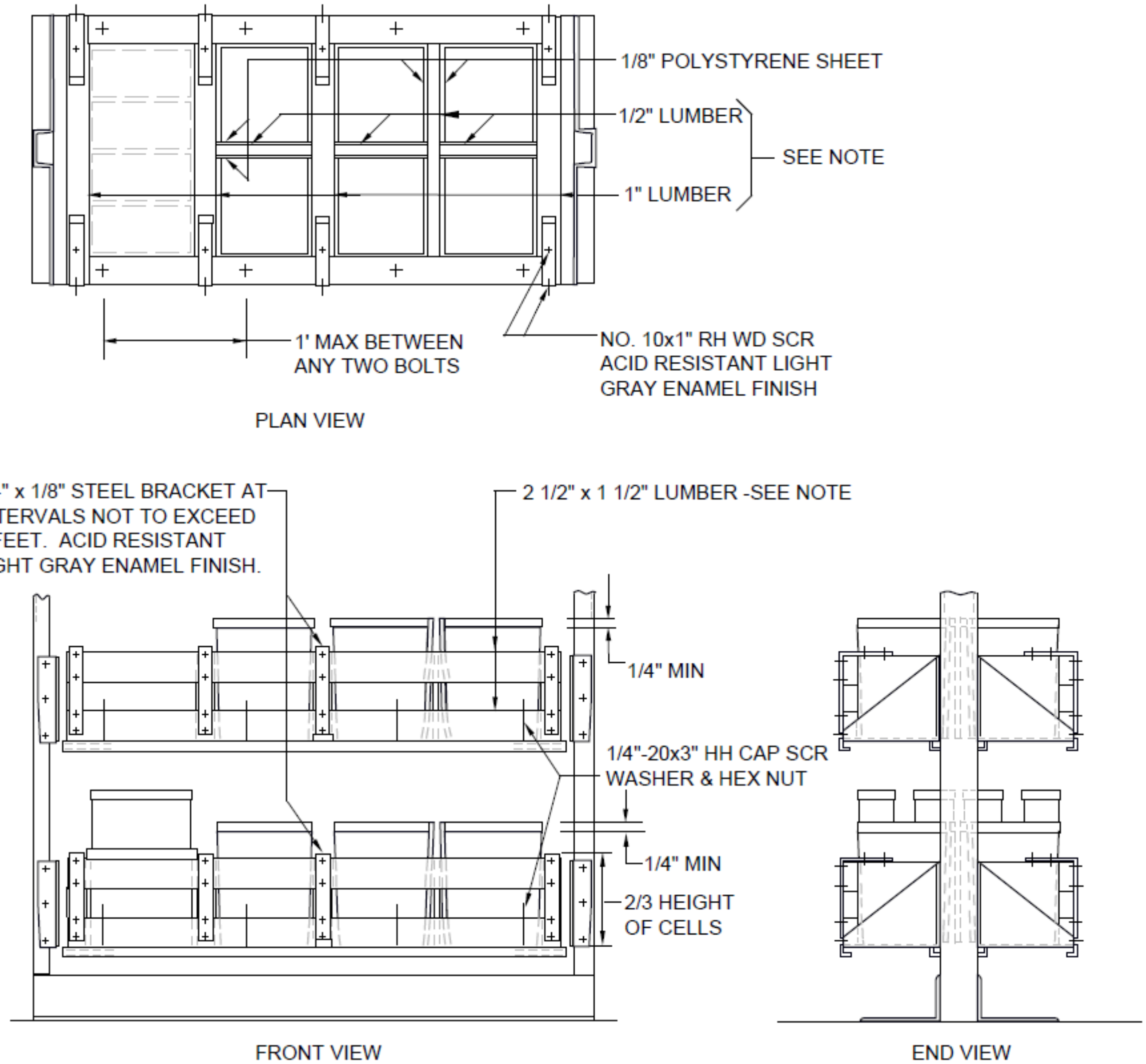


EXHIBIT 2-E5-21C

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

2-E5-21D SUPPORTS FOR BATTERIES ON RELAY-RACK-TYPE BATTERY SHELVES

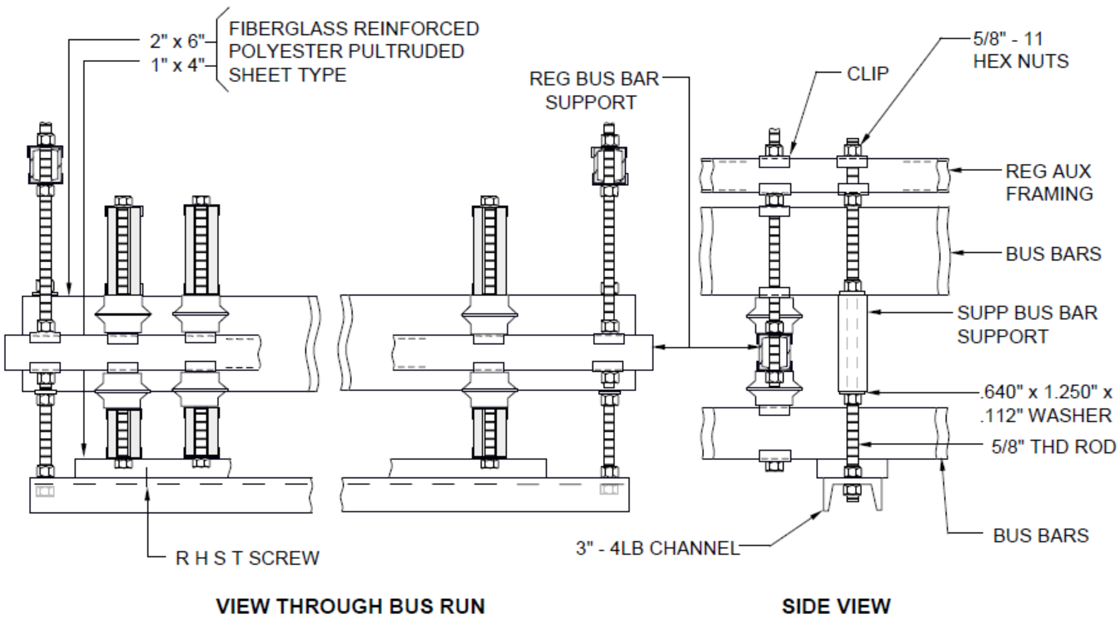


EXHIBIT 2-E5-22A

2-E5-22A SUPPLEMENTARY SUPPORTS FOR BUS BAR RUNS

Contents

FIGURES

6. Cable Rack

6F Cable Distribution Systems For Conventional Floor Supported Systems

6F.1 General

Section 6F.2 covers the equipment requirements for engineering of a system of cable racking called "Cable Distribution Systems" (also referred to as compartmentalized "Cableway" or "Compartment" type systems) for existing floor supported systems. This system has been discontinued and information provided in this chapter is used for reference only to grow this environment to its logical conclusion.

Section 6F.3 covers the equipment requirements for engineering of a new ladder-type 7 foot floor supported cable racking system.

For specific hardware and application information for cable distribution systems, refer to CenturyLink Technical documents then manufacturers' documentation.

6F.2 Cable Distribution Systems

Cable distribution systems provide a means for cable separation or support. These types of compartmentalized 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 CenturyLink Technical Publications or Standard Configuration documents.

NOTE: No cable distribution systems may be added to new non-switch areas within CenturyLink Network Facility environments. Compartmentalized cable Distribution systems are conditionally approved and restricted to extending existing line-ups to their logical conclusion. All new equipment lineups and areas will be engineered for a 7 foot, floor supported environment utilizing multi-layer ladder type cable rack. Typical existing arrangements are Digital Cableway or Electronic Switch System

6F.2.1 Requirements

Cable distribution systems are provided over line-ups of equipment frames and are fastened to adjacent line-ups by cross-aisle racks.

- Compartmentalized 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 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.2.2 Stanchions

- Where frames are not provided under cable distribution systems, approved support stanchions, manufacturer specific to the cableway system, 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.2.3 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 AC source 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, approved 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 CenturyLink 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 where cables transition from horizontal to vertical orientation (i.e. into equipment frames). Refer to Technical Publication 77350 for details regarding the requirements on cable transition and protection.

For additional requirements regarding the use of cable distribution systems in seismic (earthquake) zones, refer to Unit E of this Module.

6F.3 Standard 7 Foot Floor Supported Environment

The following section provides for engineering requirements associated with establishing a new 7ft floor supported environment equipped with ladder rack. Additional engineering requirements are available throughout this chapter and also in the Planning and Engineering Guidelines documentation.

6F.3.1 Engineering Requirements

- 7 foot floor supported cable rack shall not be physically attached with auxiliary framing or cable rack to a ceiling supported cable rack or support system.
- Cable rack and auxiliary framing support shall follow the engineering standards previously outlined in Chapter 6.
- Equipment lineups shall be spaced utilizing the front and rear aisle spacing requirements outlined in Chapter 2.
- New 7 foot environments shall be built to a standard build of 18 feet in length (two 9-8 ½" cable rack segments) and three equipment lineups (for dedicated power cable rack in

the rear aisle). Less than standard builds are acceptable based on individual site specific conditions including:

- Less than 18 foot of equipment lineup available or remaining
- Equipment lineup does not require dedicated power rack in the rear aisle, or the rear aisle must be ceiling supported

6F.3.2 Stanchions and Auxiliary Frame Support

Stanchions columns shall adhere to the engineering standards outlined in Chapter 2 and Chapter 6 of CenturyLink Technical Publication 77351. Actual site conditions may dictate different designs not outlined below.

- A maximum of 2 inches exposed threaded rod is allowed from the top of the stanchion column to the bottom of the auxiliary framing.
- Stanchion columns shall not be placed directly under the intersecting auxiliary framing sections as shown in Exhibit 2-E2-2G.
- Stanchions shall be placed in 5 foot increments down the equipment lineup and placement of stanchions within each lineup shall be made to align with the equipment lineup upright and top support requirements.
- Primary auxiliary framing support shall be placed at a height of 7-8 along the equipment lineups.
- Secondary auxiliary framing support shall be placed at a height of 7-10 perpendicular to the 7-8 auxiliary framing and at 5 foot intervals.

6F.3.3 Cable Rack Design Criteria

The following provides general engineering standards for establishing cable racking within the 7 foot floor supported low level environment. Actual site conditions may dictate a different cable rack design

- Cable rack shall be sized based on ultimate cable rack capacity and pileup limitations:
  - Cable racks shall be centered in the front or rear aisle when used to provide cabling for both lineups.
  - 3 foot front aisle cable racks shall be 20 inches in width
  - 4 foot front aisle cable racks shall be 25 inches in width

- 2 foot 6 and 3 foot rear aisle cable racks shall be 20 inches in width.

- Cable rack shall be provided at the following heights based on a 7 foot environment:
    - Switchboard cable rack shall be placed centered in the front aisle as the first tier rack at 8-2.
    - Fiber cable rack shall be placed centered in the front aisle as second tier rack at 9-6 and supported with C-Clips (unless cable rack width is 24 inches or greater and requires auxiliary framing).
    - Switchboard and Fiber racks shall be equipped with pan and brackets
    - Power cable rack shall be placed centered in the rear aisle as second tier rack at 9-6 and supported with auxiliary framing.
    - Cross aisle cable racks shall be avoided whenever possible as they may interfere with cabling access into the equipment bays and/or cabinets. When required, cross aisle racks shall be placed as to not interfere with cabling entering the framework and/or cabinets, and may require placing smaller size cross aisle racks to prevent this.

Refer to the Standard Configuration for more engineering requirements associated with the 7 foot floor supported environment.

FIGURE 6F.1: CEILING SUPPORT CABLE RACK – TRANSITION TO 7 FOOT

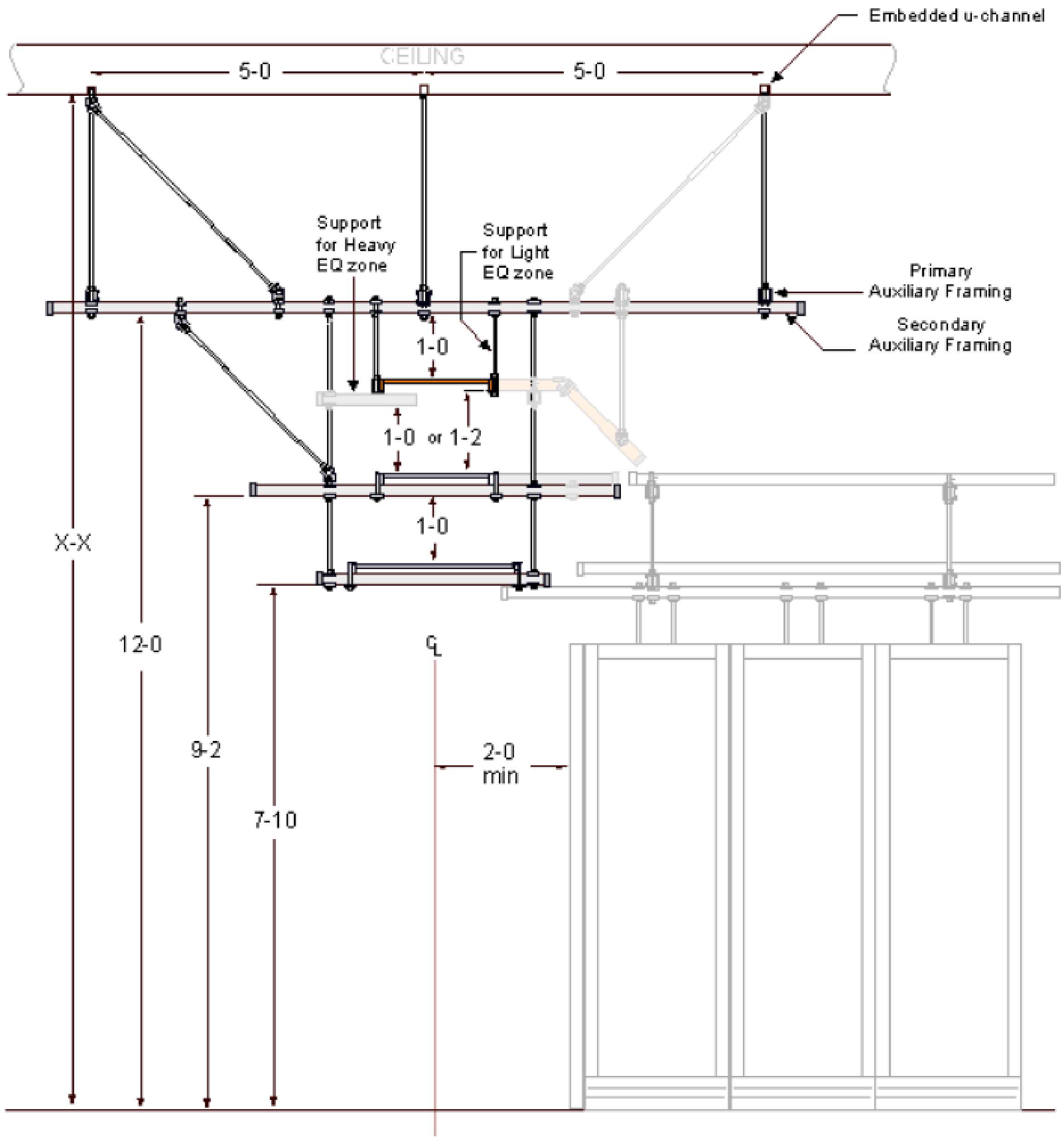
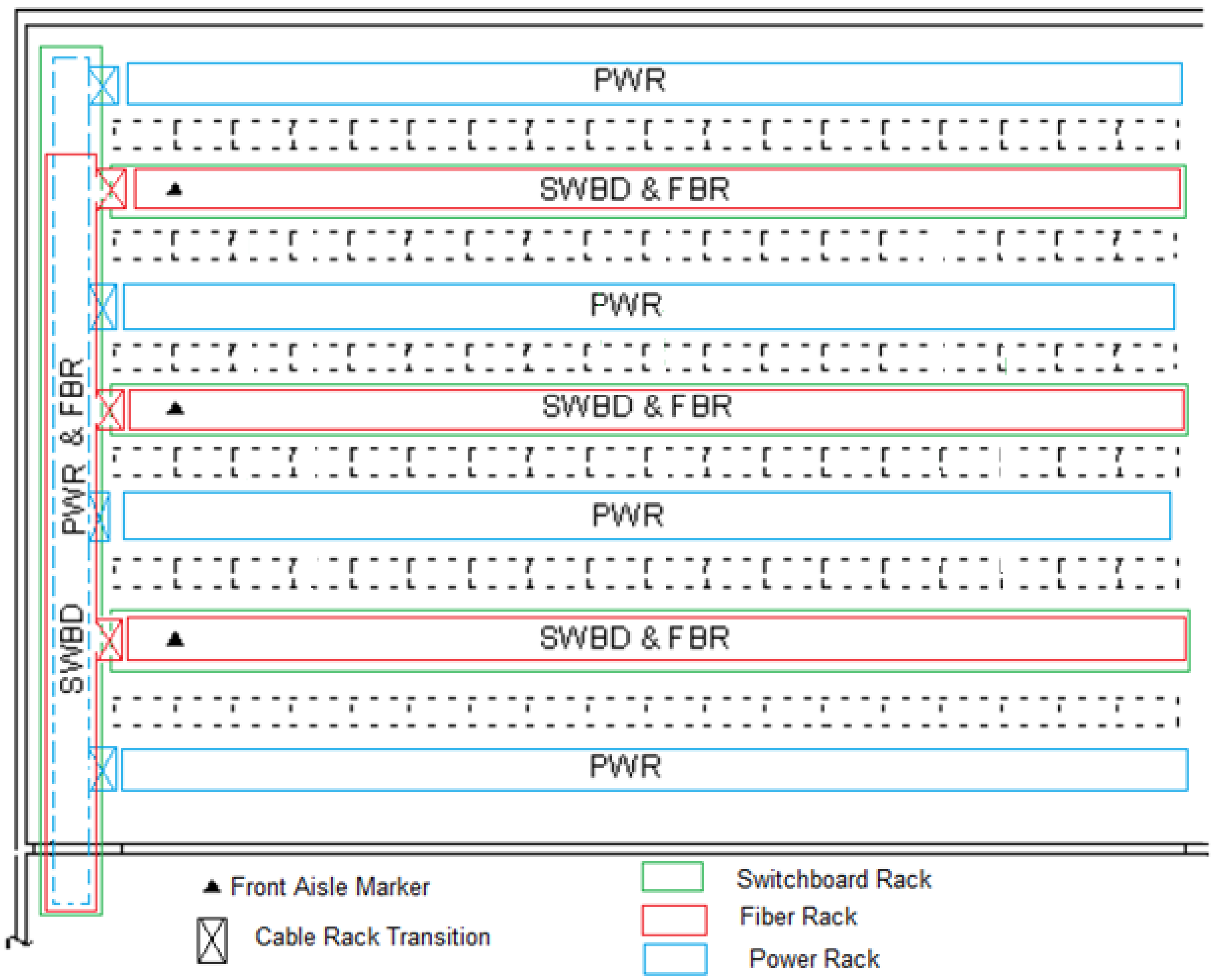


FIGURE 6F.2: TYPICAL MAIN AISLE AND 7FT CABLE RACK ARRANGEMENT



NOTE: Additional options may be available for providing two tier main aisle cable rack from one end (non-growth) of the equipment lineup and the third cable rack from the opposite end of the fully extended lineup.

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<u>TABLES</u>

6G Fiber Protection System (FPS) - Cable Distribution for Fiber Optic Cable

6G.1 General

This section covers the engineering guidelines for fiber protection systems (FPS) or "fiber trough" used to support and protect fiber optic cables required by telecommunications equipment frames placed within a CenturyLink Network Facilities environment.

Refer to Chapter 3 for specific engineering requirements associated with fiber facilities including fiber splice and fiber distribution. Refer to Chapter 10.4 for specific engineering requirements associated with fiber management and fiber cabling.

Wherever physically possible, fiber optic cable will be segregated from other types of Network Facility cables (i.e. power and switchboard) to provide the required isolation and protection. Ideally, fiber cable support systems dedicated to fiber optic cable only should be planned.

When a fiber cable support system must be shared by cables of differing types, every effort must be made to segregate the cable types for all new cable installations to prevent damage. This is best accomplished by routing cables as straight as possible while maintaining minimum bend radius requirements along the cable route.

Within CenturyLink Network Facilities, and buildings, there are two main support and routing systems utilized for fiber optic cables.

- Ladder type cable racks for the heavily sheathed, inter-office fiber optic riser cables (fiber entrance and fiber distribution cable) and is the preferred method of support and protection of all fiber optic cables.
- Fire rated duct-type Fiber Protection Systems (FPS) for the fiber optic patch cords or jumpers (conditionally approved in limited locations)

Fiber cables or jumpers may be run on approved cable support brackets attached to cable rack stringer or auxiliary framing in specific conditions not capable of placing fiber protection system or fiber rack. Support brackets must be placed 6 inches on center or less.

- Network Facility floor space, exterior to and equipment cabinet is prohibited as a component of a fiber optic cable support system, temporary or permanent (raised floor environments exempted). All new fiber optic cable must be installed using an approved fiber optic cable support system as listed above.

Specific hardware and application information is located in CenturyLink Standard Configuration documents. Any deviation from the requirements listed below shall be directed to the CenturyLink 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 Protection Systems (FPS)

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.

TABLE 6G.1 FIBER CABLES IN FPS

Inter-Office Fiber Optic Cables	Can be run in a Fiber Protection Duct System
Approved Fiber Optic Jumper Cable: 1 to 4 fibers	Yes(*)
Approved Multi-Fiber Indoor Cable: 12 fibers	Yes (**)
Approved Multi- Fiber Indoor Cable: over 12 fibers	No
Approved Multi-Fiber Indoor/Outdoor Cable: 12 fiber and above	No

*The outer sheathing on 4 fiber cable assemblies must be split back and removed prior to transitioning from horizontal to vertical due to the bend radius limitations of the FPS downspout design.

* A maximum of ten 12 count fiber cables is permissible in FPS due to the following:

- Protection of older fiber cables that may be in the FPS and not equipped with currently approved fiber sheathing and may be damaged due to the overall weight.
- Maintain sufficient capacity for running individual fiber jumpers in the FPS.
- Maintaining minimum bend radius around corners and transitions
- The outer sheathing on 12 fiber cable assemblies must be split back and removed prior to transitioning from horizontal to vertical due to the bend radius limitations of the FPS downspout design.

New duct type systems for the support of large quantities (more than 10 total) of high fiber count cables (12 count or more) will require a letter of deviation.

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 CenturyLink 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.4.31 FIBER DISTRIBUTION CABLE SUPPORTCABLES in FPS.

It is especially important that fiber duct, when initially installed, is designed to allow for future growth.

Care must be taken to consider the entire route when selecting the fiber duct support options so as not to obstruct existing cable rack or force a change of level. Modifications to an existing duct arrangement supporting live fiber can generate potential complications effecting service.

6G.2.1 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.
- Fiber duct shall be dedicated to fiber optic cables only
- 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 and maintain fiber cable bend radius
- 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.
- New FPS shall be provided in limited conditions which prevent the installation of a dedicated, segregated fiber optic cable rack system such as small Community Dial Offices (CDO's), Controlled Environment Vaults (CEV), Huts, or customer premises.

- FPS systems will be designed to accommodate minimum bend radius around corners, transitions and downspouts requirements of the largest multi-count cable intended for use. Fiber cable sizing for duct applications is defined in the CenturyLink Standard Equipment documentation.
- Small quantities of bundled fiber cables are allowed in Fiber Protection Systems but are limited due to the following:
    - Protection of older fiber cables that may be in the FPS and not equipped with currently approved fiber sheathing and may be damaged due to the overall weight.
    - Maintain sufficient capacity for running individual fiber jumpers in the FPS.
- The Fiber Protection System (FPS) will be designed to prevent interference with future or existing cable racks, cross aisle racks, vent ducts, etc. The CenturyLink Network Facility drawings shall reflect the current office FPS routes, heights, sizes and types. Any deviation from the initial FPS design by installation shall be communicated to the CenturyLink representative responsible for detail engineering.

6G.2.2 FPS Ratings

Any questions regarding the rating of a manufacturer's FPS product shall be directed to the CenturyLink representative responsible for Common Systems standards or CenturyLink Standard Configuration documents.

STANDARD - CenturyLink requires the use of the “standard” fiber protection system for all-new Network Facilities and buildings.

CONDITIONAL - An existing FPS constructed from a non-standard manufacturer can be extended only if the product is rated “conditional”.

6G.2.3 Growth

It is especially important that the FPS, when initially installed, is sized and 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 provide an overhead clearance to allow access and opening of the overhead duct cover. A recommended clearance of approximately 2 inches greater than the width of the duct shall be provided.

6G.2.4 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 specified fiber duct drawings associated with the Network Facility records.

6G.2.5 Horizontal FPS

Horizontal Fiber Protection Systems require:

- A solid duct is required for all horizontal Fiber Protection Systems. Slotted duct is prohibited on all horizontal runs and vertical offsets.
- A main support is required 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 are required every 1 foot 6 inches if the FPS manufacturer uses a contingent support system such as the FPS manufacturer's threaded rod bracket kit or u-channel.
- Stenciling is not required on the approved brightly colored FPS.
- Duct covers are mandatory on horizontal duct systems.
- The use of captive split nuts is restricted and only when attaching fiber duct.

6G.2.6 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 typically be provided for every fiber frame requiring patch cord termination. Sharing a single duct between two bays shall be sized appropriately to accommodate the fiber cabling requirements for both bays. This vertical duct arrangement is not required when inter-bay management panels (IMP) are provided.

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.2.7 Fiber Protection System Capacity

The following table provides for an estimated number of fiber cables that could be installed in a fiber protection system based on average fiber diameter options.

- The values provided assume that fiber cable quantities are laid uniformly into the duct

TABLE 6G.2 FIBER PROTECTION SYSTEM CAPACITY

The upper number (gray) on the table below represents the approximate number of fiber cables and the lower number (white) the approximate weight in pounds per linear foot.

Fiber Protection System		Fiber Cables in Fiber Protection System (diameter - inches) (weight - lb/ft)				
		Single	Dual	Quad	6 Fiber Stranded	12 Fiber Stranded
		0.0787	0.0787	0.2126	0.26	0.33
FPS Dimensions	Cable Pileup (in)	0.00854	0.0122	0.0182	0.0244	0.0377
2" x 2"	2	617	617	84	56	35
		5	8	2	1	1
4" x 4"	2	1234	1234	169	113	70
		11	15	3	3	3
	3	1851	1851	253	169	105
		16	23	5	4	4
	4	2468	2468	338	226	140
		21	30	6	6	5
4" x 6"	2	1851	1851	253	169	105
		16	23	5	4	4
	3	2776	2776	380	254	157
		24	34	7	6	6
	4	3702	3702	507	339	210
		32	45	9	8	8
4" x 12"	2	3702	3702	507	339	210
		32	45	9	8	8
	3	5553	5553	760	508	315
		47	68	14	12	12
	4	7404	7404	1014	678	421
		63	90	18	17	16

The capacities on the above table are based on the estimated diameter of fiber cable and the cable space available. Values have been decreased to 75% for cable space loss between cables unsecured in the Fiber Protection System.

6G.3 Slack Storage

Cable slack storage in any type of fiber protection system is strictly prohibited. Letters of deviation will not be considered valid.

Contents

FIGURES

7. Frame and Aisle Lighting

7A 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 CenturyLink 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 three distinct types of lighting found in CenturyLink Network Facility environments:

- Building or Egress (Emergency) Lighting is installed and maintained by CenturyLink Real Estate. Building Lighting provides general lighting for an area, not the equipment. Egress (Emergency) Lighting is provided in specified areas of egress including stairways and exits.
- System or Equipment Task Lighting is supported from the equipment frames or ironwork to provide lighting specifically for the telecommunications equipment.
- System or Equipment DC Task Lighting is required in specified areas for providing lighting for critical power equipment. Refer to section 7C for details on DC Task Lighting

Lighting and lighting arrangements not specifically identified in this document shall adhere to the intent of the requirements and guidelines defined herein.

Refer to CenturyLink 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 CenturyLink standard may be acceptable and will be documented in CenturyLink Standard Configuration documents.

In areas other than the Network Facility 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

- Conduit shall be securely fastened at intervals of 6 feet or less.
- Conduit shall not be run in locations normally occupied by auxiliary framing, cable racks, etc.
- Conduit shall, where possible, be run parallel and adjacent to the superstructure to assure maximum headroom and to provide easy access to cable racks.
- Conduit shall not be run in cable racks with telephone equipment cables or DC power cables.
- Conduit shall not be run in the maintenance area of a lineup.
- All conduit fittings shall be nonferrous.
- Conduit and lighting arrangements for 7 feet low-level environments shall be provided per CenturyLink Standard Configuration documents.
- Conduit and conduit arrangements for existing 9 feet and 11 feet 6 inch environments shall be per CenturyLink Standard Configuration documents or arrangements previously established for those areas.
- 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 poly-phase 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 solder-less 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 – Task Lighting

Equipment task lighting shall be provided in the front and rear of an equipment lineup. Equipment lighting is supported below the cable rack environment from the lowest level auxiliary framing.

Equipment task lighting may be comprised of older T8, T12 type of fixtures or newer T5 fixtures.

Only approved single and double tube fluorescent lighting fixtures may be installed in equipment areas of CenturyLink Network Facilities.

Locations equipped with adequate building lighting do not require separate task lighting. The building lighting may also be used as equipment task lighting unless otherwise blocked or cannot provide adequate lighting to the equipment.

7A.4.1 T8 and T12 Lighting Fixtures

- Existing equipment lineups (7 ft, 8ft, 9ft, 10ft, 11ft-6).
- Double tube fluorescent fixtures are required in all lineup equipment front (maintenance) aisles when required by both equipment lineups.
- Single tube fixtures are installed only in the rear (wiring) aisles of equipment frames requiring rear maintenance, or double tube fixtures may be installed when rear aisle maintenance is required by both equipment lineups.
- Existing lineups with three lights or less, recommended replacing with T5 lights when feasible.
- New equipment lineups shall utilize the T5 lighting fixture.

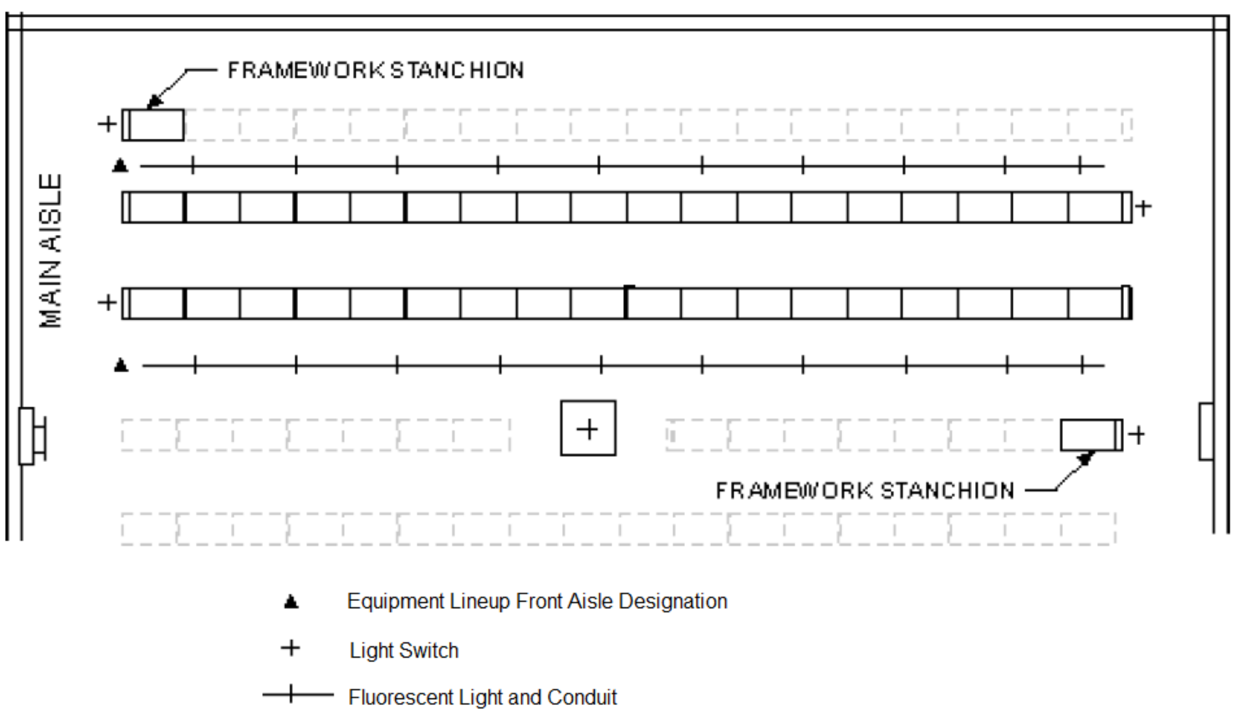
The CenturyLink Engineering Representative prior to engineering or installation must evaluate any deviation from the approved fixtures.

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.

FIGURE 7A.1 LIGHT SWITCH LOCATION



7A.6 Single Pole Switches

For aisles having an ultimate length of 20 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 20 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 Network Facilities. All wiring, conduit, and fixtures installed in CenturyLink 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.

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 CenturyLink 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 or cabinet and subsequently installed every 6 feet not to exceed 10 feet within a Network Facility equipment lineup, or more frequently if required.

- In equipment areas other than main Network Facility switch environments, appliance outlets for equipment frames shall be installed in the base (both the front and rear) of each bay or cabinet requiring an outlet.

- When only one bay or cabinet is furnished initially in a lineup, an outlet shall be provided in that bay or cabinet.
- 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 CenturyLink Equipment Locations.

- Special use outlets (orange) as identified in Exception #4 of Article 250-74 in the NEC are **prohibited** in all CenturyLink facilities. The only exception is when this will apply only to any existing switch (SPCS) already equipped with orange outlets may continue use of orange outlets.

- Appliance outlets are not provided in power bays such as a BDFB or Power Board.

- Only CenturyLink approved metallic junction boxes and faceplates are permitted in the Network Facility environment. Use of plastic faceplates and junction boxes, along with any residential grade type outlets associated hardware, is prohibited.

7B.4 Risers

Risers including risers for outlets on either side of frame gaps:

- Shall be located at the non-growth end of partial lineups of frames or cabinets and at either end of complete lineups.

7B.5 Conduit And Fittings

All conduit provided for frame base outlets and task lighting:

- Shall be securely fastened to the auxiliary framing or u-channel at a standard interval of five feet and not to exceed six feet.
- 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 AC Copper Cable

Armored AC copper cable as defined by the NEC:

- Shall be a maximum of three feet in length (vertical only).
- Shall be run only in the locations and in the manner shown in CenturyLink Technical Publications (see 77350 and 77385) and Standard Configuration documents.
- Armored cable shall never be run in any cable rack with switchboard, fiber 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

7C Emergency Lighting

7C.1 General

This unit covers requirements for task lighting and emergency building/egress lighting used in CenturyLink locations.

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

7C.2 DC Task Lighting

- DC task lighting, also referred to as DC lighting, is required by CenturyLink in critical power areas of the network facility.
- DC Task lighting is provided by the CenturyLink Network Power Engineer or the Engineer responsible for DC power equipment.
- DC Task lighting shall not be used in place of emergency egress lighting on a going forward basis.
- DC Task lighting is provided in specified areas to provide the technician the ability to perform critical work operations during site restoration.

7C.2.1 Requirements

- The preferred DC task lighting arrangement is DC lights powered from the main power plant, BDFB or miscellaneous fuse panel.
- The DC task lighting power demand should be minimal, and the DC current requirements should be provided to the CenturyLink Power Engineer when these lights are used to ensure a proper sizing of the battery plant.
- AC inverters will not be used solely to provide DC task lighting.
- The task lighting systems may be controlled either manually or automatically as specified by the CenturyLink Engineer.
- For small DC task 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 provide maintenance and operations the ability to operate the DC task lighting upon entering the building.
- All wiring for the DC task lighting will conform to the Network Facility grounding requirements including proper routing through the ground window when applicable.

- Refer to CenturyLink Technical Publication 77385, Chapter 12 and the Standard Configuration Guideline for additional engineering requirements for DC task lighting.

7C.2.2 DC Task Lighting Placement

- DC task lighting is used in power rooms and is located in a position to illuminate the control board and/or the Power Monitor/System Controller (PSMC).

- The DC task lighting at the control board should be adequate for maintenance and operations to read any meters or switches required to perform necessary restoral functions.

- DC task lighting should also be provided in the standby engine room and located to enable starting the engine during site restoration.

- Additional DC task lighting may be required near the transfer switch to provide lighting during site restoration.

- All battery and ground leads for DC power units should be run on open cable racks.

  In areas without cable racks, the leads may be run in conduit. This conduit shall not contain any AC circuit wires.

7C.3 Emergency Building/Egress Lighting

- Emergency building/egress lighting is provided by CenturyLink Real Estate.
- Emergency building/egress lighting is required by the NEC and Life Safety Codes (must come on within 10 seconds of a power outage and last for a minimum of 90 minutes) for egress from a building (stairwell, main aisle, exit signs, etc).
- Emergency lights are placed to enable maintenance and operations the ability to find their way to exit the building in the event of a power failure.

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8 Internal Network Operations Support Systems

8.1 General

This part covers standards for the installation of equipment as a subsystem of Internal Network Operations Support Systems. These systems perform a variety of maintenance or monitoring, functions associated with the switching, transmission, and data network facilities.

Equipment classified for Internal Network or Operations Support Systems may include equipment that is not approved for deployment within the Network equipment space itself and requires segregation from Network equipment. This equipment may be classified for administrative use.

All new equipment required for internal network operations support should adhere to these standards. Modifications to existing systems should be engineered to incorporate these requirements.

This section provides information regarding special requirements for this type of equipment.

Due to the large variety of such systems, only general information is included in this section. Where internal system documentation is provided containing the necessary information, that documentation will take precedence over this document.

8.2 Requirements

- Equipment must be used only to support network equipment function/maintenance. This equipment shall not be used for carrying or providing direct CenturyLink customer service for either regulated or non-regulated CenturyLink entities.

- NEBS Level 1 compliance of equipment is preferred.

- Equipment may be AC or DC powered. The use of DC powered equipment is preferred. If AC powered equipment is providing a critical function, an inverter may be provided.

- Equipment may have direct cabling connections to Network equipment and may require necessary support infrastructure. Refer to other chapters in Technical Publication 77351 regarding network infrastructure requirements.

8.3 Location And Layout

Equipment in support of internal network operations require special consideration for space requirements due to their compliance within a Network Facility.

- Space may not be refurbished for telecommunications equipment use unless the internal network support equipment can be relocated to another separate segregated room meeting the conditions described in this chapter.
- Internal Network Operations Support Systems must be limited to maintain adherence to the International Building Code and local building and fire codes. The appropriate CenturyLink Engineer responsible for floor space within a Network Facility shall administer building space accordingly for usage and to maintain compliance. Additional coordination with CenturyLink Real Estate will be required when evaluating or repurposing space.
- Equipment deployed for internal network operations support that do not adhere to NEBS Level 1 requirements for placement in the network equipment space, shall require a separate, segregated room/area equipped with appropriate 1hr fire rated walls and all penetrations into the space must be equipped with approved fire stopping.
- Adequate cooling for the internal network support equipment must be provided as necessary to ensure reliability.
- In general, the weights of the internal network support and operations components are well within the range of live loads specified for Network Facility Equipment, and standard administrative equipment room configurations. However, some administrative equipment installations may be located in other than the two previously mentioned space types. In these instances, the CenturyLink engineer, or space and power planner, should determine floor loading based upon equipment weight information, and system configuration from the equipment manufacturer's specifications, to determine the viability of installation at that location.
- Equipment requiring the design of raised floor application shall adhere to the requirements for raised floors as outlined by the manufacturer’s recommendations and engineering standards outlined in Chapter 13 of CenturyLink Technical Publication 77351.
- Desks, chairs or cabinets placed in network equipment space must be of non-combustible material. Desks, chairs, cabinets, printers, etc. may also be located within internal network support space.

8.4 Environmental Controls

Computers and equipment required for Internal Network Operations Support 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 a high temperature of 85° Fahrenheit and a low temperature of 60° Fahrenheit. Heating shall be provided to achieve a target temperature of 70° Fahrenheit and cooling provided to achieve a target temperature of 78° Fahrenheit. The temperature shall be measured at a point of 59 inches above the floor, in the middle of the cold aisle (usually the equipment front aisle), or approximately 18 inches from the face of equipment intake grills if there is no facing equipment

When the equipment is clustered in one location, the system with the most stringent temperature requirements shall be discussed with the CenturyLink planner and engineer to determine the most prudent direction for the environment.

Operation of the equipment at altitudes greater than 8000 feet above sea level may require additional precautions and restrictions.

Equipment may be sensitive to excessive vibration and shock. Isolation from the source of the vibration and shock may be required.

For maximum reliability of operation, equipment 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 equipment from electromagnetic radiation from sources such as radar, radio or television transmitters, or similar emitters shall be investigated prior to installation.

8.5 Power Requirements

In raised floor environments, if cabling is run under the floor, but not in conduit, 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 internal network operations support area.

Note: This master disconnect switch in raised floor environments is typically referred to as an Emergency Power Off (EPO) button/switch.

The procedures for grounding equipment are contained in the Protective Grounding part of this publication. (See Module 1, Chapter 4, 4.5.)

The single point grounding system in most AC-powered areas 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 equipment installations are summarized below.

Existing Conditions - To clarify interrelationships, the various sources and combinations of AC supplies that can be used to power equipment installations are summarized as follows:

- Unconditioned commercial AC power is the least expensive form of power supply suitable for equipment installation. This supply is not adequate for most equipment 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 Network Facilities 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.
- If an inverter is operated in AC-preferred mode, the equipment it serves must be capable of tolerating source switching interruptions of 4 ms.
- Uninterruptable Power Supply (UPS) may also be utilized within the Network Facility environment when a DC battery plant is not available, or the protected AC load needs are greater than 60KW.

When commercial AC supply does not allow satisfactory operation of the equipment, 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 non-regulating 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 equipment. 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) 2250-30. 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 equipment, 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 equipment.
  2. In place of LVR when voltage sags are not a problem.
  3. As part of some power distribution units.

Inverters operating in a DC-preferred mode from a DC power plant are employed to supply interruption proof AC power when the equipment cannot tolerate processing interruptions. The AC output is not affected by the noise that could occur on the commercial AC supply. Modern inverters may or may not be designed for N+1 redundancy. However, redundancy is preferred, more reliable, and may be required depending on the criticality of the load being fed.

8.6 Communications Protocol

All equipment protocol shall be in compliance with Electronic Industries Association (EIA) protocol standards.

8.7 Alarms

At a minimum, alarm systems shall be provided for the equipment required for internal network operations support which include the following:

- Computer insanity alert (such as a watchdog or sanity check circuit)
- Loss of power to the equipment
- Operation of fire detection
- Failure of HVAC system (Heating, Ventilating and Air Conditioning)
- High humidity
- High and low temperature
- Water alarms
- Loss of commercial power
- Computer Monitoring Systems

The equipment shall be alarm compatible with external maintenance and monitoring systems. The CenturyLink equipment engineer will specify interconnection requirements for external maintenance and monitoring.

The alarm system should function whether using normal or emergency power.

Contents

EXHIBITS

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 CenturyLink.

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 CenturyLink.

9.2 Alarms

There are three levels of severity of alarm indications common to "Switching", "Transport", and "Data" 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 NE trouble condition that requires maintenance action.

Local alarms shall be provided in all Network Facilities. 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 Network Facility Alarm Cut-Off (ACO)

A local control shall be provided for Network Facility audible ACO.

The ACO shall silence Network Facility audible alarms for that NE and shall not inhibit subsequent Network Facility audible indications, which indicate additional failures. The ACO shall not retire any visual or remote indications, and shall not issue a clear indication.

The Network Facility 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 Network Facility 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.

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 effect 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 Network Facility visible alarms such as aisle pilots and for other supplementary alarm panel lamps shall be made according to the following chart.

Alarm classification	Color
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 Network Facility 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, the CenturyLink Equipment Engineer shall be notified to determine if remoting is required.

Specific design criteria may vary within CenturyLink. 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 or installation 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

Uni-polar 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.

CenturyLink 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 CenturyLink 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 non-alarmed 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
  - Assignment terminal blocks shall terminate the discrete alarm and control point leads of the remote telemetry device.
  - The assignment terminal block pin arrangement, as viewed from the front, shall be as follows:
    - Numbered from top to bottom.
    - Numbered from left to right.
    - 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.
    - 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.

    - 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.
    - 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.
    - 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.
    - 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
  - Equipment terminal blocks shall terminate the discrete alarm and control point leads of each NE.
  - The Equipment terminal block pin-arrangement, as viewed from the front, shall be as follows.
    - Numbered from top to bottom.
    - Numbered from left to right.
    - 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.
    - 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.
    - 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.
    - 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

  - 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.)

- 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.
- 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.
- 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 Network Facility, it is the responsibility of the CenturyLink detail engineer or 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 engineering design work package and this publication.

The CenturyLink detail-engineer or 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 engineering design work package and Module 2 of this Publication.

9.4.2 Remote Telemetry System Additions or Removals

The CenturyLink detail engineer or 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 engineering design work package and Module 3 of this publication.

9.4.3 Network Facility Base Drawings

The CenturyLink detail engineer or engineering vendor is responsible for identifying, marking and creating all the appropriate CenturyLink Network Facility base drawings; for all equipment added, removed or assigned to.

Specific requirements shall be outlined in the engineering design work package.

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 Network Facility.

Refer to: Technical Publication 77385, Chapter 8 PSMC's and Battery Monitors, and Chapter 13 Standard Alarm Thresholds for Power, 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 Alarms

Building and environmental alarms shall be provided to meet the fire, life and safety requirements of CenturyLink.

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 CenturyLink detail-engineer or engineering vendor. These alarms shall be transported from the demarcation point to the Network Monitoring and Analysis (NMA) system or legacy alarm 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 Network Facility 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.

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.

9.8 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 CenturyLink Network Monitoring and Analysis - Facility Modules.

9.9 Transmission/Facility Equipment

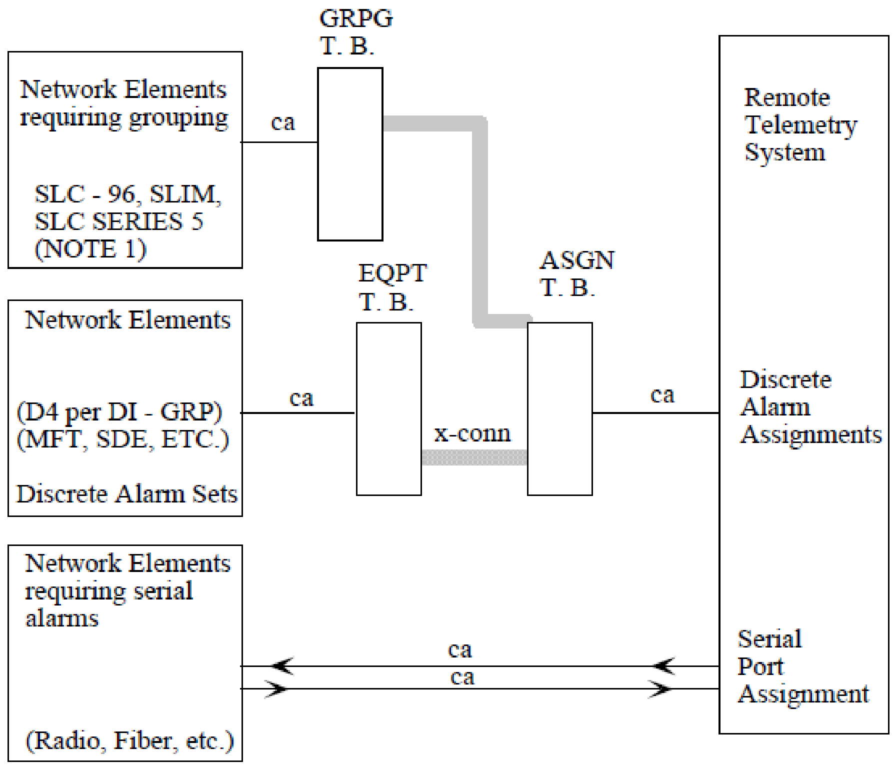
Remote telemetry capability shall be provided for the surveillance of all NEs in both switching and non-switching sites. The telemetry device will be connected to the appropriate OSS.

Non-switching sites

- The CenturyLink 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:

GRPG 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
2-H-1 TELEMENTRY BLOCK DIAGRAM

Contents

<u>TABLES</u>

10 Wire, Cable and Fiber 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 engineering job package and standard configurations. 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. Refer to CenturyLink Technical Publication 77385 "Power Equipment and Engineering Standards" for proper AC/DC power cabling requirements.

Insulation must meet the fire and abrasion resistance requirements in Chapter 11 of this Module. Low smoke, low flame or 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.

Telecommunications 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 such as::

- <u>Electrical Factors like</u> voltage drop, transmission properties, frequency, capacitance, inductance and voltage breakdown.

- 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 is also a factor in the selection of wire and cable.

Also, certain types of wire are listed. 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 CenturyLink Technical Publication 77350, "Central Office Telecommunications Equipment Installation and Removal Guidelines".

The use of segregated cable racks for power, fiber and switchboard cable is the first choice of installation. All forms of copper cable (switch, data, transport, etc) may share the same switchboard cable rack with the following exceptions:

- Ground Cable
- Unfused Power Cable
- Fused Power Cable larger than 4/0 regardless of fuse size
- All power cable with a 70amp protection device or larger
- In small sites (such as huts), where separate power cable rack may not exist, segregation of fused power cable from switchboard cable on the only cable rack may be used if power cables cannot be run on brackets attached to the switchboard rack.

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.

Distributing frame wire shall consist of DT type solid conductor hook-up wire (tinned copper with irradiated polyvinyl chloride (IPVC) insulation.

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 conductors 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 non-soldered terminations:
  a. Use IPVC 22, 24 or 26 gauge, solid copper conductor

- Local AC power cable:
  a. Use of THWN, THW, or THHN.

- Local DC power cable (16 gauge and smaller):
  b. Use of RHW, RHH or XHHW preferred for 16 gauge and smaller.
  c. Use of THWN, THHN and TFFN may be used where protected from abrasion and coldflow at points of impingement.
  d. Use of TFFN without cotton braid may be used in conduit or attached to side of cable rack (but must be protected from abrasion and coldflow at points of impingement)
  e. Refer to Technical Publication 77385 "Power Equipment and Engineering Standards" Issue J, July 2013 for additional engineering requirements regarding power cable.

- Surface wiring:
  a. Use BH2 type (dual insulation – IPVC over semi rigid PVC) 22 or 24 gauge solid copper conductor.

- Extra strength/abrasion resistance:
  a. . Use BH2 type (dual insulation – IPVC over semi rigid PVC) 22 or 24 gauge solid copper conductor.

- Shielded wire –
  a. 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 a switchboard cable, run on cable racks:
  a. In general, only one to four leads (wires) should be run without using cable (1 to 4 leads of wire should not be run in cable racks).
  b. Use PVC CBL, 20, 22 or 24 gauge solid copper conductor

- Wire run in conduit:
  a. THWN, THW or THHN for AC applications
  b. XHHW, RHH, RHW, THHN and THWN for DC applications
  c. Refer to Technical Publication 77385 "Power Equipment and Engineering Standards" Issue J, July 2013 for additional engineering requirements regarding wires run in conduit

- 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 -	Ground wiring

Red -	Only allowed in in-bay wiring and in Prem locations where power wire is brought to CenturyLink, and must be labeled at both ends for polarity when the wire belongs to CenturyLink (except for legacy RUS offices where the red and black are very common)

While other colors may be used on positive or negative leads, if the colors are different for positive and negative, the gray is preferred for the grounded return side (usually positive) in traditional gray and black power cable offices, while red and black are commonly used in traditional RUS offices.

10.3.6 Cross - connect Wire

The following table reflects the recommended standard colors and recommended connecting and connector block termination connection types for Distributing Frames within the Network Facility DF Network (note: follow suite with existing frame wire gauge and connection type, where applicable.)

Distributing frame wire shall consist of DT type solid conductor hook-up wire (tinned copper with irradiated polyvinyl chloride (IPVC) insulation.

Table 10.1 Distributing Frame Cable

Wire Type	Wire gauge	Insulation Color	Service Circuit	Framework type / Block connection type
Single	24 GA	BK (black)	Misc. lead single	Modular / quick-clip, Small Conventional/ wire-wrap
1 Pair-twisted	24 GA	Y/BL (yellow/blue)	POTS	Modular / quick-clip, Small Conventional / wire-wrap
1 Pair-twisted	24 GA	Y/R (yellow/red)	Specials	Modular / quick-clip, Small Conventional / wire-wrap

1 Pair- tight-twist (cat5)	24 GA	V / BL (violet/blue) (violet/green pending)	DSLAM	Modular / quick-clip, Small Conventional / wire-wrap
2 Pair-twisted	24 GA	Y/R (yellow / red) 2 pair	Specials (4WR) , use 2 pair	Modular / quick-clip
Single	22 GA	S (slate)	Misc. lead single	Large Conventional / wire-wrap
1 Pair-twisted	22 GA	W / BL (white/blue)	POTS	Large Conventional / wire-wrap
1 Pair-twisted	22 GA	W/R (white/red)	Specials	Large Conventional / wire-wrap
1 Pair- tight-twist (cat5)	22 GA	V/BL (violet/blue)	DSLAM	Large Conventional / wire-wrap
2 Pair-twisted	22 GA	W/R (yellow/red) 2 pair	Specials (4WR), when transmit-receive separation required	Large Conventional / wire-wrap
2 Pair-twisted quad	22 GA	W/BL/R/G (white/blue/red /green)	Specials (4WR), when transmit-receive separation not required	Large Conventional / wire-wrap

Refer to Chapter 3 in Technical Publication 77351 for additional details regarding distributing frame cabling.

10.4 Fiber Optic Cable

10.4.1 General Fiber Cable Requirements

The following general requirements apply to all indoor fiber optic cable assemblies used within a CenturyLink network facility.

- Third party independent testing and compliance to GR-326, GR-409, applicable sections of GR-20 are required for all indoor, indoor/outdoor and armored fiber cable assemblies.

- Buffered riser OFNR rated fiber cables, third party independent tested and compliant to UL-1666 flammability rating, shall be used within CenturyLink indoor environments.

- Buffered plenum OFNP rated fiber cables, third party independent tested and compliant to NFPA-262 flammability rating, shall be used within CenturyLink indoor environments where cable routing is in an air supply or return system.

- Indoor/Outdoor rated fiber entrance cable third party independent tested and compliant to UL-1666 for OFNR or NFPA-262 for OFNP may be used to extend into the network facility environment beyond the 50 sheathed foot rule.

- Armored Cable assemblies, third party independent tested and compliant to UL-1666 for OFNR or NFPA-262 for OFNP fiber subunits, may be used in network facilities that require a minimal number of fiber cable runs and cannot accommodate the construction of a cable support system such as cable rack or fiber duct.

- Outside Plant (OSP) cables do not have the required American National Standards Institute (ANSI) ratings and will not be run in the network facility environment.

- All indoor general purpose fiber shall be factory connectorized assemblies. The exception is a stub end cable intended to be fusion spliced within an approved fiber splice facility. Use of 'Splice-On' connectors is approved for maintenance activities only due to varying quality and increasing speed and bandwidth requirements.

- Field installed connectors shall <u>not</u> be considered as a means to change connector type for an incorrectly ordered cable assembly. In these instances the cable shall be returned to the manufacturer and the correct assembly reordered.

- General purpose fiber cables to be terminated to an FDP, OPP or at the FDF lineup shall be equipped with SC- Ultra Physical Contact (UPC) polish connectors per the CenturyLink Fiber Connector Policy.

Use of single-mode SC- Angled Physical Contact (APC) polish is permissible where circuit protocols dictate. If the circuit design criteria has not specified UPC or APC polish requirements, the adapter type shall default to UPC. Refer to the CenturyLink Fiber Connector Policy for details.

- All CenturyLink fiber provisioning shall be terminated to a CenturyLink network facility FDP, OPP or at the FDF lineup equipped with single mode connectors per the published CenturyLink Fiber Connector Policy. Provisioning at customer locations may require multi-mode connectivity.

For CenturyLink general purpose infrastructure applications, the use of multi-mode fiber and connectors have a distance limitation and are confined to within an equipment bay, cabinet or system and must be authorized by the Standard Configuration document for the specific equipment device. Due to modal dispersion and high optical and return loss characteristics, multi-mode fiber will not support optimum Network Reliability.

- Multi-count fiber cables shall be used wherever possible to consolidate multiple cable runs originating and terminating in the same locations

- Using multi-count fiber cables saves cable installation expense, provide additional protection in the overhead cable racks and reduce cable congestion.

10.4.2 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:

- Outdoor rated fiber entrance cable must be spliced and converted to OFNR rated indoor fiber cable within 50 sheathed feet of the cable's entrance from an outside wall.
- Refer to Chapter 3, Section 4 for additional details regarding fiber cabling requirements from the outside wall.

- 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. Refer to chapter 6 for additional cable rack requirements.

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.

10.4.3 Inner-duct

Plastic type inner-duct or coreflex products that do not pass NEC standards for fire propagation and smoke emission levels will not be used inside any CenturyLink network facility on a going forward basis.

Existing inner-duct that do not meet NEC standards will be terminated in the cable entrance facility and plugged for gas protection at the entrance to the building. As existing inner-duct is vacated, it will not be reused, but will be removed from the building as soon as possible. Existing inner-duct can also be removed during trigger events, such as the re-terminating of fiber cables onto the FDF.

Plastic enclosures that do not meet NEBS level 3 fire rating, such as splice cases and terminal boxes, must be enclosed in a fire resistant wrap called a fire "blanket".

All existing inner-duct inventory shall be evaluated by the CenturyLink Strategy and Development representative responsible for Network Facility fiber products. Contact the Strategy and Development group if an evaluation is necessary.

10.4.4 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.

- Fiber cables shall maintain a minimum bend radius recommended by the cable manufacturer, or if not specified, equal to 10 times the outer diameter at no tensile load.

Care must be taken to size cable rack/fiber duct and transition fittings appropriately to accommodate increased bend radius requirements when larger multi-count cables are planned. Most fiber duct systems are not designed to accommodate the sweeping bend radii required for multi-count cables constructed with central strengthening units. Congestion and blocked cable paths are inevitable when multiple multi-count fiber cables greater than 12 fibers and constructed with a central strength unit are placed within the same fiber duct system.

10.4.5 Measuring and Ordering

Network Facilities are not equipped to manage large volumes of excess fiber cable length, therefore ordering the site specific lengths optimizes network capacities. Ordering fiber cables longer than the required length increases costs to the corporation by the additional need to provision adequate fiber management devices and increases the potential combustible material in the network facility. When proper fiber management devices are not installed, managing excess cable slack becomes problematic and could negatively impact Network Reliability.

- General purpose fiber cables shall always be ordered to the length required for the site specific cable route or application, rounded up to the nearest whole meter.
- Wherever possible, field measurements shall be taken for each cable route prior to detail engineering and material ordering and must account for all rise and run elevation changes throughout the cable route path.

10.4.6 Securing

- Securing the indoor, inter-office, fiber optic cable assembly to the gray horizontal or vertical and the orange vertical ladder type cable rack shall follow a standard procedure. Fiber cable assemblies 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.
- Fiber cable must be closely monitored for possible cable crimping where it is tied.
- Where securing is required, approved cable clamps or fiber sheeting and lacing cord shall be used.
- Cable ties are prohibited on any type of fiber optic cable.
- Fiber optic cables will not be secured within the FPS.

10.4.7 Intra-System Fiber Optic Cable Routing

- A system is defined as a dedicated, multiple adjacent bays or cabinets of telecommunication equipment performing a specific function and carrying the same Network CLLI code. One bay or cabinet does not constitute a system.
- All Equipment to Equipment connections will be routed from the Network Element (NE) to the centralized Fiber Distribution Frame (FDF) for cross-connect when the FDF is an established cross-connect arrangement. Refer to Chapter 3 for fiber cross-connect systems.
- Direct inter-connection between NEs is permissible for network facilities with an establish interconnect FDF

- Direct inter-connection between optical interfaces in different bays or cabinets by-passing the centralized cross-connect FDF is only permissible when the interconnecting equipment is defined as a system and contains a purposefully designed fiber routing path or is specifically identified within the Standard Configuration document for the given equipment.
- Fiber optic cable 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 CenturyLink Standard Configuration documents prior implementation.

10.4.8 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. Refer to chapter 6 for cable rack information.

10.4.9 Fiber Management

The success of any equipment with fiber terminations is dependent on effective fiber cable management. Pinched fiber cables, micro and macro bends, and stress points, can lead to intermittent transmission problems and increased signal attenuation which negatively impacts network reliability. Sensitivity to signal attenuation becomes an increasing concern as higher speed/bandwidth circuits are introduced across the fiber network.

- All excess cable slack (multi-fiber cables and/or equipment fiber jumpers) shall be managed within an approved fiber management device specifically designed for fiber cable storage of the cable size being installed.

- Storage of excess cable slack within the fiber cable support system (e.g. cable rack or fiber duct) is strictly prohibited.

    - Storage of excess cable length in the cable rack/fiber duct systems prematurely exhaust the support system, create cable route obstructions, increase the vertical load of the support system, introduce macro bending and pinched fibers and increases the potential combustible material in the network facility all of which negatively impact Network Reliability.

- When deploying fiber termination panels or fiber fed equipment technologies for any application, engineering shall consider placement of additional fiber management devices to effectively manage excess fiber cable lengths.

Some of the equipment devices are equipped with fiber management spools mounted within the panel or shelf with the assumption that not all cables will have slack. Often, these spools provide a minimal amount of storage and an additional storage device will be required to manage all the potential excess cable associated for future terminations.

Fiber cable storage devices can be configured in the vertical space adjacent to a bay frame, such as an IMP spacer (a network spacer with fiber spools mounted on the filler panel) or in the horizontal space within the equipment bay or cabinet. Choosing the appropriate storage device is dependent on the available space and ultimate storage capacity required. Often, appropriate fiber storage devices are recommended for a given technology deployment and are documented in the Standard Configuration guide.

- Most shelf or panel style fiber management devices are designed to support the bend radius of 2.0mm jacketed fiber and less (this includes single and dual cable assemblies). The outer cable sheath of Quad fiber assemblies should be stripped back and removed to allow individual jacketed single fibers to enter the equipment shelf

- Multi-fiber cable assemblies (≥4 fibers) constructed with bend-optimized fiber may be routed through vertical fiber management style spacers (IMP/FOT/FOTSP) if fiber storage is required. In these applications the outer cable sheath of the multi-fiber cable assembly shall be stripped back and removed to the last tie point as the cable transitions off the cable rack. Only the exposed jacketed fiber subunits containing bend-optimized fiber are permitted to enter the vertical storage device for storage using the dowels. Multi-fiber cable assembly subunits shall never be routed through shelf/panel style fiber management devices as they are not designed for cables that large.

- 900µm and 250µm buffered fibers shall always be stored within the equipment chassis or fiber panel. These are typically equipped in breakout/fanout style cable assemblies. Storage of buffered fibers outside of the panel places the fibers at significant risk for damage and could negatively impact service and Network Reliability.

10.4.10 Fire and Electrical Requirements for Optical Fiber Cables

All optical fiber cables and any raceway containing them will be resistant to the spread of fire and to specific levels of smoke emissions.

- Exceptions are for existing fiber cables within a metallic conduit.

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 Riser (OFNR) and Optical Fiber Conductive Riser (OFCR) cables are required for use in horizontal runs, vertical runs, shaft-to-shaft, or floor-to-floor applications.
- Optical Fiber Nonconductive Plenum (OFNP) and Optical Fiber Conductive Plenum (OFCP) cables are required for use in drop ceilings, raised floors, plenums and other space used for network facility environmental air.
- Optical Fiber Nonconductive (OFN) and Conductive (OFC) cables are suitable for general purpose use, but shall not be installed as riser or plenum in a network facility environment.
- Outside Plant (OSP) cables do not have the required American National Standards Institute (ANSI) ratings and will not be run in the network facility environment.
- Conduit, including the inner-duct 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 CenturyLink Technical Publication 77355, "Grounding - Central Office and Remote Equipment Environment" for additional engineering requirements.
- Only intermediate and rigid metallic conduit may be used as vertical or horizontal raceways in extreme situations for cable that does not meet fire propagation and smoke emissions standards.

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11 Network Facility Equipment Building Environment Requirements

11.1 General

This part of Module 1 defines the desired environment for Network Facility Equipment. 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 Network Facility activity. Such considerations are described in instructions provided by the Director of Health and Safety.

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 Network Facility Equipment 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.

References made throughout this Chapter are in compliance with GR-63-CORE "NEBS Requirements: Physical Protection, Telcordia Technologies Generic Requirements", Issue 4, April 2012.

11.2 Network Equipment Building System -Equipment Testing Requirements

Equipment to be located within CenturyLink equipment structures (network facilities, R.O.W sites, remote huts, fiber hubs etc.) shall meet NEBS level one requirements. These include but are not limited to:

- Surface Temperature Requirement
- Heat Dissipation Documentation Requirements
- Fire Resistance Criteria

As referenced in Telcordia Document GR-63-CORE, "Network Equipment - Building System (NEBS) Requirements: Physical Protection".

- Radiated Emission (Closed Door Requirement)
- Conducted Emission for Power, Signal, and Voiceband leads
- Voltage Limiting Protection for CO Switching Systems
- Short Circuit Tests for Telecom Ports
- Second-Level Lightning and AC Power Fault Tests for Equipment with Telecom Ports
- Second-Level Lightning for Equipment with AC Power Ports
- Second-Level Lightning and AC Power Fault Tests for Equipment with Coaxial Cable Ports
- Electrical Safety and Listing Requirements
- Bonding and Grounding

As referenced in Telcordia Document GR-1089-CORE, "Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment".

Telecommunications equipment directly connected with the outside plant cabling, or any metallic cabling leaving the CenturyLink Network Facility shall also conform to the applicable NEBS level one tests below as determined by the NRTL (Nationally Recognized Testing Lab):

- Current Limiting Protector Test
- AC Power Fault Immunity (second level)
- Voltage Limiting Protector Test

As referenced in Telcordia 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 (Indoor Levels) (NEBS 2)
- Altitude Requirements (NEBS 3)
- Package Handling Shock Requirements and Transportation Vibrations (NEBS 3)
- Fan-Cooled Equipment Requirements (NEBS 3)
- Temperature Margin (NEBS 3)

As referenced in Telcordia Document GR-63-CORE.

- ESD (Installation and Repair) (NEBS 3)
- EFT (NEBS 3)
- Radiated Emissions (Open Doors) (NEBS 3)
- Radiated Immunity (Conditional Requirement) (NEBS 3)
- Conducted Emission for Broadband Leads (NEBS 3)
- Conducted Immunity for Broadband and Voiceband Leads (NEBS 3)
- Protection Coordination (NEBS 3)
- Lightning Immunity (First Level- All sections) (NEBS 2)
- EMI Immunity (Open Doors) (NEBS 3)
- DC Potential Difference (NEBS 2)
- Bonding and Grounding, Compatible to CBN (NEBS 2)
- Corrosion (NEBS 2)

As referenced in Telcordia Document GR-1089-CORE.

Equipment directly connected with outside plant cabling or any metallic cabling leaving the CenturyLink Network Facility:

- 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 Network Facility lineups shall meet these additional criteria requirements as they apply to the specific equipment:

- Spatial Requirements
- Root Cause Analysis
- Altitude Objectives
- Equipment Air Filter Criteria
- Surface Temperature Objective
- Acoustic Noise
- Illumination
- DC Potential Difference
- Corrosion
- Heat Dissipation Limit Objective

- Equipment Airflow
- Surface Temperature Objective
- Lightning Surge laboratory test equipment must meet Telcordia requirements
- Fan-Cooled Equipment Objective
- DC Power Port Criteria

11.3 Thermal

All equipment shall remain operational within the following room ambient temperature and humidity limits (see Note 2). Thermal requirements for Internal Network Maintenance and Operation Systems can be found in Module 1, Chapter 7.

Operating Temperature:	+41°F to +104°F
Short-Term Temperature: (see Note 3)	Minimum +23°F Maximum +122°F
Nominal Ambient Temperature:	+68°F to +78°F
Maximum Rate of Temperature Change:	86°F in 60 min.

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 (60 inches) 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.)

For maximum energy conservation and to enhance fan life, some network equipment fan systems may be thermostatically controlled and equipped for variable speed. Network equipment systems requiring special considerations for cooling or additional spacing requirements will be noted in the CenturyLink Standard Configurations.

All equipment shall remain operational when installed in Network Facilities located from 200 feet below sea level to 13,000 feet above sea level.

11.4 Heat Dissipation

The heat dissipation criteria in this section are based on standard cooling capacities of traditional network facilities and standard aisle spacing. The average designed system equipment area that heat load shall not exceed is 134.7 watts/square foot (134.7W/s.f.) unless special equipment frame as well as equipment room cooling provisions are made.

The maximum rate of heat release and method of cooling (natural convection, forced-air fans) shall be documented as follows for all equipment:

- For circuit packs, document the rate of heat release in Watts (W).
- For equipment shelves, document the rate of heat release in Watts as well as the rate of heat dissipation in W/s.f. per vertical height unit.
- For floor-mounted equipment, document the rate of heat release in Watts, as well as the rate of heat dissipation in W/s.f. of floor area.

The floor area used to calculate the following limits always includes the associated aisles. For example, in the case of an individual equipment frame or shelf, the area is that of a rectangle outlined by the frame sides and the center lines of the standard front and rear aisles (1/2 of the total front aisle and 1/2 of the total rear aisle measurements).

NOTE: If no other equipment is placed in an aisle adjacent to the equipment, then the full aisle measured may be used.

To determine if this limit is met, all equipment is considered in one of the following classes:

TABLE 11.1 Equipment Area Rate of Heat-Dissipation

	Rate of Heat Dissipation	
Equipment	**Natural Convection**	**Forced-Air Fans**
Shelf (based on vertical frame space the equipment uses)	20.9 W/s.f./ft	27.9 W/s.f./ft
Individual Frame (2-post)	134.7 W/s.f.	181.2 W/s.f.
Multi-Frame Systems	79.9 W/s.f.	99.9 W/s.f.

Specific equipment that may exceed the above requirements shall be outlined in the standard configuration guidelines and may require custom cooling solutions, special placement in equipment cabinets, and/or require increased aisle spacing.

Information on equipment heat dissipation shall be included in the CenturyLink Standard Configuration documents and equipment specifications. The data should be as accurate as possible to avoid uneconomical power and air conditioning facilities. This will alert planners of the need to provide special air distribution, increased aisle spacing, or special deployment. If aisle spacing deviates from the standard in Chapter 2, for an individual frame, the specific cooling plan must be indicated particularly if it involves other than natural convection. These recommendations should appear in CenturyLink Standard Configuration documents and equipment specifications.

11.5 Fire Resistance

The following specifies fire resistance requirements for new Network Facility Equipment 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 Electro-technology 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.

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_2 charge) 15 minutes after flame outbreak in the assembly. [As specified in Telcordia Technical Reference GR-63-CORE, "Network Equipment-Building System (NEBS) Generic Equipment Requirements.
- In cable distribution assemblies shall meet the requirements of ANSI/ATIS-0600307 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.
- CenturyLink approved material and equipment shall adhere to the above requirements and shall also be noted in the standard configuration guidelines where applicable. Contractor provided equipment and material shall also adhere to these requirements.

11.6 Earthquake And Office Vibration

Equipment facilities struck by earthquakes will be subject to motions, which depend mostly upon the 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 (red) corresponds to the most active earthquake prone areas, Zone 3 (yellow) is the next most active seismic area, and Zone 2 (green) and 1 (blue) 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.

Network Facility Equipment 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. Network Facility 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 Network Facilities. This vibration may be caused by nearby rotating equipment, rail or truck traffic outside the building, or construction work in adjacent buildings. Surveys of Network Facilities 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.

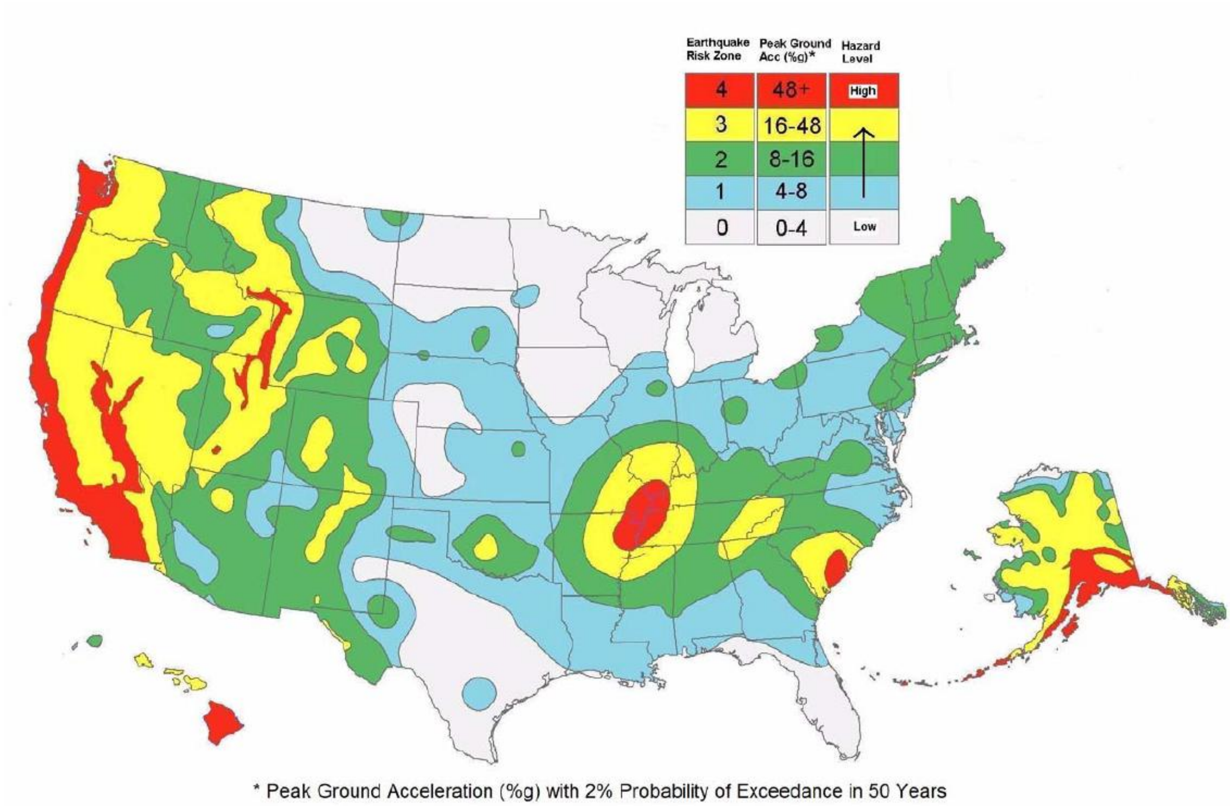

EXHIBIT J-1 EARTHQUAKE ZONING MAP

11.7 Airborne Contaminants

CenturyLink 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 Network Facility.

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 Network Facility construction and modification.

Normal Network Facility operating conditions will be maintained to not more than 100,000 particles of 0.5 microns in size or greater per cubic foot of air. All Network Facility Equipment 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.

11.8 Acoustical Noise

Network Facility 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 network facility 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 S12.10-2010 “Acoustics-Measurement of Airborne Noise Emitted by Information Technology and Telecommunications Equipment”, ANSI S12.12-1992 “Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity” or ANSI S12.54-2001 “Acoustics – Determination of Sound Power Levels and Sound Energy Levels of Noise Sources Using Sound Pressure – Engineering Methods in an Essentially Free Field Over a Reflecting Plane”.

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 Network Facility personnel. Sound measurement shall be made in a room or enclosure which duplicates as much as possible the acoustical properties of a Network Facility 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 Network Facility 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
	Equipment to be located in a Telecommunications Room	78
Outdoor	All equipment	90*

*Local ordinances may require lower sound levels

Note: The dB values are referenced to 20 μN/m2 (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.

11.9 Illumination

Minimum levels of illumination (see Exhibit J-2) shall be maintained in Network Facility Equipment 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 J-2.

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	LEVELS (FOOT CANDLES)
EQUIPMENT FRAME AREA	
Maintenance Aisle	15 (note 1)
Wiring Aisle(Use portable lighting units during maintenance)	No design level
DISTRIBUTING FRAME AREA	
Maintenance Aisle	20 (Note 1)
Wiring Aisle	10 (Note 1)
POWER AND BATTERY AREAS	
Aisles and open spaces	30 (Note 2)
AC switchboards and DC Battery Distribution Boards (BDB's)-Measured at center of board	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 (measured on shelf)	50
Print display board (measure at center of board)	50
Desk top (measured on writing surface)	50-70
Light Emitting Diode (LED) display	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

11.10 Electro-Magnetic Compatibility

The following stipulates the minimum electromagnetic compatibility objectives for all new equipment intended for operation in Network Facilities. 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).

11.11 Electrostatic Discharge (ESD)

This section states the Electrostatic Discharge Control (ESDC) concerns for all new equipment assemblies intended for use in Network Facilities. 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.

A completed equipment assembly must meet the static electricity resistance requirements as specified in Telcordia Technical Reference GR-1089-CORE.

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.

Contents

12 General Interaction Requirements

12.1 General Interaction Requirements

This Part covers interconnection requirements for equipment to be engineered and installed in CenturyLink offices. Additionally, this part includes information concerning equipment removed for reuse, human interactions, interconnect records and CenturyLink points of contact.

12.2 Equipment Interconnect Requirements

The equipment installed in Network Facilities 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, bay framework, and cabinets should conform to existing frame types, heights and widths, or to those specified by the CenturyLink 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.

> NOTE: Mountings and shelves which have been tested and meet appropriate CenturyLink approved measurement standards, and are provided as part of a standard equipment design arrangement by approved suppliers may be assumed to have met this requirement.

The CenturyLink engineering representative 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 CenturyLink Representative in charge of equipment engineering shall be contacted if there are any interconnect conflicts.

12.3 Equipment Removed For Reuse

- Prior to removal of any equipment, the CenturyLink engineer and installation vendor shall verify there are no working circuits and that the local network operations personnel are not utilizing the equipment that is to be retired/removed.

- Engineering and Installation shall adhere to the correct CenturyLink method and procedure document NS-LN-XP-MP-13-0215 associated with the removal and disposition of network equipment. The CenturyLink engineering represented shall be contacted to obtain a copy of the M&P document as required.

- Cards, modules, and circuit packs must first be removed from the equipment chassis and returned separately. They shall be prepared for returning in anti-static bags and returned to PICS/LCAM and/or operations as required per CenturyLink equipment removal and disposition process.
- All cables associated with the equipment being removed shall also be removed from the cable racks to their furthest possible location and all labeling updated from existing network elements.
- The installation supplier shall validate the equipment to be removed by comparing individual part number with the equipment identified in the job engineering package to ensure the correct material will be removed. Any discrepancies identified shall be communicated back to the CenturyLink design engineer for resolution prior to removal of equipment.
- 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 listed on the Material Review Form (MRF)
- The installation supplier shall verbally notify the CenturyLink 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 follow the appropriate Material Review Form and must contain the installation suppliers company name, CenturyLink project number, equipment/material part number and description, the inspection date and a detailed description of the location and (or) condition of the equipment damage.
- The CenturyLink engineer will contact the Asset Recovery and Disposition by completing the MRF 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.
- Equipment and frameworks/cabinets will be tagged on the equipment, frame or bay uprights and on the material review form attached to the outside of the shipping cartons
- The installation supplier shall sign, date and return photocopies of all material review forms to the Asset Recovery and Disposition prior to shipment of equipment.
- The CenturyLink engineer shall make arrangements for the installation supplier to receive the shipping and packing materials necessary for shipment of un-mounted units per the Asset Recovery and Disposition instructions.

- The installation supplier will utilize the appropriate assembly instructions when preparing to ship equipment removed for reuse. All equipment must be packed and secured as specified in the instructions to safeguard against possible equipment damage during shipment.
- Un-mounted units shall be palletized using CenturyLink standard pallets. Cartons shall be stacked on pallets so that all labels are visible.
- All frames being shipped for reuse shall be transported using CenturyLink approved transportation. The 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 CenturyLink project. The equipment installation design, for example, should ensure that Network Facility Technicians have an optimum interaction with installed equipment.

Interconnect added equipment with the Network Reliability Operations Center (NROC) via data links, when possible. Information on these interaction systems is shown on Network Facility records.

Engineer equipment added to a CenturyLink Network Facility to provide equipment maintenance performable by one person, either at the fault location, or at the NROC. The equipment added to a Network Facility should be engineered to provide assurance, at either location, that it has received and understood maintenance commands, and is responding appropriately.

Engineer equipment that allows maintenance routines or repairs to be performed without interrupting service. 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 CenturyLink. Instructions to installers should include directions to contact CenturyLink 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 Chapter 11, section 8, Exhibit J-2 "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 the CenturyLink engineer or the engineering contractor.

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 CenturyLink engineer whose name and telephone number are listed on the engineering job package. Contact specifics are noted below:

Project control is retained by the CenturyLink engineer, who provides the point of contact for equipment additions and issue escalation.

The 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 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 CenturyLink engineer is a secondary point of contact.

Only the CenturyLink 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 Network Facility 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 CenturyLink drawing system tracks assignments/reservations for equipment floor space, Distributing Frames (conventional, fiber and modular), manual DSXs, fuses and/or circuit breakers in BDFBs/PBDs. This applies to CenturyLink equipment within CenturyLink buildings, customer locations, or other locations where assignment records are required, as well as collocation assignment requirements. Changes made to original assignments/reservations shall be updated in the CenturyLink drawing system by the CenturyLink engineer and/or the engineering vendor.

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FIGURES

TABLES

13 Raised Floor Environments

Raised floors typically provide an under-floor space for use either as an air plenum and/or a cable distribution system in support of network and data equipment.

This chapter provides generic requirements for raised floor systems and is not to be construed as a suggestion to modify or change any product requirements provided by the raised floor manufacturer's specifications.

Engineering requirements associated with cable rack, fiber protection system, and cabling in an overhead environment shall adhere to the requirements outlined in other chapters of this document. Engineering requirements associated with placement under a raised floor environment are included in this chapter.

- Overhead cable rack and air distribution should be considered as the first choice when establishing a new area before considering a raised floor environment.
- Overhead cable rack and under-floor air distribution shall be considered as the standard design when establishing a new raised floor environment.
- New raised floor environments shall be limited for deployment with 7 foot framework and cabinets and shall be avoided when requiring frameworks and/or cabinets taller than 7 feet. Taller frameworks and cabinets may contribute to potential overloading of the raised floor structure.
- Raised floors may be required as an alternative for providing overhead cable racking and/or overhead air distribution where site conditions limit overhead clearances, or additional cooling capacity is required. This determination is made through a coordination of the Real Estate project manager and the CenturyLink Planner or Design Engineer.
- Determination of the height required in a raised floor environment is dependent on several factors:
    - Site location including location within the building (floor and room).
    - Expected equipment structural (lb/s.f.), power (watts/s.f.) and heat dissipation loadings.
    - Cable rack placement – above frameworks and cabinets or under the floor.

- Existing floor to ceiling clearance and the amount of building mechanical/electrical piping or conduit that could obstruct air flow or cable installations.
- Aisle and egress including doors and ramp locations.
- National, State, and Local requirements

- Coordination between CenturyLink Network Planner/Engineer, Real Estate Project Manager, Construction Project Manager, Facility Operations Manager and Design Consultants may be necessary to ensure proper design of the raised floor environment that meets the above requirements and optimizes the available floor space and balances capital costs and schedule constraints along with future operating expenses.

13.1 Raised Floor Structure

There are many types of commercially available floors that offer a wide range of structural strength and loading capabilities depending on the component construction and materials. The three general types of raised floor environments include: stringer-less, stringered, and structural platform. The height of these floors may vary, but the preferred pedestals are arranged in a 2-foot by 2-foot grid pattern to accept the floor tiles/panels.

- Raised floor material shall be comprised of non-combustible, CenturyLink Corporate Real Estate approved material.
- Floor panels containing bare galvanized steel pans shall not be used. Exposed galvanized metal may cause “zinc whiskers” on electronic circuits, leading to premature failure.
- Raised floors will require special engineering design to account for increased lateral loads.
- Finished floor heights are typically provided at 6 inches, 12 inches, 18 inches or 24 inches depending on under-floor clearance required. Increased raised floor heights may be necessary based on cooling and structural requirements.
- Panel size shall be a nominal 24 inches by 24 inches.
- Cutouts in panels shall not exceed 1/4 of the total panel surface.
- Floor panels supporting equipment shall be designed for the following weight requirements:

TABLE 13.1 Raised Floor – Panel Design Support Limits

	Seismic Zone	
	Light	**Heavy**
Supporting Equipment		
Minimum Concentrated Load (on 1 square inch)	1500 lbs	3000 lbs
Ultimate Load	4500 lbs	9000 lbs
Equipment Aisles		
Minimum Concentrated Load (on 1 square inch)	1500 lbs	1500 lbs
Ultimate Load	4500 lbs	4500 lbs
Supporting Equipment -Rolling Load	1500 lbs	2000 lbs
Equipment Aisles -Rolling Load	1500 lbs	1500 lbs

- Raised floor environment shall be engineered for a minimum design floor loading of 110 lbs/sqft. This includes all necessary equipment, frameworks, cabinets, lighting, etc that will be placed on the raised floor environment. In no case shall the raised floor environment floor loading exceed the design floor loading of the sub-floor.
- In addition to the equipment, framework/cabinets, cable rack and cabling, raised floor component weights (floor panels, floor tiles, pedestals, etc) must be taken into consideration when determining the floor loading on the sub-floor.
- Panels shall be permanently marked with a stencil or color coding, indicating the manufacturers name, load rating, and the manufacture date.

13.1.1 Stringer-Less Raised Floors

This arrangement consists of an array of pedestals that provide the necessary height for routing cables and also serve to support each corner of the floor panels. This type of system provides maximum accessibility to the space under the floor, but is significantly weaker than stringered raised floors in supporting lateral loads, and are not recommended.

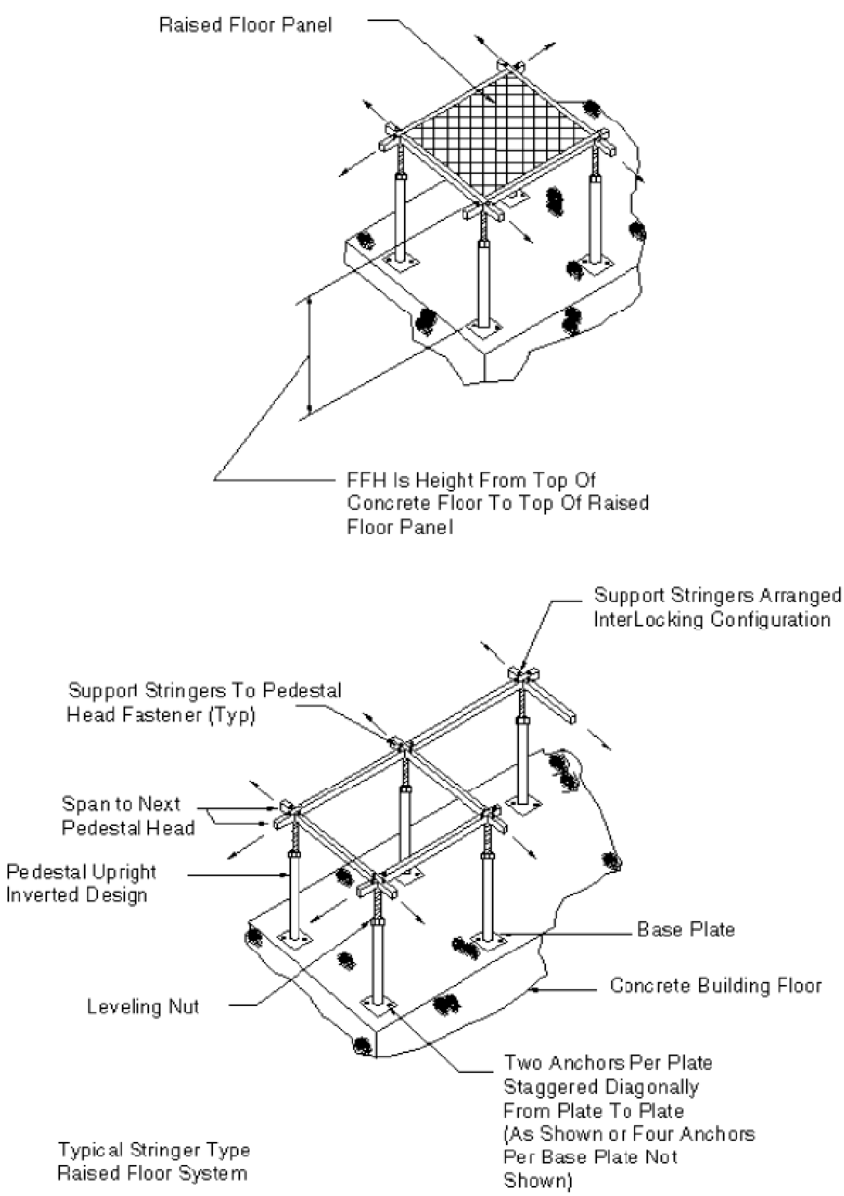
13.1.2 Stringered Raised Floors

This arrangement generally consists of an array of vertical steel pedestal assemblies, each comprised of a steel base plate, tubular upright and an adjustable head for leveling.

- Pedestals are generally installed in uniform grid size based on tile size and shall be fastened to the concrete floor.

- A matrix of horizontal steel stringers span across the top of the pedestal heads in orthogonal directions.
- The stringers are fastened to each pedestal head to form an interlocking design.
- Stringers and pedestals are used to support the floor tiles.
- Shorter stringers may be used in aisles and in areas along walls or columns where less strength is required.

FIGURE 13.1 Stringer Raised Floor

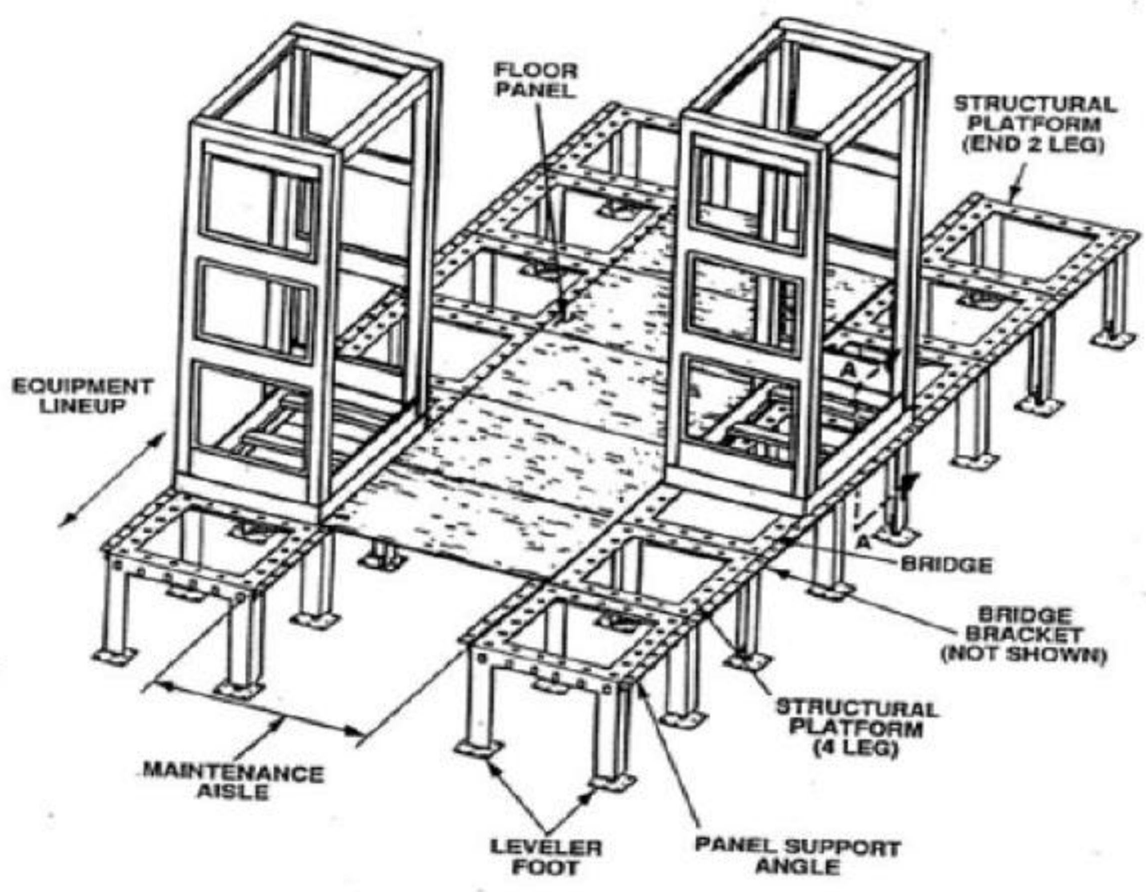


13.1.3 Structural Platforms

This arrangement consists of members constructed of steel angles or channels that are welded or bolted together to form a platform for supporting equipment. Structural platforms may or may not contain panels or stringers.

- Steel members are bolted or welded together and supported by pedestals with leveling feet.
- Steel plate floor panels are mounted to the steel members.

FIGURE 13.2 Structural Platform



13.2 Equipment Layout Requirements

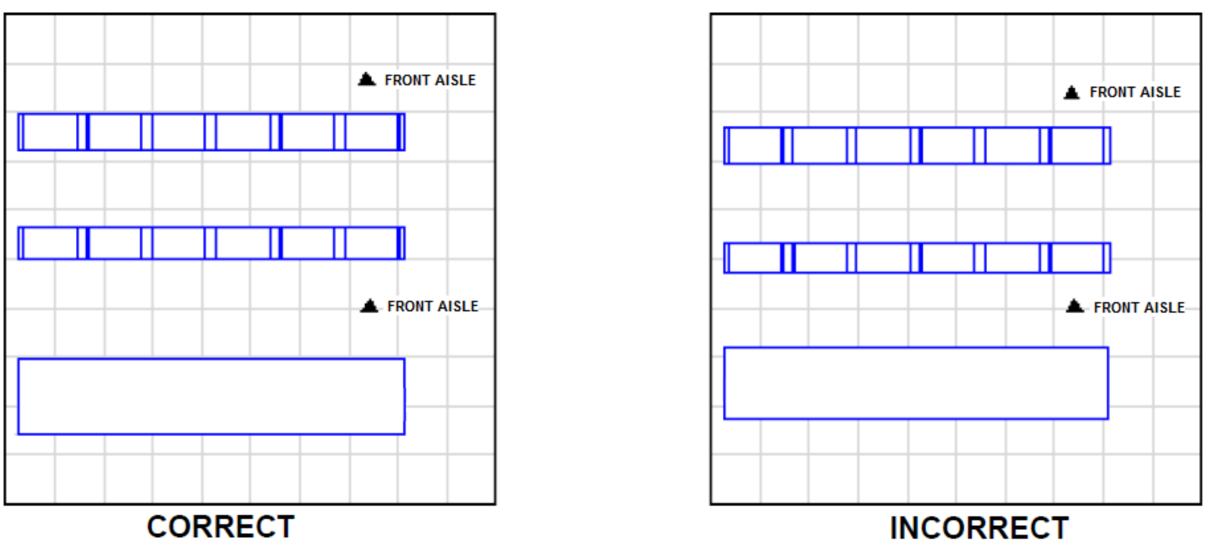
Raised floor environments may require access to the sub-floor for either cable distribution management or air distribution. As a result, it is necessary to provide an equipment layout that does not interfere with access.

13.2.1 Equipment Aisle Spacing

Equipment aisle spacing is primarily dictated by the size of floor tiles, but shall not be planned or engineered to less than the minimum aisle spacing standards outlined in Chapter 2, Section 2.2.

- Equipment lineups shall be located so the front and rear aisle floor tiles can be removed for access. This will usually result in the front or rear of a bay aligning with a tile seam.
- Equipment lineups shall not be planned or engineered where they cross a tile seam, preventing the removal of floor tiles and blocking convenient access beneath the raised floor.

FIGURE 13.3 Equipment Lineups in a Raised Floor Environment



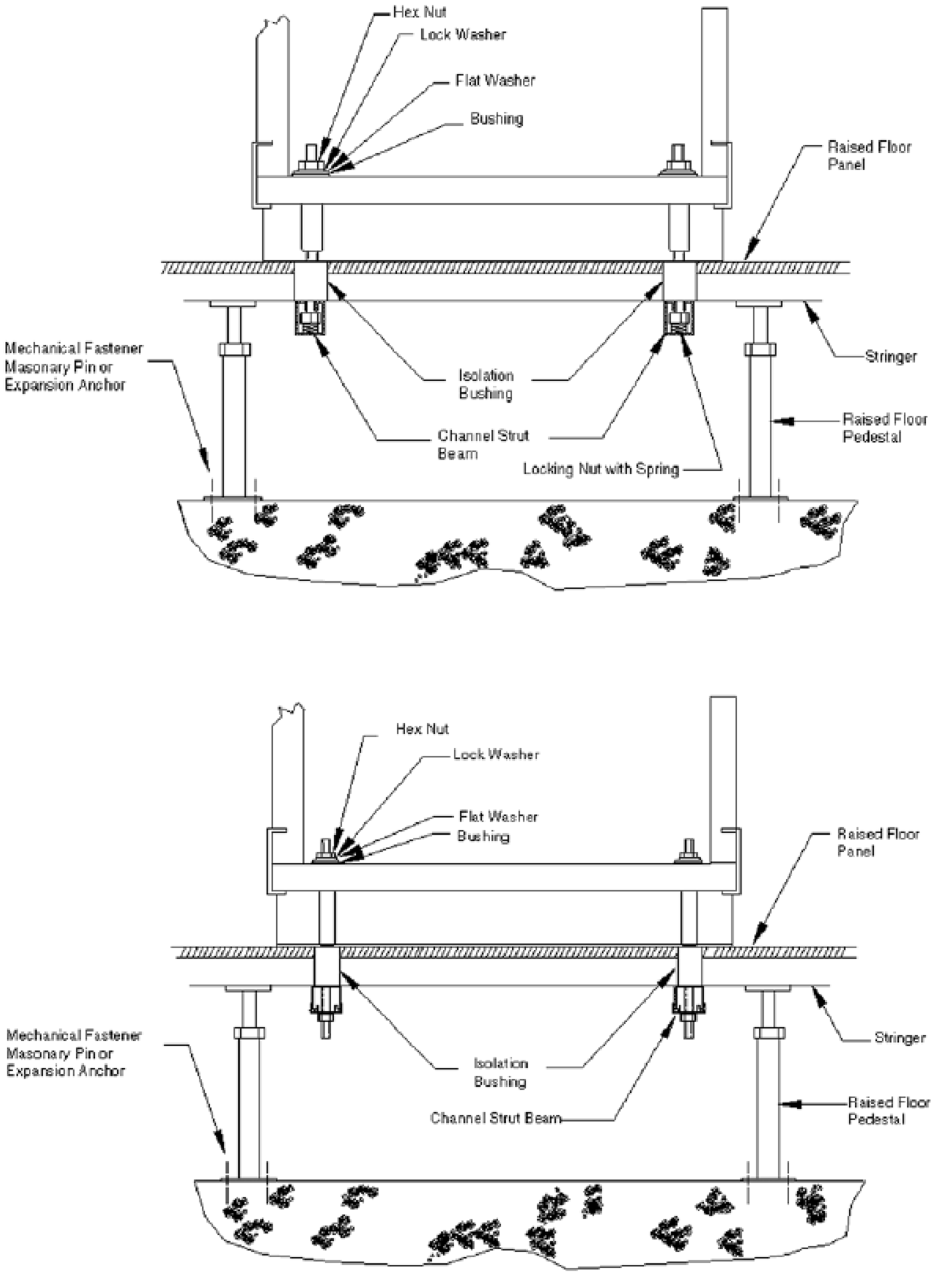
- Column stanchions shall be engineered along a tile seam wherever possible.
- Aisle floor panels must be fully accessible from the floor grid to facilitate access to the area below.

13.2.2 Equipment Mounting

All raised floor types shall be level prior to equipment installation. Raised floors not uniformly flat (greater than 1/32 inch difference between adjacent tiles) shall be brought into compliance prior to installation.

- Framework and cabinets may be secured to the raised floor environment using one of the following methods:
  - Threaded rod into the concrete floor.
  - Bolted into unistrut or u-channel mounted perpendicular to the equipment lineup under floor stringers and under floor tiles per raised floor manufacturer requirements.
  - Bolted directly to a steel equipment platform system per raised floor manufacturer requirements.
- Various methods may be deployed to secure framework and/or cabinets to the floor. The installation service provider shall verify the approved method prior to installation.

FIGURE 13.2 Equipment Mounting in Light Seismic Zone

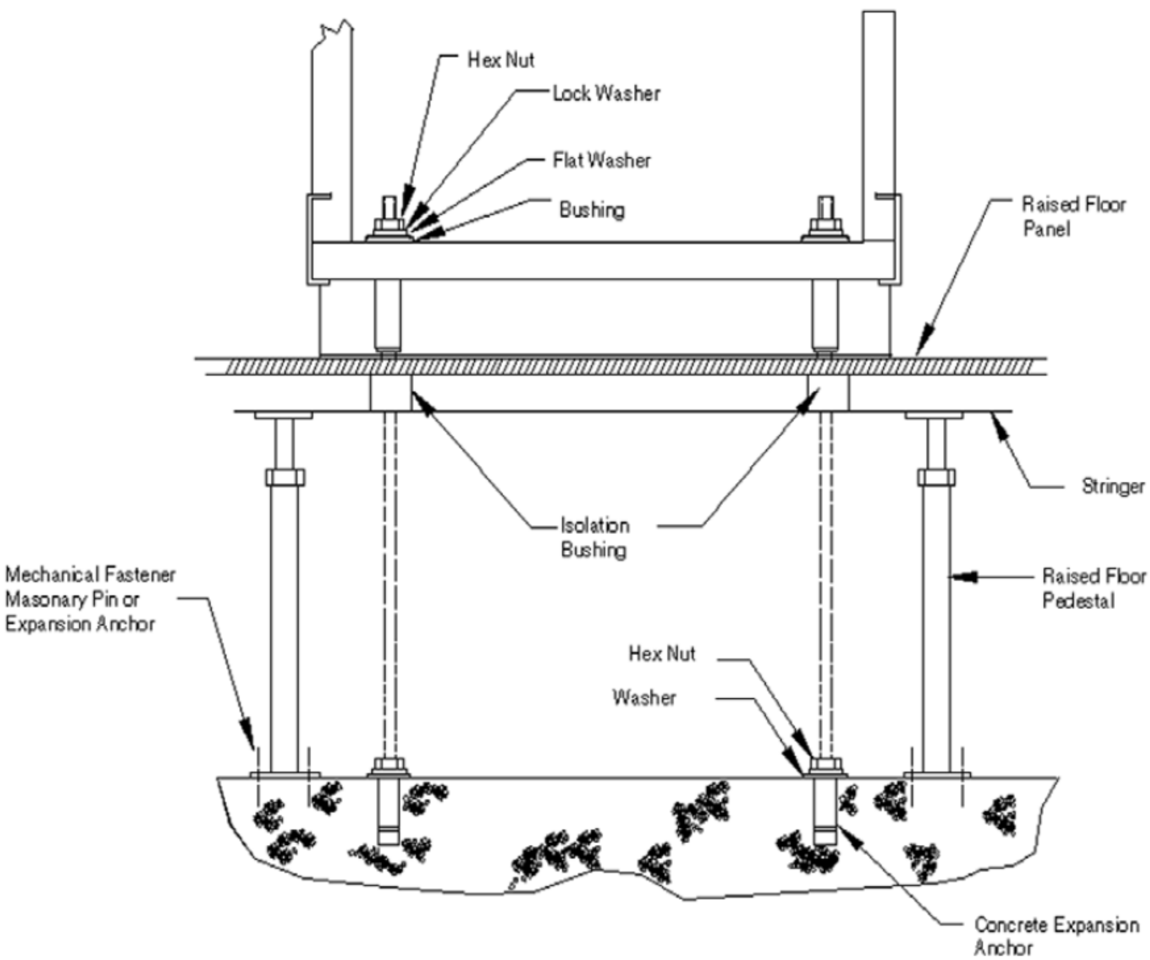


- Floor shims, leveling plates or leveling feet shall not be used to level equipment frames or cabinets.
- Stanchion columns shall not be attached to the raised floor system and shall be extended through the floor tile, and attached directly to the floor slab below the raised floor in all seismic zones to provide the necessary structural rigidity.

  - Floor tiles penetrated by stanchions must first be cut, finished and supported according to the raised floor manufacturer specifications.

- In heavy seismic zones (3,4) four threaded rods shall be used to secure equipment, using appropriately approved seismic anchors.

FIGURE 13.4 Equipment Mounting in Heavy Seismic Zone



- Equipment mounted to a structural platform shall be bolted directly to the platform per the floor manufacturer specifications.

13.3 Engineering Requirements - Cable Distribution Systems

Cable in the under floor area is an alternative to when overhead cable rack cannot be provided. Cable distribution shall be provided by way of cable racking. The requirements outlined in this section identify the use of cable racking under the floor area. Existing locations with loose placement of cable shall provide cable racking in new areas when feasible.

- Overhead cable rack and air distribution should be considered as the first choice when establishing a new area before considering a raised floor environment.
- Overhead cable rack and under-floor air distribution shall be considered as the standard design when establishing a new raised floor environment.

13.3.1 Cable Rack Requirements

- Approved cable rack and cable rack material shall be used in a raised floor environment.
- Cable racks shall be segregated (fiber, power, switchboard) whenever possible.
- Cable rack shall be installed on u-channel, by direct attachment to the floor, or by using auxiliary framing. Cable racks shall be elevated from the floor by at least one inch.
- Cable rack shall be secured, anchored and supported every 5 feet.
- Bridges shall be constructed in instances where cables or cable racks cross.
- A 90-degree bend or equivalent is required when transitioning from a horizontal cable rack run to a vertical cable rack run.
- Cable rack shall be installed as a continuous route under the floor.
- Cable rack installed under raised floor shall be bonded to the raised floor ground system with a minimum #6 AWG green conductor.

13.3.2 Fiber Protection Systems –FPS (Fiber Duct)

- Fiber optic cable/jumpers shall be installed in segregated fiber optic protection systems (or dedicated fiber cable racks).
- Fiber optic protection systems shall be secured to the pedestal at the height specified by the CenturyLink design engineer.
- Fiber optic protection systems shall not be secured with plastic or nylon ties.

13.3.3 Cabling Requirements

- If the under floor area is also used for air distribution, plenum rated cable is required, or a cable plenum shall be constructed to house the cable.
    - Power cables shall be run in accordance with the NEC requirements, including the use of conduit or armored power cables. The NEC, in article 645 compliant under floor IT spaces allows up to a 15 foot AC power cord not in conduit.
- Data processing interconnecting cables and connecting cables do not require a plenum rating if the plenum meets the criteria of the National Fire Protection (NFPA) 70-645, and the plenum has a smoke detection system.
- Communications cable as defined in NFPA 70-800-51 must meet the listing requirement of types CMP, MPP, OFNP, OFCP, or FPLP for use in ducts, plenums, and other space used for environmental air.
- All cable in the under floor area shall be protected from sharp edges (i.e. angle iron, threaded rod mechanisms in pedestals) utilizing approved methods for cable protection.
- No stringers shall be removed when installing or removing cable in a stringer type raised floor environment.
- Switchboard cable shall be run in the front equipment aisles of the equipment lineup. Switchboard cables shall be bundled and secured to other switchboard cables at a minimum of every 6 feet.
- Primary distribution cables shall be run in the rear equipment aisle of the equipment lineup. Battery and battery return cables shall be run bundled with other power cable and run on dedicated cable rack.
- Secondary distribution power cables shall be run in the rear equipment aisle of the equipment lineup. Battery and battery return cables shall be run bundled with other power cable and run on dedicated cable rack, or segregated from other cables when possible.

13.4 Grounding Requirements

Grounding requirements for a raised floor environment shall also adhere to the general grounding requirements outlined in CenturyLink Technical Publication 77355, "Grounding Central Office and Remote Electronic Equipment Environments" and detailed engineering requirements outlined in Chapter 11, "Computer Room Ground Environment" of Technical Publication 77355.

A Signal Reference Ground (SRG) system shall form a ground reference for the raised floor equipment and at a minimum shall consist of a bolted or welded stringer raised floor support structure.

13.4.1 Ground Bars

- Ground bars serving the under-floor environment shall be located under raised floor tiles where complete access to the ground bar is unrestricted.
  - The ground bar shall not be mounted to any of the raised floor apparatus.
  - The ground bar shall be installed with a minimum 2 inch space between the bar and any building surface.
  - Cables not associated with the ground bar shall have a minimum clearance of 6 inches from the ground bar so as to not obstruct access.
  - The location of the ground bar shall be clearly marked on the floor tile directly above the ground bar. A secondary means for identifying the ground bar location may be located on a wall or building column, but in no cases shall the designation be fixed or attached to any temporary equipment, desk or other removable position.
  - A ground bar provided in a raised floor environment shall be an extension of the CO ground and fed by a 750kcmil, copper ground wire.
  - The SRG shall be connected to the under-floor ground bar with a #2 AWG, copper, stranded bare wire.

13.4.2 Ground Cabling

In existing facilities where a pedestal only floor is installed, a supplemental SRG must be installed and shall be composed of multiple runs of bare, stranded #2 AWG copper wire routed along each row of the raised floor pedestals in both directions, thus forming a grid. A copper cable SRG is also desirable even when there is a bolted or welded stringer system.

- Each wire run is bonded at the intersecting point of each perpendicular wire and the raised floor support pedestal by a mechanical connector that shall also tie the grid to the pedestal.
- Individual equipment frameworks or cabinets requiring a connection between the framework/cabinet and the SRG shall be made with a #6 AWG or an equivalent cross-sectional area of flat braided copper strapping, no longer than two feet in length.

Refer to Technical Publication 77355, Chapter 11 for additional engineering requirements.

Contents

14 . Acronyms/Glossary

14.1 Acronyms

A & M (LA) (rating)	A product rating: Additions and Modifications only (Limited Availability)
A / D	Analog to Digital Conversion
ABC	Area Bus Centers
AC / ac	Alternating current
ACD	Automatic Call Distributor
ACEF	Auxiliary Cable Entrance Facility
ACEG	Alternating Current Equipment Ground
ACFT	Analog Carrier Facilities Terminal
ACO	Alarm Cut - Off
AFT	Analog Facilities Terminal
AMA	Automatic Message Announcement
AML	Actual Measured Loss (on a circuit)
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWG	American Wire Gauge
AXE	Ericsson Family of Switching Systems
BAT	Battery (on a circuit)
BDB	Battery Distribution Boards
BDCBB	Battery Distribution Circuit Breaker Board
BDFB	Battery Distribution Fuse Board
BELLCORE	Bell Communications Research (obsolete), now known as Telcordia
BIS	Business Information Systems (obsolete)
BISCUS/FACS	Business Information Systems – Customer Service Facilities Assignment and Control System. (obsolete)
BNC	Bayonet-Type Connector
BOC	1) Bell Operating Company, 2) Building–Out Capacity (on the circuit)
BQC	Bifurcated Quick Clip
BSP	Bell System Practice (obsolete)
BWW	Bifurcated Wire Wrap
CB	Channel Bank
CC	Command Control
CCB	Circuit Concentrator Bay (discontinued)
CCITT	International Telephone and Telegraph Consulting Committee (obsolete)
CCO	Circuit Control Office (on an order)
CCR	Command Control Return
CD	Circuit Description (on an order)
CDF	Combination Distributing Frame
CDO	Community Dial Office (discontinued)
CEF	Cable Entrance Facility

CENTREX	Centralized Exchange for Business Customer Services
CEPT	European Conference of Postal and Telecommunications Administrations
CEU	Current Estimated Usage, a CFAS Switch Traffic Parameter (discontinued)
CEV	Controlled Environment Vault
CFAS	Computerized Frame Administration System ((discontinued))
CHAN	Channel (on an order)
CLEI	Common Language Equipment Identifier
CLR	Circuit Layout Record (on an order)
CMDF	Combined Main Distributing Frame (obsolete functional frame type)
CO	Central Office
CO GRD	Central Office Ground
COE	Central Office Equipment
COEE	Central Office Equipment Engineer (obsolete)
COSMIC	Common Systems Main Interconnecting Frame System
COSMOS	Computer System For Main Frame Operations (discontinued)
COT	(1) Central Office terminal (2) Central Office technician
CP	1) Cable / Pair, 2) Capacity Provisioning
CPE	Customer Premise Equipment
CREG	Concentrated Range Extender with Gain
CRF	Cable Rearrangement Facility
CRMS	An AT&T Cable Routing and Measuring System (discontinued)
CSPEC	Common Systems Planning and Engineering Center
CTLENS (DIP)	Cut Through Line Equipment (same as DIP- Dedicated Inside Plant)
CXR	Carrier
D4	D4 Channel Bank
DA (MD) (rating)	A product rating: Discontinued Availability (previously MD- Manufacture Discontinued)
DACS	Digital Access Cross Connect System
DAS	Digital Access Switch
DATS	Digital Access Test Set
dB	Decibel
DC / dc	Direct Current
DCFT	Digital Carrier Facilities Terminal
DCLU	Digital Carrier Line Unit
DCO	Digital Central Office
DCS	Digital Cross-Connect System
DCT	Digital Carrier Trunk Frame
DD	Due Date (on an order)
DDD	Direct Distance Dialing
DDS	Digital Data System
DF	Distribution Frame
DFS	Distributing Frame System
DFSPM	Distributing Frame Systems Products Manual

DFT	Digital Facilities Terminal
DFW	Distributing Frame Wire
DIP (CTLENS)	Dedicated Inside Plant (same as Cut Through Line Equipment)
DLC	Digital Loop Carrier
DLL	Dial Long Lines
DMS	Northern Telecom Family of Switching Systems
DP	Dial Pulsing
DS	Digital Signal
DSLPDF	Double-Sided Low Profile Distributing Frame
DSX	Digital System Cross-Connect
DSX	Digital Cross Connect
DT	1) Distant Terminal; 2) Type of Distributing Frame cross-connect (jumper) wire; 3) Dial Tone (on an order)
DVA	Designed, Verified, Assigned (on an order)
ED	Equipment Drawing
EDE	Electronic Distributing Frame (discontinued)
EF&I	Engineer, Furnish, and Install
EIA	Electronic Industries Association
EIM	Engineering Information Memorandum (obsolete)
EMI	ElectroMagnetic Interference
EML	Expected Measured Loss (in a circuit)
EMS	Equivalent Main Stations
EMT	Electrical Metallic Tubing
EPA	Environmental Protection Agency
EPO	Emergency Power Off
ERL	Echo return Loss (in a circuit)
ESD	Electro Static Discharge
ESDC	Electro Static Discharge Control
ESS	Electronic Switching Systems (discontinued)
EWSD	Siemens Family of Digital Electronic Switching Systems (discontinued)
FB	Fuse Bay
FCC	1) Frame Control Center (on an order); 2) Federal Communications Commission
FCD	Frame Continuity date (on an order)
FDF	Fiber Distributing Facility / Frame
FDP	Fiber Distributing Panel
FLM	Fiber Optic Multiplexer
FMUX	Fiber Multiplexer
FPD	Floor Plan Data
FPDS	Floor Plan Data Sheets (discontinued)
FPS	Fiber Protection Systems
FR	Frame (on an order)
FSF	Fiber Splice Facility / Frame
FX	Foreign Exchange (on an order)

GA (rating)	A product rating: General Availability (replaced AT&T Standard rating)
Gb	Gigabit (one billion bits)
GDF	Group Distributing Frame (obsolete functional frame type)
GRD	Ground
GTD	GTE Family of Switching Systems (discontinued)
HDF / HMDF	Horizontal (Shelf) Side of the Conventional DF (Compare with (VDF/VMDF) (discontinued terminology)
HFCP	High Frequency Cable Pair
HFDF	High Frequency Distributing Frame (obsolete functional frame type)
HVAC	Heating, Ventilating and Air Conditioning
ICB	Inter-Connection Bay (discontinued)
ID	Identification / Identifier
IDC	Insulation Displacement Clip (Quick Clip) Terminal Type
IDF	Intermediate Distributing Frame
IEC	International Electro-technology Commission
IO	Inter-Office
IPF	Indiana Publication Center (obsolete)
IPVC	Irradiated Polyvinyl Chloride
ISDN	Integrated Services Digital Network
ISLU	Integrated Services Line Unit (5ESS Switch product)
Kb	Kilobit (one thousand bits)
LA (rating)	A product rating: Limited Availability (for Additions and Modifications only)
LAN	Local Area Network
LATA	Local Access Transport Area
LCAM	Life Cycle Asset Manager
LCIE	Lightguide Cable Interconnection Equipment
LCR	Line Concentration Ratio
LDS	Lightguide Distribution System (AT&T's LGX DF) (discontinued)
LE	Line Equipment
LEC	Local Exchange Carrier / Company
LED	Light-Emitting Diode
LET	Line Equipment Transfer
LG	Lightguide
LGX	Lightguide Cross-connect Frame (trademark for AT&T fiber Distributing Frame) (discontinued)
LIU	Line Interface Unit
LMDF	Lightguide Main Distributing Frame (discontinued)
LNI	Line Network Interface
LOIS	Location Oriented Identification System (used in Modular Frame mechanized assignments)
LPCDF	Low Profile Conventional Distributing Frame
LPDPF	Low Profile Double-sided Protector Frame (discontinued)
LPDSPF	Low Profile Double-Sided Protector Frame (replaced by LPDPF) (discontinued)
LSCIE	Lightguide Stranded Cable Interconnection Equipment (discontinued)

LSS	Loop Switching System
LST	Line Station Transfer
LTD	Limited
LVR	Line Voltage Regulator
LX	Integrated Loop Carrier Switch Interface Equipment
Mb	Megabit (one million bits)
MBPS	Megabits per second
MC	Maintenance Control
MCC	Maintenance Control Center
MD (DA) rating	A product rating: - Manufacture Discontinued (now known as DA-Discontinued Availability
MDF	Main Distributing Frame
ME	Miscellaneous Equipment
MEDF	Miscellaneous Equipment Distributing Frame (obsolete functional frame type)
MELD	Mechanized Engineering and Layout for Distributing Frames (AT&T's frame engineering system, now Lucent)
MFT	Metallic Facilities Terminal
MGD	Main Ground Bus
ML	Maintenance Line
MLHG	Multi Line Hunt Group (obsolete)
MLSI	Maintenance Line Status Indicator
MM	Multimode
MOD	Module
MS	Main Station (Switched POTS services)
MT	Message Trunk
MUX	Digital Multiplexer
NBOC	Network Building-Out Capacitance
NE	Network Elements
NEBS	1) New Equipment Building System; 2) Network Equipment Building System
NEC	National Electrical Code
NEPA	National Fire Protection Agency
NMA	Network Monitoring and Analysis
NNX	Network Numbering Exchange (telephone number central office prefix)
NPA	Numbering Plan Area (telephone number Area Code)
NPWE	Net Present Worth of Expenditures
NROC	Network Reliability Operations Center
OCO	Order Control Office
OCRF	Optical Cable Rearrangement Facility
OFCP	Optical Fiber Conductive Plenum
OFCR	Optical Fiber Conductive Riser
OFNP	Optical Fiber Non-Conductive Plenum
OFNR	Optical Fiber Non-Conductive Riser
OPGP	Office Principle Ground Point
OPGPB	Office Principle Ground Point Bus

OPS	Off Premises Station (on an order)
OPX	Off Premises Extension (on an order)
ORB	Office Repeater Bay
OS	Operating System
OSS	Operations Support Systems
OSHA	Occupational Safety and Health Administration (Act)
OSP	Outside Plant
OSS	Operational Support Systems
OTC	Operating Telephone Company (pre-divestiture 1984)
OW	Order Wire
P&CE	AT-9049 PF Protector and Cable Enclosure (discontinued)
PACE	Programs for Arrangement of Cables and Equipment (discontinued)
PBX	Private Branch Exchange
PCO	Plant Assignment Office (on an order)
PDC	Power Distribution Board (DMS Switch)
PDFB	Power Distribution Fuse Boards
PDS	Premises Distribution System (discontinued)
PE	Polyethylene
PEG	Planning and Engineering Guidelines
PF	Protector Frame
PGS	Pair Gain System
PICS	Plug-In Inventory Control System
PLR	Pulse Link Repeater (discontinued)
PM	Performance Monitoring
POI	Point of Interface
POTS	Plain Old Telephone Service
PROT	Protector / Protection
PSMC	Power Systems Monitor Controller
PTD	Plant test Date (on an order)
PVC	Polyvinyl Chloride
PVC CBL	Polyvinyl Chloride, Cotton, Braid, Lacquered
PVC CL	Polyvinyl Chloride, Cotton and Lacquered
PWB	Printed Wiring Board
QCX	Quick Connect Cross-Connect Bay (discontinued)
R	1) Ring conductor (of a Tip and Ring pair of wires), 2) Receive (path in a circuit)
RBOC	Regional Bell Operating Company
REC / RCV	Receive
REG	Range Extender with Gain
RISLU	Remote Integrated Services (ISDN) Line Unit
RL	Return Loss (in a circuit)
R.O.W	Right Of Way
RR	Relay Rack (an equipment bay / frame)
RSM	Remote Switch Module
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	Uninterruptible Power Supply

14.2 Glossary

Analog Carrier Facilities Terminal (ACFT) (discontinued)	An analog carrier terminal that provides transmission and signaling functions by means of plug-in units.
Analog Facilities Terminal (AFT)	An analog carrier terminal that provides transmission and signaling functions by means of plug-in units.
AT Specification	AT&T Specification for Outside Plant product manufactured by other suppliers (discontinued)
Attenuation	The loss of energy of a signal
Auxiliary Cable Entrance facility (ACEF)	Secondary cable splicing facility between the CEF and a DF.
Back Tap	A DF jumper connected at one end to a termination on which another jumper already exists and at the other end to a new facility or equipment. Upon removal of the original jumper, the second jumper provides a new circuit configuration. (a.k.a. half-tap)
Bay	(1) DF apparatus mounting space between adjacent framework elements. A horizontal bay is the space on a shelf between adjacent verticals. (2) A modular framework partially/fully enclosed by sheet metal panels.
Bifurcated	A terminal, quick clip or wire wrap, with provisions for connecting two conductors. Used to provide the ability to back tap, or half tap.
Blocked-in layout	A DF termination pattern that locates all terminations from a given equipment or facility in close proximity.
Bridge Lifter	A device used in circuits with two or more facilities to reduce signal loss/noise (e.g. as for party service). Most can be replaced by Mini bridge lifter coils (voltage protection units placed in the connector block).
Bridge Tap	Splicing into an existing circuit, generally to add additional, permanent. branch(es) (compare with Half-Tap)
Bridged Circuit	A circuit with two or more facilities.
Building Cable	A cable with a protective fire-retardant sheath that is typically recommended for use in buildings.
Cable Duct	A single pipe, tube, or conduit through which cables can be passed.

Cable Entrance Facility (CEF)	The location in a wire center (Central office) where the OSP (outside plant) cables enter the building and are spliced to interior cabling. (a.k.a. cable vault)
Cable Mining	Systematic removal of dead/unused cable from the building cable distribution systems (racks, ducts, risers, etc…)
Cable Riser	The opening or slot in the building floor or wall for cable passage.
Cable Throw (Cable Transfer)	The transfer of a working circuit from one cable pair to another cable pair.
Capacitance	The build up or storage of electrical charge between conductors separated by insulating material. Capacitance is represented by the letter C and measured in farads.
Carbon Block (discontinued)	Small block of carbon used in DF voltage protection units. The breakdown provides a path to ground for voltages over 350 volts.
Carrier System	A transmission system that electronically stacks one voice message on top of another at the transmitting end and separates them at the receiving end. A system for providing several communication channels over one path.
Central Office (C.O. or Wire Center)	Historically, a central office referred to a specific switching entity or local switching system. Today it refers to a telephone company building in which a switching system is located and includes other equipment that may be located in such building. (See Wire Center)
Central Office Equipment (COE)	Electrical, electronic, and mechanical devices located in the wire center.
Central Office Terminal (COT)	Equipment in the wire center associated with a system. Equipment that provides multiplex/de-multiplex and analog/digital conversion functions at the central office end of a loop T-carrier circuit. The COT may be provisioned to provide line-powering (i.e. interface directly with loop T-carrier) or to interface with a DS1 signal at the DSX.
Channel	One communication path via a pair of wires, phantom, carrier, or microwave. One circuit.
Channel Bank	Equipment that provides multiplex / de-multiplex and analog / digital conversion functions, typically for interoffice circuits.
Churn	The connection, disconnection, and rearrangement activity of cross-connections at a Distributing Frame
Circuit	An electrical path between two or more points to provide a service.
Circuit Concentration Bay (CCB) (discontinued)	Interconnection bays (ICB's) provided in the past by non-Bell System suppliers (non Western Electric)
Circuit Transfer	A change in a working circuit configuration. On DF's, new assignments and jumper changes are usually required.
Class of Service	A sub-grouping of telephone customers based on rate distinctions.
Closure	A facility used for storing and environmentally sealing copper or fiber cable splices, typically placed in a cable entrance facility or in the outside plant environment.
Code 5	A wire Center circuit fault code; one of many circuit fault codes, with -05 being attributed to the wire center, and -053 attributed to

	the Distributing Frame. A series of codes are used to measure service performance across the network.
Coils	1) Another name for the Voltage Protection Units present in an OSP protected connector block. 2) A number of turns of wire wound around an iron core or onto a form made of insulating material, It offers opposition to AC but little to DC.
Combination Distributing Frame (CDF)	The Combination Distributing Frame is a functional frame type within the Distributing Frame Network. Since the frame function is described in terms of the outside plant terminations allocated, it is a DF that terminates both subscriber and trunk cable pairs, as well as all Equipment requiring termination. It is usually the only frame in the office. It is sometimes referred to as a Main Distributing Frame (MDF), or a Combined Main Distributing Frame (CMDF).
Combined Main Distributing Frame (CMDF) (obsolete functional frame type)	The Combined Main Distributing Frame is a functional frame type within the Distributing Frame Network. Since the frame function is described in terms of the outside plant terminations allocated, it is a DF that terminates both subscriber and trunk cable pairs, along with Test access and Miscellaneous equipment. It is sometimes referred to as a Main Distributing Frame (MDF), or a Combination Distributing Frame (CDF).
Community-Dial Office	A small dial equipment building that has no resident forces.
Compression	Replacement of low-density DF termination apparatus with hi-density apparatus to achieve more termination space.
Computer System for Mainframe Operations (COSMOS) (discontinued)	An automated assignment and record keeping system initially designed by Bell Laboratories (BELLCORE, now known as Telcordia), to assist the BOC's (Bell Operating Companies) in effectively managing MDF subscriber facilities and equipment POTS circuits. An OSS (Operations Support System) for DF administration, it has been replaced by a system known as SWITCH.
COSMIC DF	Common Systems Main Inter-Connecting Distributing Frame: A wiring appearance for switching system office equipment (OE or LEN), exchange cable pairs, and tie pairs.
Concentrated Range Extender with Gain (CREG) (discontinued)	A range extender within electronic switching systems. (see range extender)
Concentrator	Equipment used to reduce a large number of incoming circuit paths to a smaller, limited number of outgoing paths.
Connecting apparatus	A DF termination apparatus (block) with cross connect features, used to provide cross connect ability for equipment. (also see termination apparatus)
Connector apparatus	A DF termination apparatus (block) with electrical protection features, used to protect Outside Plant facilities. (also see termination apparatus)
Control Leads	A set of leads that is associated with monitoring and controlling a

	device or system.
Conventional Distributing Frame	A DF Framework hardware type characterized by an open lattice structure of vertical and horizontal iron bar members.
COSMOS	An automated assignment and record keeping system initially designed by Bell Laboratories to assist BOC's in effectively managing MDF subscriber facilities and circuits. Originally a Bellcore OSS for DF administration, it has been replaced by the SWITCH database.
COSMOS-L (discontinued)	A COSMOS system for large wire centers that have multiple cable pair and/or line equipment appearances and complex frame systems. (replaced by SWITCH database)
COSMOS-N (discontinued)	A COSMOS system for dial administration (replaced by SWITCH database)
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.
Crossbar System (XBAR)	A switching system using contact spring switches operated by relay controlled horizontal and vertical bars.
Crossbar System (XBAR) (discontinued)	A switching system using contact spring switches operated by relay controlled horizontal and vertical bars. Replaced by digital switches, none remain in the CenturyLink Network.
Cross-connection (X_CONN)	A wired connection (paired, triples, or quads) run between terminal apparatus on a distributing frame, also known as a Cross-connect, and commonly referred to as a "jumper" or "jump".
Crosstalk	The undesired transference of a signal onto an adjacent signal caused by electromagnetic coupling between physically separated circuits.
Cutover	Deactivation of old equipment and near simultaneous activation of new, replacement equipment.
Data Link	A circuit designed to carry digital information, usually by time division multiplex techniques.
Dead Jumper	Any DF jumper disconnected at one or both ends. (also see floater)
Dedicated Inside Plant (DIP)	A jumper left connected at termination of service with the intention of reuse by the next customer using the same cable-pair.
Dedicated Plant	A plan for providing the permanent assignment of cable pairs from a wire center main frame to all residential and (non-key) business locations.
Defacto Plan	An interim working DF plan for the existing DF network; not based on a DF planning study.
DF Administration	Daily distributing frame operations management, including assignment.
DF Assignment	Selection of specific DF facility/equipment terminations for cross-connection to provide a given service/circuit.
DF Configuration	1) The physical arrangement of a specific DF, typically in terms of its modules, verticals, and lineups. 2) The arrangement of specific Distributing Frame Functional frames to create the Distributing

	Frame Network.
DF Layout	The arrangement of facility/equipment terminations on a DF
DF Network	The Wire Center's entire complex of all DF's, the associated tie pairs, and DF terminations allocation viewed as a total interconnection system.
DF System	The Wire Center's entire physical DF Network and associated administration.
Dial Pulsing (DP)	A system of DC pulsing in which the digits are transmitted by the interruption of the dc circuit a number of times, one to ten interruptions corresponding to the digits "1' through "0" on the phone dial.
Dial Tone (DT)	A tone used dial telephone systems to indicate that the equipment is ready for the dialing operation. This tone is 600 Hz modulated by 120 Hz when supplied by a tone alternator of 133 Hz when supplied by an interrupter. The modulating frequency gives this tone its low-pitched sound. Interrupted low tone is used for line busy reorder, and "no circuit tone" signals reached by the customer.
Digital Cableway	A type of cable pathway typically utilized with AT&T transmission equipment that may be adapted for use with the LGX distributing frame. (discontinued)
Digital Carrier Facilities Terminal (DCFT)	A digital carrier terminal that combines digital carrier transmission and signaling functions into one unit per digital carrier line including digital banks.
Digital Carrier Transmission Facilities (DCTF)	Facilities used to transmit digital signals in both the loop and interoffice plant. Repeaters, which provide signal equalization and regeneration, are deployed at regular intervals. T-Carrier was the popular short-haul digital transmission facility.
Digital Carrier Trunk Frame (DCT)	A T-Carrier message trunk system that merges switching and transmission functions into a three bay framework that bypasses the switching trunk frame and the required IDF.
Digital Data System (DDS)	A nationwide private line synchronous data communications network formed by interconnecting digital transmission facilities and providing special maintenance and capabilities.
Digital Loop Carrier (DLC)	A T-Carrier System used in loop applications
Digital Signal (DS)	One of several transmission rates in the time-division multiplex hierarchy.
Digital Signal Cross-Connect (DSX)	A centralized termination, interconnection, and test point for digital equipment at a particular digital signal bit rate.
Digital Switch	A time division electronic switching system (e.g. 5ESS)
Di-group	A digitally multiplexed group of 24 voice channels.
Direct Distance Dial (DDD) Network	All Telephone equipment and facilities used to permit customers to dial their own long distance (Toll) calls.
Direct Ties	Multiple frame lineup tie linkage cabled directly between lineups

	(does not use a separate TPDF or IDF)
Disconnection	De-energizing or disabling an electrical circuit by the removal of one or more components.
Distributing Frame (DF)	A frame dedicated for cross-connect functions.
Distributing Ring	Insulated metal ring used to contain and route jumper wires or cable conductors of DF's.
Double-Sided Low Profile Distributing Frame (DSLPDF)	A NEBS compatible low-height (8 to 9 feet) double-sided conventional DF which may be used for any approved Functional Frame application. Most commonly exists in small or intermediate offices as a CDF, and intermediate or larger offices as an MDF, TMDF, or IDF (SDDF, ICDF). The conventional SMDF function is obsolete.
DSX	A family of bay-type distributing frames that provide for digital system facility/equipment cross-connections.
DT-type wire	DF jumper wire with slick insulation and smaller diameter. (replaced U-type cotton covered DF wire)
Electromechanical Switching Equipment	Switching systems that employ electromechanical devices to perform the base switching functions (e.g. SXS (step-by-step). Replaced by digital switches, none remain in the CenturyLink Network.
Electronic Switching Systems	Switching systems that use solid state devices. Replaced by digital switches, none remain in the CenturyLink Network.
End Guard	Protective finishing member attached to ends of installed framework.
Equipment	Wire center systems/technology commonly restricted to those providing switching and signaling functions.
Equipment Frame	A frame primarily for mounting electronic or electromechanical devices
Equivalent Main Station (EMS)	Non POTS switched services
Equivalent Pairs	The number of physical pairs associated with a certain type of facility or equipment requiring termination outside the system.
ESS Modular DF	A single sided DF characterized by modules of terminal blocks mounted in vertical arrangements. Installed in conjunction with the first ESS Switching systems.
Exchange Area	The territory within which telephone service is provided without toll charges (long distance) and covered by a specific rate basis (local calling area)
Exchange Cable	A paired cable principally for connecting the customer (subscriber) premises to a wire center (central office).
Express Trough (Trough)	Horizontal Space for the running of long jumpers on Modular DF's and Single-Sided Low Profile Conventional Distributing Frames.
Facilities	Any one of the elements of physical telephone plant that are needed to provide service, commonly restricted to transmission facilities.

Fanning Strip	A narrow strip with holes or slots through which cross-connecting wires can be routed for orderly termination on a given piece of termination apparatus.
Fiber Distribution Frame	A generic term used to describe a cross-connection / interconnection Fiber distributing frame that can easily accommodate large numbers of optical fibers (e.g. LGX, FDF, NGF, NG3 type frames)
Fiber Protection System (FPS)	An approved type of cable support structure sometimes referred to as fiber duct and used for fiber cables only.
Fiber Splice Frame	A generic term used to describe the point at which outside plant or Indoor/Outdoor rated fiber cable is transitioned to low smoke indoor cable.
Fill	Ratio of working terminations to total terminated (e.g. OSP fill, LE fill)
Floater	A jumper disconnected on both ends. (also see dead jumper)
Frame	The entire framework, together with the apparatus and equipment that have been mounted on it.
Frame Force	Operations personnel who administer and maintain the DF Network.
Frame Maps	Frame Monitoring and Planning System (discontinued)
Frame Mask	A block diagram of present and future placement of fiber cables and equipment on the fiber frame panels
Frame Zoning	Division of the frame mounting space into two or more layout and/or assignment zones.
Framework	A bare structure composed of mounting uprights, a base assembly, and a top member for support.
Functional Frames	DF applications which are distinguished by the presence and types of OSP terminations on the frame (e.g. MDF, SMDF, TMDF, IDF)
Fundamental Planner	A long-range planner who performs fundamental planning.
Fundamental Planning	A systematic long-range planning process characterized by design and objective evaluation of alternative plans. (a.k.a. Comprehensive Planning)
Gauge	Gauge is the size of wire. It is represented by a number such as 24 or 26.The larger the number, the smaller the size of wire and the smaller the wire, the more resistance it provides.
Generic DF Networks	A few, similar classes of common DF networks used in most wire centers (common configurations)
Grounding	An engineered low impedance path from equipment chassis or framework to the structure driven ground.
Guard Rails	Protective railings installed at the base of frameworks.
H drawing	Engineering Method of Procedures or Equipment Specifications produced by AT&T Network Systems Engineering Centers (discontinued)
Half-Tap	Splicing into an existing circuit for in-service relocation; original branch is customarily removed (un-bridged) after relocation is

	completed. (compare with Bridge-Tap)
Heat Coil	A protective device, inserted at the connector block, and used in series with the line at the Main Distributing Frame (or the associated Protector Frame), which operates to open and ground the line if excess current flows. (a.k.a. Voltage Protection Unit)
High-Frequency Cable Pair (HFCP)	A cable pair used in the multiplexed portion of a circuit carrying more than one channel.
High-Frequency Distributing Frame (HFDF)	A functional IDF dedicated to termination of high frequency (or modulated) circuit facilities.
Impedance	The combined effect of resistance, capacitance, and inductance in a circuit. Impedance is represented by the letter Z and measured in Ohms.
Incremental Growth	The ability to increase the termination capacity of an installation in an incremental fashion.
Incremental Planning	Recurring short-range planning characterized by frequent small equipment additions and no long-range plans.
Indiana Publication Center (IPC)	Western Electric (WECO) facility that used to inventory and distribute major Bell System Documents and Bell System Publications (BSP's).
Inductance	In a circuit, the property which opposes any change in the existing current.
Integrated Carrier	Switching system equipment that provides the functions of separate carrier terminals.
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
Interbay Management Panel (IMP)	Normally a 5 inch spacer equipped with fiber management dowels attached to the face of a space filler panel. Commonly used between equipment bays to provide fiber slack storage.
Inter-Connection Bay (ICB)	General term for the entire class of small bay-like distributing frames. It includes CCB (Circuit Concentration Bay) and QCX (Quick Connect Cross-connect Bay) (discontinued)
Inter-Frame Tie Pairs	Tie pairs joining separate Functional Distributing Frames within the DF Network.
Intermediate Distributing Frame (IDF)	The Intermediate Distributing Frame is a functional frame type within the Distributing Frame Network. Since the frame function is described in terms of the outside plant terminations allocated, it is the DF function without OSP cable terminations.
Inter-Wire Center Special Service circuit (Inter-office)	Any special service circuit with physical connections in two or more wire centers. (originating and terminating through more than one Central Office)
Inter-Zone Jumpers	Jumpers connecting two terminals located in two different frame assignment zones. Also known as long jumpers.
Intra-Frame Tie Pairs	Tie pairs joining separate regions of the same Functional

	Distributing Frame within the DF Network, most often used in multi-lineup Modular SMDF complexes, but can be found on long conventional frames or long modular single lineups.
Intra-Wire Center Special Service circuit (Intra-Office)	Any Special service circuit that is completely connected within one wire center's exchange area. (originating and terminating through the same Central Office)
Intra-Zone Jumpers	Jumpers connecting two terminals located in the same frame assignment zone. Also known as short jumpers.
IO (Inter-Office)	Associated facilities / equipment, circuits between Central Offices. (compare with LOOP)
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.
Jumper	A wired connection (paired, triples, or quads) run between terminal apparatus on a distributing frame to establish circuits. Also known as a "jump", functionally known as a "cross-connection" or "cross-connect".
Jumper Pileup	The number of jumpers passing through a specific cross-section of a frame or shelf.
KS Specification	AT&T Specification for Inside Plant product manufactured by other suppliers (discontinued)
Lead Absorption	Practice of using IDF's to terminate all equipment leads, and then routing them onto MDF's in smaller subsets via tie pairs to create reduced termination space requirements. Associated with electromechanical and electronic switching machines.
Lead Groups	The categorization of equipment leads according to their function. (i.e. signaling leads). Associated with electromechanical and electronic switching machines.
Leakage Rate	The fraction of jumpers that originate but do not terminate in an assignment zone.
Level	An expression of electrical or sound power expressed in decibels (dB) above or below some point of reference
Life Cycle Asset Manager (LCAM)	Web based application that manages spare and installed network electronics equipment.
Lightguide	Used to describe AT&T fiber optic media products including cable, connectors, and interconnection devices.
Light wave	Particles of light known as photons raveling in waves. The length of the waves determines the light's color, speed, and behavior in a Lightguide.
Line	Any type of circuit terminated in a telephone (or equivalent) at one end and a switching machine at the other end. The term line can be applied to any type of service when at least one terminal of the circuit cannot connect to any other circuit.
Line Equipment (LE)	1) The customer side of a switching entity, 2) Switch equipment associated with loop subscriber lines.

Line Equipment Transfer (LET)	A systematic change of a subscriber's line equipment
Line Station Transfer (LST)	A systematic change of a subscriber's cable pair.
Lineup	A row or line of framework modules or verticals in a building.
Load Balancing	The process of assigning line equipment to customers so as to maintain a proper distribution and balance of traffic in a switching system.
Load Coils (Load Pots)	Inductance coils arranged at designated intervals to balance transmission characteristics of the voice frequencies 300 Hz to 3200 Hz.
Loaded Cable	Cable designed with Load coils at designated intervals to balance transmission characteristics of the voice frequencies 300 Hz to 3200 Hz.
Local Channel	The cable, or the outside wire, used to connect the serving Central Office to the customer location.
Local Switches	End Office (class 5) switching systems to which customer loops or lines are connected.
Long Jumper	A cross-connect that runs between two separate frame bays, modules, or zones that are not adjacent.
Long Range Planner	Same as Fundamental Planner.
LOOP	1) The facility that connects a subscriber to a Central Office Exchange, usually a metallic circuit. 2) Facilities domain between a central office and its served customers. (compare with IO)
Loop Switching System (LSS)	A remote voice frequency switching system not normally located in class 5 wire centers. (discontinued)
Loss	The decrease in energy, expressed in dB, between two points in a circuit.
Low Profile Conventional Distributing Frame (LPCDF)	A NEBS compatible low-height (8 to 9 feet) conventional DF
Low Profile Double-Sided Protector Frame (LPDPF)	A NEBS compatible double-sided, conventional protector frame. (discontinued)
Main Distributing Frame (MDF)	The Main Distributing Frame is a functional frame type within the Distributing Frame Network. Since the frame function is described in terms of the outside plant terminations allocated, it is a DF that terminates subscriber cable pairs, along with test access and miscellaneous equipment. It is sometimes referred to as a Combined Main Distributing Frame (CMDF), or a Combination Distributing Frame (CDF).
Main Frame Fill	The ratio of cable pairs in use at the mainframe to the total number of pairs terminated.
Main Station (MS)	Switched POTS service
Marker Lead	Equipment lead(s) associated with status or control support. Associated with electromechanical switching machines (discontinued)

Mechanized Assignment	Assignment logic provided by a computer system(s)
Mechanized Engineering and Layout for Distributing Frames (MELD)	AT&T's frame engineering system, now supported by Lucent Technologies, is used for mechanized engineering of the Modular COSMIC SMDF.
Message trunk (MT)	A circuit connecting two switching entities.
Metallic Facilities Terminal (MFT)	A voice frequency terminal that combines voice frequency transmission and signaling functions in one unit.
Miscellaneous Equipment (ME)	Combined term for types of signaling and conditioning equipment terminated on DF's, such as bridge lifters, echo suppressors, MFT's, etc.
Modular Distributing Frame	A DF Framework hardware type, usually single sided, characterized by shelves contained in sheet metal type modules with an alternating pattern of termination zones.
Multiplexing	The process of combining a number of channels into/onto a single, special channel for transmission.
N-Carrier	Analog transmission system designed for short haul (up to 200 miles) on paired wires.
Network	A planned path that allows one element to be connected to another
Network Element (NE)	A term used to describe a specific type of electronic equipment located in the network that interfaces with other equipment or systems.
Network Facility	A telephone company building in which network equipment is located.
Network Reliability Operations Center (NROC)	The Network Reliability Operations Center (NROC) are responsible for alarm monitoring and overall network reliability within CenturyLink.
New Equipment-Building System Standards (NEBS)	Spatial and Environmental requirements for design and installation planning of new equipment systems to be located in wire centers.
NNX Code (Network Numbering Exchange)	The first three digits of the telephone number (the central office code).
Non-Loaded Cable (NL)	Cable with no Load coils to balance the transmission characteristics of the voice frequency.
Off-Hook	The condition that indicates the active state (loop closed) of a station line or other circuit. When the telephone handset is removed from its switchhook, the loop is closed and the line is said to be in the "off-hook" condition.
Office Repeater Bay (ORB)	Equipment that provides the interface between a T-carrier circuit and the DSX. It regenerates the incoming signal to the DS-1 (or DS-1C) level, and provides line powering to the outside plant repeaters.
Ohm	Unit to measure resistance. One ohm is the value of resistance necessary for one volt to maintain one ampere.
On-Hook	The condition that indicates the idle state (loop open) of a station

	line or other circuit. When the telephone handset is on its switchhook, the loop is open and the line is said to be in the "on-hook" condition.
Operations Systems (OS)	Mechanized systems that are designed to support administration, operation and maintenance functions. They maintain records, monitor network growth, and assist in planning, engineering, and assignment.
Optical Fibers	Fibers through which light may be transmitted with small intensity losses.
Order Activity	The sum of work orders (company initiated) and service orders (subscriber initiated) generated per unit time.
Order Wire (OW)	Provides talking facilities between frames or between the C.O. and outside plant locations.
Outside Plant (OSP)	The part of the telephone system that is located physically outside of the telephone company buildings.
Outside Plant Cable	Combining term for exchange cable and trunk cable
Pads	A resistance network of value needed to introduce a specific transmission loss.
Pair Gain	Reduced exchange cable requirements achieved by the use of multiplexing or concentration technologies.
Party Line	Two, four, eight, or more customers sharing the same line to the Central Office.
Pathways	A physical means for routing and holding cable or jumper media. Boundaries for the pathways are formed by retaining devises that control the intended direction and location of the cables and jumpers.
Pileup	The mass of jumpers or cables passing through a specific cross-section of a frame, shelf, or cable rack.
Plain Old Telephone Service (POTS)	Voice communication public telephone service provided via switched facilities.
Planning Horizon	The time interval intended to cover a plan
Plug-In Inventory Control System (PICS)	Controls and reports the acquisition, movement, utilization, repair and retirement of plug-in equipment.
Point of Interface (POI)	The interface between a LEC (Local Exchange Carrier) and a long distance carrier.
Preferential Assignment	The assignment of facilities and equipment with the objective of short jumper length, in addition to all other assignment considerations. (e.g. load balance, class of service, etc.)
Private Branch Exchange (PBX)	A private switching system, either manual or dial, usually serving an organization such as a business company or a government agency and usually located on the customer's premises.
Program for Arrangement of Cables and Equipment (PACE)	A mechanized layout system used for spreading loop cable, line equipment, and tie cables on the COSMICTM frame.
Protector	A devise used to prevent damage to lines and equipment caused

	by dangerously high voltages or currents. The devise may be a sparkgap, varistor, thermistor, etc. The devise usually has a very high resistance to ground until the presence of an abnormal voltage or current causes the resistance to decrease. It will then conduct and eliminate the dangerous condition.
Protector Frame	A frame that solely provides protected termination for outside plant cable (has no cross-connect capabilities).
Quick Connect Cross-Connect Bay (QCX)	A type of ICB (interconnect bay) provided by WECO with quick-connect blocks.
Random Assignment	The process of assigning facilities and equipment without consideration for frame block location.
Range Extender with Gain (REG)	A solid state circuit package that will permit the extension of conductor loop signaling and transmission for long loops served from a central office.
Rehabilitation	Reuse of an existing DF using re-termination, compression, additional ironwork and mining techniques.
Remote Site	An unattended equipment location located outside the wire centers.
Remote Switching System (RSS)	A remote concentrator-carrier switching system that operates under the control of a host switching system, e.g., digital #5ESS type, digital DMS type, etc.)
Remote Terminal (RT)	A terminal associated with a system located outside the wire centers.
Repeat Coil	A coil with two or more windings, each magnetically coupled to all other windings. It is used for the impedance matching of facilities and equipment, simplexing, and isolation. In signaling equipment, repeat coils are used to pass VF (ac) while blocking dc.
Repeater	A gain devise used to correct distortion or loss of volume in a circuit.
Resistance	A circuit element designed to offer a predetermined opposition to current. Resistance is measured in ohms.
Re-termination	Transferring terminated conductors to different termination points, e.g., to achieve a different DF layout.
Re-termination block	A DF termination apparatus for temporary mounting to simplify re-termination, usually used in conjunction with tandem blocking apparatus.
Right Of Way (ROW)	Reference made for modular buildings installed over a strip of land over which facilities such as highways, railroad, and telecommunications equipment.
Riser Cable	Large pair, fire retardant cable for vertical distribution of OSP between the CEF and ACEF or CRF (Compare with Stub Cable)
Service Horizon	The time period over which an equipment, plan, etc. is expected to be viable.
Service Order (SO)	An order prepared by the telephone operating company at the request of the customer (residence, business, retail, wholesale) to

	establish a service, change an existing service, or discontinue a service.
Sheath	The outer covering of a cable, originally lead, but more commonly plastic.
Shielded Cable	A cable having an electrostatic shield around the pairs and inside the sheath.
Shoe (Test Shoe)	(1) A plug-in type device which can be clamped to electrified terminals for the purpose of making a temporary test connection. (2) Series test access within a circuit at the DF.
Short Jumper	A cross-connect which is entirely contained within a single bay / module / zone, or run between two adjacent bays. Short jumpers do not require use of an express trough on modular frames.
Signaling	The transmission of address (pulsing), supervision, or other switching information between stations and switching systems, including any information required for billing.
Single-Sided Low Profile Conventional Distributing Frame (SSLPDF)	A NEBS compatible low-height (7 to 8 feet) single-sided conventional DF which may be used for most approved Functional Frame application. Most commonly exists in small offices or remote locations as a CDF, and intermediate or larger offices as an IDF (SDDF). The conventional SMDF function is obsolete.
Sleeve	A third conductor (c.f. Tip, Ring, Sleeve) usually used for equipment control. (used primarily in the Electromechanical Switching Systems)
Span	A transmission facility between two Central Offices, or between a Central Office and a remote site.
Special Service	Any of a variety of switched services, non-switched services, or special rate services, examples of which are PBX, WATS< FX Services and burglar alarms.
Splice	Direct connection of metallic conductors or Optical fibers.
Split-Lead (Split-Terminated)	Terminating separate lead groups from the same equipment to different frames.
Spreading	Ensuring the placement of equipment in several locations (in the DSX) line up
Station (STA)	Denotes transmitting and / or receiving equipment at any location on a customer's premises.
Step-by-Step (SXS)	An electromechanical switching system. (discontinued)
Strap Cable	Tie pair cable (non-inventoried and hardwired) joining the Protector Frame with associated distributing Frames, used to connect the protected connector blocks to the cross-connect facility connecting block.
Stub Cable (Tip Cable)	Cable between the Cable Entrance Facility (CEF), the Cable Rearrangement Facility (CRF) and the DF connectors on the Protector Frame, Main Distributing Frame, or Subscriber Main Distributing Frame. (Compare to riser cable)
Subscriber Digital Distributing Frame	A distributing frame that typically cross-connects ORB's to OSP (compare with HFDF-High Frequency Distributing Frame)

(SDDF)	
Subscriber Line (Loop)	A telephone channel from the central office to the subscriber's telephone, also called loop.
Subscriber Loop Carrier (SLC)	Pair gain systems for application to the subscriber loop.
Subscriber Main Distributing Frame (SMDF)	A distributing frame that terminates exchange cable services.
Switchboard Cable	Cables for interconnecting central office equipment, or for terminating equipment on distributing frames.
Switched Maintenance Access System (SMAS)	A wire center equipment system that provides for remote test access to circuits via a central controller and in-circuit test points.
Switching Entity	Designates a specific switching system within a Wire Center (Central Office). Intermediate and large office may contain more than one Switching entity.
Switching System	An Electromechanical, electronic, or digital system for connecting lines to lines, lines to trunks, or trunks to trunks.
T Drawing	AT&T Termination Schematics
T1 Cross-Connect	A cross-connect system for T-1 carrier circuits. Unlike a DSX, a T-carrier cross-connect involves circuits with different signal levels that may have line powering. TCAS is a T-carrier administration system
T-Carrier System	A digital system that uses time division multiplexing (muxing) to combine channels onto unloaded pairs. T-1 carrier operates at 1.544 Mb/second, T-1C operates at 3.152 Mb/second.
Terminal	(1) A metallic lug or binding post on apparatus connecting conductors. (2) Equipment at the end of a communication circuit.
Terminal Block	An apparatus with many terminals that is partially enclosed. (discontinued)
Terminal Strip	An apparatus with many terminals that is not enclosed. (discontinued)
Termination Apparatus	Combining term for DF apparatus used to terminate facility/equipment cable on DF's (i.e., connectors, terminal strips, terminal blocks, connecting blocks)
Terminations	Conductor connections on a termination apparatus.
Test Access Equipment	Equipment such as test jacks and SMAS that provide access to a circuit for testing.
Test Shoe (Shoe)	(1) A plug-in type device which can be clamped to electrified terminals for the purpose of making a temporary test connection. (2) Series test access within a circuit at the DF.
Tie Cable, Tie Pairs (TP)	Building cable interconnecting two distributing frames or distributing frame regions. Tie cable connections are inventoried in their respective databases, dependant on the equipment they serve. (POTS circuits, including DSL: SWITCH database, Switched and Non-Switched Specials: TIRKS database)

Tie Pair Distributing Frame (TPDF)	An Intermediate distributing frame that is used to connect lineups in a multi-lineup Subscriber Main Distributing Frame (SMDF), to ensure the entire SMDF complex can provide inter-connect ability. (Any equipment can connect to any facility). Intended for use with Modular SMDF multi-lineup complexes. Other applications are no longer approved.
Tip and Ring (T&R)	The names of the two conductors associated with a two-wire cable pair
Toll Call	Any call for a destination outside of the local service area of the calling station. (long distance)
Toll Switches	Switching Systems that provide telephone service outside the designated local exchange service area. (Intra-Lata or Inter-Lata)
Traffic Service Position System (TSPS)	A system that provides operator assistance for toll calls (long distance), using stored program control technology (computerized)
Transmission	The passage of electrical energy from one point to another along a path, or the passage of radio waves through space between transmitting and receiving stations.
Trough (Express Trough)	A jumper pathway consisting of horizontal space provided above or below a bay / module to allow long jumpers to run horizontally on the frame on Modular DF's and Single-Sided Low Profile Conventional Distributing Frames.
Trough (Vertical)	A jumper pathway consisting of vertical space provided between adjacent bays / modules to allow jumpers to run vertically on the frame from one bay / module to another, or from a bay / module to the upper or lower express trough. Vertical troughs exist on Modular DF's.
Trunk	A communications channel between two switching systems.
Trunk Cable (TCP)	Inter-Office Cable between two wire centers intended to connect two switching machines. Switches currently use inter-office cabling at the DS-1 or higher rate, therefore, their associated trunking no longer resides on the Distributing Frame Systems. (Isolated exceptions may exist)
Trunk Circuit, or Trunk Equipment (TE)	Switching equipment associated with the connection of a trunk to the switching system, sometimes referred to as trunk equipment.
Trunk Distributing Frame (TDF)	An Intermediate Distributing Frame (IDF) associated with a switching system, used for message trunk load balancing and interoffice signaling compatibility.
Trunk Equipment (Trunk Circuit)	Switching equipment associated with the connection of a trunk to the switching system, sometimes referred to as trunk equipment.
Trunk Integrated Record Keeping System (TIRKS)	A Business Information Systems (BIS) program for maintaining data required in the Trunks and Special Services operations dealing with facility and equipment inventory, assignment, scheduling, and planning.
Trunk Main Distributing Frame (TMDF)	A Distributing Frame that terminates VF (voice frequency) trunk cable but not local exchange cable.

Ultimate Capacity	The maximum terminations / jumpers that a frame system with finite apparatus / jumper space is expected to carry by design plan for layout, assignment, and operation.
Unbridge, Unbridging	The removal of a half-tap, or bridged connection
Uniform Spread	Spreading of each type of equipment and facility uniformly across the length of a frame.
Universal Carrier	Central Office terminals (COT's) with frame-terminated channels (compare with Integrated Carrier)
U-Type Wire	Older DF jumper wire with an outer layer of cotton (thicker than the DT-type slick plastic covered wire that replaced it).
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.
Vent Safe	Assurance of gas tube protector over-voltage protection in the event of gas leakage.
Vertical Trough	A jumper pathway consisting of vertical space provided between adjacent bays / modules to allow jumpers to run vertically on the frame from one bay / module to another, or from a bay / module to the upper or lower express trough. Vertical troughs exist on Modular DF's.
Voice-Frequency Trunk Pair	Trunk cable used for a single communication channel (not multiplexed or concentrated)
Wire Center (Central Office, or C.O.)	A building at which customer loops converge and one or more switching and related equipment systems are located.
Wire Center Plan (Comprehensive Plan)	The combined collection of fundamental plans from all areas (planning disciplines) for a specific wire center. (aka Comprehensive Plan)
Work Order Activity	Quantity of work orders generated per unit time.
Work Orders	Telephone orders to add, remove, or change facilities or equipment for OTC (Operating Telephone Company) convenience. (company initiated work activities)
Working Plan	A DF fundamental plan specification documented to facilitate implementation engineering and plan monitoring.
W-type Wire	Older DF jumper wire used on ESS Modular Distributing Frames, replaced by DT-type wire.
Y-Splice	A direct tap of a pair of wires onto another pair of wires.
Zone Spread	DF layout of outside plant and line equipment terminations into partitioned zones with approximately equal quantities.
Zones	DF regions (modules or range of verticals defined for termination layout engineering and / or short jumper assignment administration.
Zoning	Reserving a certain area for specific equipment

Contents

15 References

15.1 National Electric Code

NEC	*National Electrical Code*, 2014

15.2 Telcordia Documents

GR-63-CORE	*Network Equipment - Building System (NEBS) Requirements: Physical Protection*, Issue 4, April 2012.
GR-347-CORE	*General Requirements for Telecommunications Power Cable*, Issue 3, July 2008.
GR-1089-CORE	*Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment*, Issue 6, May 2011.
GR-1275-CORE	*Central Office/Network Environment Equipment Installation/Removal Generic Requirements,* Issue 12, December 2010
GR-1502-CORE	*Central Office/Network Environment Detail Engineering Generic Requirements,* Issue 9, December 2010
GR-2930-CORE	*Network Equipment – Building Systems (NEBS): Raised Floor Generic Requirements for Network and Data Centers,* Issue 1, November 1996
GR-295-CORE	*Mesh and Isolated Bonding Networks: Definition and Application to Telephone Central Offices*, Issue 1, November 2004.

15.3 CenturyLink Technical Publications

PUB 77350	*Telecommunications Equipment Engineering, Installation and Removal Guidelines.* Issue N, January 2007.
PUB 77355	*Grounding - Central Office and Remote Electronic Equipment Environment.* Issue H, June 2012.
PUB 77385	*Power Equipment and Engineering Standards*, Issue J, July, 2013.

15.4 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.

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