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NEMA STANDARDS PUBLICATION NO. VE 2

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Metal Cable Tray Installation Guidelines

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 1300 N. 17th Street, Rosslyn, Virginia 22209

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NEMA Standards Publication VE 2-1996

METAL CABLE TRAY INSTALLATION GUIDELINES

Published by:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

Approved by:

Cable Tray Institute
4101 Lake Boone Trail
Raleigh, NC 27607

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FOREWORD

For Cable Tray Installers—This publication is intended as a practical guide for the proper installation of aluminum or steel cable tray systems.

These guidelines and information do not intend to cover all details or variations in cable tray systems nor provide for every possible installation contingency.

Construction Experience—It is recommended that the work described be performed by qualified persons familiar with standard electrical construction practices, electrical equipment, and safety of electrical wiring systems.

These guidelines of NEMA's Cable Tray and Wire and Cable Sections and the Cable Tray Institute will be useful to engineers, contractors, and maintenance personnel. This publication will be reviewed periodically with the purpose of updating it to reflect advancing technology and construction techniques. Please address any comments or questions to:

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or

Technical Director
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4101 Lake Boone Trail
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Raleigh, NC 27607-6518

This is the first edition of this publication.

SCOPE

This publication addresses shipping, handling, storing, and installing metal cable tray systems. Information on maintenance and system modification is also provided.

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Section 1
GENERAL

WARNING!—Do Not use as a walkway, ladder or support for people; cable tray is a mechanical support system for cables and raceways.

WARNING!—Hazardous voltages in electrical equipment can cause severe personal injury or death. Safety related work practices, as described in NFPA 70E, Part II, should be followed at all times.

The performance of a cable tray wiring system is dependent on its proper installation, including supports and cables. Neglecting installation and maintenance guidelines may lead to personal injury as well as damage to property.

Installation and maintenance of cable tray wiring systems shall be conducted only by qualified personnel. For the purposes of this guideline, a qualified person is one who is familiar with electrical construction. In addition, the person is:

Trained and authorized to test, energize, clear, ground, tag and lock out circuits in accordance with established safety practices.

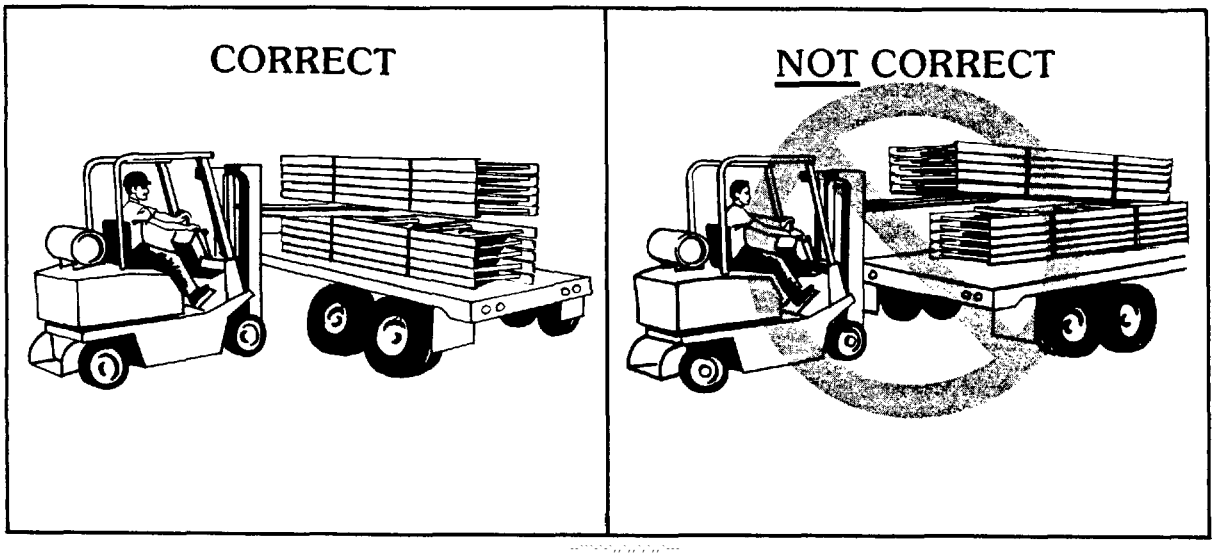
Trained in the proper care and use of protective equipment such as insulated rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing in accordance with established safety practices.

Section 2
RECEIVING AND UNLOADING

Cable tray is generally bundled and shipped via motor freight, except for export shipments that could be crated or loaded in containers. Accessories and small components are boxed and often skidded.

Cable tray can be shipped via enclosed van, trailer or flat bed trailer. Van trailers are normally used for less than truck load (LTL) shipments. This method of shipment is most common and cost effective and offers maximum protection from the weather during shipment. LTL shipments should be hand unloaded unless provisions have been made with the cable tray manufacturer for fork lift unloading.

Flat bed trailers are often used for full truck load shipments and when customers want side fork lift unloading or sling unloading by crane. (Special care must be exercised using slings so tray is not crushed from the improper location and lifting by sling.)

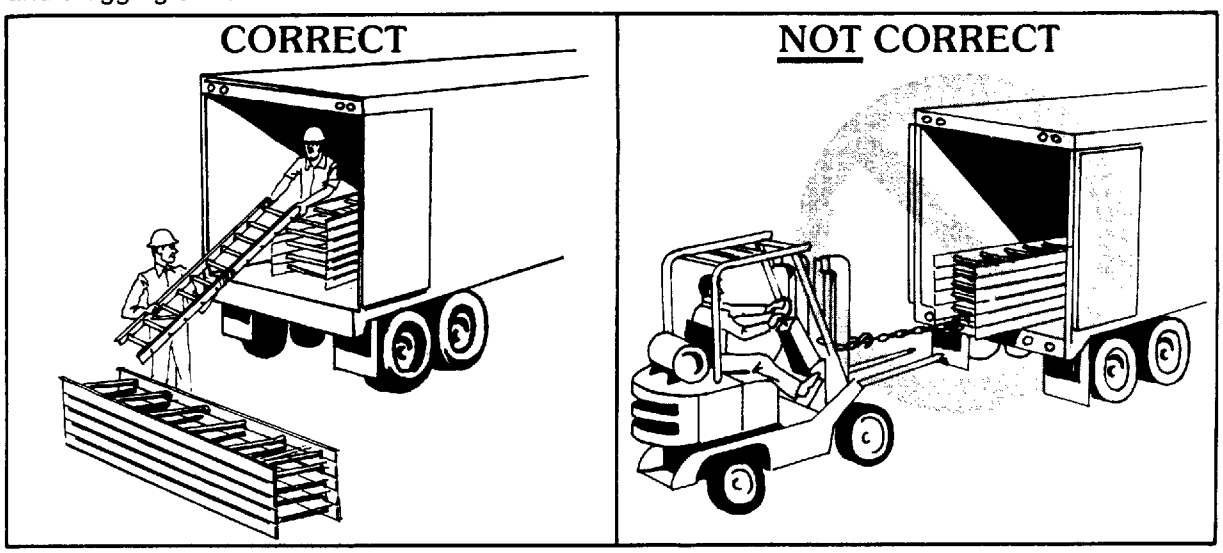


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Small to medium size orders (less than 2000 feet) are generally shipped via common carrier - LTL in enclosed vans.

If hand unloaded, workers should wear gloves.

To prevent damage to cable tray, never pull cable tray from truck trailer by chaining to bottom rung and dragging out of trailer.



Inventory all items immediately after unloading, using the manufacturer's packing list. Note on the bill of lading any shortage or shipping damage for filing freight claim.

Section 3
STORAGE

Hot dipped, galvanized after fabrication (H.D.G.A.F.) (see ASTM A 123) steel, aluminum and stainless steel cable tray can be stored outside without cover, but should be loosely stacked, elevated off the ground and ventilated to prevent storage stain. If appearance is important, cable tray should be stored indoors to prevent water or other foreign materials from staining or adhering to cable tray.

Mill galvanized (see ASTM A 924) cable tray must be protected or stored in a well ventilated, dry location.

PVC or painted cable tray should be protected and stored indoors if possible. Cable tray must be protected from scratching and marring of finish.

Small accessories should be stored to prevent loss.

Cable tray should be stored away from high traffic areas. Cable tray should be stacked by width and type.

Section 4
INSTALLATION

For Cable Tray Installers—This publication is intended as a practical guide for the proper installation of aluminum or steel cable tray systems.

These instructions and information do not intend to cover all details or variations in cable tray systems nor provide for every possible installation contingency.

Construction Experience—It is recommended that the work described be performed by qualified persons familiar with standard electrical construction practices, electrical equipment, and safety of electrical wiring systems.

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4.1 Common Tools for Installation

The following tools are commonly used for installation of cable tray:

- Metal cutting saw
- Touch-up material
- Screwdriver
- Drill with bits
- File
- Open end wrench
- Nylon cord or laser
- Leveling device
- Tape measure
- Square
- C-clamp
- Torque wrench
- Ratchet wrench

4.2 Support Installation

Caution! *Do not cut or drill structural members (e.g. I-beams) without approval by the general contractor.*

In order to install the cable tray supports, first find the required elevation from the floor to the bottom of the tray and establish a level line with a laser or a nylon string. A string works well because it can be used to align the threaded rods on one side of a trapeze and find the tops of the supports.

In order to speed the process of installing the trapeze hangers, some nuts may be prethreaded onto the threaded rod to the approximate location that the nut will be needed. One method for prethreading the nuts is to put the nuts onto the end of a piece of threaded rod, attach a drill to the threaded rod, and run the nuts up the rod holding onto them with an open-end wrench.

4.2.1 Tray Supports

Caution! *Supports for cable trays should provide a strength and working load capability sufficient to meet the load requirement of the cable tray wiring system.*

4.2.1.1 Trapeze Type (See Figures 4.1A through 4.1F.)

To install:

a. Thread nuts onto threaded rod approximately 2 inches above desired location of bottom of tray.
b. Slide on square washers followed by cross member and second set of square washers.
c. Thread second set of nuts onto threaded rod.
d. Move cross members so its top surface is located where bottom of cable tray run will be located.
e. Move second set of nuts up threaded rod until cross member is reached and held in place.
f. Make sure cross member is level, then move first set of nuts down threaded rod until cross member is secured in place.

In most cases, hold-down guide clamps may be mounted on either the inside or outside of the cable tray side rail. When installed on the inside of the cable tray, the clamp and/or attaching hardware should not extend above the rung.

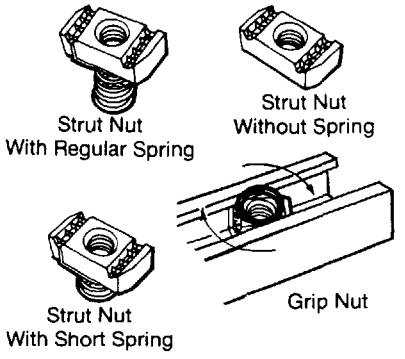


Figure 4.1A
Strut Nut

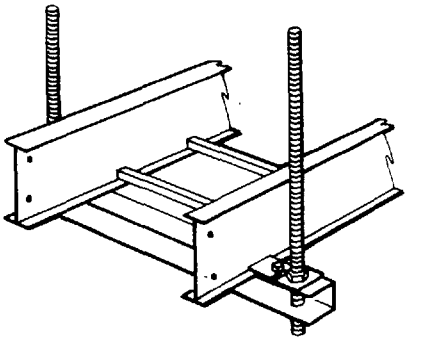


Figure 4.1B
C-Channel

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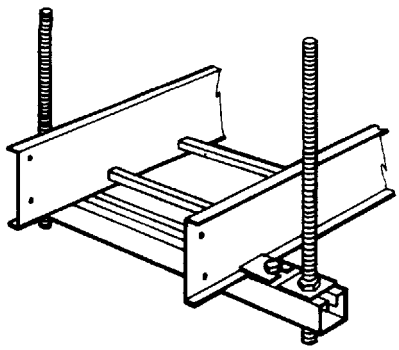


Figure 4.1C
Strut

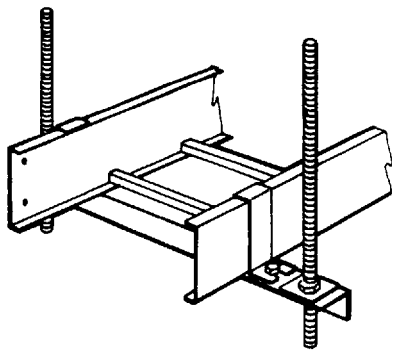


Figure 4.1D
Angle Iron

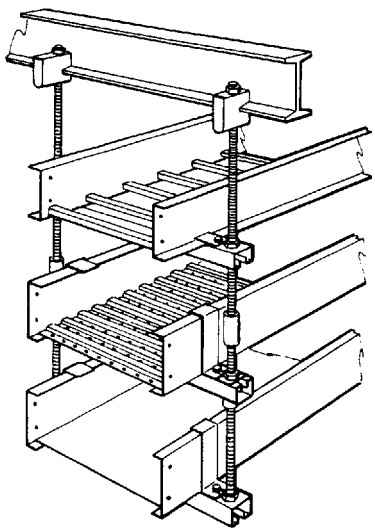


Figure 4.1E
Typical Strut Installation

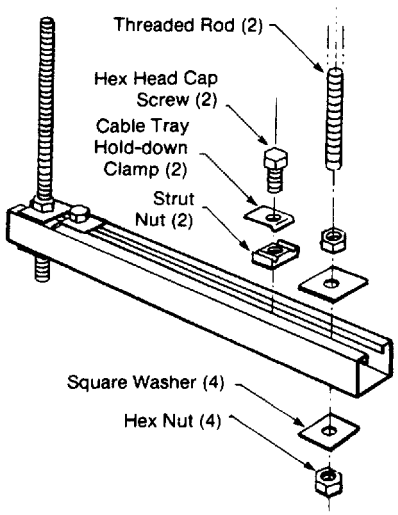


Figure 4.1F
Strut-Exploded View

4.2.1.2 Hanger Rod Clamp (See Figures 4.2A through 4.2D.)

To install:

a. Thread nuts onto threaded rod approximately 9 inches above desired location of bottom of tray.
b. Place clamp around side rail of cable tray.
c. Lift entire cable tray section onto threaded rod running threaded rod through two holes in clamp.
d. Thread a second set of nuts onto threaded rod moving them up until bottom of cable tray reaches desired location.
e. Move first set of nuts down threaded rod and secure clamps in place.

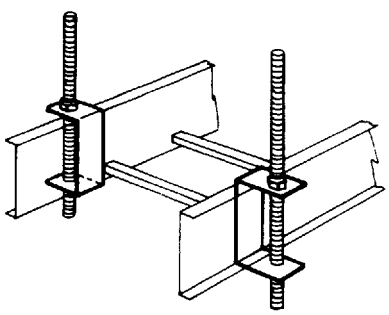


Figure 4.2A
Single Tray Hanger

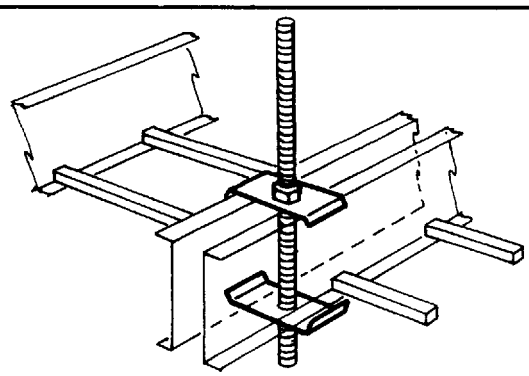


Figure 4.2B
Double Tray Hanger

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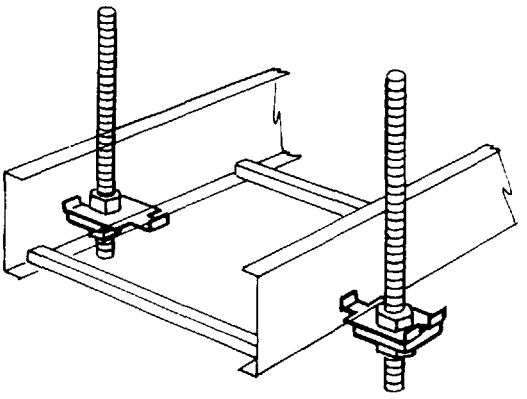


Figure 4.2C
Alternate Single Tray Hanger

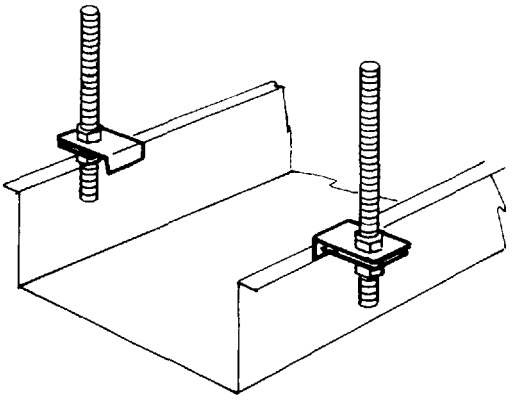


Figure 4.2D
Alternate Single Tray Hanger

4.2.1.3 Center Hung Support (See Figures 4.3A through 4.3D.)

To install:

a. Thread nut onto threaded rod approximately 9 inches above desired location of bottom of tray.
b. Slide support onto threaded rod with upright tube going through center of cable tray section needing support.
c. Place a square washer on threaded rod and thread on second nut.
d. Move cross member so its top surface is located at the place where bottom of cable tray run will be located.
e. Move second nut up threaded rod until it reaches cross member and holds it in place.
f. Move first nut down threaded rod until it secures cross member in place.

In most cases, hold-down/guide clamps may be mounted on either the inside or outside of the cable tray side rail. When installed on the inside of the cable tray, the clamp and/or attaching hardware should not extend above the rung.

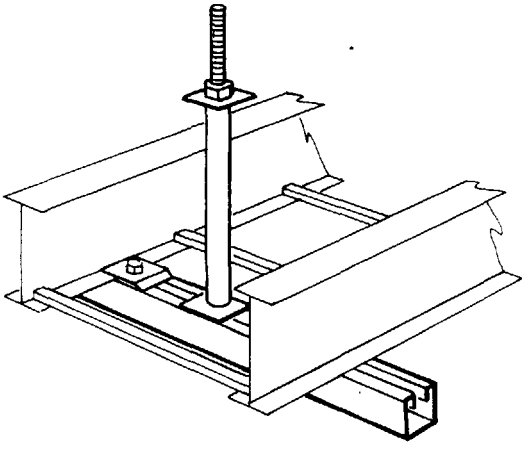


Figure 4.3A
Center Hanger Support

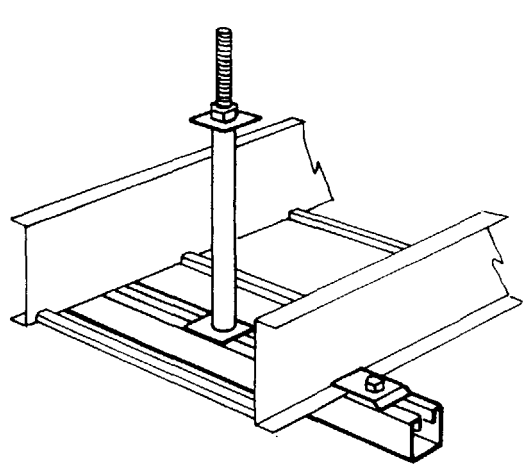


Figure 4.3B
Center Hanger Support

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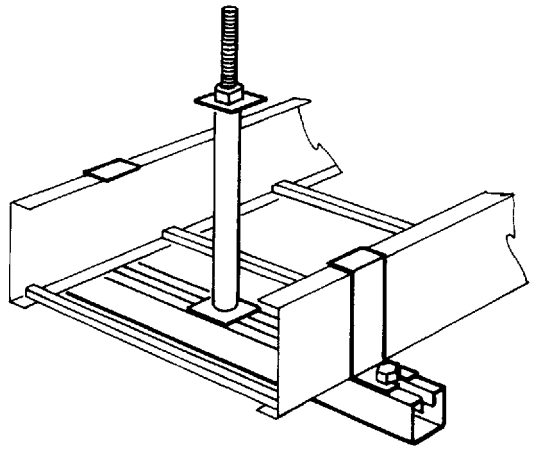


Figure 4.3C
Center Hanger Support

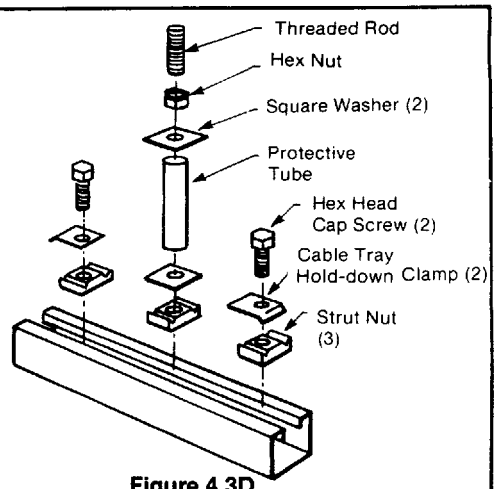


Figure 4.3D
Center Hanger Support - Exploded View

4.2.1.4 Single Channel Cable Tray Hanger (See Figures 4.4A through 4.4B.)

To install:

a. Thread nut onto threaded rod to height required.
b. Place hanger on threaded rod and follow with one nut.
c. Run nut up threaded rod until bottom of hanger is at desired height.
d. Place channel on hanger (and secure in place as necessary).

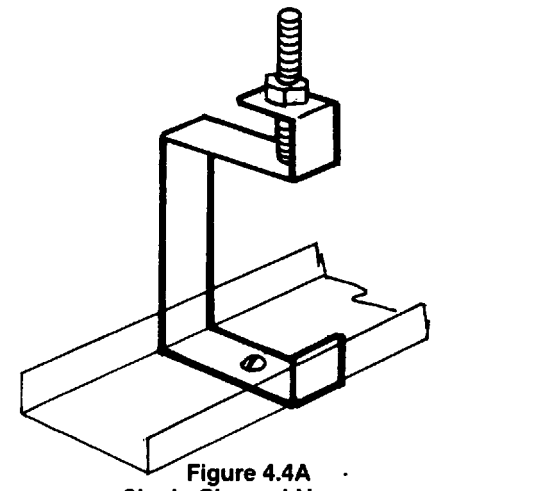


Figure 4.4A
Single Channel Hanger

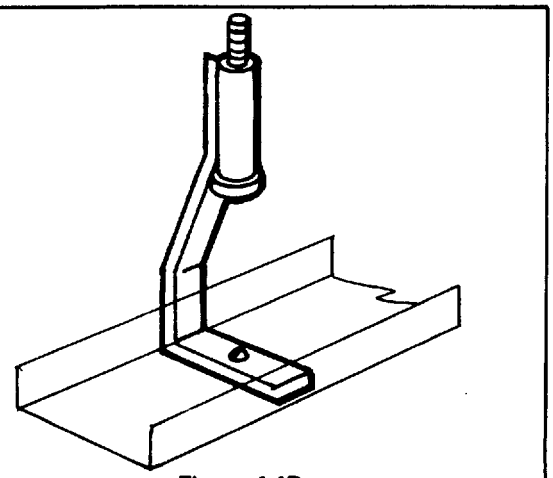


Figure 4.4B
Alternate Single Channel Hanger

4.2.1.5 Double Channel Cable Tray Hanger (See Figure 4.5.)

To install:

a. Thread nut onto threaded rod to height required.
b. Place hanger on threaded rod and follow with one nut.
c. Run nut up threaded rod until bottom of hanger is at desired height.
d. Place channels on hanger (and secure in place as necessary).

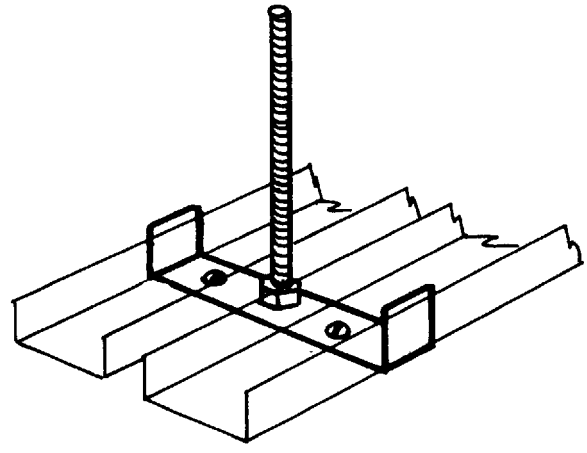


Figure 4.5
Double Channel Hanger

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4.2.2 Wall and Cantilever Brackets (See Figures 4.6A through 4.6D.)

Secure the brackets to the structure making sure they are level and even with each other.

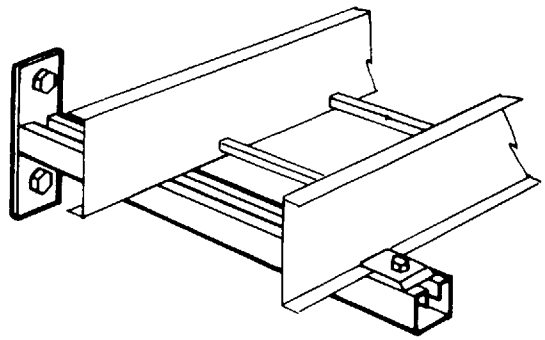


Figure 4.6A
Single Strut Cantilever Bracket

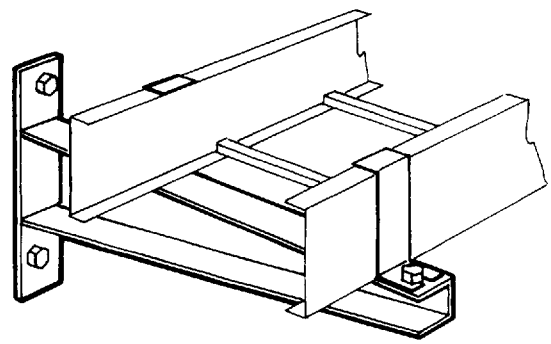


Figure 4.6B
Wall Support Cantilever Bracket

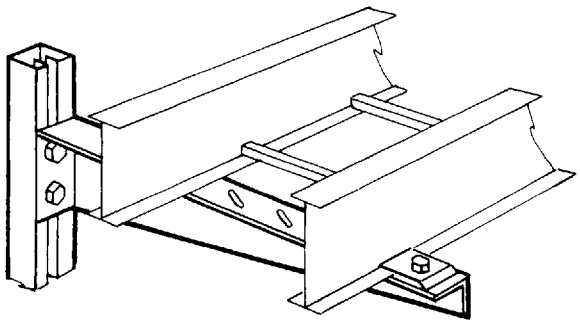


Figure 4.6C
Gusset Cantilever Bracket

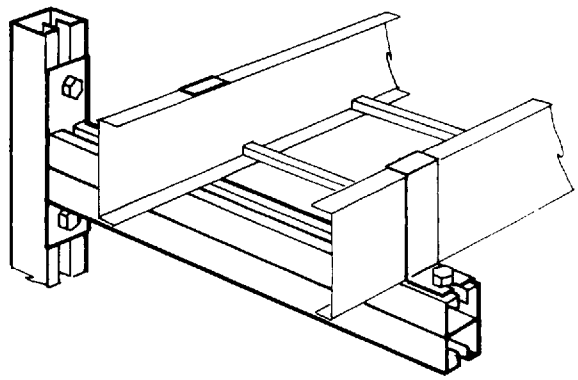


Figure 4.6D
Double Strut Cantilever Bracket

4.2.3 Floor and Roof Installations (See Figure 4.7.)

Cable tray should not be laid directly on the floor or roof. It should be mounted far enough off the floor or roof to allow the cables to exit through the bottom of the tray. If strut is used for this purpose, mount the strut directly to the floor or roof and attach the cable tray to the strut using hold-down clamps and/or guide clamps.

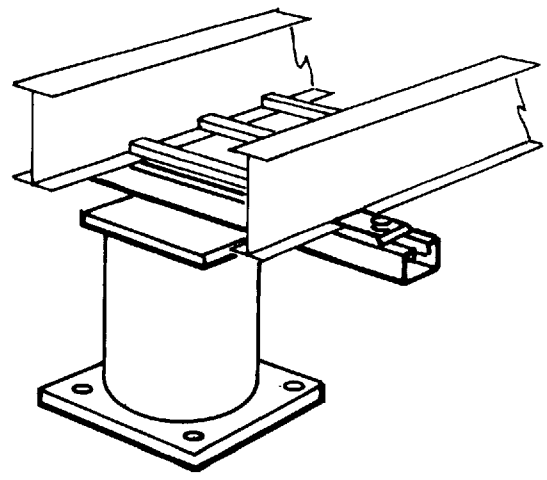


Figure 4.7
Elevated Strut Floor Support

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4.2.4 Vertical Applications (See Figures 4.8A through 4.8C.)

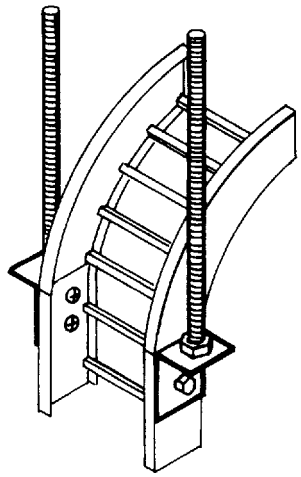


Figure 4.8A
Vertical Threaded Rod Support

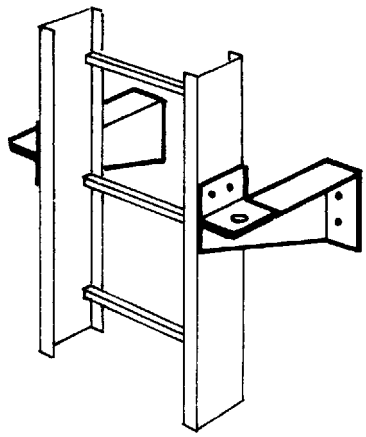


Figure 4.8B
Vertical Gusset Cantilever Support

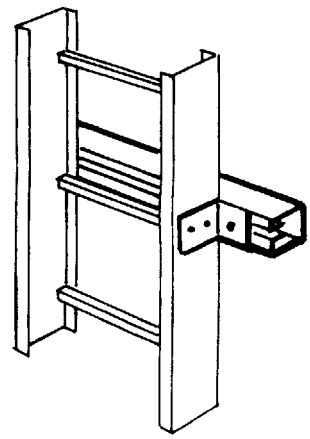


Figure 4.8C
Vertical Strut Support

4.3 Straight Section Installation

4.3.1 Straight Section Position

After the supports are in place, the installation of the cable tray can begin at any place that is convenient. It is not necessary to start at one end of the run. It is ideal to lay out the system so that splice joints fall between the support and the quarter point (Fig. 4.9). This maximizes the rigidity of the cable tray. For example, when installing a 12-foot long section, a support spacing of 12 feet will cause the splice joints to fall at the same position every time.

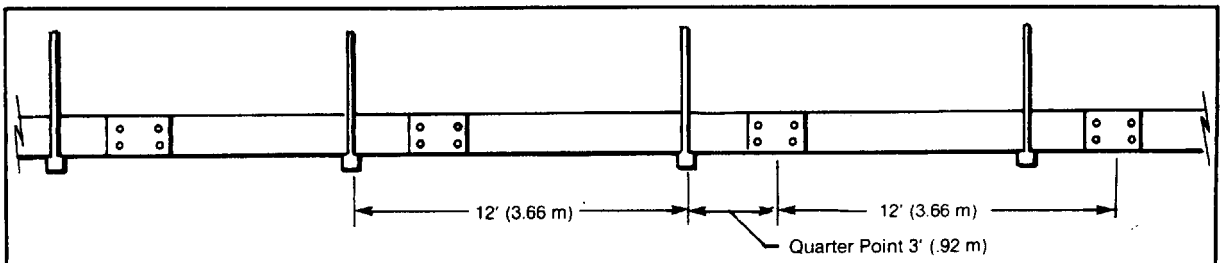


Figure 4.9
Cable Tray Support Locations

To begin, place a straight section across two supports so that the ends of the section are not directly on the support (Fig. 4.10A). If the support span is equal to the length of the straight sections, bolt two pieces together for this step. ***The support span should not be greater than the straight section length, to ensure no more than one splice is located between supports.*** As a general practice, avoid placing splice plates over supports or at mid-span (Fig. 4.10B).

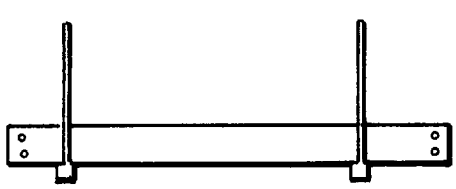


Figure 4.10A
Cable Tray Installation

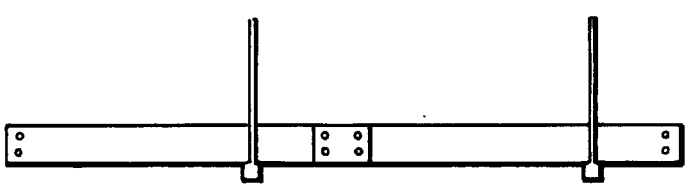


Figure 4.10B
Cable Tray Installation

alent in parentheses

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Place the next straight section across the next support and attach it to the previous section with a pair of splice plates and hardware. Splice plates should be placed on the *outside* of the cable tray with the bolt heads on the *inside* of the cable tray (Fig. 4.11). Hardware for standard duty cable trays will be ⅜" dia. (9.5 mm). Tighten with enough torque to draw splice plates flush with side rail (approximately 19 to 25 ft-lbs. (25 to 34 Nm).

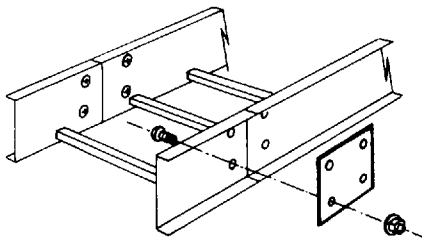


Figure 4.11
Splice Plate Attachment

4.3.2 Expansion Splice Plates

It is important that thermal contraction and expansion be considered when installing cable tray systems. The length of the straight cable tray run and the temperature differential govern the number of expansion splice plates required (see table below).

Table 4-1
Maximum Spacing Between Expansion Joints that Provide for One Inch Movement

Temperature Differential		Steel		Aluminum	
°F	(°C)	feet	(m)	feet	(m)
25	(-4)	512	(156)	260	(79)
50	(10)	256	(78)	130	(40)
75	(24)	171	(52)	87	(27)
100	(38)	128	(39)	65	(20)
125	(51)	102	(31)	52	(16)
150	(65)	85	(26)	43	(13)
175	(79)	73	(22)	37	(11)

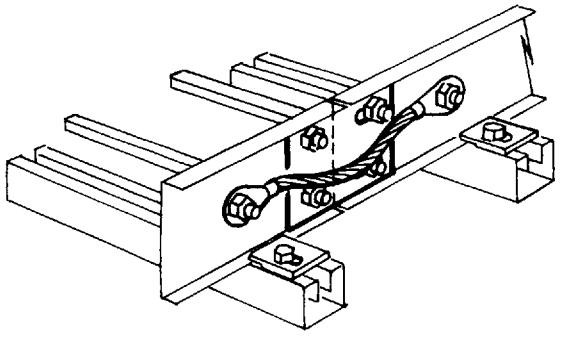


Figure 4.12
Expansion Splice Plate Attachment

The cable tray should be anchored at the support nearest to its midpoint between the expansion splice plates and secured by expansion guides at all other support locations (see Figure 4.13A). The cable tray should be permitted longitudinal movement in both directions from that fixed point.

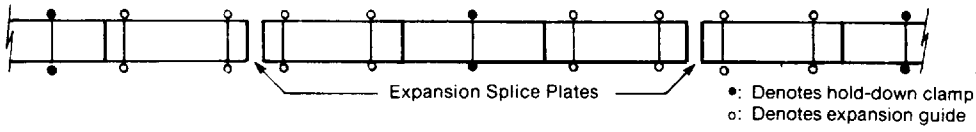


Figure 4.13A Hold Down and Guide Clamp Locations

Accurate gap setting at the time of installation is necessary for the proper operation of the expansion splice plates. The following procedure should assist the installer in determining the correct gap:

a. Plot the highest expected metal temperature on the maximum temperature line.
   Example Value = 100°F (38°C)
b. Plot the lowest expected metal temperature on the minimum temperature line.
   Example Value = -28°F (-33°C)
c. Draw a line between the maximum and minimum points.
d. Plot the metal temperature at the time of installation to determine the gap setting.
   Example Value = ⅜" (9.5 mm), 50°F (10°C).

Special hardware is supplied with expansion splice plates. The nuts may have a stopping device (plastic stop nut). **Important**—for plastic stop nut designs, tighten hardware then loosen ½ turn. For other types of hardware follow manufacturers instruction.

Expansion joints require bonding for electrical continuity. Refer to Section 4.7 for bonding jumper installation.

Supports should be located within 2 ft (0.6 m) of each side of expansion splice plates.

Note: Metric equivalent in parentheses

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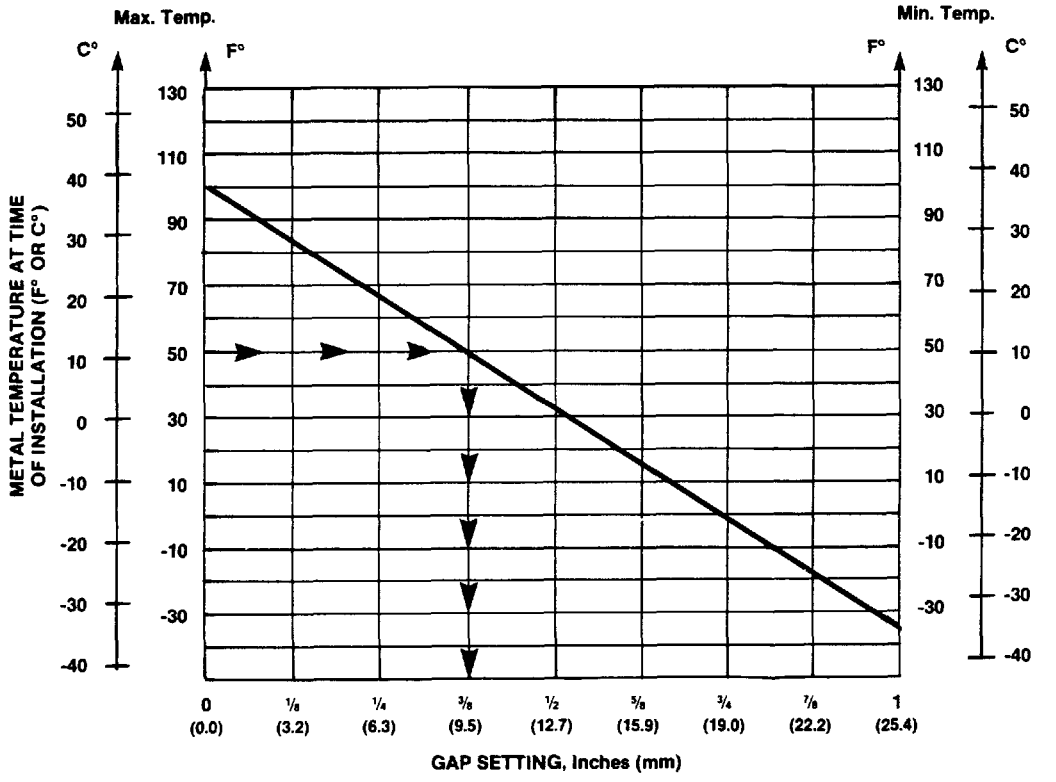


Figure 4.13B
Gap Setting of Expansion Splice Plate
1" (25.4) Gap Maximum

4.3.3 Vertical Adjustable Splice Plates

(See Figures 4.14A and 4.14B.)

For minor changes in vertical direction not requiring a radius, use vertical adjustable splice plates. Supports should be located within 2 ft (0.6 m) of each side of vertical adjustable splice plates.

a. Position splice halves so that offsets adjust for material thickness and fasten with nut and bolt using hole (A).
b. Attach to positioned cable tray sections which will set needed angle.
c. Drill to complete hole (B). Figure 4.14A only.
d. Insert and tighten all hardware.

Bonding jumpers are required for electrical continuity, unless the splice plates meet the electrical continuity requirements of NEMA Standard VE-1.
(Refer to Section 4.7 - Grounding)

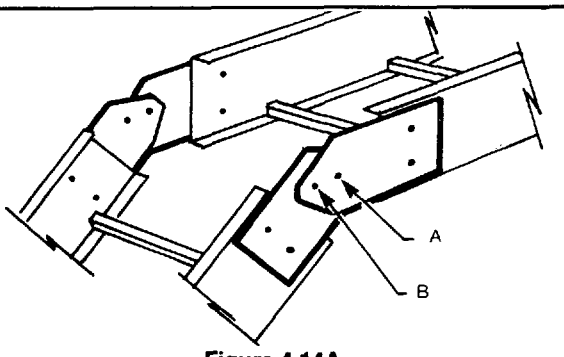


Figure 4.14A
Two Bolt Vertical Adjustable Splice Plates

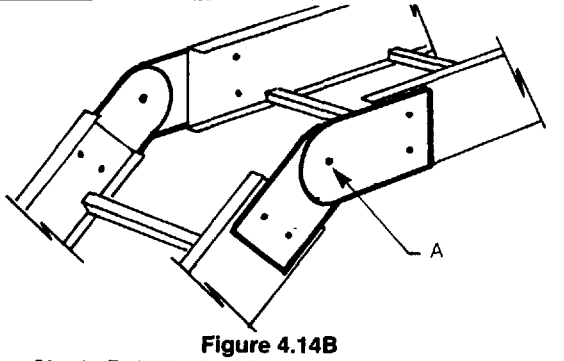


Figure 4.14B
Single Bolt Vertical Adjustable Splice Plates

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4.3.4 Horizontal Adjustable Splice Plates

(See Figure 4.15.)

For minor changes in horizontal direction not requiring a radius, use horizontal adjustable splice plates. Supports should be located within 2 ft (0.6 m) of each side of horizontal adjustable splice plates.

a. Connect inside connector (short piece) and position cable tray sections to set angle.
b. Position outside connector locating hinge at mid-point.
c. Drill required holes and install and tighten all hardware.

Bonding jumpers are required for electrical continuity.
(Refer to Section 4.7 - Grounding)

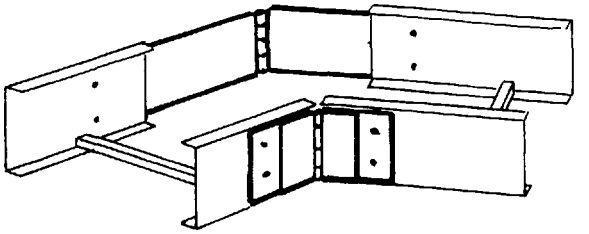


Figure 4.15
Horizontal Adjustable Splice Plates

4.3.5 Tray-to-Box or Floor Splice Plates

(See Figure 4.16.)

For termination of cable tray system to equipment or structures.

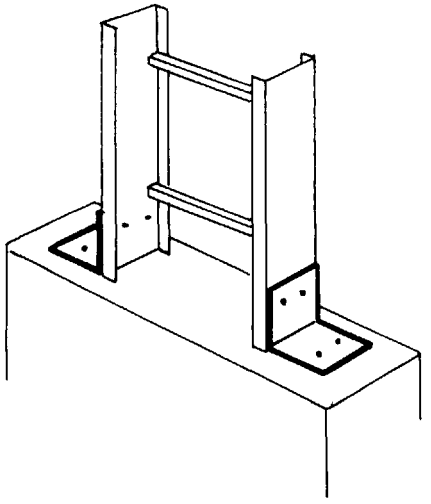


Figure 4.16
Tray-to-Box/Floor Splice Plates

4.3.6 Offset Reducing Splice Plates

(See Figure 4.17.)

For immediate width changes use offset reducing splice plates.

a. Use an offset reducing splice plate with a standard splice plate to form an offset reduction.
b. Use a pair to form a straight reduction.

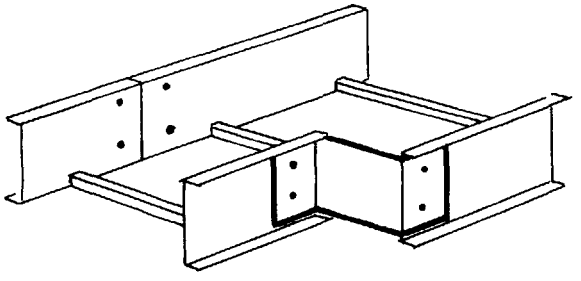


Figure 4.17
Offset Reducing Splice Plate

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4.3.7 Vertical Support Plates

(See Figure 4.18.)

Use vertical support splice plates for additional support of extended vertical runs. (See Section 4.2.4)

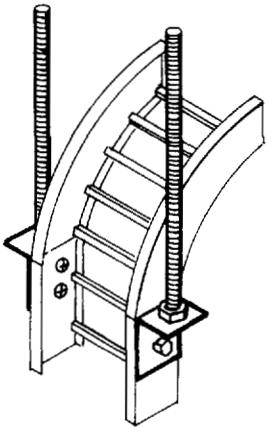


Figure 4.18
Vertical Support Plates

4.3.8 Step-down Splice Plates

(See Figure 4.19.)

Use step-down splice plates when connecting cable trays of different heights.

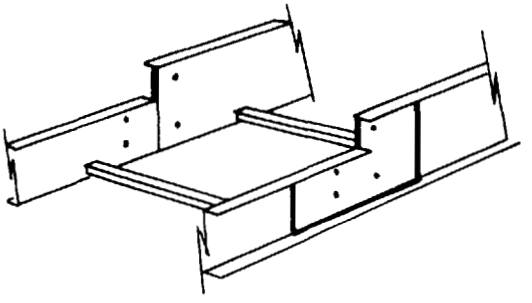


Figure 4.19
Step-down Splice Plates

4.3.9 End Plates

(See Figure 4.20.)

For dead-end closure indicating termination of cable tray run use end plates.

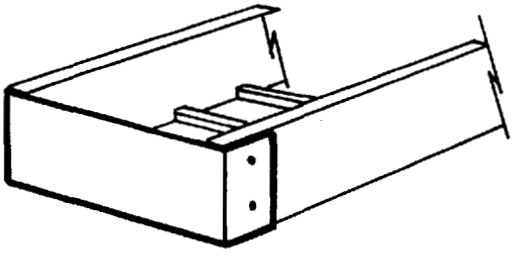


Figure 4.20
End Plate

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4.4 Fitting Installation

4.4.1 Recommended Support Locations for Fittings

Horizontal Elbow Support Supports for horizontal tray fittings should be placed within 2 ft (160 mm) of each fitting extremity, and as follows:

a. 90 degree supports at the 45 degree point of arc.
b. 60 degree supports at the 30 degree point of arc.
c. 45 degree supports at the 22½ degree point of arc (except for the 12-inch [305 mm] radii).
d. 30 degree supports at the 15 degree point of arc (except for the 12-inch [305 mm] radii).

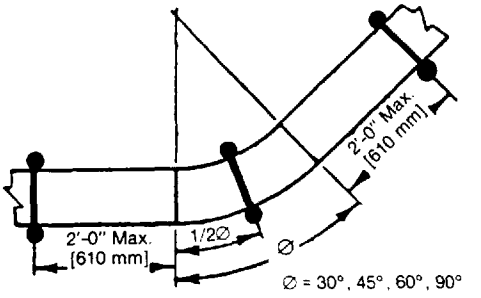


Figure 4.21
Horizontal Elbow Support

Horizontal Tee Support Place horizontal tee supports within 2 ft (610 mm) of each of the three openings connected to other cable tray items for the 12-inch (305 mm) radius. On all other radii, at least one support should be placed under each side rail at the horizontal tee, preferably as shown.

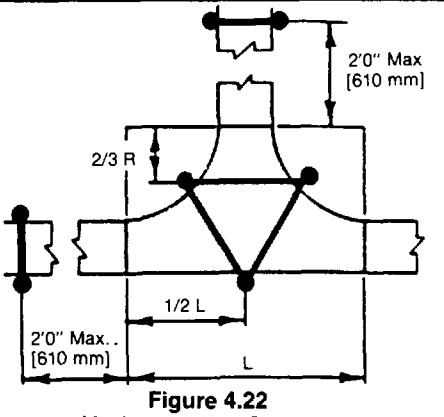


Figure 4.22
Horizontal Tee Support

Horizontal Wye Support Place horizontal wye supports within 2 ft (610 mm) of each of the three openings connected to other cable tray items, and at 22½ degree point of the arc adjacent to the side branch.

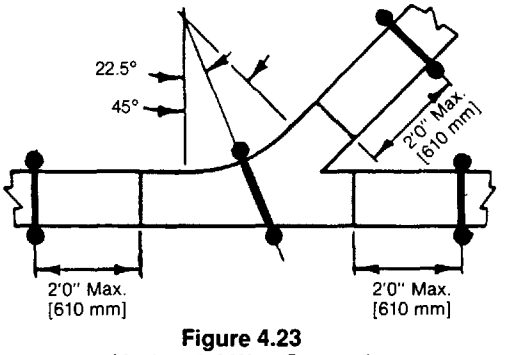


Figure 4.23
Horizontal Wye Support

Horizontal Cross Support Place horizontal cross support within 2 ft (610 mm) of each of the four openings connected to other cable tray items for the 12-inch (305 mm) radius. On all other radii, at least one support should be placed under each side rail of the horizontal cross, preferably as shown.

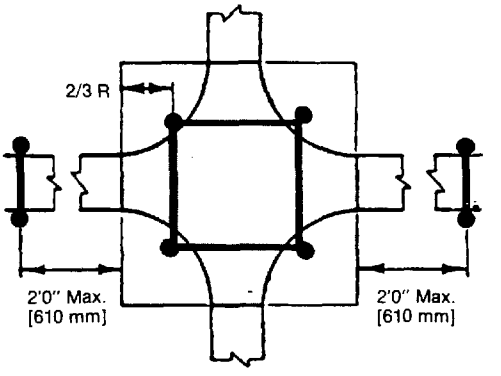


Figure 4.24
Horizontal Cross Support

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Reducer Support Place reducer supports *within 2 ft (610 mm) of each fitting extremity.*

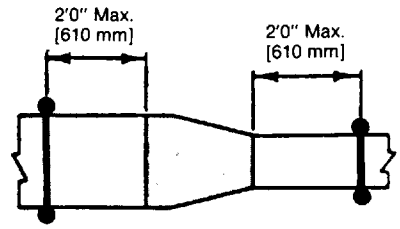


Figure 4.25
Reducer Support

Reducer Support Place reducer supports within 2 ft (610 mm) of each fitting extremity.

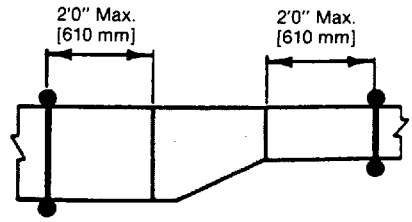


Figure 4.26
Reducer Support

Vertical Cable Tray Elbows Vertical cable tray elbows at the top of runs should be supported at each end; at the bottom of runs they should be supported at the top of the elbow and within 2 ft (610 mm) of the lower extremity of the elbows.

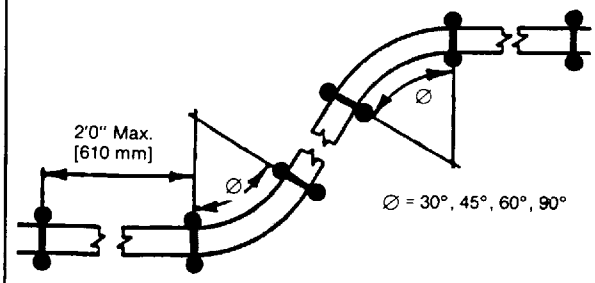


Figure 4.27
Vertical Cable Tray Elbows

Vertical Cable Tray Tees Vertical cable tray tees should be supported within 2 ft (610 mm) of each fitting extremity.

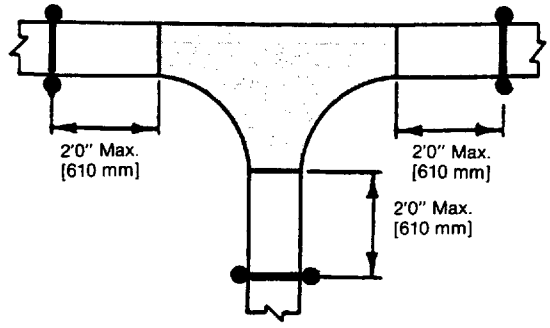


Figure 4.28
Vertical Cable Tray Tees

Note: Metric equivalent in parentheses

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4.4.2 Cable Support Fitting (See Figures 4.29 and 4.30.)

These fittings are recommended for use at the top of long vertical runs of heavy cable to support the cables.

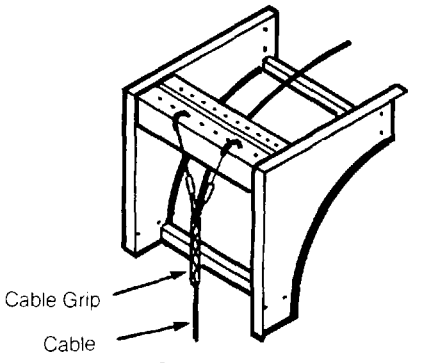


Figure 4.29
Vertical Cable Support

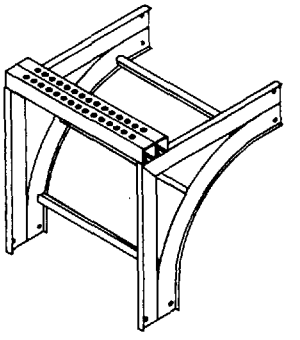


Figure 4.30
Vertical Cable Support

4.5 Field Modifications

Eventually it will be necessary to field cut the cable tray because the length of the cable tray required will be less than standard length. If there are many cuts to be made in a given area, waste can be prevented by making a cut list which can be used to calculate the most efficient use of the standard sections.

4.5.1 Marking (See Figures 4.31 and 4.32.)

Using a square that reaches across the width of the cable tray, gauge off the edge of one side rail and mark both flanges (Fig 4.31). Next, position the square as shown in Fig 4.32 and mark the web of the rail. Marking can be done with a scribe, metal marking pen, or a pencil.

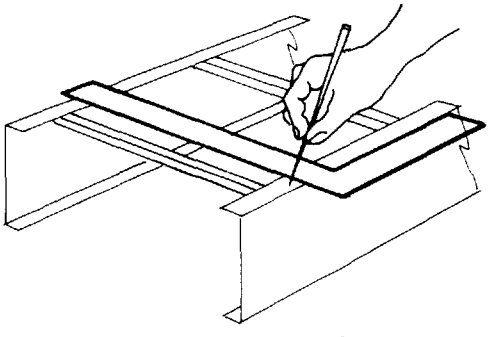


Figure 4.31

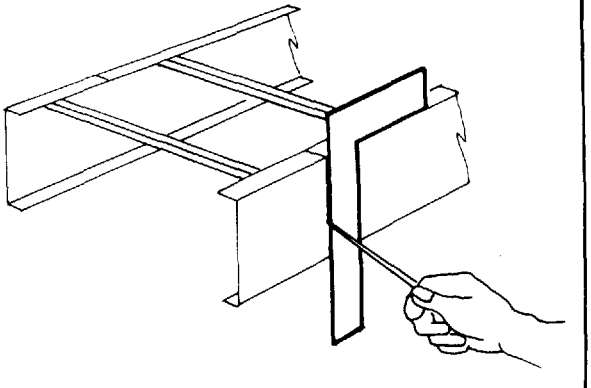


Figure 4.32

4.5.2 Cutting

The cut can be made using a hand held hack saw, carbide tipped metal-cutting circular saw, or a hand-held band saw. It is important to get a square cut to ensure a good splice connection. Cable tray manufacturers offer jigs and other devices to aid in field cutting (Fig 4.33). After cutting, file the cut edges to remove any burrs.

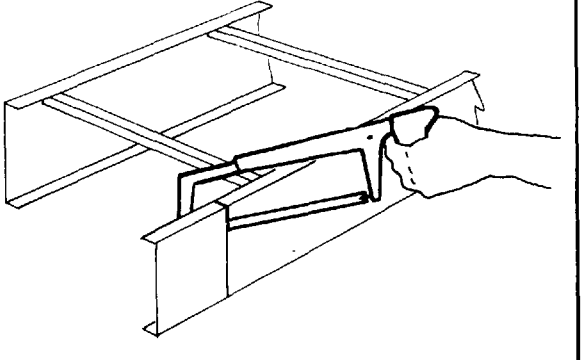


Figure 4.33

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4.5.3 Drilling (See Figures 4.34 through 4.36.)

Holes for splice plates must be drilled in field-cut cable trays. The most common method of locating the hole positions is to use a splice plate as a template. Drill jigs (Fig 4.34) are also available. A short piece of side rail that is punched with the standard factory hole pattern can be bolted to the splice plate to serve as a stop that rests against the end of the field-cut side rail (Fig 4.35). Clamp the splice plate to the rail and drill through the splice plate holes and the side rail (Fig 4.36). The correct drill size is dependent on the hardware supplied with the tray. Match the holes that exist in the cable tray. After drilling, file off any burrs.

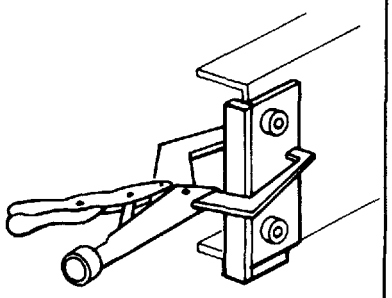


Figure 4.34

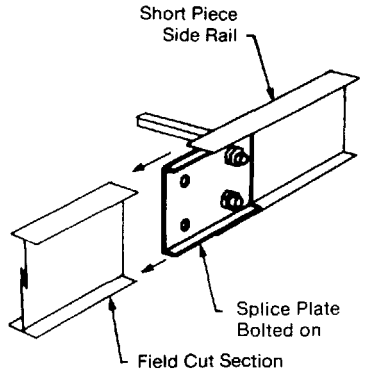


Figure 4.35

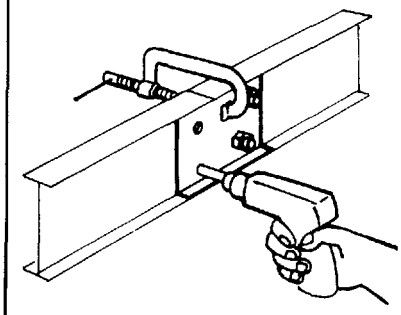


Figure 4.36

4.5.4 Finish Touch Up

Cable trays that have a hot dip galvanized coating applied after fabrication need to be retouched after cutting, drilling or deburring or if the coating gets damaged. These cutting operations leave bare metal edges that will begin to corrode immediately. Cable trays made from mill galvanized steel do not need to be touched up because they are not designed to be used in heavily corrosive atmospheres and have bare metal edges inherent in their design. Aluminum trays do not need to be touched up.

Touch up of the galvanized finish must be done according to ASTM A 780, "Repair of Damaged Hot-Dip Galvanized Coatings." Use an approved zinc-rich paint that meets the requirements of ASTM A 780. The paint can be applied by brushing or spraying. Always paint ½" (12.7 mm) to 1" (25.4 mm) beyond the bare area to prevent undercutting by corrosion.

Other protective coatings that are cut or damaged must be touched up with compatible coatings.

4.6 Accessories (See Figures 4.37 through 4.44.)

4.6.1 Barrier Strips

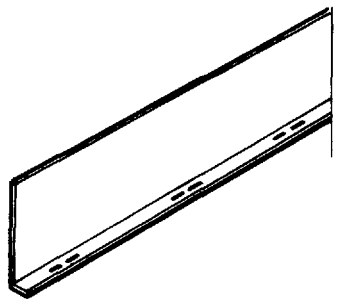


Figure 4.37
Barrier Strip - Straight Section

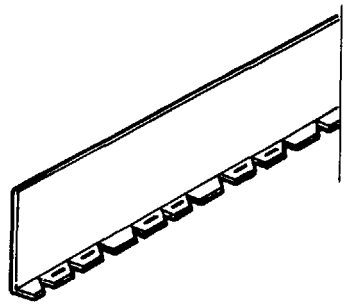


Figure 4.38
Barrier Strip - Horizontal Fitting

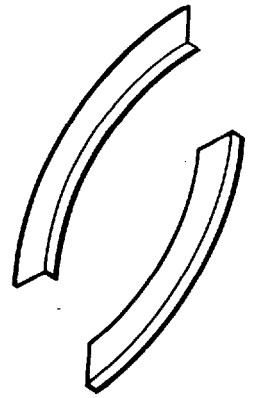


Figure 4.39
Barrier Strip - Vertical Fitting

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Barrier strips are sometimes used to separate cables with a cable tray as required by the National Electrical Code® (NEC).

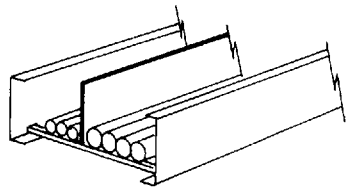


Figure 4.40
Barrier Strip Application

Barrier strips are installed by placing them at the desired location, then fastening them down with the hardware provided. This connection should be made at approximately 3 ft (0.9 m) on center.

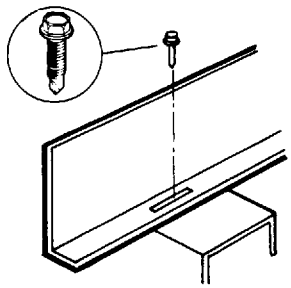


Figure 4.41
Barrier Strip Attachment, Self-Drilling and Self Tapping Screw

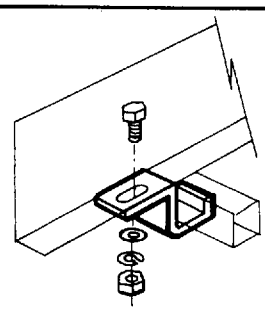


Figure 4.42
Barrier Strip Attachment, Barrier Clip

Barrier strips along a cable tray run may be connected using a barrier strip splice.

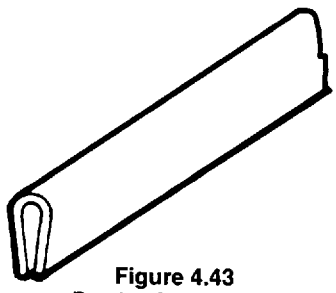


Figure 4.43
Barrier Strip Splice

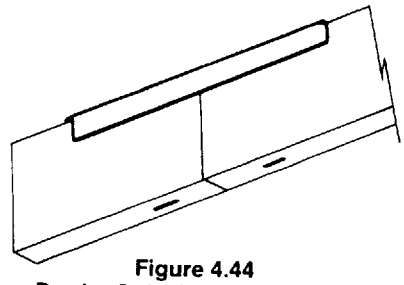


Figure 4.44
Barrier Strip Splice - Installed

4.6.2 Drop Outs (See Figures 4.45 through 4.47.)

The drop-outs and drop-out bushings provide a smooth surface to protect the cable insulation as it exits the cable tray.

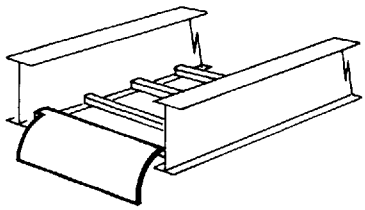


Figure 4.45
Ladder Drop-out

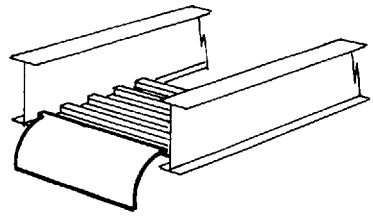


Figure 4.46
Trough Drop-out

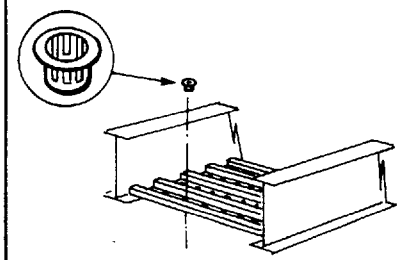


Figure 4.47
Trough Drop-out Bushing

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4.6.3 Conduit-to-Cable Tray Adaptors (See Figures 4.48 through 4.50.)

These adaptors provide for attachment of conduit that terminates at a cable tray run. If a connector is not UL listed, it only provides a mechanical connection, not an electrical connection. In order to make an electrical connection, an equipment grounding conductor must be run from the conduit to the cable tray.

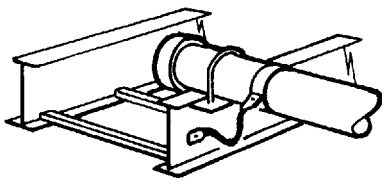


Figure 4.48
Installed Conduit to Cable Tray Adapter

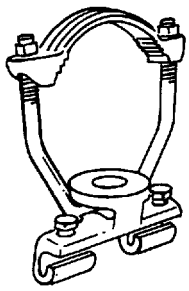


Figure 4.49
Swivel Conduit to Cable Tray Adapter

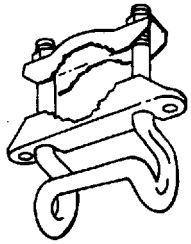


Figure 4.50
Conduit to Cable Tray Adapter

4.6.4 Covers and Clamps (See Figures 4.51 and 4.52.)

Examples of cable tray covers are provided below.

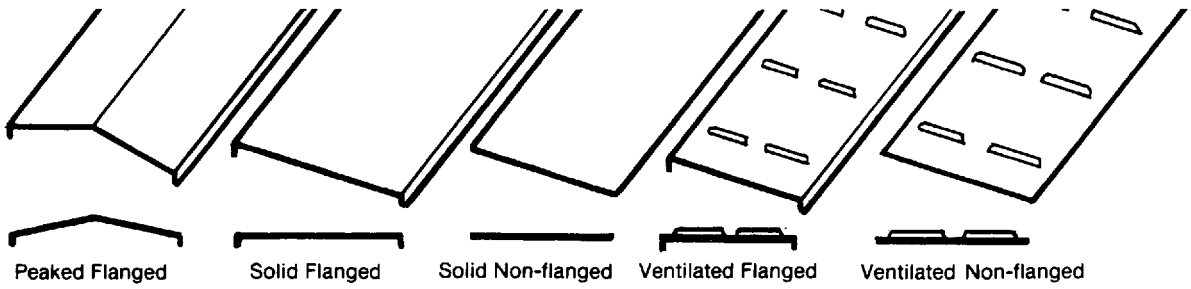
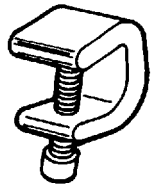
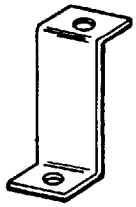


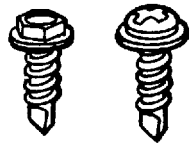
Figure 4.51
Cable Tray Covers



a. Heavy Duty Cover Clamp (recommended for indoor service)



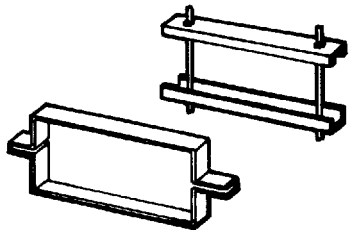
b. Combination Cover and Hold-down Clamp (indoor service only)



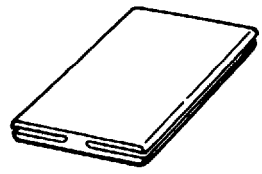
c. Self Drilling and Self Tapping Screws (indoor/ outdoor service)



d. Cover Clip (recommended) for indoor service)



e. Heavy Duty Double Cover Clamps (indoor/outdoor service)



f. Cover Joint Strip (used to join covers—optional)

Figure 4.52
Cable Tray Cover Clamps and Accessories

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The following chart provides information on the required spacing for cover clamps.

Table 4-2
Quantity of Standard Cover Clamps Required

Straight section, 6 ft (1.83 m)	4 pieces
Straight section, 12 ft (3.66 m)	6 pieces
Horizontal/vertical bends	4 pieces
Tees	6 pieces
Crosses	8 pieces

Note: When using the heavy duty cover clamp, only half the quantity of pieces are required.

4.7 Grounding

Metal cable trays must be grounded and electrically continuous systems per NEC 318-7. For specific areas requiring bonding for electrical continuity, (refer to Section 4.3).

4.7.1 Cable Tray Used as the Equipment Ground Conductor (EGC) (See Figures 4.53 through 4.56.)

Aluminum and galvanized steel cable trays are permitted to be used as an Equipment Ground Conductor per NEC Sections 318-3(c) and 318-7 when labeled and marked with the available cross sectional area. If the cable tray is to be used as an EGC, bonding jumpers must be installed on both side rails at the locations illustrated in Figures 4.53 through Figure 4.56.

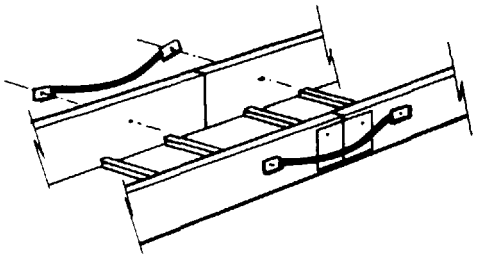


Figure 4.53
Expansion Splice Plates

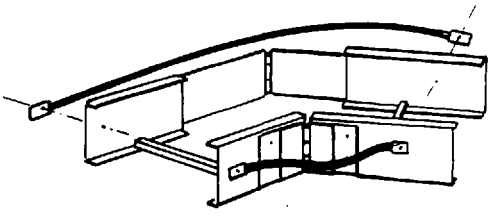


Figure 4.54
Horizontal Adjustable Splice Plates

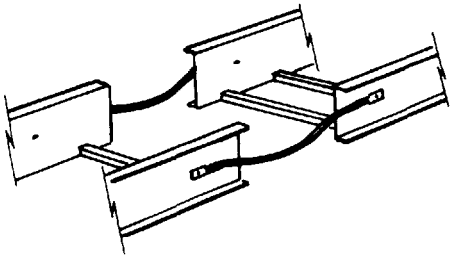


Figure 4.55
Discontinuous Tray Section

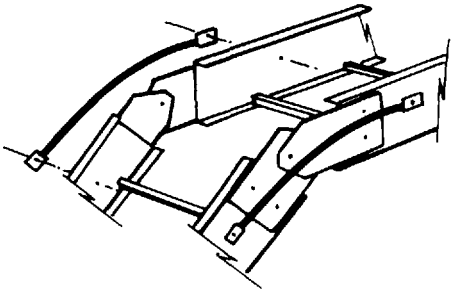


Figure 4.56
Vertical Adjustable Splice Plate

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It is not necessary to install bonding jumpers at standard rigid aluminum or galvanized steel splice plate connections or offset reducing splice plate connections.

For rigid splice plate connections of materials and finishes other than aluminum or galvanized steel, bonding jumpers may be required. For example, stainless steel splice plates require bonding jumpers.

4.7.2 Cable Trays with Separate Equipment Grounding Conductor Installed (See Figure 4.57.) When a separate EGC cable is installed in or on cable tray, it may be bonded to the cable tray with a grounding clamp. Ground clamp styles include bolted lug types that require drilling the cable tray side rail and clamp-on styles that work like a beam clamp.

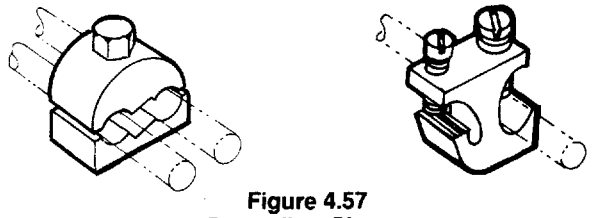


Figure 4.57
Grounding Clamps

Bare copper EGC cable should not be used in aluminum cable tray.

Bonding jumpers are not required if the separate EGC is properly bonded to all equipment.

4.7.3 Check for Properly Sized Bonding Jumpers
Bonding jumpers shall be sized according to NEC Tables 318-7(b)(2) and 250-95. Note that NEC Table 318-7(b)(2) is the actual circuit breaker trip setting and not the maximum allowable. If the maximum ampere rating of the cable tray is not sufficient for the protective device to be used, the cable tray cannot be used as an EGC and a separate EGC must be included in each cable or attached to the tray.

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Table 4.3
Metal Area Requirements for Cable Trays
Used as Equipment Grounding Conductors (NEC Table 318-7(b)(2))

Maximum Fuse Ampere Rating, Circuit Breaker Ampere Trip Setting or Circuit Breaker Protective Relay Ampere Trip Setting for Ground-Fault Protection of any Cable Circuit in the Cable Tray System.	Minimum Cross-Sectional Area of Metal* in Square Inches	
	Steel Cable Trays	Aluminum Cable Trays
60	0.20	0.20
100	0.40	0.20
200	0.70	0.20
400	1.00	0.40
600	1.50**	0.40
1000	—	0.60
1200	—	1.00
1600	—	1.50
2000	—	2.00**

For SI units: 1 square inch = 645 square millimeters.
*Total cross-sectional area of both side rails for ladder or trough cable trays: or the minimum cross-sectional area of metal in channel cable trays or cable trays of one-piece construction.
**Steel cable trays shall not be used as equipment grounding conductors for circuits with ground-fault protection above 600 amperes. Aluminum cable trays shall not be used as equipment grounding conductors for circuits with ground-fault protection above 2000 amperes.

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Table 4.4
Minimum Size Equipment Grounding Conductors
for Grounding Raceway and Equipment (NEC Table 250-95)

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit etc. Not exceeding (Amperes)	Size	
	Copper Wire No.	Aluminum or Copper-Clad Aluminum Wire No.*
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250 kcmill
1600	4/0	350 "
2000	250 kcmill	400 "
2500	350 "	600 "
3000	400 "	600 "
4000	500 "	800 "
5000	700 "	1200 "
6000	800 "	1200 "

*See installation restrictions in NEC Section 250-92(a).

4.7.4 How To Install Bonding Jumpers (See Figure 4.58.)

Types of typical jumpers (always size jumpers to meet above NEC tables) include insulated, bare, and braided or laminated.

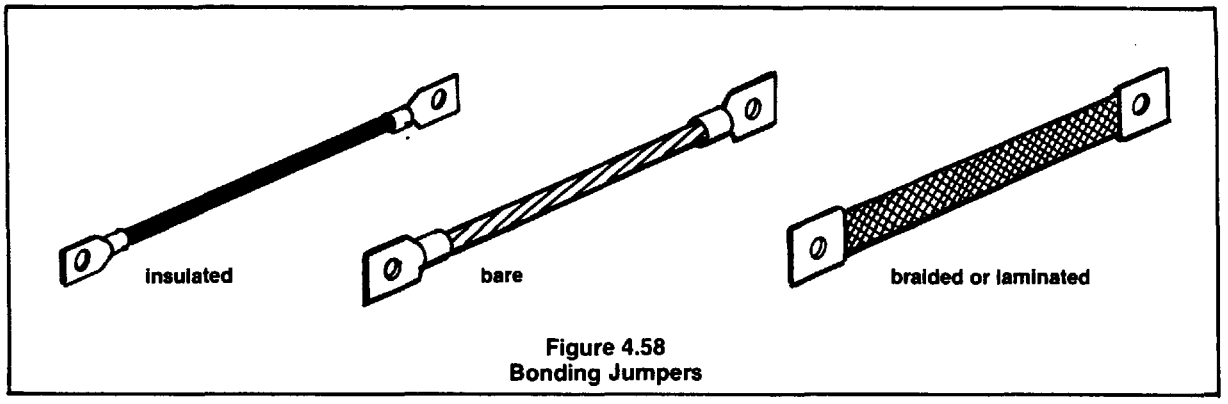


Figure 4.58
Bonding Jumpers

Drill holes in side rail 2 inches (50.8 mm) from each end of the splice plate so the jumper will span the discontinuity. Do not use splice plate bolt locations to connect jumper to cable tray.

Place screw head on inside of cable tray, put jumper on outside of cable tray, add flat washer, locknut, and tighten.

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Section 5
INSTALLATION OF CABLE

The text of this section has been provided by NEMA Wire and Cable Manufacturers. The Metal Cable Tray Section hereby acknowledges the Wire and Cable Sections' cooperation and contribution.

5.1 General

This section offers some general guidelines or rules of thumb on the installation of cable in cable tray. This information is not intended to replace the recommendations of the cable manufacturer. The manufacturer of the product is the best source for information on the product, its use, and installation practices.

5.2 Handling and Storage

To avoid personal injury or damage to the cable and reels, follow guidelines below on handling and storage of cable upon receipt at the job site.

a. Inspect all reels upon receipt for proper material and any type of damage. Be sure to note any damage on the receiving papers.

b. Do not allow the reels to drop from the delivery truck during the unloading process. When a fork lift is used, the forks must support both reel flanges. Reels can be hoisted by lifting on a metal shaft of sufficient size and strength placed through the center hole of the reel. Handling equipment must not come in contact with the cable.

c. Reels may be marked with a directional arrow such as "Roll This Way" to indicate the proper direction to roll the reel. Reels should only be rolled in the direction shown, or in the direction opposite to the direction that the cable is wrapped on the reel. Rolling reels in the wrong direction can cause the cable to loosen on the reel, which may cause problems during cable dereeling or installation. Do not allow reels to roll uncontrolled as they may roll into objects, damaging the cable or causing personal injury. When rolling reels down inclines, the incline should be as gradual as possible, and control of the reel must be maintained.

d. Use care when choosing a location for cable storage. The temperature of the storage location should be 14°F (-10°C) or higher. Select an area that is remote from construction activity, where the cable will be protected from equipment, falling objects, excessive heat, or cold, chemicals, etc., resulting in potential damage. Cable reels should be stored indoors on a dry surface or if stored outdoors, placed on suitable dunnage of sufficient size to support the reel weight without sinking or allowing the reels to come in contact with moisture. Reels stored outside should be covered with weatherproof material to protect reels and cable from sunlight and moisture. Cable ends must be kept sealed and should remain fastened to the reel flange to prevent them from laying on the ground. Reels should never be stored or stacked on their sides. Store reels on their flanges, properly chocked to prevent rolling. Be sure to allow enough room between reels to allow access to the reels for removal.

5.3 Cable Tray Preparation

Prior to installing cable in the cable tray, examine cable paths to ensure all areas are free of debris which may interfere with the cable's installation. The cable tray should never be used as a walkway.

5.4 Cable Pulling Considerations

Most cable installations require the use of cable pulling tools.

a. On horizontal straight runs, the cables generally ride on rollers mounted in or on the cable tray. These rollers should be properly spaced dependent on the size and weight of the cable to prevent the cable from sagging and dragging in the tray during the pull. Contact the cable manufacturer for information regarding proper roller spacing.

b. On horizontal bends and vertical pulls the cables are generally run through pulleys or sheaves to maintain a minimum bending radius. Pulleys and sheaves must be of sufficient diameter to prevent pinching the cable between the pulley flanges. Each cable will have a minimum bending radius that must be maintained to prevent damage to the cable. Contact the cable manufacturer for the proper minimum bending radius. Multiple pulling tools may be required at one bend to maintain this radius. Be careful with the entry and exit angle of the cable at the pulling tool, as this angle can exceed the bending radius.

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c. Due to the length of some cable pulls and the cable weight, a great deal of force can be applied to the pulleys on horizontal and vertical bends. These pulleys should be anchored to the structural steel and not to the tray due to the force that can be applied during pulling. Do not pull down on the horizontal rollers as they are not designed for this purpose and damage could result to the cable or cable tray.

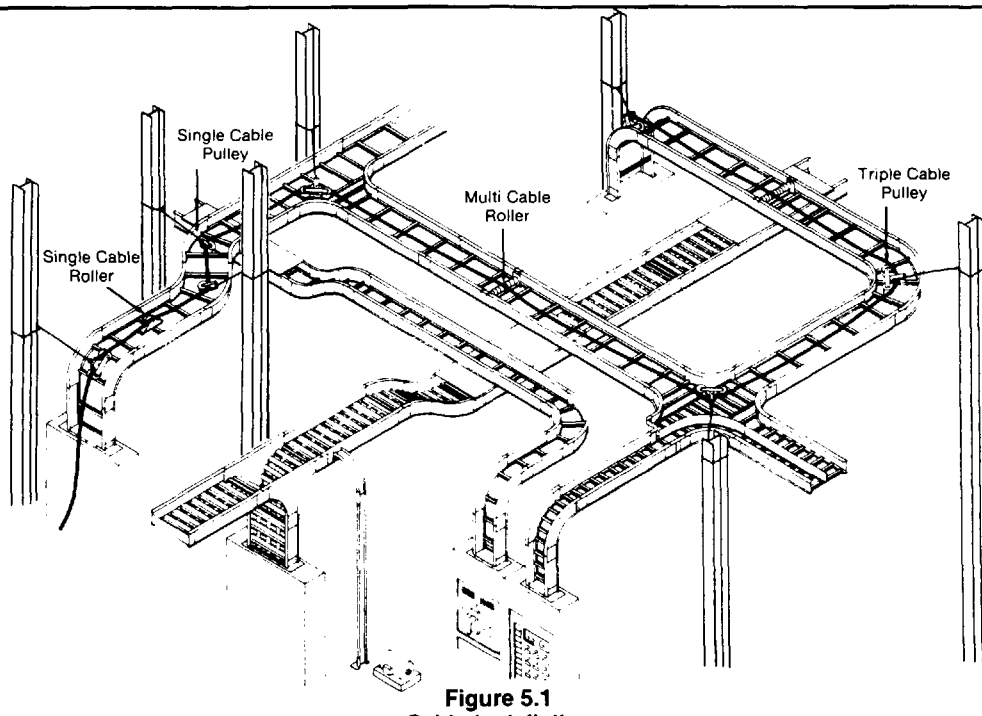


Figure 5.1
Cable Installation

5.5 Pulling the Cable

Larger cables will usually require a basket grip and/or pulling eye to be attached to the leading end of the cables metallic conductor(s). If your cable does not have a pulling eye attached by the manufacturer, contact the cable manufacturer for information on field installation of a pulling eye and/or basket grip. Where pulling attachments are used on the conductors, cover them with rubber-like or plastic tapes to prevent scoring of the trays and installation sheaves during a conductor pull. The reel will generally be placed on reel jacks with an axle of sufficient size and strength to allow the reel to turn freely with a minimum of friction. Since cables have pulling tension restrictions, a dynamometer may be installed at the pulling end and the readings recorded with every pull to assure that the cables maximum pulling tension is not exceeded. Communications should be established between the pulling end of the run and the reel end of the run. The cable should be pulled at a constant speed during the pull. Contact the cable manufacturer for maximum pulling tension and cable pulling speed. Be sure to have adequate personnel available at the reel end to aid in feeding the cable, watching to prevent cables from getting crossed and for reel braking if necessary. Be sure to pull enough cable to allow for removal of pulling eyes or basket grips, resealing of the cable ends and connections. Once the cable is installed, the cable must be removed from the pulling devices and laid in the tray. Do not allow the cables to drop in the tray as this may damage the cable and/or the tray. If cable connections will not be made immediately, the pulling eye or basket grip should be removed and all cable ends resealed to prevent moisture from entering the cable.

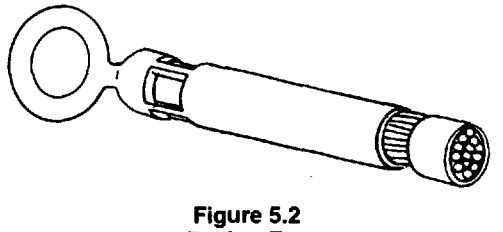


Figure 5.2
Pulling Eye

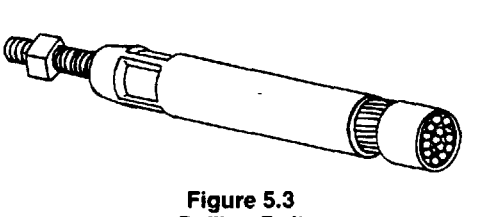


Figure 5.3
Pulling Bolt

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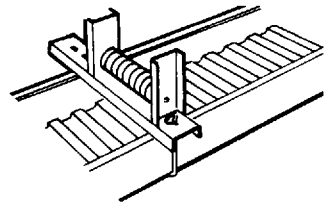


Figure 5.4
Straight Roller (Top Mounted)

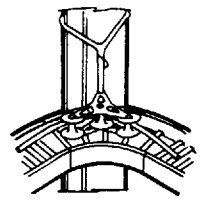


Figure 5.5
Triple Pulley Guide

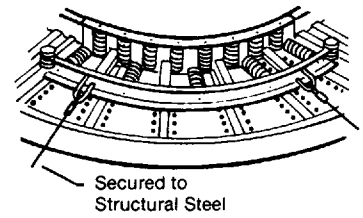


Figure 5.6
90° Roller

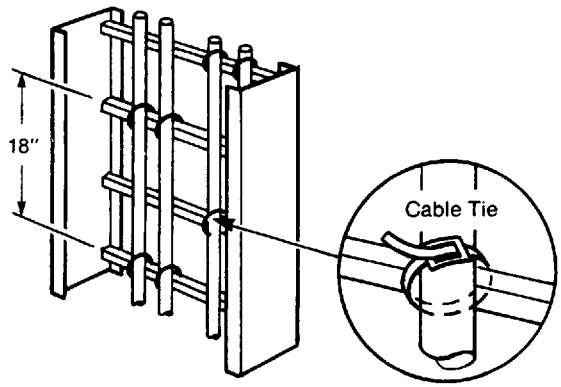


Figure 5.7
Cable Ties - Vertical Application

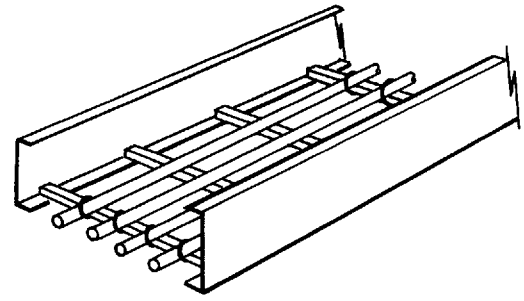


Figure 5.8
Cable Ties - Horizontal Application

5.6 Fastening the Cables

a. Cables may be fastened to the cable tray by means of cable clamps or cable ties. Generally, cables are fastened every 18 inches on vertical runs. Although not required by the NEC, single conductor cables can be fastened on horizontal runs to maintain spacing, prevent movement due to a fault current magnetic forces and insure that the cable is confined within the cable fill area. When using cable clamps, the clamps should be sized correctly and only tightened enough to secure the cable without indenting the jacket. The same precaution should be observed with cable ties and they should be applied with a pressure limiting device.

b. Extremely long vertical drops introduce a new set of problems requiring special considerations. The weight per foot of the cable multiplied by the number of feet in the vertical drop will in many cases exceed the load caring capacity of the tray component such as the one or two rungs supporting this weight and could exceed the allowable cable tension. The cable weight should be supported in such a manner to prevent damage to the cable tray or cable during this type of installation. As the cable is installed, intermediate supports should be installed on the vertical drop to break the cable load into segments supported at multiple places.

5.7 Protecting the Installed Cable

Once the cable is installed in an open tray system, care must be taken to protect the exposed cables from falling objects or debris that could cause damage to the cable. In areas where the tray is to be covered, the covers should be installed as soon as possible. Temporary protection for the cables and tray can be constructed of available wood or metal materials until the risk of damage is over.

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Section 6
MAINTENANCE

WARNING—No electrical apparatus should be worked on while it is energized. When it is necessary to work in the vicinity of energized cables, all safety precautions should be followed, such as described in NFPA 70B. If cables are to be touched or moved, they should be de-energized.

6.1 Inspection

While cable tray is virtually maintenance free under normal conditions, inspection of the cable tray is recommended as part of the facility's routine maintenance schedule for electrical equipment. Cable tray should be serviced by qualified personnel.

Visual checks should be made for loose bolted connections at joints and bonding areas. Tighten all hardware in suspect areas.

Visual checks should be made for deposits of dust, foreign objects and debris. These items should be removed to improve ventilation and reduce potential fire hazard.

Inspect cable tray after any severe weather including high winds, seismic disturbances or other abnormal occurrences.

6.2 Inactive or Dead Cables

It is considered good cable and wire management practice to remove inactive or dead cables from the cable tray wiring system. This practice opens capacity in the cable tray wiring system for future cable needs and eliminates the frustrations of electricians trying to establish the routing of an inactive cable.

6.3 Adding Cables

When additional cables are to be added to the cable tray wiring system, refer to NEC 318 for allowable fill and NEMA Standard VE 1 for allowable load.

Follow cable manufacturer's recommended procedure for pulling and installing cables. (Also see Section 5 of this publication.)

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NEMA STANDARDIZATION BACKGROUND

The purpose of NEMA standards, their classification, and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp. 5)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, pp. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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GS Metals
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Greenville, SC

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